Synapse Documentation

Release 2.141.0

The Vertex Project

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CHAPTER

ONE

INTRODUCTION

Synapse is a versatile central intelligence and analysis system created to support analyst teams in every stage of the intelligence life cycle.

The Vertex Project designed and developed Synapse to help analysts and algorithms answer complex questions which require the fusion of large data sets from disparate sources that span multiple disciplines.

Synapse's data store (known as a *Cortex*) is organized as a hypergraph. Combined with its structured and extensible *Data Model* and the powerful and intuitive *Storm* query language, Synapse gives analysts unparalleled power and flexibility to ask and answer any question, even over large and complex data sets.

1.1 Key Features

Extensible Data Model

Synapse includes an extensive (and extensible) *Data Model* capable of representing real-world objects, relationships, and events in an intuitive and realistic manner.

Strong Typing

Synapse uses *Type Normalization* and *Type Enforcement* to apply meaningful constraints to data to ensure it is well-formed, preventing "bad data" from cluttering the knowledge store. *Type Awareness* simplifies use of the Storm query language and helps analysts discover novel relationships in the data.

Powerful and Intuitive Query Language

Synapse's *Storm* query language is a powerful, intuitive "data language" used to interact with data in a Synapse Cortex. Storm frees analysts from the limitations of "canned" queries or hard-coded data navigation and allows them to ask - and answer - **any** analytical question.

Unified Analysis Platform

Synapse's unified data store provides analysts with a shared view into the same set of data and analytical annotations, allowing them to better coordinate, collaborate, and peer-review their work.

Designed and Tested in Partnership with Analysts

Synapse is the product of a unique close collaboration between Vertex developers and analysts that leverages innovative software design and engineering to directly support analyst needs and workflows.

Modular Architecture

Synapse is extensible through **Power-Ups** (see *Power-Up*) that add functionality, integrate with third-party data sources, or connect to external databases.

Record Analytical Assessments

Synapse allows analysts to annotate data with assessments and observations through a flexible and extensible set of tags (see *Tag*). By recording assessments **and** data in a structured manner, analysts and algorithms can leverage **both** in their queries and workflows.

"Git for Analysis"

Synapse supports the use of layers (see *Layer*) to comprise a *View* into Synapse's data store. Analysts can create a *Fork* of a given view and use it for testing or research without modifying the underlying production data. Once work in the fork is complete, changes can be merged into the production view or discarded.

Fine-Grained Access Controls

Synapse provides access controls and detailed permissions that can be applied to users or roles. Permissions can be specified broadly or to a level of detail that restricts a user to setting a single property on a single form.

Flexible Automation

Synapse allows you to create custom automation for both analytical and administrative tasks, ensuring consistency and eliminating tedious or time-consuming workflows. Automation (see *Storm Reference - Automation*) is provided using event-based triggers (*Trigger*), scheduled cron jobs, or stored macros.

API Access

Synapse includes multiple well-documented APIs for interacting with the data store and other Synapse components. (See *Synapse HTTP/REST API* and *Synapse Python API*.)

Lightning Fast Performance

Synapse uses LMDB for high-performance key-value indexing and storage, combined with asynchronous, streaming processing. This means queries start returning results as soon as they are available - so your "time to first node" is typically milliseconds, regardless of the size of your result set.

Horizontally and Vertically Scalable

A single Synapse Cortex can easily scale vertically to hold tens of billions of nodes. In addition, Synapse supports high-availability topologies such as mirroring.

1.2 What's Next?

Get Started!	• There are several options for you to deploy and start using Synapse! See our *Getting Started* guide to see which one is right for you. • Watch Synapse 101
Users	• *Synapse User Guide* • *Storm Reference* • Changelog • Ask a question in Slack
DevOps	• *Synapse Devops Guide* • *Synapse Deployment Guide* • Synapse sizing guide
Developers	• *Synapse Developer Guide* • *Synapse HTTP/REST API* • *Synapse Python API* • *Synapse Data Model* • *Storm Library Documentation*
Admins	• *Synapse Admin Guide*
Synapse UI (commercial)	• Synapse UI ("Optic") documentation (includes guides for users, devops, and developers)
Learn More	• Upcoming Webinars • Video Library • Visit The Vertex Project Website
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CHAPTER

TWO

GETTING STARTED

So you've looked over our *Introduction* to Synapse and want to try it out! What do you do next?

Open-source Synapse and demo versions of commercial Synapse (Synapse Enterprise) are both available for you to deploy and test. Both versions include the **same key features,** including Synapse's core architecture and functionality, our extensive data model, and the full capabilities of the Storm query language and libraries.

Open-source versions of Synapse provide a **command-line interface** (the Storm CLI) to interact with Synapse and its data. You can download *Open-Source Synapse* from our Github repository or use *Synapse Quickstart* to easily load a basic instance of Synapse.

Demo instances of Synapse Enterprise include Synapse's **web-based UI**, also known as **Optic.**

- If you want to get started with Synapse as quickly as possible, then a *Synapse Demo Instance* or *Synapse Quickstart* are right for you.
- If you're interested in deploying your own test or production environment, then take a look at *Open-Source Synapse*.

We'll explain each option in more detail below.

2.1 Synapse Quickstart

Synapse Quickstart is a Docker container that includes everything you need to start using Synapse and the Storm CLI right away. Because Synapse Quickstart is self-contained, you can easily install and launch this basic Synapse instance on Linux, Windows, or MacOS.

You can find the instructions to download and install Synapse Quickstart here.

Synapse Quickstart is best for:

- Individual users.
- Users who want to test Synapse without the need for a formal deployment.
- Users who are most interested in learning about Synapse's data and analytical models and the Storm query langauge (vs. deployment or development tasks).
- Users who want to test or use Synapse with proprietary or sensitive data that must be hosted locally.

Synapse Quickstart is **not** pre-loaded with any data.

2.2 Open-Source Synapse

The full open-source version of Synapse is available from our Github repository. Instructions for deploying a test or production environment are available in the *Synapse Deployment Guide*.

Open-source Synapse is best for:

- Users who want to work with or try out a full version of Synapse.
- Supporting multiple users and / or networked users, including the (optional) ability to configure roles and permissions.
- Developers who want to build on or integrate with Synapse.
- Users who want to test or use Synapse with proprietary or sensitive data that must be hosted locally.

Open-source Synapse is **not** pre-loaded with any data. However, some of Synapse's Power-Ups are available as open source and can help you automate adding data to Synapse:

- Synapse-MISP
- Synapse-MITRE-ATTACK
- Synapse-TOR

2.3 Synapse Demo Instance

Commercial Synapse (Synapse Enterprise) and our commercial demo instances include the web-based Synapse UI (Optic). **Demo instances** are **cloud-hosted,** so there is nothing for you configure or deploy to get started - all you need is a web browser (we recommend Chrome).

You can request a demo instance from our web site.

Note: Synapse Enterprise can be deployed either on premises or in the cloud. Only the demo instances are cloud-only.

Demo instances provide access to all of Synapse's Rapid Power-Ups, both open-source and commercial. Any Rapid Power-Up can be installed in your demo instance (although some Power-Ups may reqiure API keys and / or paid subscriptions from the associated third-party).

Demo instances are updated automatically each week with any new releases of Synapse and Optic. New or updated Rapid Power-Ups are available upon release and can be updated manually from the Power-Ups Tool.

In addition, demo instances are **pre-loaded** with sample data and tags (just under 300,000 objects). You can explore the data on your own, or use our APT1 Scavenger Hunt as a guided way to learn about the Synapse UI and Storm query language.

A **demo instance** is best for:

- Users who want to test all of Synapse's features and capabilities, including those only available with Synapse Enterprise.
- Supporting multiple users and / or networked users, including the (optional) ability to configure roles and permissions.
- Simple deployment - no hardware/software needed (other than a web browser).
- Developers who want insight into developing Power-Ups or Workflows.
- Users and developers who want access to the "latest and greatest" releases and features during testing.

- Users who want to take advantage of all of Synapse's features (including built-in Help for Synapse's data model, Storm auto-complete, etc.) while learning - even if you ultimately deploy an open-source version.

Note: Because demo instances are cloud-based, they are **not suitable** for hosting any sensitive or proprietary data.

CHAPTER

THREE

SYNAPSE USER GUIDE

This User Guide is written by and for Synapse users and is intended to provide a general overview of Synapse concepts and operations. Technical documentation appropriate for Synapse deployment and development can be found elsewhere in the Document Index.

The User Guide is a living document and will continue to be updated and expanded as appropriate. The current sections are:

3.1 Background

The following sections provide background on Synapse and a brief introduction into graphs and hypergraphs.

3.1.1 Background - Why Synapse?

Synapse is a versatile central intelligence and analysis system created to support analyst teams in every stage of the intelligence life cycle. We designed and developed Synapse to help analysts and algorithms answer complex questions which require the fusion of large data sets from disparate sources that span multiple disciplines. Analysis is based on the ability to represent data in a structured model that allows analysts to represent, annotate, and query across the collected data.

Tip: See Synapse's *Key Features* for an overview of Synapse's advantages!

Perhaps most importantly, **Synapse is based on a proven methodology informed by real-world experience.**

The Vertex Project did not develop Synapse as a mathematical abstraction or software engineering experiment. Instead, Synapse grew out of a **real-world need** to track a complex, diverse, and very large data set: namely, cyber threat data.

Synapse is the successor to the proprietary, directed graph-based analysis platform (Nucleus) used within Mandiant to produce the APT1 Report.

The developers and analysts behind Synapse (and the earlier Nucleus system) came from a variety of government and commercial backgrounds but shared a common goal: the desire to record, annotate, and track cyber threat activity (specifically, nation-state level activity) both reliably and at scale. At the time when government and industry were just beginning to grasp the scope and scale of the problem, "tracking" this complex activity was largely done using long-form reports, spreadsheets, or domain knowledge residing in an analyst's mind. There was no way to effectively store large amounts of disparate data and associated analytical findings in such a way that relationships among those data and analytical conclusions were readily apparent or easily discoverable. More importantly, critical analytical decisions such as attribution were either impossible, or being made based on loose correlation, analysts' recollection, or generally accepted "truths" - and **not** based on concrete, verifiable data whose source and analysis could be traced and either verified or questioned.

In contrast, Synapse and its predecessors were **designed from the beginning** to support the following critical elements:

- The use of a **shared analytical workspace** to give all analysts access to the same data and assessments in real time.
- The idea that the analysis captured within the system should "speak for itself": that is, to the extent possible, data and analytical findings must be represented in such a way that **relationships among data and conclusions about data should be self-evident.**

These features give Synapse the following advantages:

- Synapse allows (and requires) analysts to "show their work" in a reasonably concise manner. Analysts should not have to refer to long-form reporting (or rely on the unquestioned word of a subject matter expert) to trace a line of analytical reasoning.
- Synapse allows analysts to better review and validate their findings. Conflicting analysis is highlighted through the structure of the data itself. Analysis can readily be questioned, reviewed, deconflicted, and ultimately improved.

Synapse's predecessor was designed to store a broad range of threat data, including:

- Network infrastructure
- Malware and malware behavior
- Host- and network-based incident response data
- Detection signatures and signature hits
- Decoded network packet captures
- Targeting of organizations, individuals, and data
- Threat groups and threat actors
- People and personas
- Newsfeeds and reference materials

Synapse is the evolution of this technology, built on approximately six years of technical and analytical lessons learned combined with four years (and counting!) of development and real-world use of Synapse itself:

- Synapse's hypergraph design addresses many of the shortcomings identified with earlier directed graph and prototype hypergraph systems.
- Because our experience taught us the power of a flexible analysis platform over **any** large and disparate data set, Synapse has been designed to be flexible, modular, and adaptable to **any** knowledge domain - not just threat data.

Many of the real-world examples in this User Guide reference data from the fields of information technology or threat tracking, given Synapse's history. But Synapse's structures, processes, and queries can be applied to other knowledge domains and data sets as well. **The intent of Synapse is that any data that could be represented in a spreadsheet, database, or graph database can be represented in a Synapse hypergraph using an appropriate data model.**

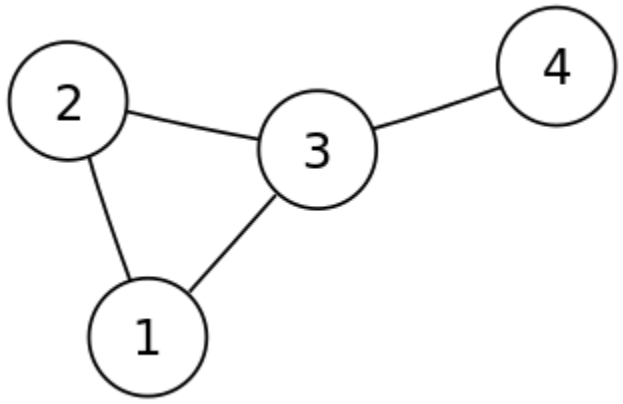
3.1.2 Background - Graphs and Hypergraphs

To understand the power of Synapse, it helps to have some additional background. Without delving into mathematical definitions, this section introduces key concepts related to a **hypergraph,** and contrasts them with those of a **graph** or a **directed graph.** Most people should be familiar with the concept of a graph – even if not in the strict mathematical sense – or with data that can be visually represented in graph form.

Graphs

A **graph** is a mathematical structure used to model pairwise relations between objects. Graphs consist of:

- **vertices** (or **nodes**) that represent objects, and
- **edges** that connect two vertices in some type of relationship.



Edges are specifically pairwise or two-dimensional: an edge connects exactly two nodes. Both nodes and edges may have properties that describe their relevant features. In this sense both nodes and edges can be thought of as representational objects within the graph: nodes typically represent things ("nouns") and edges typically represent relationships ("verbs").

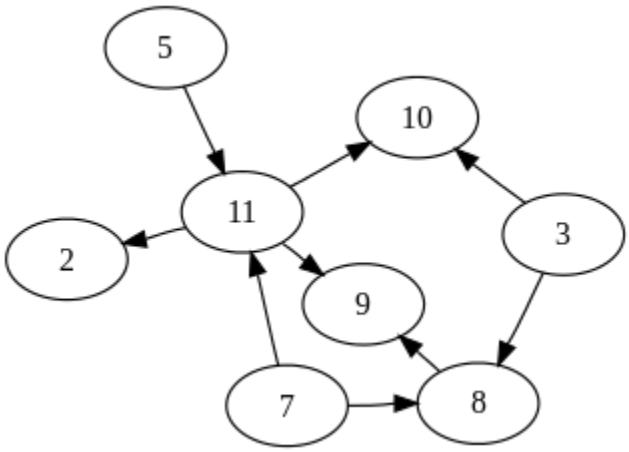
Examples

Cities and Roads. A simple example of data that can be represented by a graph are cities connected by roads. If abstracted into graph format, each city would be a vertex or node and a road connecting two cities would be an edge. Since you can travel from City A to City B or from City B to City A on the same road, the graph is **directionless** or **undirected.**

Social Networks. Another example is social networks based on "connections", such as Facebook or LinkedIn. In this case, each person would be a node and the connection between two people would be an edge. Because basic connections in these networks are mutual (you can't "friend" someone on Facebook without them agreeing to "friend" you in return), it can be considered a directionless graph. (This is a simplification, but serves our purpose as an example.)

Directed Graphs

A **directed graph** is a graph where the edges have a direction associated with them. In other words, the relationship represented by the edge is one-way. Where an edge in an undirected graph is often represented by a straight line, an edge in a directed graph is represented by an arrow.



Examples

Cities and Roads. In our cities-and-roads example, the graph would be a directed graph if the roads were all one-way streets: in this case you can use a particular road to go from City A to City B, but not from City B to City A.

Social Networks. Social networks that support a "follows" relationship (such as Twitter) can be represented as directed graphs. Each person is still a node, but the "follows" relationship is one way – I can "follow" you, but you don't have to follow me. If you choose to follow me, that would be a second, independent one-way edge in the opposite direction. (Again, this is a simplification but works for a basic illustration.)

Other Examples. Many other types of data can be represented with nodes and directed edges. For example, in information security you can represent data and relationships such as:

```
<malware_file> -- <performed DNS lookup for> --> <domain>
```

or

```
<domain> -- <has DNS A record for> --> <ip_address>
```

In these examples, files, domains and IP addresses are nodes and "performed DNS lookup" or "has DNS A record" (i.e., "resolved to") are edges (relationships). The edges are directed because a malware binary can contain programming to resolve a domain name, but a domain can't "perform a lookup" for a malware binary; the relationship (edge) is one-way.

In addition to nodes and edges, some directed graph implementations may allow labeling or tagging of nodes and edges with additional information. These tags can act as metadata for various purposes, such as to create analytically relevant groupings.

Many tools exist to visually represent various types of data in a directed graph format; Maltego (which bills itself as a "…tool that renders directed graphs for link analysis") is a well-known example.

Analysis with Graphs

Directed graphs have become increasingly popular for representing and conducting analysis across large data sets. Analysis using a directed graph can be highly generalized into three methods for interacting with the data:

- **Lifting** or retrieving data. Lifting simply asks about and returns specific nodes or edges from the graph. For example, you can ask about the node representing your Twitter account or the node representing IP address 1.2.3.4. You can also ask about sets of nodes that share some common feature – for example, all of the Twitter users who signed up for the service in January 2014, or all the PE executables whose compile date is 6/19/1992.
- **Filtering** the results. Once you lift an initial data set (a node or set of nodes), filtering allows you to refine your results by including or excluding data based on some criteria. For example, once you have the set of Twitter users who signed up in January 2014, you may decide to exclude users who list their location as the United States. Similarly, once you have the set of files compiled on 6/19/1992, you can filter those results to only include files whose size is greater than 26576 bytes.
- **Traversing** the graph structure. Once you've lifted an initial data set, you can ask about relationships between your data set and other nodes by pathing (traversing) along the edges (relationships) that connect those nodes. For example, if you retrieve the node for your Twitter account, you can identify all of the accounts you are following on Twitter by traversing all of the "follows" edges from your node to the nodes of accounts that you follow. Similarly, if you retrieve the node for IP address 1.2.3.4, you can retrieve all of the domains that resolve to that IP by pathing backwards (remember, edges are directional) along the all of the "has DNS A record for" edges that point from various domains to that IP.

Some graph implementations may include a limited form of **pivoting** across nodes with like properties. Once you've lifted an initial data set, pivoting allows you to retrieve additional nodes or edges that share some property in common with your original data. For example, you can retrieve the node representing a PE executable and then "pivot" to any other PE executables that share the same PE import hash or the same PE compile time. (Note that this description of a "pivot" is effectively just lifting a set of nodes that share a specific property value, such as an import hash.)

Analysis Limitations

Despite their utility and increased use, directed graphs have certain limitations, most notably the "two-dimensionality" inherent in the concept of an edge. The fact that an edge can only connect exactly two nodes leads to a variety of consequences, including:

- **Performance.** Even though a directed graph edge can only join two nodes, in theory there is no limit to the **total** number of edges to or from a given node. These "edge dense" or "heavy" nodes represent a potential performance limitation when attempting to conduct analysis across a large or complex directed graph. The computational resources required to traverse large numbers of edges, hold the resulting set of nodes in memory, and then perform additional operations on the results (filtering, pivoting, additional traversals, etc.) can become prohibitive.

  Example: "edge dense" nodes may include those representing extremely common objects such as IP address 127.0.0.1 or the MD5 hash representing the "empty" (zero-byte) file. Tens of thousands of domains may have been configured to resolve to 127.0.0.1 at various times. Similarly, hundreds of thousands of individual malware samples may attempt to write a zero-byte file to disk to test write permissions before infecting a host. Attempting a query that traverses the edges pointing to or from one of those nodes can return significant amounts of irrelevant data at best, or be performance-prohibitive at worst.

- **Data Representation.** Some relationships involve more than two objects, which may require some creativity to force them into a two-dimensional directed graph model. One side effect may be a multiplication of edges (because you need to show the relationship of several `foos` to a single `bar`), or the arbitrary "clustering" of data to combine what would normally be two or more nodes into a single node simply so the cluster can be associated with another node via a single edge.

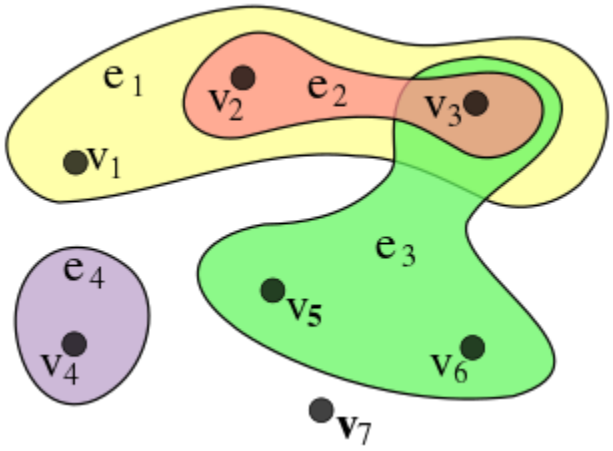
Example: "genetic parentage" is a multi-dimensional relationship. In modeling genealogy research, you need to represent two parents and a child. In a directed graph, you can do this by representing "parentage" as a directed relationship between a single parent (`n1`) and the child (`n2`). If each individual parent is a single node, you require three nodes and two edges to represent the complete relationship among two parents and the child.

Alternately, you could conflate the two parent nodes into as single node (`n1`) that consisted of the combination of the two individuals, with an edge between this "pair" (`n1`) and the child (`n2`). Here you use only two nodes and a single edge, but have created a semi-artificial "cluster" node to do so; and you will need to create a unique "cluster" node for every set of two parents that have a child. In addition, there may be cases where you want to treat one of the parents as an individual person (node) for other purposes (for example, to note the person's date of birth and date of death as properties on that person's node). Now the same person may be represented in multiple places in the directed graph, both as an individual node and as one part of multiple "parent clusters".

The issue may seem only moderately challenging for genealogy but consider a broader field like plant biology. In an attempt to create a more drought-tolerant or disease-resistant rose bush, botanists may combine genetic material from multiple "parents" to produce a hybrid offspring.

Hypergraphs

A **hypergraph** is a generalization of a graph in which an edge can join any number of nodes. Because an edge is no longer limited to joining exactly two nodes, edges in a hypergraph are often called **hyperedges.** If a directed graph where edges join exactly two nodes is two-dimensional, then a hypergraph where a hyperedge can join any number (n-number) of nodes is **n-dimensional.**



Looked at another way, they key features of a hypergraph are:

- **Everything is a node.** Objects ("nouns") are still nodes in a hypergraph, similar to a directed graph. However, relationships ("verbs", commonly represented as edges in a directed graph) are now also represented as nodes. Where an edge in a directed graph consists of three objects (two nodes and the edge connecting them), in a hypergraph the same data is represented as a single multi-dimensional node.
- **Hyperedges connect arbitrary sets of nodes.** An edge in a directed graph connects exactly two nodes (represented as an arrow connecting two points). A hyperedge can connect an arbitrary number of nodes; this makes hypergraphs more challenging to visualize in a "flat" form. As in the image above, hyperedges are commonly represented as a set of disconnected nodes encircled by a boundary; the boundary represents the hyperedge "joining" the nodes into a related group. Just as there is no limit to the number of edges to or from a node in a directed graph, a node in a hypergraph can be joined by any number of hyperedges (i.e., be part of any number of "groups").

In Synapse, hyperedges are represented by **tags,** which can be thought of as labels applied to nodes.

Analysis with a Synapse Hypergraph

Synapse is a specific implementation of a hypergraph model. Within Synapse, an individual hypergraph is called a **Cortex.** A Cortex is a scalable hypergraph implementation which also includes key/value-based node properties and a data model which facilitates normalization.

Analysis of data using a Cortex leverages some of the same methods as a directed graph: **lifting** nodes and **filtering** results are still part of the process. However, in the absence of pairwise edges there is no traversal. Instead, all navigation is based on a **pivot.** (Technically, selecting a set of nodes from a Cortex based on a tag could be considered "navigating" along a hyperedge. But mostly everything is a pivot.)

Synapse optimizes this ability to pivot across properties through two key design features: **type safety** and **property normalization.**

- **Type safety** ensures that all node properties have an explicitly declared *Type* and these types are enforced across the data model. For example, where a property value is an IP address, that IP address is declared and stored as an integer for consistency - as opposed to being stored as an integer in some instances and a dotted-decimal string in others. (Technically an IPv4 address is stored as an IPV4 (`inet:ipv4`) type, which can be thought of as an integer with additional constraints on things like allowable values.)
- **Property normalization** ensures that properties are represented in a consistent manner for both storage and display purposes, regardless of the format in which they are received. Synapse takes a "do what I mean" approach to input where possible, attempting to recognize common formats and normalize them on the user's behalf. This allows users to work with data in a way that should feel natural.

  For example, a user can enter an IP address as an integer, a hex value, or a dotted decimal string; Synapse will automatically store the IP as an integer and represent it back to the user as a dotted-decimal string. Similarly, a user can enter a directory path using either Windows format (`C:\foo\bar\baz.exe`) or Linux format (`/home/user/foo/bar`) and using any combination of upper and lowercase letters; Synapse will automatically enforce normalization such as the use of forward slashes for directory separators and the use of all lower-case letters for drive, path, and file names.

These features make pivoting highly effective because they ensure that data of the same type and / or with the same value is represented consistently throughout the Cortex.

In contrast, **lack** of consistency can cause analysts to miss relevant correlations - either because the same data is represented in multiple forms, or because the burden is placed on the analyst to properly normalize their input when entering data or querying the system. It is significantly harder to identify correlations when the same data is represented or referenced in multiple ways throughout a system.

Synapse's optimized use of pivots, combined with the ability to represent relationships (including complex "multi-dimensional" relationships) as nodes, provides some significant advantages over a directed graph.

Performance

"Asking questions" of a hypergraph may be less computationally intensive than in a directed graph. As a simple example, let's say you want to know all of the IP addresses that a domain has resolved to.

Directed Graph

In a directed graph, "resolves to" ("has a DNS A record for") is a relationship (edge). To answer the question of which IP addresses a domain has resolved to, you need to:

- lift the node for the domain; and
- traverse an arbitrary number of "resolves to" edges to reach the set of nodes represented by the endpoints of all those edges (i.e., the IP addresses).

For a handful of edges (a small number of IPs) this traversal is not very difficult; but if the domain has resolved to hundreds or thousands of IP addresses, traversing all of those edges becomes more computationally intensive.

Looked at another way (and depending on the specific implementation of the directed graph), an edge traversal in a directed graph may be the computational equivalent of two pivots:

Assume a generic representation of an edge as a tuple comprised of two nodes and the specific edge relationship (`{n1, edge,n2}`). In our example, a "resolves to" edge would be represented by a domain (`n1`), the relationship "resolves to" (the edge tuple), and the IP address (`n2`). In this case, traversing the "resolves to" edges is really two pivots:

- lift the node (`n1`) for the domain;
- pivot from that node to all of the "resolves to" edges where the domain is the `n1` of the "resolves to" tuple;
- pivot from the `n2` (IP address) of each "resolves to" tuple to the node representing that `n2`.

Synapse Hypergraph (Cortex)

In a Cortex, a single node represents the "resolves to" ("has DNS A record for") relationship, with the domain and IP address involved in the relationship both stored as properties on that node. To determine the IP addresses a domain has resolved to, you simply need to:

- lift the "DNS A record" nodes where the domain is a property;
- pivot from the IP address property of those nodes to the nodes representing the IP addresses themselves.

Alternately, you could simply view the IP addresses as properties on the lifted "DNS A record" nodes themselves without performing the pivot at all.

No Loss of Granularity

The pairwise nature of edges in a directed graph may result in a loss of granularity for complex relationships that realistically involve three or more elements. In order to "fit" those relationships into a directed graph model, one option is to arbitrarily combine some of those elements into a single node in order to force the relationship to be pairwise. This results in some loss of detail as elements that should rightly be treated as independent components are artificially conflated. Synapse's ability to represent multidimensional relationships as a single node removes this limitation.

Discovery

"Asking questions of" or exploring a directed graph has some inherent limitations. First, since relationships are represented by edges, an analyst is limited to asking about (traversing) known relationships (that is, edges that are already defined in the model). This may limit the discovery of new or unexpected patterns or correlations.

Similarly, while directed graphs may support some navigation via pivots, analysts are often limited to pivoting via the same property and value on the same node type. For example, I can ask about all PE file nodes that have the same PE import hash value as a given PE file node because I am asking about the same value for the same property across the same node type. In a directed graph it is harder to ask about a value that may be present in different properties on different node types. Synapse's use of type enforcement and property normalization removes this restriction.

For example, let's say you have a malicious domain and you determine the set of IP addresses that the domain has resolved to. You want to know if any of those IP addresses have also been used to send spear phishing email messages. Speaking generically, there is no readily apparent relationship between an IP address as the resolution of a domain, and an IP address as the source of an email message, other than the fact that they are both IP addresses. This lack of an apparent relationship (edge) implies that you can't get your answer using a few simple traversals.

How you answer this question will vary depending on the specific implementation of the directed graph. However, if you assume an implementation with the following defined edges:

```
<domain> -- <has DNS A record> --> <IP address>
```

and

```
<IP address> -- <was source IP for> --> <RFC822 file>
```

Then you may be able to obtain an answer through a multi-part query similar to the following:

1. Start from (lift) the domain.
2. Traverse the set of "has DNS A record" edges from the domain to obtain the set of IP addresses the domain has resolved to.
3. From those IP addresses, traverse any "was source IP for" edges to the set of RFC822 messages (if any) associated with the IPs.
4. From the RFC822 messages, traverse **back** along the "was source IP for" edges to get the subset of IP addresses that were used to send email messages.

If the above sounds messy and a bit redundant, to an extent it is. There may be slightly more "elegant" solutions given alternate directed graph implementations (for example, if the source IP of an email message was stored as a property on the email message node as opposed to being associated with the message via an edge). But it still requires some creative navigation amongst nodes, edges, and properties to find the answer.

In a Synapse hypergraph, the IP addresses can appear as properties on both the set of "domain has DNS A record" nodes (as the "resolved to" property, for example) and the set of "spear phishing email nodes" (as the "source IP" property, for example). You can simply pivot between the two node types based on the value of those properties to find your answer. Not only is the navigation itself significantly easier, but you are able to readily ask questions across disparate or arbitrary data types (DNS records and email messages), as long as they share a particular typed value in common – even if that value represents a different property in each case.

Conclusions

Though hypergraphs may be less familiar than traditional graphs, they offer distinct performance and analytical advantages over directed graph models, addressing historical shortcomings in representation, navigation, and analytical capability. Synapse, as a specific implementation of a hypergraph model, incorporates additional design features (type safety, property normalization, and a robust query language, in addition to storage and indexing optimization for performance) that further enhance its power and flexibility as an analysis tool.

3.2 Data Model

Synapse includes a number of built in types and forms which are available for use out of the box. Some of these built in concepts are discussed in the following sections.

See the *Synapse Data Model* technical reference for descriptions of individual types and forms, as well as the data model deprecation policy.

3.2.1 Data Model - Terminology

Note: This section describes the Synapse data model from a conceptual user perspective. See the *Synapse Data Model* technical documentation for information that may be more useful for developers.

Synapse is a distributed key-value hypergraph analysis framework. That is, Synapse is a particular implementation of a *Hypergraph* model; an instance of a Synapse hypergraph is called a Cortex. In our brief discussion of graphs and hypergraphs, we pointed out some fundamental concepts related to Synapse's implementation:

- **(Almost) everything is a node.** Most of Synapse's data model consists of nodes; there are a limited number of pairwise ("two-dimensional") edges in Synapse. We use "lightweight" (light) edges to support specific use cases, but mostly everything is a node.
- **Tags act as hyperedges.** In a directed graph, an edge connects exactly two nodes. In Synapse, tags are labels that can be applied to an arbitrary number of nodes. These tags effectively act as an n-dimensional edge (a hyperedge) that connects or groups any number of nodes.
- **(Almost) every key navigation of the graph is a pivot.** Because Synapse's data model primarily consists of nodes, you generally don't explore Synapse's data by traversing edges. Instead, you **pivot** from the properties of one set of nodes to the properties of another set of nodes (though you also traverse the occasional light edge).

To build on those concepts, you need to understand the basic elements of the Synapse data model. The fundamental terms and objects you should be familiar with are:

- *Type*
- *Form*
- *Node*
- *Property*
- *Tag*
- *Lightweight (Light) Edge*

Tip: Synapse uses a query language called **Storm** (see *Storm Reference - Introduction*) to interact with data and tags. Storm allows a user to lift, filter, pivot, traverse, and modify data based on node properties, values, tags, and light edges. Understanding these model elements will improve your ability to use Storm and interact with Synapse data.

Type

A **type** is the definition of a data element within the Synapse data model. A type describes what the element is and enforces how it should look, including how it should be normalized, if necessary, for both storage (including indexing) and representation (display).

The Synapse data model includes standard types such as integers and strings, as well as types defined within Synapse such as globally unique identifiers (`guid`), date/time values (`time`), time intervals (`ival`), and tags (`syn:tag`).

Knowledge domain-specific objects may also be specialized types. For example, an IPv4 address (`inet:ipv4`) is its own type. An IPv4 address is stored as an integer, but the type has additional constraints (i.e., to ensure that IPv4s created in Synapse only use integer values that fall within the allowable IPv4 address space). These constraints may be defined by a **constructor** (`ctor`) that specifies how a property of that type can be created (constructed).

For the most part, users do not interact with types directly. Types are primarily used "behind the scenes" to define and support the Synapse data model. From a user perspective:

- **Strong typing** means every element in Synapse has a type. **Forms** define the objects that can be represented in Synapse. Forms have **properties** (primary and secondary) and every property is defined as a particular type.
- **Type enforcement** helps prevent "bad data" from getting into Synapse. Synapse has "rules" for how properties of a given type can be created. This prevents simple errors like entering an email address value where you need an FQDN, but also ensures (to the extent possible) that values "make sense" for their type (e.g., that a URL looks reasonably like a URL).
- **Type awareness** makes it easier to navigate data within Synapse. Synapse and Storm are "model aware" and know which types are used for each property in the model. This simplifies exploring or pivoting across data because Synapse and Storm **automatically** recognize relationships where different forms share properties with

the same type and same value. This makes navigation easier in general, but also allows Synapse to show you relationships you may not know exist.

Type-Specific Behavior

Synapse includes various type-specific optimizations to improve performance and functionality. Some of these are "back end" optimizations (i.e., for indexing and storage) while some are more "front end" in terms of how users can interact with data of certain types via Storm. See *Storm Reference - Type-Specific Storm Behavior* for additional detail.

Viewing or Working with Types

Types are defined within the Synapse source code. An auto-generated dictionary of Types (*Base Types* and *Types*) can be found in the online documentation.

Types can also be viewed within Synapse. A full list of current types can be displayed with the following Storm command:

```
storm> syn:type
```

You can view detail about a specific type as follows:

```
storm> syn:type=inet:fqdn
syn:type=inet:fqdn
        :ctor = synapse.models.inet.Fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
```

See *Storm Reference - Model Introspection* for additional detail on working with model elements within Storm.

Form

A **form** is the definition of an object in the Synapse data model. A form acts as a "template" that tells you how to create a particular object (*Node*). While the concepts of form and node are closely related, it is useful to maintain the distinction between the **template** for creating an object (a form) and an instance of a **particular** object (a node). `inet:fqdn` is a form; `inet:fqdn = woot.com` is a node.

A form consists of the following:

- A **primary property.** The primary property must be unique across all possible instances of that form. In addition, the primary property must have a specific **type.** In many cases, a form will be its own type - for example, the `inet:fqdn` form has a type of `inet:fqdn`. While all forms are types (that is, must be defined as a type), not all types have associated forms.
- Optional **secondary properties.** Secondary properties must also have a type. Properties may have additional constraints, such as:
  - Whether the property is read-only once set.
  - Any normalization (outside of type-specific normalization) that should occur for the property (such as converting a string to all lowercase, stripping any whitespace, etc.).

Secondary properties are form-specific and are explicitly defined for each form. Synapse also supports a set of universal secondary properties (**universal properties**) that are valid for all forms.

Property discusses these concepts in greater detail.

Forms comprise the essential "structure" of the data that analysts work with. Understanding the forms Synapse uses to represent various objects or concepts is key to working with Synapse data.

Form Namespace

The Synapse data model uses a structured namespace for forms. Each form name consists of at least two namespace elements separated by a colon (`:`). For example:

- `file:bytes`
- `inet:email`
- `inet:fqdn`
- `ou:org`

The first element in the namespace represents a rough "category" for the form (i.e., `inet` for Internet-related objects). The Synapse data model is meant to be extensible. The ability to group portions of the data model into related categories makes a large model easier to manage, and also allows Synapse users to focus on those portions of the model most relevant to them.

The second and / or subsequent elements in the form name define the specific "subcategory" or "thing" within the form's primary category (e.g., `inet:fqdn` represents a fully qualified domain name (FQDN) within the "Internet" (`inet`) category, and `inet:dns:query` represents a query using the DNS protocol within the "Internet" category).

Properties have a namespace that extends the form namespace (form names are also primary properties). See *Property* and *Property Namespace* below for additional detail.

Viewing or Working with Forms

Like types, forms are defined within the Synapse source code. An auto-generated dictionary of *Forms* can be found in the online documentation.

Forms can also be viewed within Synapse. A full list of current forms can be displayed with the following Storm command:

```
storm> syn:form
```

You can view detail about a specific form as follows (form only):

```
storm> syn:form=inet:fqdn
syn:form=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :runt = false
        :type = inet:fqdn
```

Or a form with its secondary properties:

```
storm> syn:prop:form=inet:fqdn
syn:prop=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :extmodel = false
        :form = inet:fqdn
        :type = inet:fqdn
        :univ = false
syn:prop=inet:fqdn.seen
        :base = .seen
        :doc = The time interval for first/last observation of the node.
        :extmodel = false
        :form = inet:fqdn
```

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```
        :relname = .seen
        :ro = false
        :type = ival
        :univ = false
syn:prop=inet:fqdn.created
        :base = .created
        :doc = The time the node was created in the cortex.
        :extmodel = false
        :form = inet:fqdn
        :relname = .created
        :ro = true
        :type = time
        :univ = false
syn:prop=inet:fqdn:domain
        :base = domain
        :doc = The parent domain for the FQDN.
        :extmodel = false
        :form = inet:fqdn
        :relname = domain
        :ro = true
        :type = inet:fqdn
        :univ = false
syn:prop=inet:fqdn:host
        :base = host
        :doc = The host part of the FQDN.
        :extmodel = false
        :form = inet:fqdn
        :relname = host
        :ro = true
        :type = str
        :univ = false
syn:prop=inet:fqdn:issuffix
        :base = issuffix
        :doc = True if the FQDN is considered a suffix.
        :extmodel = false
        :form = inet:fqdn
        :relname = issuffix
        :ro = false
        :type = bool
        :univ = false
syn:prop=inet:fqdn:iszone
        :base = iszone
        :doc = True if the FQDN is considered a zone.
        :extmodel = false
        :form = inet:fqdn
        :relname = iszone
        :ro = false
        :type = bool
        :univ = false
syn:prop=inet:fqdn:zone
        :base = zone
        :doc = The zone level parent for this FQDN.
```

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```
        :extmodel = false
        :form = inet:fqdn
        :relname = zone
        :ro = false
        :type = inet:fqdn
        :univ = false
```

See *Storm Reference - Model Introspection* for additional detail on working with model elements within Storm.

Node

A **node** is a unique object within Synapse. Nodes represent standard objects ("nouns") such as IP addresses, files, people, conferences, or airplanes. They can also represent more abstract objects such as industries, risks, attacks, or goals. However, in Synapse nodes can also represent relationships ("verbs") because many things that would be edges in a directed graph are nodes in a Synapse hypergraph. You can think of a node generically as a "thing" - most "things" you want to model within Synapse are nodes.

Every node consists of the following:

- A **primary property**, represented by the *Form* of the node plus its value (`<form> = <valu>`). All primary properties must be unique for a given form. For example, the primary property of the node for the FQDN `woot.com` is `inet:fqdn = woot.com`. The uniqueness of the `<form> = <valu>` pair ensures there can be only one node in Synapse that represents the domain `woot.com`. Because this unique pair "defines" the node, the comma-separated form / value combination (`<form>,<valu>`) is also known as the node's *Ndef* (short for "node definition").
- One or more **universal properties.** As the name implies, universal properties are applicable to all nodes.
- Optional **secondary properties.** Similar to primary properties, secondary properties consist of a property name (of a specific type) and the property's associated value for the node (`<prop> = <pval>`). Secondary properties are specific to a given kind of node and provide additional detail about that particular node.
- Optional **tags**. A *Tag* acts as a label with a particular meaning that can be applied to a node to provide context. Tags are discussed in greater detail below.

Viewing or Working with Nodes

To view or work with nodes, your instance of Synapse must contain nodes (data). Users interact with data in Synapse using the Storm query language (*Storm Reference - Introduction*).

Node Example

The Storm query below lifts and displays the node for the domain `www.google.com`:

```
storm> inet:fqdn=www.google.com
inet:fqdn=www.google.com
        :domain = google.com
        :host = www
        :issuffix = false
        :iszone = false
        :zone = google.com
```

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```
        .created = 2023/07/12 15:15:57.140
        #rep.moz.500
```

In the output above:

- `inet:fqdn = www.google.com` is the **primary property** (`<form> = <valu>`).
- `.created` is a **universal property** showing when the node was added to the Cortex.
- `:domain`, `:host`, etc. are form-specific **secondary properties** with their associated values (`<prop> = <pval>`). For readability, secondary properties are displayed as **relative properties** within the namespace of the form's primary property (e.g., `:iszone` as opposed to `inet:fqdn:iszone`).
- `#rep.moz.500` is a **tag** indicating that `www.google.com` has been reported by web analytics company Moz as one of their top 500 most popular websites.

Property

Properties are the individual elements that define a *Form* or (with their specific values) that comprise a *Node*.

Primary Property

Every *Form* consists of (at minimum) a **primary property** that is defined as a specific *Type*. Every *Node* consists of (at minimum) a primary property (its form) plus the node-specific value of the primary property (`<form> = <valu>`). When defining a form to represent a particular "thing", the primary property must be defined so that its value is unique across all possible instances of that "thing".

The concept of a unique primary property is straightforward for forms that represent simple objects. For example, the "thing" that makes an IP address unique is the IP address itself: `inet:ipv4 = 1.2.3.4`. Defining a primary property for more complex nodes (such as those representing a *Relationship* or an *Event*) can be more challenging; these forms are often *GUID* forms.

Because a primary property uniquely defines a node, **it cannot be modified once the node is created.** To "change" a node's primary property you must delete and re-create the node.

Secondary Property

A *Form* can include optional **secondary properties** that provide additional detail about the form. Each secondary property must be defined as an explicit *Type*. A *Node* may include secondary properties with their associated values (`<prop> = <pval>`).

Secondary properties may further describe a given form and its associated nodes. For example, the Autonomous System (AS) that an IP address belongs to (`inet:ipv4:asn`) does not "define" the IP (and in fact an IP's associated AS can change), but it provides further detail about the IP address.

Many secondary properties are derived from a node's primary property (**derived properties**) and are automatically set when the node is created. For example, creating the node `file:path='c:\windows\system32\cmd.exe'` will automatically set the properties `:base = cmd.exe`, `:base:ext = exe`, and `:dir = c:/windows/system32`. Because a node's primary property cannot be changed once set, any secondary properties derived from the primary property **also** cannot be changed (i.e., are read-only). Non-derived secondary properties can be set, modified, or deleted.

Universal Property

Most secondary properties are form-specific and provide additional detail about particular objects within the data model. However, Synapse defines a subset of secondary properties as **universal properties** that are applicable to all forms. Universal properties include:

- `.created`, which is set for all nodes and whose value is the date / time that the node was created within that instance of Synapse.
- `.seen`, which is optional for all nodes and whose value is a time interval (minimum or "first seen" and maximum or "last seen") during which the node was observed, existed, or was valid.

Property Namespace

Properties extend the *Form Namespace*. Forms (form names) are **primary properties**, and consist of at least two elements separated by a colon (`:`). **Secondary properties** exist within the namespace of their primary property (form). Secondary properties are preceded by a colon (`:`) and use the colon to separate additional namespace elements, if needed. (Universal properties are preceded by a period (`.`) to distinguish them from form-specific secondary properties.) For example, the secondary (both universal and form-specific) properties of `inet:fqdn` include:

- `inet:fqdn.created` (universal property)
- `inet:fqdn:zone` (secondary property)

Secondary properties also make up a relative namespace (set of **relative properties**) with respect to their primary property (form). The Storm query language allows (or in some cases, requires) you to reference a secondary property using its relative property name (i.e., `:zone` vs. `inet:fqdn:zone`).

Relative properties are also used for display purposes within Synapse for visual clarity (see the *Node Example* above).

Secondary properties may have their own "namespace". Both primary and secondary properties use colons to separate elements of the property name. However, not all separators represent property "boundaries"; some act more as "sub-namespace" separators. For example `file:bytes` is a primary property / form. A `file:bytes` form may include secondary properties such as `:mime:pe:imphash` and `:mime:pe:complied`. In this case `:mime` and `:mime:pe` are not secondary properties, but sub-namespaces for individual MIME data types and the "PE executable" data type specifically.

Viewing or Working with Properties

Properties are used to describe forms and are defined within the Synapse source code with their respective *Forms*. Universal properties are not defined "per-form" but have their own section (*Universal Properties*) in the online technical documentation.

Properties can also be viewed within Synapse. A full list of current properties can be displayed with the following Storm command:

```
storm> syn:prop
```

You can view individual primary or secondary properties as follows:

Primary property:

```
storm> syn:prop=inet:fqdn
syn:prop=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :extmodel = false
        :form = inet:fqdn
```

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```
        :type = inet:fqdn
        :univ = false
```

Secondary property:

```
storm> syn:prop=inet:fqdn:domain
syn:prop=inet:fqdn:domain
        :base = domain
        :doc = The parent domain for the FQDN.
        :extmodel = false
        :form = inet:fqdn
        :relname = domain
        :ro = true
        :type = inet:fqdn
        :univ = false
```

See *Storm Reference - Model Introspection* for additional detail on working with model elements within Storm.

Tag

Tags are annotations applied to nodes. They can be thought of as labels that provide context to the data represented by the node.

Broadly speaking, within Synapse:

- Nodes represent **things:** objects, relationships, or events. In other words, nodes typically represent observables that are verifiable and largely unchanging.
- Tags typically represent **assessments:** observations that could change if the data or the analysis of the data changes.

For example:

- An Internet domain is an "observable thing" - a domain exists, was registered through a domain registrar, and can be created as a node such as `inet:fqdn = woot.com`.
- Whether a domain has been sinkholed is an assessment. A researcher may need to evaluate data related to that domain (such as domain registration records or current and past IP resolutions) to decide whether the domain appears to be sinkholed. This assessment can be represented by applying a tag such as `#cno.infra.dns.sinkholed` to the `inet:fqdn = woot.com` node.

Tags are unique within the Synapse model because tags are both **nodes** and **labels applied to nodes.** The tag `#cno.infra.dns.sink.holed` can be applied to another node; but the tag itself also exists as the node `syn:tag = cno.infra.dns.sink.holed`. This difference is illustrated in the example below.

Tip: Synapse does not have any pre-defined tags. Users are free to create tags that are meaningful for their analysis. See *Analytical Model - Tag Concepts* for more detail.

Viewing or Working with Tags

As tags are nodes (data) within the Synapse, they can be viewed and operated upon just like other nodes. Users typically interact with data using the Storm query language (*Storm Reference - Introduction*).

Tag Example

The Storm query below displays the **node** for the tag `cno.infra.dns.sink.holed`:

```
storm> syn:tag=cno.infra.dns.sink.holed
syn:tag=cno.infra.dns.sink.holed
        :base = holed
        :depth = 4
        :doc = A domain (zone) that has been sinkholed.
        :title = Sinkholed domain
        :up = cno.infra.dns.sink
        .created = 2023/07/12 15:15:57.327
```

The Storm query below displays the **tag** `#cno.infra.dns.sink.holed` applied to the **node** `inet:fqdn = hugesoft.org`:

```
storm> inet:fqdn=hugesoft.org
inet:fqdn=hugesoft.org
        :domain = org
        :host = hugesoft
        :issuffix = false
        :iszone = true
        :zone = hugesoft.org
        .created = 2023/07/12 15:15:57.350
        #cno.infra.dns.sink.holed
```

Note that a tag **applied to a node** uses the "hashtag" symbol (`#`). This is a visual cue to distinguish tags on a node from the node's secondary properties. The symbol is also used within the Storm syntax to reference a tag as opposed to a `syn:tag` node.

Lightweight (Light) Edge

Lightweight (light) edges are used in Synapse to provide greater flexibility and improved performance when representing certain types of relationships. A light edge is similar to an edge in a traditional directed graph; each light edge links exactly two nodes (`n1` and `n2`), and consists of:

- A **direction.** Light edge relationships only "make sense" in one direction, given the forms that they link. For example, an article can reference an indicator such as an MD5 hash, but an MD5 hash does not "reference" an article.
- A **"verb"** that represents the relationship (e.g., `refs` for "references" in the example above).

Light edges do not have properties, and you cannot apply tags to light edges - hence the "light" in light edge.

Light edges are used for performance and flexibility in certain use cases, such as:

- The **only** information you need to record about a relationship is that it exists (that is, no properties are required to further "describe" the relationship). An example is `meta:ruleset -(contains)> meta:rule`.

- The objects (nodes) involved in the relationship may vary. That is, either the `n1` or `n2` node (or both) may be **any** kind of node, depending on the context of the relationship. Examples include `meta:source -(seen)> *` (where a data source may "see", observe, or provide data on any `n2` object) and `* -(refs)> *` (where a variety of `n1` nodes may "reference" or contain a reference to any `n2` node).

Synapse's data model does not include any pre-defined light edges. In addition, Synapse does not enforce or restrict the objects (nodes) that can be linked with light edges. Users are free to create / define their own light edges and use them as they see fit.

Tip: Light edges should not be used as a convenience to short-circuit proper data modeling using forms. Using forms and nodes (combined with Synapse's strong typing, type enforcement, and type awareness) are key to the powerful analysis and performance capabilities of a Synapse hypergraph.

Viewing or Working with Light Edges

Light edges are not "objects" in Synapse in the same way as forms, types, or properties. (In fact, light edges do not exist until you create them.) The Storm *model* commands (specifically the `model.edge.*` commands) include options for working with light edges that exist in a given Cortex.

Internal to The Vertex Project, we have defined a number of light edges for our own use. Light edges may also be created by Vertex-provided components such as Power-Ups (see *Power-Up*). Any light edges used by Power-Ups are described in the associated Power-Up documentation.

Light edge conventions used by The Vertex Project are documented within the Synapse source code. Light edges that can be used with a given form are also documented with the *Forms* in the Synapse Data Model technical reference. These conventions are not currently enforced and meant as recommendations.

3.2.2 Data Model - Object Categories

Recall that within the Synapse data model:

- **Nodes** commonly represent "things": observables that can be verified and are unlikely to change over time.
- **Tags** commonly represent "assessments": judgements or evaluations that may change given new data or revised analysis.

Within Synapse, forms are the building blocks of our analysis system. Forms are used to create nodes, which are the objects used to represent (model) knowledge and answer analytical questions about the captured information. This means that the proper design of forms is essential.

In Synapse's hypergraph-based model (where almost everything is a node) forms take on additional significance. Specifically, forms must be used to represent more than just "nouns" and must be used to capture several general categories of objects. These categories can be broadly defined as entities, relationships, and events.

- *Entity*
- *Relationship*
- *Event*
- *Instance Knowledge vs. Fused Knowledge*

This section discusses the informal "categories" of **objects** that can be modeled in Synapse. See *Data Model - Form Categories* for a discussion of some of the common "categories" of **forms** used to represent these objects.

Entity

Forms can represent atomic **entities,** whether real or abstract. For cyber threat data, entities include domains, IP addresses (IPv4 or IPv6), hosts (computers / devices), usernames, passwords, accounts, files, social media posts, and so on. Other entities include people, organizations, and countries. Any entity can be defined by a form and represented by a node. Entities are often (though not always) represented as a *Simple Form*. The term "simple" means that these forms can be represented as a primary property with a single value that uniquely defines the entity.

Example

An email address (`inet:email`) is a basic example of an entity-type node / simple form:

```
storm> inet:email=kilkys@yandex.ru
inet:email=kilkys@yandex.ru
        :fqdn = yandex.ru
        :user = kilkys
        .created = 2023/07/12 15:14:43.044
```

Relationship

Forms can represent specific **relationships** among entities. In a directed graph a relationship is represented as a directed edge joining exactly two nodes; but in a hypergraph the entire relationship is represented by a single node (form), and the relationship may consist of any number of elements – not just two.

For cyber threat data, relationships include a domain resolving to an IP address or a malware dropper containing or extracting another file. Other types of relationships include a company being a subsidiary of another business, an employee working for a company, or a person being a member of a group.

Relationship-type forms are often represented as a *Composite (Comp) Form*. Comp forms have a primary property consisting of a comma-separated list of two or more values that uniquely define the relationship.

Example

A DNS A record (`inet:dns:a`) is a basic example of a relationship-type form / comp form:

```
storm> inet:dns:a=(google.com,172.217.9.142)
inet:dns:a=('google.com', '172.217.9.142')
        :fqdn = google.com
        :ipv4 = 172.217.9.142
        .created = 2023/07/12 15:14:43.118
```

Event

Forms can represent individual time-based occurrences. The term **event** implies that an entity existed or a relationship occurred at a specific point in time. Events represent the combination of a form and a timestamp for when the form was observed.

Examples of event forms include an individual login to an account, a specific DNS query, or a domain registration (whois) record captured on a specific date.

The structure of an event form may vary depending on the specific event being modeled. For "simple" events that can be uniquely represented by the combination of a timestamp and an entity, the form may be a *Composite (Comp) Form* that happens to include a timestamp as one element of the form's value. For exaple, an `inet:whois:rec` form consists of a whois record and the time that record was observed or retrieved.

For more "multi-dimensional" events involving several components, the form may be a *Guid Form* with the timestamp as one of several secondary properties on the form (i.e., as in an `inet:dns:request` form).

Example

A specific, individual DNS query (`inet:dns:request`) is an example of an event-type form:

```
storm> inet:dns:request=00000a17dbe261d10ce6ed514872bd37
inet:dns:request=00000a17dbe261d10ce6ed514872bd37
        :query = ('tcp://199.68.196.162', 'download.applemusic.itemdb.com', '1')
        :query:name = download.applemusic.itemdb.com
        :query:name:fqdn = download.applemusic.itemdb.com
        :query:type = 1
        :reply:code = 0
        :server = tcp://178.62.239.55
        :time = 2018/09/30 16:01:27.506
        .created = 2023/07/12 15:14:43.182
```

Instance Knowledge vs. Fused Knowledge

For certain types of data, event forms and relationship forms can encode similar information but represent the difference between **instance knowledge** and **fused knowledge.**

- Event forms represent the specific point-in-time existence of an entity or occurrence of a relationship - an **instance** of that knowledge.
- Relationship forms can leverage the universal `.seen` property to set "first observed" and "last observed" times during which an entity existed or a relationship was true. This date range can be viewed as **fused** knowledge - knowledge that summarizes or "fuses" the data from many individual observations (instances) of the node over time.

Instance knowledge and fused knowledge represent differences in data granularity. Whether to create an event form or a relationship form (or both) depends on how much detail is required for your analysis. This consideration often applies to relationships that change over time, particularly those that may change frequently.

Example

DNS A records are a good example of these differences. The IP address that a domain resolves to may change infrequently (e.g., for a website hosted on a stable server) or may change quite often (e.g., where the IP is dynamically assigned or where load balancing is used).

One option to represent and track DNS A records is to create individual timestamped forms (events) every time you check the domain's current resolution (e.g., `inet:dns:request` and `inet:dns:answer` forms). This represents a very high degree of granularity as the nodes will record the exact time a domain resolved to a given IP, potentially down to the millisecond. The nodes can also capture additional detail such as the querying client, the responding server, the response code, and so on. However, the number of such nodes could readily reach into the hundreds of millions, if not billions, if you create nodes for every resolution of every domain you want to track.

On the other hand, it may be sufficient to know that a domain resolved to an IP address during a given **period** of time – a "first observed" and "last observed" (`.seen`) range. A single `inet:dns:a` node can be created to show that domain `woot.com` resolved to IP address `1.2.3.4`, where the earliest observed resolution was 2014/08/06 at 13:56 and the most recently observed resolution was 2018/05/29 at 7:32. These timestamps can be extended (earlier or later) if additional data changes our observation boundaries.

This second approach loses some granularity:

- The domain is not guaranteed to have resolved to that IP **continuously** throughout the entire time period.
- Given only this node, we don't know **exactly** when the domain resolved to the IP address during that time period, except for the earliest and most recent observations.

However, this fused knowledge may be sufficient for our needs and may be preferable to creating thousands of nodes for individual DNS resolutions.

Of course, a hybrid approach is also possible, where most DNS A record data is recorded in fused `inet:dns:a` nodes but it is also possible to record high-resolution, point-in-time `inet:dns:request` and `inet:dns:answer` nodes when needed.

3.2.3 Data Model - Form Categories

Synapse forms can be broadly grouped into conceptual categories based on the **object** a form is meant to represent - an *Entity*, a *Relationship*, or an *Event*.

Synapse forms can also be broadly grouped based on how their **primary properties** (<form> = <valu>) are formed.

Recall that <form> = <valu> must be unique for all forms of a given type. In other words, the <valu> must be defined so that it uniquely identifies any given node of that form; it represents that form's "essence" or "thinghood" in a way that allows the unambiguous deconfliction of all possible nodes of that form.

Conceptually speaking, the general categories of forms in Synapse are:

- *Simple Form*
- *Composite (Comp) Form*
- *Guid Form*
- *Generic Form*
- *Digraph (Edge) Form*

This list represents a conceptual framework for understanding the Synapse data model.

Simple Form

A simple form refers to a form whose primary property is a single typed <valu>. They are commonly used to represent an *Entity*, and so tend to be the most readily understood from a modeling perspective.

Examples

- **IP addresses.** An IP address (IPv4 or IPv6) must be unique within its address space and can be defined by the address itself: `inet:ipv4 = 1.2.3.4`. Secondary properties include the associated Autonomous System number and whether the IP belongs to a specialized or reserved group (e.g., private, multicast, etc.).
- **Email addresses.** An email address must be unique in order to route email to the correct account / individual and can be defined by the address itself: `inet:email = joe.smith@company.com`. Secondary properties include the domain where the account receives mail and the username for the account.

Composite (Comp) Form

A composite (comp) form is one where the primary property is a comma-separated list of two or more typed <valu> elements. While no single element makes the form unique, a combination of elements can uniquely define a given node of that form. Comp forms are often (though not universally) used to represent a *Relationship*.

Examples

- **Fused DNS A records.** A DNS A record can be uniquely defined by the combination of the domain (`inet:fqdn`) and the IP address (`inet:ipv4`) in the A record. Synapse's `inet:dns:a` form represents the knowledge that a given domain resolved to a specific IP at some time, or within a time window (fused knowledge): `inet:dns:a = (woot.com, 1.2.3.4)`. The time window is captured by the universal `.seen` property.

- **Web-based accounts.** An account at an online service (such as Github or Twitter) can be uniquely defined by the combination of the domain where the service is hosted (`inet:fqdn`) and the unique user ID (`inet:user`) used to identify the account: `inet:web:acct = (twitter.com, vtxproject)`.
- **Social networks.** Many online services allow users to establish relationships with other users of that service. These relationships may be one-way (you can follow someone on Twitter) or two-way (you can mutually connect with someone on LinkedIn). A given one-way social network relationship ("Alice follows Bob") can be uniquely defined by the two users (`inet:web:acct`) involved in the relationship: `inet:web:follows = ( (twitter.com,alice), (twitter.com,bob) )`. (A two-way relationship can be defined by two one-way relationships.)

  Note that each of the elements in the `inet:web:follows` comp form is itself a comp form (`inet:web:acct`).

Guid Form

A guid (Globally Unique Identifier) form is uniquely defined by a machine-generated 128-bit number. Guids account for cases where it is impossible to uniquely define a thing based on a property or set of properties. Guids are also useful for cases where the amount of data available to create a particular object (node) may vary greatly (i.e., not all properties / details are available from all data sources).

A guid form can be considered a special case of a *Simple Form* where the typed <valu> is of type <guid>.

Note: Guid forms can be arbitrary (generated ad-hoc by Synapse) or predictable / deconflictable (generated based on a specific set of inputs). See the *guid* section of *Storm Reference - Type-Specific Storm Behavior* for a more detailed discussion of this concept.

Examples

- **People.** Synapse uses a guid as the primary property for a person (`ps:person`) node. There is no single property or set of properties that uniquely and unambiguously define a person. A person's full name, date of birth, or place of birth (or the combination of all three) are not guaranteed to be fully unique across an entire population. Identification numbers (such as Social Security or National ID numbers) are country-specific, and not all countries require each citizen to have an ID number.
- **Host execution / sandbox data.** The ability to model detailed behavior of a process executing on a host (or in a sandbox) is important for disciplines such as incident response and malware analysis. Modeling this data is challenging because of the number of effects that execution may have on a system (files read, written, or deleted; network activity initiated). Even if we focus on a specific effect ("a process wrote a new file to disk"), there are still a number of details that may define a "unique instance" of "process writes file": the specific host where the process ran, the program that wrote the file to disk, the process that launched the program, the time the execution occurred, the file that was written, the file's path, and so on. While all of these elements could be used to create a comp form, in the "real world" not all of this data may be available in all cases, making a guid a better option for forms such as `it:exec:file:write`.

Generic Form

The Synapse data model includes a number of "generic" forms that can be used to represent metadata and / or arbitrary data.

In an ideal world, all data represented in Synapse would be accurately modeled using an appropriate form. However, designing a new form for the data model may require extended discussion, subject matter expertise, and testing against "real world" data - not to mention time to implement model changes. In addition, sometimes data needs to be added to a Cortex for reference or analysis purposes where the data simply does not have sufficient detail to be represented accurately, even if an appropriate form existed.

The use of generic forms is not ideal - the representation of "generic" data may be lossy, which may impact effective analysis. But generic forms may be necessary for adding arbitrary to Synapse, either because an appropriate model element does not yet exist but the data is needed now; or because there is no other effective way to represent the data.

These generic forms exist in two primary parts of the data model: `meta:*` forms and `graph:*` forms. Examples include:

- `meta:seen` nodes, used to represent a data source used to ingest data into Synapse. Data sources may include sensors or third-party connectors such as Synapse Power-Ups. A `meta:source` is linked to the data it provides via a `-(seen)>` light edge.
- `meta:rule` nodes, used to represent a generic detection rule for cases where a more specific form (such as `it:av:sig` or `it:app:yara:rule`) is not available.

Some generic forms are "edge forms" (see *Digraph (Edge) Form*, below) used to represent relationships between arbitrary forms.

Digraph (Edge) Form

Note: The use of light edges (see *Lightweight (Light) Edge*) is preferred over edge forms (which predate light edges) where possible.

A digraph form ("edge" form) is a specialized *Composite (Comp) Form* whose primary property value consists of two `<form>,<valu>` pairs ("node definitions", or ndefs). An edge form is a specialized relationship form that can be used to link two arbitrary forms in a generic relationship.

Edge forms have not been officially deprecated. However, edge forms (used to create nodes) incur some additional performance overhead vs. light edges (particularly for large numbers of edge nodes). In addition, there are some nuances to working with edge nodes using Storm (see *Pivot to Digraph (Edge) Nodes*, for example) that can make navigating Synapse data more complex. For these reasons, light edges are now preferred.

3.3 Analytical Model

The analytical model that is used in Synapse is driven primarily by the use of tags to make assessments. This is discussed in the following sections:

3.3.1 Analytical Model - Tag Concepts

Recall from *Data Model - Terminology* that two of the key components within Synapse are nodes and tags. Broadly speaking:

- **Nodes** represent "things": observables that can be verified and are unlikely to change over time.
- **Tags** represent assessments: conclusions that may change in light of new data.

The types, forms, and properties that define nodes make up the Synapse **data model.** The **tags** applied to nodes can be thought of as the **analytical model** used to record assessments about Synapse data. This section provides additional background on tags before a more in-depth discussion on their use:

- *Tags as Nodes*
- *Tags as Labels*

Tags as Nodes

Tags are used to record analytical observations, but tags are also nodes within Synapse. Every tag is a `syn:tag` node.

A tag node's primary property (`<form> = <valu>`) is the name of the tag; so the tag `foo.bar` has the primary property `syn:tag = foo.bar`. The dotted notation can be used to construct tag hierarchies / tag trees to organize tags and represent varying levels of specificity (see below).

This example shows the **node** for the tag `syn:tag = rep.feye.apt1`:

```
storm> syn:tag=rep.feye.apt1
syn:tag=rep.feye.apt1
        :base = apt1
        :depth = 2
        :doc = Indicator or activity FireEye calls (or associates with) APT1.
        :title = APT1 (FireEye)
        :up = rep.feye
        .created = 2023/07/12 15:14:57.343
```

The `syn:tag` node has the following properties:

- `.created`, which is a universal property showing when the node was added to a Cortex.
- `:title` and `:doc`, which store concise and more detailed definitions for the tag. Having definitions on tag nodes helps ensure tags are applied (and interpreted) correctly by Synapse analysts and other users.

The `:depth`, `:up`, and `:base` secondary properties help to lift and pivot across tag nodes:

- `:depth` is the "location" of the tag in a given tag tree, with the count starting from zero. A single-element tag (`syn:tag = rep`) has `:depth = 0`, while a three-element tag (`syn:tag = rep.feye.apt1`) has `:depth = 2`.
- `:base` is the final (rightmost) element in the tag tree.
- `:up` is the tag one "level" up in the tag tree.

Additional information on viewing and pivoting across tags can be found in *Storm Reference - Model Introspection*. For details on the Storm query language, see *Storm Reference - Introduction*.

Tags (`syn:tag` forms) have a number of type-specific behaviors within Synapse with respect to how they are indexed, created, and manipulated via Storm. Most important for practical purposes is that `syn:tag` nodes are created "on the fly" when a tag is applied to another node. You do not need to create the `syn:tag` node before the tag can be used; applying the tag will cause the creation of the appropriate `syn:tag` node (or nodes).

See the *syn:tag* section within *Storm Reference - Type-Specific Storm Behavior* for additional detail on tags and tag behavior in Synapse and Storm.

Tags as Labels

Synapse does not include any pre-populated tags. A good set of tags (that is, a good analytical model) should be structured to best answer relevant questions for the analysis being performed. Organizations using Synapse have the flexibility to create a tag structure that is most useful to them.

A tag's value (`syn:tag = <valu>`) is simply a string and can be set to any user-defined alphanumeric value. The strings are designed to use a dotted naming convention, with the period (`.`) used as a separator to delimit individual elements of a tag if necessary. This dotted notation means it is possible to create tag hierarchies or tag trees. These trees can be used to "categorize" different types of tags (with each top-level or root tag representing a particular category). The structure can also support increasingly detailed or specific observations. For example, the top level tag `foo` can

represent a broad set of observations, while `foo.bar` and `foo.baz` could represent subsets of `foo` or more specific observations related to `foo`.

Within a tag tree, specific terms are used for the tags and their components:

- **Leaf tag:** The full tag.
- **Root tag:** The top / leftmost element in a given tag.
- **Base tag:** The bottom / rightmost element in a given tag.

For the tag `foo.bar.baz`:

- `foo.bar.baz` is the leaf tag (leaf).
- `foo` is the root tag (root).
- `baz` is the base tag (base).

When you apply a tag to a node, all of the tags **above** that tag in the tag tree are automatically applied as well (and the appropriate `syn:tag` nodes are created if they do not exist). That is, when you apply the tag `foo.bar.baz` to a node, Synapse automatically applies the tags `foo.bar` and `foo` as well.

When you delete (remove) a tag from a node, the tag and all tags **below** it in the tag tree are deleted. If you delete the tag `foo.bar.baz` from a node, the tags `foo.bar` and `foo` will remain. However, if you delete the tag `foo` from a node with the tag `foo.bar.baz`, then all three tags (`foo`, `foo.bar`, and `foo.bar.baz`) are deleted.

Deleting a tag from a node does **not** delete the `syn:tag` node for the tag itself.

See the *syn:tag* section within *Storm Reference - Type-Specific Storm Behavior* for additional detail on tags and tag behavior within Synapse and Storm.

See *Analytical Model - Tags as Analysis* and *Design Concepts - Analytical Model* for additional considerations for tag use and creating tag trees.

Tag Timestamps

Applying a tag to a node has a particular meaning; it is an assessment about that node with respect to the current data in Synapse. Many assessments are binary in the sense that they are either always true or always false; in these cases, the presence or absence of a tag can accurately reflect the current assessment, based on available data.

There are other cases where an assessment may be true only for a period of time or within a specified time frame. Internet infrastructure is one example; you can annotate whether an IP address is part of an anonymization service such as TOR using tags such as `cno.infra.anon.tor`. But this information can change over time if the TOR service is removed or the IP address is reallocated to a different customer. The relevant tag can be applied while the IP is a TOR node and removed when that is no longer true; but completely removing the tag causes us to lose the historical knowledge that the IP **was** a TOR node **at one time.**

Synapse supports the optional use of **timestamps** (technically, time intervals) with any tag applied to a node. The timestamps can represent "when" (first known / last known times) the **assessment represented by the tag was relevant for the node to which the tag is applied.** (These timestamps are analogous to the `.seen` universal property used to represent the first and last known times the **data represented by a node** was true / real / in existence.)

Applying a timestamp to a tag affects that specific tag only. The timestamps are not automatically propagated to tags higher up (or lower down) in the tag tree. This is because the specific tag to which the timestamps are applied is the most relevant with respect to those timestamps; tags elsewhere in the tree may have different shades of meaning and the timestamps may not apply to those tags in the same way (or at all).

Like `.seen` properties, tag timestamps represent a time **range** and not necessarily specific instances (other than the "first known" and "last known" observations). This means that the assessment represented by the tag is not guaranteed to have been true throughout the entire date range (though depending on the meaning of the tag, that may in fact be the

case). That said, the use of timestamps allows much greater granularity in recording observations in cases where the timing of an assessment ("when" something was true or applicable) is relevant.

Example - Tor Exit Nodes

Many web sites provide lists of TOR nodes or allow users to query IP addresses to determine whether they are TOR nodes. These sites may provide "first seen" and "last seen" dates for when the IP was identified as part of the TOR network. These dates can be used as timestamps for "when" the tag `#cno.infra.anon.tor` was applicable to that IP address.

If we have a data source that verifies that IP address `197.231.221.211` was a TOR node between December 19, 2017 and February 15, 2019, we can apply the tag `#cno.infra.anon.tor` with the appropriate time range as follows:

```
storm> inet:ipv4 = 197.231.221.211 [ +#cno.infra.anon.tor = (2017/12/19, 2019/02/15) ]
inet:ipv4=197.231.221.211
        :asn = 37560
        :dns:rev = exit1.ipredator.se
        :latlong = 8.4219,-9.7478
        :loc = lr.lo.voinjama
        :type = unicast
        .created = 2023/07/12 15:14:57.431
        #cno.infra.anon.tor = (2017/12/19 00:00:00.000, 2019/02/15 00:00:00.000)
```

Tag Display

When a tag is used as a **label** applied to a node, the data is displayed differently than it is for a `syn:tag` node. This example shows a node with multiple **tags** applied:

```
storm> inet:fqdn = aunewsonline.com
inet:fqdn=aunewsonline.com
        :domain = com
        :host = aunewsonline
        :issuffix = false
        :iszone = true
        :zone = aunewsonline.com
        .created = 2023/07/12 15:14:57.487
        #cno.threat.t15.own = (2009/09/08 00:00:00.000, 2013/09/08 00:00:00.000)
        #rep.feye.apt1
        #rep.symantec.commentcrew
```

Tags on a node are listed alphabetically following the node's properties. Tags are prefixed with the pound / hashtag (`#`) symbol to indicate they are tags.

By default, Storm displays only the **leaf tags** applied to a node (e.g., `#rep.feye.apt1` but not `#rep.feye` or `#rep`) **and** any tags with *Tag Timestamps* or *Tag Properties* (even if they are not leaf tags).

Any timestamp values are displayed following an equals sign after the tag. In the example above, the tag `#cno.threat.t15.own` indicates the domain is associated with ("owned" by) internally-tracked Threat Cluster 15 (T15). The dates reflect our assessment that T15 "owned" / controlled the FQDN between September 8, 2009 and September 8, 2013.

Tag Properties

Synapse supports the creation and use of custom **tag properties** that can provide additional context to a given tag or set of tags. Tag properties must be created programmatically before they can be used. Once a tag property is created, it can be applied (appended) to any tag.

Note: Synapse still supports the use of tag properties, but their use is now discouraged in most cases in favor of extended model properties. A discussion of extended model elements (forms, properties, etc.) is beyond the scope of this document. Storm libraries for working with extended model elements can be found here: *$lib.model.ext*.

3.3.2 Analytical Model - Tags as Analysis

Analysis consists of collecting and evaluating data and drawing conclusions based on the data available to you. Assuming data is collected and modeled accurately within Synapse, the data itself - nodes and their properties - should not change. But as you collect more data or re-evaluate existing data, your **assessment** of that data - often encoded in tags - may change over time. Nodes and properties are largely stable; tags are meant to be flexible and readily modified if needed.

Every knowledge domain has its own focus and set of analytical questions it attempts to answer. The "answers" to some of these questions can be recorded in Synapse as tags applied to relevant nodes. These tags provide **context** to the data in Synapse.

The Synapse **data model** for tags is simple - it consists of the single `syn:tag` form. The appropriate **use** of tags to annotate data is more nuanced. You can think of tags - their structure and application - as an **analytical model** that complements and extends the power of the data model.

This analytical model:

- **Is largely independent from the data model.** You do not need to write code to implement new tags or design a tag structure; you simply need to create the appropriate `syn:tag` nodes.
- **Is specific to an analytical discipline.** Tags used for cyber threat analysis may be very different from tags used to track financial fraud.
- **Is tightly coupled with the specific questions you want to answer.** The tags you create and apply should be driven by your particular analysis goals.
  - The tags should annotate assessments and conclusions that are **important to your analysis.**
  - The tags should allow you to ask **meaningful questions** of your data.

The effective use of Synapse to conduct analysis depends on:

- **The data model:** how you represent the data you care about using Synapse's forms, properties, and types.
- **The analytical model:** how you design and use a set of tags to annotate data, provide context, and answer the questions that matter to you.

Tag Examples

The sections below provide a few examples of the kinds of context - observations and assessments - that you can represent with tags. Recording these assessments in Synapse alongside the relevant data provides immediate **context** to that data, and allows you to query both data (nodes) and assessments (tags).

These examples are simply meant to illustrate a few possible "real-world" applications for tags. There is no "right" or "wrong" set of tags (although there are "better" and "worse" design decisions that may impact your ability to answer questions efficiently).

See *Design Concepts - Analytical Model* for considerations in designing tags and tag trees.

See *Design Concepts - General* for considerations on whether to model something as a form, a property, a tag, or a tag associated with a node.

See *Tags Associated with Forms* for Synapse's ability to link tags to nodes to more easily cross-reference tags with data model elements that those tags represent.

Domain-Specific Assessments

The purpose of analysis is to draw relevant conclusions from the data at hand. The conclusions will vary based on the knowledge domain, but could include big-picture assessments such as "The increase in widget manufacturing due to lower production costs has had a negative effect on the demand for gizmos" or "The threat group Vicious Wombat is working on behalf of the Derpistan government".

Those large assessments can be made based on numerous smaller assessments (tags) which are themselves based on the observables (nodes) in Synapse. To build up to those larger assessments, you must start by recording those smaller assessments as tags on nodes.

The folowing examples from cyber threat intelligence illustrate some of the assessments that can be recorded using tags.

Tip: The specific tags referenced below are based on The Vertex Project's tag trees and use our conventions. Use what works for you!

Threat Clusters

A common practice in threat intelligence involves deciding not only whether an indicator (such as a file, domain, or IP address) is malicious, but whether it should be associated with a **threat cluster.** That is, can an indicator be linked to other indicators (e.g., from the same indcident or intrusion) to create a known set of related indicators and activity. "Threat clusters" may be built up and expanded over time to represent a broader set of activity presumed to be carried out by some (generally unknown) set of malicious actors (a "threat group").

You can tag nodes to indicate that the node is associated with a particular threat cluster. For example:

`cno.threat.<cluster>`

Where `cno` is a top-level tag for assessments related to Computer Network Operations (CNO), `threat` is a sub-tag used for threat clusters / threat groups, and `<cluster>` is the "name" of the particular threat cluster based on your organization's conventions (names, numbers, etc.)

Tactics, Techniques, and Procedures (TTPs)

The methodologies (sometimes known as tactics, techniques, and procedures or TTPs) that a threat group uses to conduct activity provide insight into the group and its operations. Knowledge of past TTPs may help predict future actions or operations. Sets of TTPs observed together may provide a "fingerprint" of a group's activity. General knowledge of TTPs in current use can help organizations more effectively protect and defend their assets.

"TTP" can cover a broad range of observed activity, from whether a group uses zero-day exploits to the specific packer used to obfuscate a piece of malware. When a node represents an instance of the use of a TTP, it may be useful to tag the node with the TTP in question.

For example, you have an email message (RFC822 file) that you assess is a phishing attack. You can tag the relevant node or nodes (such as the `file:bytes` of the message and / or the `inet:email:message` node representing the message metadata) with that TTP:

`cno.ttp.phish.message`

Where `cno` is our top-level tag, `ttp` represents the TTP sub-tree, `phish` represents assessments related to phishing, and `message` indicates the node(s) represent the phishing email (e.g., as opposed to an attachment or URL representing the phishing `payload`, or the sending email address or IP representing the `source`).

Third-Party Assertions

Some third-party data sources provide both data and tags or labels associated with that data. For example, Shodan may provide data on an IPv4 address (such as which ports were open as of the last Shodan scan) as well as tags such as `self-signed` or `vpn`. Similarly, VirusTotal may provide metadata and multiscanner data for files along with tags such as `peexe` or `invalid-signature`.

In addition, many commercial organizations conduct their own threat tracking and analysis and publish their research. This type of research commonly includes "indicators of compromise" or IOCs - hashes, domains, IP addresses, and so on indicative of the reported activity. These reports do not necessarily include tags provided by the reporting organization. But the report may make it clear that the reporter associates the IOCs with particular malware families, "campaigns", or threat groups.

Shodan's label indicating that an IPv4 address hosted a VPN and ESET's reporting that a SHA1 hash is associated with the X-Agent malware family are both assertions. These assertions are valuable data and can be useful to your analysis.

That said, you may not have the means to **verify** these assertions yourself. To accept the assertion at face value means you need to trust the third-party in question. "Trust" may include things like understanding the source of the data; knowing their general reputation (i.e., within your analysis community); or building trust over time as you determine the reliabilty and accuracy of their reporting.

Your own assertions are presumably "more trustworthy" based on direct access to your internal data and processes. Assertions made by others may be open to question or validation, so it can be useful to record these third-party assessments separately. This allows you to retain the context of what "other people" say while keeping those (potentially lower-confidence) assertions separate from your own.

You can use tags to annotate "other people's analysis" by tagging relevant nodes with what "other people" say about them:

- `rep.eset.sednit`: ESET says this SHA1 hash is associated with Sednit
- `rep.shodan.vpn`: Shodan says this IPv4 hosts a VPN
- `rep.vt.peexe`: VirusTotal says this file is a PE executable

Where `rep` is a top-level tag for third-party reporting, the second tag element (e.g., `eset`) is the name of the reporting organization, and the third tag element is the information the third party is reporting.

Domain-Relevant Observations

Within a particular knowledge domain, it may be useful to record observations that **support** your analysis process in some way. In other words, the observations are **relevant** to your analysis, but do not represent the specific output or objective of your analysis.

In cyber threat intelligence, a primary goal is to track malicious activity and maintain awareness of the current threat landscape, often in terms of malware, threat groups, and techniques / TTPs. Part of this tracking includes noting infrastructure (such as IP addresses, netblocks, or domains) used in malicious activity.

Identifying network infrastructure as TOR nodes, anonymous VPN endpoints, or sinkhole IPs is not a primary goal of threat intelligence, but knowing this information can be useful and help prevent analysts from mis-identifying threat actor infrastructure.

You can use tags to annotate identified infrastructure (such as `inet:ipv4` nodes) of interest:

- `cno.infra.anon.tor`: The IPv4 is a TOR exit node
- `cno.infra.anon.vpn`: The IPv4 is an anonymous VPN exit point
- `cno.infra.dns.sink.hole`: The IPv4 is used to resolve sinkholed FQDNs

Once again `cno` is our top-level tag for Computer Network Operations, `infra` indicates the "infrastructure" sub-tree, the third element indicates the kind of infrastructure (`anon` for anonymous, `dns` for DNS, etc.), and so on.

Tags as Hypotheses

Another way to look at tags is as hypotheses. If a tag represents the outcome of an assessment, then every tag can be seen as having an underlying question - a hypothesis - it is attempting to answer. Deciding to apply the tag is equivalent to deciding that the underlying hypothesis is **true.**

Making these assessments typically involves the judgment of a human analyst; so evaluating and tagging data within Synapse is one of an analyst's primary tasks.

Hypotheses may be simple or complex; tags typically represent relatively simple concepts that are used collectively to support (or refute) more complex theories. Because the concept of encoding analytical conclusions within a system like Synapse may be unfamiliar, a few examples may be helpful.

Example 1

The question "can this newly identified FQDN be associated with any known threat cluster?" can be thought of as *n* number of individual hypotheses based on the number of known threat clusters:

- Hypothesis 1: This domain is associated with Threat Cluster 1.
- Hypothesis 2: This domain is associated with Threat Cluster 2.
- …
- Hypothesis n: This domain is associated with Threat Cluster n.

If an analyst determines that the domain is associated with Threat Cluster 46, placing a Threat Cluster 46 tag (e.g., `cno.threat.t46`) on that FQDN effectively means that the hypothesis "This domain is associated with Threat Cluster 46" has been assessed to be **true** (and by implication, that all competing hypotheses are false).

Example 2

Deciding whether a domain is meant to imitate (masquerade as) a legitimate domain for malicious purposes can also be thought of as a set of hypotheses.

"Masquerading" is a threat actor technique (TTP) designed to influence a targeted user to trust something enough to perform an action. A domain that "looks like" a valid FQDN or an email address that "looks like" a trusted sender may

encourage the victim to click a link or open an attachment. In threat intelligence, the focus is on **threat actor** TTPs, so the TTPs we're interested in are (by definition) malicious.

Let's say an analyst comes across the suspicious domain `akcdndata.com`. To decide whether this is an example of a masquerade, the analyst needs to decide:

- Is the FQDN `akcdndata.com` associated with known malicious activity?
- Does the FQDN `akcdndata.com` imitate a legitimate company, site, or service?

A number of possibilities (hypotheses) exist, such as:

- Hypothesis 1: The domain is NOT malicious.
- Hypothesis 2: The domain IS malicious, but is not meant to imitate anything.
- Hypothesis 3: The domain IS malicious, and is meant to imitate a legitimate resource.

The tag (or tags) the analyst decides to apply depend on which hypotheses they can prove or disprove (assert are true, or not).

Deciding on Hypothesis 1 vs. Hypothesis 2 may involve things like reviewing domain registration data, associated DNS infrastructure, or seeing if the FQDN shows up in public reporting of malicious activity.

If Hypothesis 1 is true, we would not tag the FQDN. If Hypothesis 2 is true, we can simply assert that the FQDN is malicious (with a tag such as `cno.mal`).

If Hypothesis 2 is true, deciding on Hypothesis 3 may be trickier. Does the FQDN "look like" anything familiar? It may "look like" Akamai CDN (content delivery network) but that's a bit of a stretch... maybe it is just a coincidence? Do we have any context around **how** the FQDN was used maliciously that might indicate that the threat actors wanted to mislead victims into thinking the FQDN was associated with Akamai?

If we have enough evidence to support Hypothesis 3, we can apply a TTP tag such as `cno.ttp.se.masq` (`cno` as our top-level tag, `ttp` for our TTP sub-tree, `se` for social engineering TTPs, and `masq` for masquerade).

Individual Hypotheses to Broader Reasoning

The hypotheses represented by the tags in the examples above are fairly narrow in scope - an indicator is associated with a threat cluster (`cno.threat.t42`), a domain was designed to mislead users by imitating a legitimate web site or service (`cno.ttp.se.masq`). With Synapse, you can leverage these more focused hypotheses to answer broader, more complex questions.

A newly identified zero-day exploit has been circulating in the wild and is in use by multiple threat groups. The associated vulnerability has been assigned CVE-2021-9999 (a number we made up). The exploit is delivered via a malicious XLSX file sent as an email (phishing) attachment.

You believe that "Threat Group 12 was the first group to use the zero day associated with CVE-2021-9999". To prove or disprove this hypothesis, you could query Synapse for all files (`file:bytes` nodes) that:

- exploit CVE-2021-9999 (i.e., have a tag such as `rep.vt.cve_2021_9999`), and
- are associated with a known threat cluster or threat group (i.e., are tagged `cno.threat.<cluster>`)

If you have data for any associated phishing messages, you can pivot from the malicious XLSX files to their associated emails (`inet:email:message:attachment -> inet:email:message`) and look for the phishing message with the oldest date. By identifying the threat group associated with the earliest known email, you can determine whether the zero-day was first used by Threat Group 12 or some other group.

You are able to take tags associated with simple assessments ("this file exploits CVE-2021-9999" or "this file is associated with Threat Cluster 12") and combine nodes (files / `file:bytes`), properties (`inet:email:message:date`), and tags to answer a more complex question. That's the power of Synapse!

Note: This example is simplified; you would of course perform additional research besides what is described above (such as searching for additional samples that exploit the vulnerability and any associated phishing attempts, attributing identified samples that are not yet associated with a Threat Cluster, etc.)

Assuming you have completed your research and the data is in Synapse and tagged appropriately, you can easily answer the above question using the Storm query language using a query such as the following:

```
file:bytes#rep.vt.cve_2021_9999 +#cno.threat -> inet:email:message:attachment
  -> inet:email:message | min :date | -> # +syn:tag^=cno.threat
```

3.4 Design

There is a balance between using data in the graph, and using tags for analysis. The following sections discuss that in additional detail.

3.4.1 Design Concepts - Data Model

Synapse's ability to support powerful and effective analysis is due in large part to Synapse's **data model**. The forms, properties, and types used in Synapse are the result of our direct experience using Synapse for a broad range of analysis (along with lively and occasionally heated internal discussion and design sessions with our developers and analysts!).

A full discussion of the considerations (and complexities) of a well-designed data model are beyond the scope of this documentation. However, there are several principles that we rely on that help shed light on our approach:

- **The model is an abstraction.** A data model (and associated tags / analytical model) provides **structure** for data and assertions that allow us to quickly view data, relationships, and context, and to ask questions of the data in powerful ways. That said, analysis often involves subtle distinctions and qualifications - which is why analysis is often provided in long-form reports where natural language can convey uncertainties or caveats related to conclusions.

  Capturing data and analysis in a structured model abstracts away some of these subtleties - in some cases, trading them for consistent representation and programmatic access. A data model can never fully capture the richness and detail of a long-form report. But a **good** data model can sufficiently capture critical relationships and analytical findings so that an analyst only rarely needs to refer to external reporting or original sourcing for clarification.

- **The model should be self-evident.** While the model is an abstraction, it should not be abstracted to the point where the data and analysis in the model cannot stand on their own. While at times supplemental external reports or notes may be helpful, they should not be **required** to understand the information represented in Synapse. The model should convey the maximum amount of information possible: objects, relationships, and annotations should be unambiguous, well-defined, and clearly understood. An analyst with subject matter knowledge but no prior exposure to a given set of findings should be able to look at that information in Synapse and understand the associated analysis.

- **Take the broadest perspective possible.** Many data models suffer from being "overly-fitted". They are designed for a specific analytical discipline and the objects and relationships they contain reflect a narrow use case. We believe that Synapse's data model should represent objects and relationships as they are **in the real world** - not just "as they are used" in a particular limited context. For example, an "organization" (`ou:org`) in Synapse can represent any set of people with a common goal - from a company, to a government, to a threat group, to a department, to your kid's soccer team. This makes the model both more flexible and more broadly applicable so we can easily incorporate new data sets / sources and additional types of analysis.

- **The model should be driven by real-world need and relevance.** Any model should be designed around the analytical questions that it needs to be answer. Some models are designed as academic abstractions ("how would

we classify all possible exploitable vulnerabilities in software?") without consideration for the practical questions that the data is intended to address. Are some exploits theoretically possible, but never yet observed in the real world? Are some distinctions too fine-grained (or not fine-grained enough) for your analysis needs? Subject matter experts should have significant input into the type of data modeled, what analysis needs to be performed on the data, and how the data should be represented.

The best models evolve in a cycle of forethought combined with real-world stress-testing. Creating a model with little or no forethought can lead to a narrowly-focused and fragmented data model – in the face of some immediate need, analysts or developers may focus on the trees while missing the big picture of the forest. That said, even the best model planned in advance will fall short when faced with the inconsistencies of real-world data. Experience has shown us that there are always edge cases that cannot be anticipated. The most effective models are typically planned up front, then tested against real-world data and refined before being placed fully into production.

- **Test the basics and build from there.** No data model is set in stone – in fact, a good model will expand and evolve with analytical need. That said, changes to the model may require revising or updating existing model elements and associated analysis, and some changes are easier to make than others. When introducing a new element to the model, consider carefully what the "essence" of that element is - what makes it unique and therefore how it should "look" within the model - and design a form to capture that. It is perfectly fine (and even preferable!) to start with a limited or "stub" form while you test it against real data. It is relatively easy to make **additive** changes to the data model (introduce new forms or new secondary properties). It is more challenging to **modify** the model once you have encoded data into nodes, because those modifications may require migrating existing data to account for your changes.

3.4.2 Design Concepts - Analytical Model

The tag hierarchies (tag trees) that you use to annotate data represent your **analytical model**. Your ability to conduct meaningful analysis depends in part on whether your analytical model is well-designed to meet your needs. The tags and tag trees that work best for you may be different from those that work well for another organization.

A full discussion of tag tree design is beyond the scope of this document. However, the following points should be taken into consideration in designing your tags and associated analytical model:

- *Tag Trees*
- *Tag Definitions*
- *Tag Management*
- *Level of Detail*
- *Flexibility*
- *Precision*
- *Consistency of Use*

Tag Trees

The structure of a tag tree is an important consideration because the order of tag elements can affect the types of analysis questions you can most easily answer. Because tag trees generally move from "less specific" to "more specific", the structure you choose affects how (or whether) you can narrow your focus effectively. The structure you create should allow you to increase specificity in a way that is meaningful to the questions you're trying to answer.

For example, let's say you are storing copies of articles from various news feeds within Synapse (i.e., as `media:news` nodes). You want to use tags to annotate the subject matter of the articles. Two possible options would be:

Tag Tree #1

```
<country>.<topic>.<subtopic>.<subtopic>:
  us.economics.trade.gdp
  us.economics.trade.deficit
  us.economics.banking.lending
  us.economics.banking.regulatory
  us.politics.elections.national
  france.politics.elections.national
  france.politics.elections.local
  china.economics.banking.lending
```

Tag Tree #2

```
<topic>.<subtopic>.<subtopic>.<country>:
  economics.trade.gdp.us
  economics.trade.deficit.us
  economics.banking.lending.us
  economics.banking.regulatory.us
  politics.elections.national.us
  politics.elections.national.france
  politics.elections.local.france
  economics.banking.lending.china
```

Using Synapse's Storm (*Storm Reference - Introduction*) query language, it is easy to ask about nodes that have a specific tag (`#my.tag`). With Storm you can also ask about tag nodes (`syn:tag = my.tag`) in various ways based on their properties, and then pivot from the `syn:tag` nodes to nodes that have those tags applied. These latter queries are not difficult but may be less intuitive in practice.

The example questions below illustrate how your choice of tag structure makes it easier (or harder) to ask certain questions.

Example 1: "Show me all the articles related to France":

- Tag Tree #1:

  ```
  storm> #france
  ```

- Tag Tree #2:

  ```
  storm> syn:tag:base=france -> *
  ```

Example 2: "Show me all the articles on banking within the US":

- Tag Tree #1:

  ```
  storm> #us.economics.banking
  ```

- Tag Tree #2:

  ```
  storm> syn:tag^=economics.banking +syn:tag:base=us -> *
  ```

Example #3: "Show me all the articles about global trade":

- Tag Tree #1:

  ```
  storm> syn:tag:base=trade -> *
  ```

- Tag Tree #2:

  ```
  storm> #economics.trade
  ```

Example #4: "Show me all the articles about national elections":

- Tag Tree #1:

  ```
  storm> syn:tag:base=national -> *
  ```

- Tag Tree #2:

  ```
  storm> #politics.elections.national
  ```

Tag Tree #1 makes it easier to ask the first two questions; Tag Tree #2 makes it easier to ask the last two questions. As you can see, choosing one tag tree over the other doesn't **prevent** you from asking certain questions. If you choose the first tree, you can still ask about global trade issues. But asking that question (creating an appropriate Storm query) is a bit move involved. Creating a query based on a poorly-structured set of tags can get more difficult as both the tag depth (nubmer of tag elements) and the total number of tags increases.

These differences in query structure may seem relatively minor. But structuring your tags to make it "easier" to ask the questions that are most important to you has two important effects:

- **More efficient for Synapse to return the requested data:** In general, lifting data (selecting nodes) by the tag present on a node is more efficient than lifting `syn:tag` nodes and then pivoting to nodes that have those tags. This efficiency may be further affected if you are performing additional operations (filtering, additional pivots) on the results. These performance impacts may be relatively minor but can compound over larger data sets.
- **Simpler for analysts to remember:** Analysts want to spend their time analyzing data, not figuring out how to ask the right question (craft the right query) to retrieve the data in the first place. This has a much bigger impact on an analyst's workflow - simpler is better!

Neither tag tree is right or wrong; which is more suitable depends on the types of questions you want to answer. If your analysis focuses primarily on news content within a particular region, the first option (which places "country" at the root of the tree) is probably more suitable. If your analysis focuses more on global geopolitical topics, the second option is probably better. As a general rule, the analytical focus that you "care about most" should generally go at the top of the hierarchy in order to make it easier to ask those questions.

Tag Definitions

Tag (`syn:tag`) nodes allow you to store both short-form and long-form definitions directly on the node itself (as `:title` and `:doc` properties, respectively). We recommend that you consistently use these properties to clearly define the meaning of the tags you create within Synapse.

Synapse's forms (the data model) and your set of tags (analytical model) should convey key relationships and assessments in a concise way. Your ability to view nodes and tags and understand their meaning should be simpler (and faster) than reading a report about why an analyst interprets X to mean Y.

That said, tags are a "shorthand" used to represent specific observations and annotations. The meaning of a tag such as `cno.infra.anon.tor` may not be readily apparent. There is a risk that different analysts may interpret and use the same tag in different ways. This risk increases as both the number of tags and the number of different analysts increases.

Storing a tag's definition directly within Synapse on the associated `syn:tag` node makes Synapse "self-documenting": an analyst can view the tag's definition at any time directly within Synapse. You do not need to refer to an external application or dictionary to look up a tag's precise meaning and appropriate use.

Tag Management

Because tags are simply nodes, any user with the appropriate permissions can create a new tag. This ability to create tags on the fly makes tags extremely powerful, flexible, and convenient for analysts – they can create annotations to reflect their observations right when they are conducting analysis, without the need to wait for code changes or approval cycles.

There is also some risk to this approach, particularly with large numbers of analysts, as analysts may create tags in an uncoordinated and haphazard fashion. Creating arbitrary (and potentially duplicative or contradictory) tags can work against effective analysis.

Your approach to tag creation and approval will depend on your needs and your environment. Where possible, we recommend a middle ground between "tag free-for-all" and "tightly-enforced change management". It is useful for an analyst to have the ability to create a tag on demand to record an observation in the moment; if the analyst must wait for review and approval, the observation is likely to be lost as the analyst moves on to other tasks. That said, it is also helpful to have some type of regular review process to ensure the tags are being used in a consistent manner, fit appropriately into your analytical model, and have been given clear definitions.

Level of Detail

Tag trees can be arbitrarily deep (that is, can support an arbitrary number of tag elements). If one function of tag trees is to represent an increasing level of detail, then deep tag trees can potentially represent very fine-grained observations.

While more detail is sometimes helpful, tag trees should reflect the level of detail that is relevant for **your** analysis, and no more. That is, **the analysis being performed should drive the set of tags being used.**

Contrast this with taking an arbitrary model or taxonomy and using it to create associated tags without considering whether that taxonomy is relevant or applicable to your analysis. In the best case, using a set of tags that is not well-suited is simply be unnecessary - it may provide more detail than you really need. In the worst case, it can actually create **more** work for analysts and be detrimental to the analysis process.

Tags often represent an analytical assertion - this generally means that **a human analyst** needs to evaluate the data, make an assessment, and decide what tag (or tags) to apply to the data. If you use too many tags, or overly detailed (deep) tags, this translates directly in to "more work" (keystrokes or mouse clicks) that an analyst has to perform to annotate the data. There is also overhead associated with tag creation itself, particularly if someone needs to review or approve newly created tags.

More importantly, while the act of **applying a tag** to a node may be relatively easy, the **analytical decision** to apply the tag may require careful review and evaluation of the evidence. If tags are overly detailed and represent shades of meaning that are irrelevant, analysts may get bogged down in "analysis paralysis" - worrying about whether tag A or tag B is correct when that distinction doesn't matter to the analysis at hand.

In that situation, the (inappropriate or overly detailed) tags are driving the analysis instead of the analysis driving the tags needed to support the analytical work. When tags drive the analysis, the act of annotating the data - figuring out which tags to apply - takes over from performing real analysis.

Tip: When designing a tag tree, we recommend that tags have no more than five elements. For example:

```
syn:tag = foo.bar.baz.faz.fuzz
```

As always, your specific use case may vary but this works well as general guidance.

Flexibility

Just as a good data model evolves to meet changing needs, your analytical model (tag trees) will expand and change over time. No matter how carefully you plan your tag structure, you will identify exceptions, edge cases, and new observations that you want to capture. As far as possible, your tag structure should be flexible enough to account for future changes.

Within Synapse, it is relatively easy to "migrate" tags (i.e., to decide that a tag should have a different name or reside in a different part of the tag tree, and to re-tag existing nodes with the new tag) **as long as the change is one-to-one.** Migration works best where the tag **name** changes but the **meaning** of the tag does not. (See the Storm *movetag* command for details.)

For example, if you decide that `foo.bar.baz.hurr` and `foo.bar.baz.derp` are overly specific and should both be represented by `foo.bar.baz`, it is easy to merge those tags. Similarly, if you create the tag `foo.bar` and later decide that tag should live under the top-level tag `wut`, you can migrate `foo.bar` to `wut.foo.bar`.

This flexibility provides a safety net when designing your tag trees. It gives you the freedom to "not get it right" the first time (or the second, or the third!). Especially when you roll out a new set of tags, it is helpful to test them in practice before you finalize the tags or tag structure. The ability to say "if we don't get it quite right we can rename it later" frees up analysts or developers to experiment.

It is harder to modify tags by "splitting" them. For example, if you create the tag `foo.bar` and later decide that you really want to track two variations of `bar` (such as `foo.bar.um` and `foo.bar.wut`), it can be painstaking to review your existing `foo.bar` nodes to separate them into the appropriate categories.

Precision

Each tag should have a single, specific meaning. This means that each assessment represented by a tag can be evaluated (and the associated tags applied) independently. If you combine multiple assessments into a single tag, then you run into problems if one portion of that assessment turns out to be true and another portion turns out to be false.

As a simple example, let's say you want to tag indicators with both the threat group and malware family the indicator is associated with. It might be tempting to create a tag such as:

- `syn:tag = cno.viciouswombat.redtree`

...to show that an indicator with that tag (such as an FQDN) is associated with both the Vicious Wombat threat group and the Redtree malware family.

That's all well and good, until:

- You find out that the FQDN is used by both Redtree and Blueflower malware.
- You change your mind and decide the FQDN is associated with the Paisley Unicorn threat group, not Vicious Wombat.

By limiting a tag's meaning to a single assessment or assertion, you can easily change or remove the individual tag if that particular assessment changes:

- `syn:tag = cno.threat.viciouswombat`
- `syn:tag = cno.threat.paisleyunicorn`
- `syn:tag = cno.mal.redtree`
- `syn:tag = cno.mal.blueflower`

Consistency of Use

Creating a set of well-designed tag trees is ineffective if those tags aren't used consistently – that is, by a majority of analysts across a majority of relevant data. It's true that 100% visibility into a given data set and 100% analyst review and annotation of that data is an unrealistic goal. However, for data and annotations that represent your **most pressing** analytical questions, you should strive for as much completeness as possible.

Looked at another way, inconsistent use of tags can result in gaps that can skew your assessment of the data. At best, this can lead to the inability to draw meaningful conclusions; at worst, to faulty analysis.

This inconsistency often occurs as both the number of analysts and the number of tags increase. The larger the team of analysts, the more difficult it is for that team to work closely and consistently together. Similarly, the more tags available to represent different assessments, the fewer tags an analyst can reasonably work with. In both cases, analysts may tend to drift towards analytical tasks that are most immediately relevant to their work or most interesting to them – thus losing sight of the collective analytical goals of the entire team.

Consider an example of tracking Internet domains that masquerade as legitimate companies for malicious purposes. If some analysts are annotating this data but others are not, your ability to answer questions about this data is skewed. Let's say Threat Cluster 12 is associated with 200 domains, and 173 of them imitate real companies, but only 42 have been annotated with "masquerade" tags (`cno.ttp.se.masq`).

If you try to use the data to answer the question "does Threat Cluster 12 consistently register domains that imitate valid companies?", your assessment is likely to be "no" (only 42 out of 200 domains have the associated tag) based on the incompletely annotated data. There are gaps in your analysis because the information to answer this question has only been partially recorded.

As the scope of analysis within Synapse increases, it is essential to recognize these gaps as a potential shortcoming that may need to be addressed. Options include:

- Establish policy around which assessments and observations (and associated tags) are essential or "required", and which are secondary ("as time allows").
- Designate individual analysts or teams to be responsible for particular tasks and associated tags - often matching their expertise, such as "malware analysis".
- Leverage Synapse's tools such as triggers, cron jobs, or macros to apply tags in cases where this can be automated. Automation also helps to ensure tags are applied consistently. (See *Storm Reference - Automation* for a more detailed discussion of Synapse's automation tools.)

3.4.3 Design Concepts - General

In designing both data and analytical models, one of the first choices that must be made is whether something should be represented as:

- a form
- a property
- a light edge
- a tag
- a tag associated with a form

Every modeling decision is unique, and a full discussion of the modeling process is beyond the scope of these documents. We include some basic guidance below as background.

Forms

In the majority of cases, if there is something you want to represent in Synapse, it should be a form. Synapse's data model can represent everything from objects, to relationships, to events as forms. (See *Data Model - Object Categories* for a more detailed discussion.)

As part of Synapse's data model, forms are more structured and less likely to change. This structure allows you to more easily identify relationships between objects in Synapse and to navigate the data. Forms should be used to represent things that are observable or verifiable at some level - this is true even for more abstract forms like "vulnerabilities" (`risk:vuln`) or "goals" (`ou:goal`). If something represents an assessment or conclusion, it is likely a better candidate for a tag.

In designing a form, we recommend not "over-fitting" the form to a specific use case. As a simple example, an email address is an email address - there is no difference between a email address used as an email sender and an email address used to register a domain. Creating two separate objects for `email:sender` and `email:registrant` confuses the **object** (an email address) with **how the object is used**. The "how" is apparent in other parts of the data model (e.g., when used as an email sender, the email address will be present in the `:from` property of an `inet:email:message`).

We also recommend designing forms broadly - this may require some out-of-the-box thinking to consider how the form may apply to other fields, disciplines, or even locales ("how something works" in the United States may be different from how it works in Argentina or Malaysia).

Properties

Properties are details that further define a form. When creating a form, there are probably a number of "things you want to record" about the form that immediately come to mind. These are obvious candidates for properties.

A few considerations when designing properties:

- Properties should be highly "intrinsic" to their forms. The more closely related something is to an object, the more likely it should be a property of that object. Things that are not highly intrinsic are better candidates for their own forms, for "relationship" forms, or for tags.
- Consider whether a property has enough "thinghood" to also be its own form (and possibly type).
- The data model supports multi-value *array* properties, but arrays are not meant to store an excessive number of values (largely for performance and visualization purposes). In this situation, a "relationship" form might be preferable. Another option would be to "reverse" the property relationship.

  For example, a compromise (`risk:compromise`) may consist of a number of different attacks (`risk:attack` nodes) representing steps in the overall compromise. Instead of `risk:compromise` having an `:attacks` array with a large number of values, a `risk:attack` has a `:compromise` property so that multiple attacks can be linked back to a single compromise.

Light Edges

In Synapse, it is preferable to represent most relationships as forms in the data model, as forms support the use of additional descriptive properties as well as tags for context. However, light edges can replace "relationship" forms where:

- **Additional properties or tags are unnecessary.** That is, the only thing you need to record is that the relationship exists. In this case, a light edge can provide some performance gains over a relationship form.
- **The relationship you are representing could exist between a broad range of objects** (vs. two specific kinds of objects). This is best illustrated with some examples.

  A DNS A record represents a specific relationship between an FQDN (`inet:fqdn`) and the IP address (`inet:ipv4`) that the A record points to. This specific relationship will never exist between any other objects - an

FQDN's A record will never point to a MAC address, and a file will never resolve to an IP. A form (`inet:dns:a`) is appropriate here because the objects in the relationship are consistent - there is a one-to-one "A record" relationship between FQDNs and IPv4 addresses.

Other relationships may be "one-to-many" or "many-to-many" in that the object on one or both sides of the relationship may vary.

A data source (`meta:source` node) can observe or provide data on various objects (such as a hash or an FQDN). Creating a relationship form to represent each possible combination of `meta:source` node and object complicates the data model. This "one-to-many" relationship can be represented more efficiently with a `seen` light edge.

Similarly, a variety of objects such as articles (`media:news`), presentations (`ou:presentation`), or files (`file:bytes`) may contain references to a range of objects of interest, from indicators to people to events. This "many-to-many" relationship can be represented more efficiently with a `refs` (references) light edge.

See *Lightweight (Light) Edge* for additional discussion.

Note: Digraph nodes (also known as 'edge nodes') were previously used to account for these types of arbitrary (one-to-many or many-to-many) relationships but the use of light edges is now preferred. See *Digraph (Edge) Form* for additional discussion.

Tags

Tags should be used for:

- Observations or assessments that may change. The flexibility to add, remove, and migrate or change tags makes them useful to represent information that may be re-evaluated over time.
- Any time you need to arbitrarily group nodes to identify a subset of data or otherwise aid your analysis. For example:
  - `media:news` nodes can represent a wide range of publications, from public whitepapers to internal incident reports. Tags could be used to identify different types of `media:news` nodes to make certain nodes easier to select (lift).
  - Data tracked using tags (such as indicators or other objects associated with threat clusters - i.e., `#cno.threat.<threat>`) can easily grow to tens or hundreds of thousands of nodes. A report on the threat group will not include every tagged node. A tag can be used to indicate the "key" nodes / data points / items of interest that form the basis of a report. (The Vertex Project uses "story" tags and subtags to represent key elements of a report / "story" - for example `vtx.story.<storyname>`, `vtx.story.<storyname>.core`, etc.)
- Cases where having a tag **on a node** provides valuable context for an analyst looking at the node (i.e., knowing that an IP address is a TOR exit node). While this same context may be available by examining nearby connections in the data model (e.g., an IP address may be linked to a server with an open port running the TOR service), having the context on the node itself is particularly useful.

Tags can also be used as an initial or interim means to track or record observations before transitioning to a more structured representation using the Synapse data model. For example, cyber threat intelligence often tracks targeted organizations based on the industry or industries they are a part of. This can be modeled in Synapse by linking an organization (`ou:org` node) to a set of industries (`ou:industry`) that the organization belongs to. But it is up to Synapse users to decide on and create the set of named industries (`ou:industry` nodes) that are most useful to their analysis.

It may be easier to initially represent industries using tags placed on `ou:org` nodes (such as `#ind.finance` or `#ind.telecommunications`). This allows you to "try out" (and easily change) a set of industries / industry names before

making a final decision. Later you can create the `ou:industry` nodes and convert the tags into model elements.

Tags Associated with Forms

In some cases, it may be useful to leverage both tags **and** forms for your analysis. This is useful in cases where both of the following apply:

- The tag is associated with an assertion about something "concrete" (such as an event or entity) where that object should exist in its own right (i.e., as a node). This allows you to:
  - record information about the object (properties or other tags).
  - identify relationships (such as shared property values) with other objects.
  - navigate to related objects within Synapse.
- The tag is still useful in order to provide valuable context to **other nodes**, where this context would not be clear if a user had to identify it by navigating to other "nearby" data.

To address this need, forms in the Synapse data model can be directly linked to a tag (`syn:tag` node) they are associated with via an explicit `:tag` property. This allows you to still apply the relevant tag to other nodes for context, but easily navigate from nodes that have the tag, to the associated `syn:tag` node, to the node associated with the tag (via the `:tag` property).

An example from cyber threat intelligence is the idea of a threat group or threat cluster. A "threat group" is often a notional concept that represents an unknown organization or set of individuals responsible for a set of malicious activity. It is common to use tags (`#cno.threat.t42`) applied to nodes (such as FQDNs, files, hashes, and so on) to associate those indicators with a specific threat group. This is valuable context to immediately identify that an indicator is "bad" and associated with known activity.

But threat groups - even notional ones - still ultimately represent something in the real world. It is useful to record additional information about the threat group, such as other names the group is known by, or a known or suspected country of origin. Representing this information as properties makes it easier to query and pivot across, and provides greater flexibility over trying to somehow record all of this information on the node `syn:tag=cno.threat.t42`.

Since **both** approaches are useful, the threat group can be represented as a `risk:threat` node with associated properties, but **also** linked to its associated tag (`syn:tag = cno.threat.t42`) via the `risk:threat:tag` property.

Tip: Tracking threat activity is a good example of how initially using tags can evolve into more concrete and structured representation in the Synapse data model. When researchers identify activity that cannot be associated with a known threat, they commonly create a new threat cluster to track the new incident and associated data. Because little is known about the activity (and associated threat), it's easiest to simply create a tag to represent this. As additional related activity is identified, this new threat may be linked to (and merged with) an existing group (`risk:threat` node). Or, the new threat cluster may grow on its own to the point where researchers believe it is its own entity - at which point a new `risk:threat` node can be created. If, over time, the threat can be tied to a real world entity or organization, the `risk:threat` can be linked to an organization (`ou:org`) via the `risk:threat:org` property.

3.5 Tools

3.5.1 storm

The Synapse Storm tool (commonly referred to as the **Storm CLI**) is a text-based interpreter that leverages the Storm query language (see *Storm Reference - Introduction*).

- *Connecting to a Cortex with the Storm CLI*
- *Storm CLI Basics*
- *Accessing External Commands*

Connecting to a Cortex with the Storm CLI

To access the Storm CLI you must use the `storm` module to connect to a local or remote Synapse Cortex.

Note: If you're just getting started with Synapse, you can use the Synapse Quickstart to quickly set up and connect to a local Cortex using the Storm CLI.

To connect to a local or remote Synapse Cortex using the Storm CLI, simply run the Synapse `storm` module by executing the following Python command from a terminal window, where the *<url>* parameter is the URL path to the Synapse Cortex.

```
python -m synapse.tools.storm <url>
```

The URL has the following format:

```
<scheme>://<server>:<port>/<cortex>
```

or

```
<scheme>://<user>:<password>@<server>:<port>/<cortex>
```

if authentication is used.

Example URL paths:

- `cell://vertex/storage` (default if using Synapse Quickstart)
- `tcp://synapse.woot.com:1234/cortex01`
- `ssl://synapse.woot.com:1234/cortex01`

Once connected, you will be presented with the following Storm CLI command prompt:

```
storm>
```

Storm CLI Basics

Once connected to a Synapse Cortex with the Storm CLI, you can execute any Storm queries or Storm commands directly. Detailed information on using the Storm query language to interact with data in a Synapse Cortex can be found in the *Storm Reference*.

To view a list of available **Storm commands,** type `help` from the Storm CLI prompt:

```
storm> help
```

- Detailed help for any command can be viewed by entering `-h` or `--help` after the individual command.

- For additional detail on Storm commands, see *Storm Reference - Storm Commands*.

To exit the Storm CLI, enter `!quit`:

```
storm> !quit
```

- The `!quit` command is technically an "external" (to Storm) command, so must be preceded by the bang (exclamation point) symbol.

Accessing External Commands

You can access a subset of external Synapse tools and commands from within the Storm CLI. External commands differ from native Storm commands in that they are preceded by a bang / exclamation point (`!`) symbol.

You can view the available **external commands** by typing `!help` from the Storm CLI prompt:

```
storm> !help
!export   - Export the results of a storm query into a nodes file.
!help     - List interpreter extended commands and display help output.
!pullfile - Download a file by sha256 and store it locally.
!pushfile - Upload a file and create a file:bytes node.
!quit     - Quit the current command line interpreter.
!runfile  - Run a local storm file.
```

Notably, the Synapse `pushfile` and `pullfile` tools (used to upload and download files from a Synapse storage *Axon*) are accessible from the Storm CLI:

```
storm> !pushfile
```

```
storm> !pullfile
```

See *pushfile* and *pullfile* for additional detail on these tools.

Help for any external command can be viewed by entering `-h` or `--help` after the command:

```
storm> !export -h
```

```
storm> !export --help
```

3.5.2 pushfile

The Synapse `pushfile` command can be used to upload files to a storage Axon (see Axon in the *Synapse Devops Guide*) and optionally create an associated *file:bytes* node in a Cortex.

Large-scale file ingest / upload is best performed using an automated feed / module / API. However, `pushfile` can be useful for uploading one-off files.

Syntax

`pushfile` is executed from an operating system command shell. The command usage is as follows:

```
usage: synapse.tools.pushfile [-h] -a AXON [-c CORTEX] [-r] [-t TAGS] filenames␣
↪[filenames ...]
```

Where:

- `AXON` is the telepath URL to a storage Axon.
- `CORTEX` is the optional path to a Cortex where a corresponding `file:bytes` node should be created.

  - **Note:** while this is an optional parameter, it doesn't make much sense to store a file in an Axon that can't be referenced from within a Cortex.

- `TAGS` is an optional list of tags to be applied to the `file:bytes` node created in the Cortex.
  - `-t` takes a comma separated list of tags.
  - The tag should be specified by name only (i.e., without the # character).
- `-r` recursively finds all files when a glob pattern is used for a file name.
- `filenames` is one or more names (with optional paths), or glob patterns, to the local file(s) to be uploaded.
  - If multiple file names are specified, any tag provided with the `-t` option will be added to **each** uploaded file.

Example

Upload the file `myreport.pdf` to the specified Axon, create a `file:bytes` node in the specified Cortex, and tag the `file:bytes` node with the tag `#sometag` (replace the Axon and Cortex path below with the path to your Cortex. Note that the command is wrapped for readability):

```
python -m synapse.tools.pushfile -a tcp://axon.vertex.link:5555/axon00
  -c tcp://cortex.vertex.link:4444/cortex00 -t sometag /home/user/reports/myreport.pdf
```

Executing the command will result in various status messages (lines are wrapped for readability):

```
2019-07-03 11:46:30,567 [INFO] log level set to DEBUG
  [common.py:setlogging:MainThread:MainProcess]
2019-07-03 11:46:30,568 [DEBUG] Using selector: EpollSelector
  [selector_events.py:__init__:MainThread:MainProcess]

adding tags: ['sometag']
Uploaded [myreport.pdf] to axon
file: myreport.pdf (2606351) added to core
  (sha256:229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0) as myreport.
↪pdf
```

- `adding tags: ['sometag']` indicates the tag `#sometag` was applied to the `file:bytes` node.
- `Uploaded [myreport.pdf] to axon` indicates the file was successfully uploaded to the storage Axon.
- `file: myreport.pdf (2606351) added to core (sha256:229cdde4...5cd40ab0) as myreport.pdf` indicates the `file:bytes` node was created in the Cortex.
  - The message gives the new node's primary property value (`sha256:229cdde419ba9549023de39c6a0ca8af74b45fade2d7`) and also notes the `:name` secondary property value assigned to the node (`myreport.pdf`).
  - `pushfile` sets the `file:bytes:name` property to the base name of the local file being uploaded.

If a given file already exists in the Axon (deconflicted based on the file's SHA256 hash), `pushfile` will not re-upload the file. However, the command will still process any other options, including:

- creating the `file:bytes` node in the Cortex if it does not already exist.
- applying any specified tag.
- setting (or overwriting) the `:name` property on any existing `file:bytes` node with the base name of the local file specified.

For example (lines wrapped for readability):

```
python -m synapse.tools.pushfile -a tcp://axon.vertex.link:5555/axon00
  -c tcp://cortex.vertex.link:4444/cortex00 -t anothertag,athirdtag
    /home/user/reports/anotherreport.pdf

2019-07-03 11:59:03,366 [INFO] log level set to DEBUG
  [common.py:setlogging:MainThread:MainProcess]
2019-07-03 11:59:03,367 [DEBUG] Using selector: EpollSelector
  [selector_events.py:__init__:MainThread:MainProcess]

adding tags: ['anothertag'. 'athirdtag']
Axon already had [anotherreport.pdf]
file: anotherreport.pdf (2606351) added to core
  (sha256:229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0)
    as anotherreport.pdf
```

Note the status indicating the Axon already had the specified file. Similarly, the status noting the `file:bytes` node was added to the Cortex lists the same SHA256 hash as our first upload (i.e., `anotherreport.pdf` has the same SHA256 hash as `myreport.pdf`) and indicates the `:name` property has been updated (as `anotherreport.pdf`).

The `file:bytes` node for the uploaded report can now be viewed in the specified Cortex by lifting (see *Storm Reference - Lifting*) the file using the SHA256 / primary property value from the `pushfile` status output:

```
file:bytes=sha256:229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0

file:bytes=sha256:229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0
    .created = 2019/07/03 18:46:40.542
    :md5 = 23a14d3a4508628e7e09a4c4868dfb17
    :mime = ??
    :name = anotherrepport.pdf
    :sha1 = 99b6b984988581cae681f65b92198ed77609bd11
    :sha256 = 229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0
    :size = 2606351
    #anothertag
    #athirdtag
    #sometag
complete. 1 nodes in 3 ms (333/sec).
```

Viewing the node's properties, we see that Synapse has set the `:name` property and has calculated and set the MD5, SHA1, and SHA256 hash secondary property values, as well as the file's size in bytes. Similarly the two tags from our two example `pushfile` commands have been added to the node.

Alternatively, a glob pattern could be used to upload all PDF files in a given directory:

```
python -m synapse.tools.pushfile -a tcp://axon.vertex.link:5555/axon00
  -c tcp://cortex.vertex.link:4444/cortex00 -t anothertag,athirdtag
    /home/user/reports/*.pdf
```

3.5.3 pullfile

The Synapse `pullfile` command can be used to retrieve (download) one or more files from a storage Axon (see Axon in the *Synapse Devops Guide*).

Syntax

`pullfile` is executed from an operating system command shell. The command usage is as follows:

```
usage: synapse.tools.pullfile [-h] -a AXON [-o OUTPUT] [-l HASHES]
```

Where:

- `AXON` is the telepath URL to a storage Axon.
- `OUTPUT` is the optional directory path where the downloaded file(s) should be written.
  - If no option is specified, the file(s) will be written to the current working directory.
  - It is not possible to specify multiple `-o` options with a single `pullfile` command (i.e., a different `-o` option with each `-l HASH`, for example). If multiple `-o` options are specified, the last `OUTPUT` path specified will be used.
  - Files saved locally are named using their SHA256 hash value.
- `HASHES` is the SHA256 hash(es) of the file(s) to be retrieved.
  - Multiple hashes can be specified, but each must be listed with its own `-l` option (i.e., `-l HASH_0 -l HASH_1 ... -l HASH_n`).

Example

Download the two files with the specified SHA256 hashes from the specified Axon to the local `/home/user/Documents` directory (replace the Axon path below with the path to your Axon. Note that the command is wrapped for readability):

```
python -m synapse.tools.pullfile -a tcp://axon.vertex.link:5555/axon00
  -o /home/user/Documents
  -l 229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0
  -l 52c672f45adacca4878461c1bdd5800af8518e675819a0bdcd5c64a72075a478
```

Executing the command will result in various status messages showing the query and successful retrieval of the file(s):

```
Fetching 229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0 to file
Fetched 229cdde419ba9549023de39c6a0ca8af74b45fade2d7a22cdc4105a75cd40ab0 to file
Fetching 52c672f45adacca4878461c1bdd5800af8518e675819a0bdcd5c64a72075a478 to file
Fetched 52c672f45adacca4878461c1bdd5800af8518e675819a0bdcd5c64a72075a478 to file
```

3.5.4 feed

The Synapse `feed` tool is a way to ingest data exported from one Cortex into another Cortex. Users should be familiar with both the Synapse data model (*Data Model - Terminology* et al.) as well as Synapse concepts such as packed nodes and splices in order to use and understand the `feed` tool effectively.

Syntax

The `feed` tool is executed from an operating system command shell. The command usage is as follows (line is wrapped for readability):

```
usage: synapse.tools.feed [-h] (--cortex CORTEX | --test) [--debug] [--format FORMAT] [--
↪modules MODULES]
  [--chunksize CHUNKSIZE] [--offset OFFSET] [files ...]
```

Where: - `-h` displays detailed help and these command line options - `CORTEX` specifies the telapth URL to the Cortex where the data should be ingested.

- `--test` means to perform the ingest against a temporary, local Cortex instead of a live cortex, for testing or validation
  - When using a temporary Cortex, you do not need to provide a path.
- `--debug` specifies to drop into an interactive prompt to inspect the state of the Cortex post-ingest.
- `FORMAT` specifies the format of the input files.
  - Currently, only the values "syn.nodes", "syn.splices", and "syn.nodeedits" are supported.
  - Defaults to "syn.nodes" if not specified
- `MODULES` specifies a path to a Synapse CoreModule class that will be loaded into the temporary Cortex.
  - This option has no effect if the `--test` option is not specified
  - For more on Core Modules, see *Cortex Development Quickstart*
- `CHUNKSIZE` specifies how many lines or chunks of data to read at a time from the given files.
  - Defaults to 1000 if not specified
- `OFFSET` specifies how many chunks of data to skip over (starting at the beginning)
- `files` is a series of file paths containing data to load into the Cortex (or temporary Cortex)
  - Every file must be either json-serialized data, msgpack-serialized data, yaml-serialized data, or a json lines file. The files do not have to all be of the same type.

Ingest Examples - Overview

The `feed` tool

Ingest Example 1

This example demonstrates loading a set of nodes via the `feed` tool with the "syn.nodes" format option. The nodes are of a variety of types, and are encoded in a json lines (jsonl) format.

JSONL File:

The jsonl file (`testnodes.jsonl`) contains a list of nodes in their packed form. Each line in the file corresponds to a single node, with all of the properties, tags, and nodedata on the node encoded in a json friendly format.

```
[["it:reveng:function", "9710579930d831abd88acff1f2ecd04f"], {"iden":
↪"508204ebc73709faa161ba8c111aec323f63a78a84495694f317feb067f41802", "tags": {"my":␣
↪[null, null], "my.cool": [null, null], "my.cool.tag": [null, null]}, "props": {".
↪created": 1625069466909, "description": "An example function"},   "tagprops": {},
↪"nodedata": {}, "path": {}}]
[["inet:ipv4", 386412289], {"iden":
↪"d6270ca2dc592cd0e8edf8c73000f80b63df4bcd601c9a631d8c68666fdda5ae", "tags": {"my":␣
↪[null, null], "my.cool": [null, null], "my.cool.tag": [null, null]}, "props": {".
↪created": 1625069584577, "type": "unicast"}, "tagprops": {}, "nodedata": {}, "path": {}
↪}]
[["inet:url", "https://synapse.docs.vertex.link/en/latest/synapse/userguide.html
↪#userguide"], {"iden":
↪"dba0a280fc1f8cf317dffa137df0e1761b6f94cacbf56523809d4f17d8263840", "tags": {"my":␣
↪[null, null], "my.cool": [null, null], "my.cool.tag": [null, null]}, "props": {".
↪created": 1625069758843, "proto": "https", "path": "/en/latest/synapse/userguide.html
↪#userguide", "params": "", "fqdn": "synapse.docs.vertex.link", "port": 443, "base":
↪"https://synapse.docs.vertex.link/en/latest/synapse/userguide.html#userguide"},
↪"tagprops": {}, "nodedata": {}, "path": {}}]
[["file:bytes", "sha256:ffd19426d3f020996c482255b92a547a2f63afcfc11b45a98fb3fb5be69dd75c
↪"], {"iden": "137fd16d2caab221e7580be63c149f83a11dd11f10f078d9f582fedef9b57ad5", "tags
↪": {"my": [null, null], "my.cool": [null, null], "my.cool.tag": [null, null]}, "props
↪": {".created": 1625070470041, "sha256":
↪"ffd19426d3f020996c482255b92a547a2f63afcfc11b45a98fb3fb5be69dd75c", "md5":
↪"be1bb5ab2057d69fb6d0a9d0684168fe", "sha1": "57d13f1fa2322058dc80e5d6d768546b47238fcd",
↪ "size": 16}, "tagprops": {}, "nodedata": {}, "path": {}}]
```

Verifying the Data:

Typically, users will want to double check the data they have before loading it into a production Cortex. The `feed` tool allows us to perform an ingest our of nodes file against an empty, ephemeral Cortex, so that we can check what nodes get created before slamming them into production. To load `testnodes.jsonl` into an ephemeral Cortex and drop into a prompt to explore the ingested nodes, run:

```
python -m synapse.tools.feed --test --debug --format syn.nodes testnodes.jsonl
```

Assuming the command completed with no errors, we should now have a `cmdr` prompt connected to our test Cortex:

```
cli>
```

From which we can issue Storm commands to interact with and validate the nodes that were just ingested. For example:

```
cli> storm #my.cool.tag

it:reveng:function=9710579930d831abd88acff1f2ecd04f
        .created = 2021/06/30 19:46:31.810
```

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```
        :description = An example function
        #my.cool.tag
inet:ipv4=23.8.47.1
        .created = 2021/06/30 19:46:31.810
        :type = unicast
        #my.cool.tag
inet:url=https://synapse.docs.vertex.link/en/latest/synapse/userguide.html#userguide
        .created = 2021/06/30 19:46:31.810
        :base = https://synapse.docs.vertex.link/en/latest/synapse/userguide.html
↪#userguide
        :fqdn = synapse.docs.vertex.link
        :params =
        :path = /en/latest/synapse/userguide.html#userguide
        :port = 443
        :proto = https
        #my.cool.tag
file:bytes=sha256:ffd19426d3f020996c482255b92a547a2f63afcfc11b45a98fb3fb5be69dd75c
        .created = 2021/06/30 19:46:31.810
        :md5 = be1bb5ab2057d69fb6d0a9d0684168fe
        :sha1 = 57d13f1fa2322058dc80e5d6d768546b47238fcd
        :sha256 = ffd19426d3f020996c482255b92a547a2f63afcfc11b45a98fb3fb5be69dd75c
        :size = 16
        #my.cool.tag
complete. 4 nodes in 16 ms (250/sec).
```

Loading the Data:

Once we've inspected and verified the data is acceptable for loading, we can point the `feed` tool to the Cortex we want to load the nodes into, and the same nodes should be added.

```
python -m synapse.tools.feed --cortex tcp://cortex.vertex.link:4444/cortex00 --format
↪'syn.nodes'
  testnodes.jsonl
```

However, once we've inspected the data, let's say that the it:reveng:function and inet:ipv4 nodes are not allowed in the production Cortex, but the inet:url and file:bytes are. We can skip these two nodes by using a combination of the `chunksize` and `offset` parameters:

```
python -m synapse.tools.feed --cortex tcp://cortex.vertex.link:4444/cortex00 --format
↪'syn.nodes'
  testnodes.jsonl --chunksize 1 --offset 1
```

With the `chunksize` parameter signifying that the `feed` tool should read two lines at a time from the file and process those before reading the next line, and the `offset` parameter meaning the `feed` tool should skip all lines before and including line 1 (so lines 1 and 0) when attempting to add nodes, and only add nodes once it's read in lines 2 and beyond.

Ingest Example 2

This example demonstrates loading a series of splices via the "syn.splices" format option. Splices are atomic edits made to the Cortex, so they are more granular, and thus more voluminous than just nodes. For instance, the storm command `[it:host=1cad54991eaff5bba5d2015c29c3e3a3 :desc="synapse server" :name="syn007"]` results in this set of splices (which have been saved to `testsplices.yaml`).

```
---
- - node:add
  - ndef:
    - it:host
    - 1cad54991eaff5bba5d2015c29c3e3a3
    time: 1625087167677
    user: 267d945a32e3ae246ecf71e0bc6a620e
- - prop:set
  - ndef:
    - it:host
    - 1cad54991eaff5bba5d2015c29c3e3a3
    oldv: null
    prop: .created
    time: 1625087167677
    user: 267d945a32e3ae246ecf71e0bc6a620e
    valu: 1625087167677
- - prop:set
  - ndef:
    - it:host
    - 1cad54991eaff5bba5d2015c29c3e3a3
    oldv: null
    prop: desc
    time: 1625087167679
    user: 267d945a32e3ae246ecf71e0bc6a620e
    valu: synapse server
- - prop:set
  - ndef:
    - it:host
    - 1cad54991eaff5bba5d2015c29c3e3a3
    oldv: null
    prop: name
    time: 1625087167680
    user: 267d945a32e3ae246ecf71e0bc6a620e
    valu: syn007
- - node:add
  - ndef:
    - it:hostname
    - syn007
    time: 1625087167680
    user: 267d945a32e3ae246ecf71e0bc6a620e
- - prop:set
  - ndef:
    - it:hostname
    - syn007
    oldv: null
    prop: .created
```

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```
    time: 1625087167680
    user: 267d945a32e3ae246ecf71e0bc6a620e
    valu: 1625087167680
...
```

Verifying the Data:

To load `testsplices.yaml` into a test Cortex to see the splices getting applied, we can run the `feed` tool like so:

```
python -m synapse.tools.feed --test --debug --format "syn.splice" testsplices.yaml
```

Which drops us into a `cmdr` prompt, where we can verify that the `it:host` node and `it:hostname` nodes were created:

```
cli> storm it:host

it:host=1cad54991eaff5bba5d2015c29c3e3a3
      .created = 2021/06/30 21:34:57.181
      :desc = synapse server
      :name = syn007

complete. 1 nodes in 5 ms (200/sec).

cli> storm it:hostname

it:hostname=syn007
      .created = 2021/06/30 21:34:57.182
complete. 1 nodes in 5 ms (200/sec).
```

Loading the Data:

As before, once the data has been inspected and approved, we can point the `feed` tool at the Cortex we want to apply the splices to in order to apply them.

```
python -m synapse.tools.feed --cortex tcp://cortex.vertex.link:4444/cortex00 --format
↪'syn.splice'
  testsplices.yaml
```

3.5.5 csvtool

The Synapse `csvtool` command can be used to ingest structured data from a comma-separated values (CSV) file to create nodes in a Cortex. `csvtool` is useful for bulk-loading CSV-formatted data without the need to develop custom ingest code. (For other data formats such as JSON, yaml, or msgpack, see *feed*.)

The `--export` option can be used to export a set of data from a Cortex into a CSV file.

Storm queries are used both to ingest and export data using `csvtool`. Users should be familiar with the Storm query language (*Storm Reference - Introduction* et al.) and the Synapse data model (*Data Model - Terminology* et al.) in order to use `csvtool` effectively.

The Storm syntax used with `csvtool` makes use of a few more advanced Storm concepts such as variables, methods, libraries, and some programming flow control concepts (e.g., for loops and switch statements). However, the examples below should be fairly self-explanatory. In other words, users do **not** need to understand in detail how those concepts work in order to create basic `stormfile` queries and start loading data using `csvtool`.

That said, the set of advanced Storm concepts and features can be fully leveraged within a `stormfile` to perform complex data ingest. Interested users are encouraged to refer to the appropriate sections of the Storm reference documents for a more detailed discussion of those concepts, which may be useful for creating more complex `stormfile` queries (or Storm queries in general).

- *Storm Reference - Subqueries*
- *Storm Reference - Advanced - Variables*
- *Storm Reference - Advanced - Methods*
- *Storm Reference - Advanced - Control Flow*
- *Storm Libraries*
- *Storm Types*

Syntax

`csvtool` is executed from an operating system command shell. The command usage is as follows (line is wrapped for readability):

```
usage: synapse.tools.csvtool [-h] [--logfile LOGFILE] [--csv-header] [--cli] [--debug]
  (--cortex CORTEX | --test) [--export] stormfile csvfiles [csvfiles ...]
```

Where:

- `-h` displays detailed help and examples.
- `LOGFILE` is the optional name / path to log Storm events associated with running the `csvtool` command as a JSONL file. Messages are appended to this file when they are written to them.
- `--csv-header` is an option that indicates the first row in the CSV file is a header row and should be skipped for purposes of parsing and node creation.
- `--cli` opens a `cmdr` command prompt after `csvtool` exits.
  - The command prompt will be connected to the Cortex specified by the `--cortex CORTEX` or `--test` option.
- `--debug` will send verbose output to `stdout` during execution.
- `CORTEX` specifies the telepath URL to the Cortex where the data should be ingested.
- `--test` specifies the data should be loaded into a temporary local Cortex (i.e., for testing / validation).
  - When using a temporary Cortex, you do not need to provide a path.
- `--export` is used to extract data from the specified Cortex into a CSV file.
- `stormfile` is the name / path to a file containing a Storm query that tells Synapse how to ingest the CSV data (or how to lift and export data if the `--export` option is used).
- `csvfiles` is the name / path to one or more CSV files containing the data to be ingested (or the name/path where the CSV output should be written if the `--export` option is used).
  - If multiple `csvfiles` are listed for ingest, they are all processed with the specified `stormfile`.
  - Only a single `csvfile` can be specified for output with `--export`.

Note: The same events are output by both `--logfile` and `--debug`; one is written to file and the other is written to `stdout`.

help

The detailed help (-h) output for csvtool is shown below (lines are wrapped for readability).

```
python -m synapse.tools.csvtool -h

usage: synapse.tools.csvtool [-h] [--logfile LOGFILE] [--csv-header] [--cli] [--debug]
  (--cortex CORTEX | --test) [--export] stormfile csvfiles [csvfiles ...]

Command line tool for ingesting csv files into a cortex

The storm file is run with the CSV rows specified in the variable "rows" so most storm␣
↪files
  will use a variable based for loop to create edit nodes.  For example:

for ($fqdn, $ipv4, $tag) in $rows {
    [ inet:dns:a=($fqdn, $ipv4) +#$tag ]
}

More advanced uses may include switch cases to provide different logic based on a
  column value.

for ($type, $valu, $info) in $rows {

    switch $type {
        fqdn: {
            [ inet:fqdn=$valu ]
        }

        "person name": {
            [ ps:name=$valu ]
        }

        *: {
            // default case...
        }
    }

    switch $info {
        "known malware": { [+#cno.mal] }
    }
}

positional arguments:

stormfile             A STORM script describing how to create nodes
                      from rows.
csvfiles              CSV files to load.

optional arguments:
-h, --help            show this help message and exit
--logfile LOGFILE     Set a log file to get JSON lines from the
                      server events.
```

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```
--csv-header          Skip the first line from each CSV file.
--cli                 Drop into a cli session after loading data.
--debug               Enable verbose debug output.
--cortex CORTEX, -c CORTEX
                      The telepath URL for the cortex ( or alias
                      from ~/.syn/aliases ).
--test, -t            Perform a local CSV ingest against a temporary
                      cortex.
--export              Export CSV data to file from storm using
                      $lib.csv.emit(...) events.
```

Ingest Examples - Overview

The key components for using the `csvtool` command are the CSV file itself (`csvfile`) and the file containing the Storm query (`stormfile`) used to ingest the data.

The `stormfile` contains a Storm query to describe how the data from the CSV file(s) should be used to create nodes in a Cortex, including optionally setting properties and / or adding tags.

Note: When ingesting large sets of CSV-formatted data where the data has not been vetted, it may be useful to use the *Edit "Try" Operator (?=)* operator instead of the equivalent (=) operator within the Storm syntax in the `stormfile` used to create nodes. When using the try operator (?=), Storm will process what it can, creating nodes from "well-formatted" data and simply skipping rows that may contain bad data. In contrast, using the equivalent operator (=) will result in Storm throwing an error and halting processing if bad data is encountered.

Ingest Example 1

This example demonstrates loading a structured set of data to create nodes of a single form (in this case, DNS A records) and set secondary properties (in this case, the `.seen` universal property).

CSV File:

A CSV file (`testfile.csv`) contains a list of domains, the IP addresses the domains have resolved to, and the first and last observed times for the resolution, as represented by the example header and row data below:

```
domain,IP,first,last
woot.com,1.2.3.4,2018/04/18 13:12:47,2018/06/23 09:45:12
hurr.net,5.6.7.8,2018/10/03 00:47:29,2018/10/04 18:26:06
derp.org,4.4.4.4,2019/06/09 09:00:18,2019/07/03 15:07:52
```

Note: Because the file contains a header row, we need to use the `--csv-header` option to tell `csvtool` to skip the first row when ingesting data.

We want to load the data in the CSV file into a Cortex as a set of DNS A records (`inet:dns:a` nodes) with the first and last dates represented as the `.seen` universal property.

Stormfile:

Storm references the set of rows in the CSV file by the *$rows* built-in variable. We need to define a set of variables (see *Storm Reference - Advanced - Variables*) and to represent each field in a row (i.e., each column in the CSV file) and

tell Storm to iterate over each row using a *For Loop*. For example:

```
for ($fqdn, $ipv4, $first, $last) in $rows
```

This assigns the variable `$fqdn` to the first column (i.e., the one containing `woot.com`), `$ipv4` to the second column, and so on, and sets up the "for" loop.

We then need a Storm query that tells the "for" loop what to do with each row - that is, how to create the DNS A records from each row in the CSV file:

```
[ inet:dns:a = ( $fqdn, $ipv4 ) .seen=( $first, $last ) ]
```

We combine these elements to create our `stormfile`, as follows:

```
for ($fqdn, $ipv4, $first, $last) in $rows {

    [ inet:dns:a = ( $fqdn, $ipv4 ) .seen=( $first, $last ) ]

}
```

Testing the Ingest:

Typically, users will want to test that their `stormfile` loads and formats the data correctly by first ingesting the data into a local test cortex (`--test`) before loading the data into a production Cortex. This is typically done using either the `--debug` or `--logfile` option to check for errors and reviewing the loaded data (via `--cli`).

Testing the data will highlight common errors such as:

- Invalid Storm syntax in the `stormfile`.
- Data in the CSV file that does not pass *Type* validation on node creation (i.e., bad or incorrect data, such as an IP address in an FQDN column).

We can attempt to load our data into a test Cortex using the following command (line is wrapped for readability):

```
python -m synapse.tools.csvtool --logfile mylog.json --csv-header --cli --test
  stormfile testfile.csv
```

Assuming the command executed with no errors, we should have a `cmdr` CLI prompt for our local test Cortex:

```
cli>
```

We can now issue Storm commands to interact with and validate the data (i.e., did `csvtool` create the expected number of nodes, were the properties set correctly, etc.)

For example:

```
cli> storm inet:dns:a

inet:dns:a=('hurr.net', '5.6.7.8')
    .created = 2019/07/03 22:25:43.966
    .seen = ('2018/10/03 00:47:29.000', '2018/10/04 18:26:06.000')
    :fqdn = hurr.net
    :ipv4 = 5.6.7.8
inet:dns:a=('derp.org', '4.4.4.4')
    .created = 2019/07/03 22:25:43.968
    .seen = ('2019/06/09 09:00:18.000', '2019/07/03 15:07:52.000')
    :fqdn = derp.org
```

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```
    :ipv4 = 4.4.4.4
inet:dns:a=('woot.com', '1.2.3.4')
    .created = 2019/07/03 22:25:43.962
    .seen = ('2018/04/18 13:12:47.000', '2018/06/23 09:45:12.000')
    :fqdn = woot.com
    :ipv4 = 1.2.3.4
complete. 3 nodes in 12 ms (250/sec).
```

Loading the Data:

Once we have validated that our data has loaded correctly, we can modify our `csvtool` command to load the data into a live Cortex (replace the Cortex path below with the path to your Cortex; line is wrapped for readability):

```
python -m synapse.tools.csvtool --logfile mylog.json --csv-header
  --cortex tcp://cortex.vertex.link:4444/cortex00 stormfile testfile.csv
```

Ingest Example 2

This example demonstrates loading a more complex set of data to create nodes of multiple types, apply a single tag to all nodes, and apply custom tags to only some nodes based on additional criteria.

CSV File:

A CSV file (`testfile.csv`) contains a set of malicious indicators, listed by type and the indicator value, as represented by the example header and row data below:

```
Indicator type,Indicator,Description
URL,http://search.webstie.net/,
FileHash-SHA256,b214c7a127cb669a523791806353da5c5c04832f123a0a6df118642eee1632a3,
FileHash-SHA256,b20327c03703ebad191c0ba025a3f26494ff12c5908749e33e71589ae1e1f6b3,
FileHash-SHA256,7fd526e1a190c10c060bac21de17d2c90eb2985633c9ab74020a2b78acd8a4c8,
FileHash-SHA256,b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bfb8405,
hostname,dns.domain-resolve.org,
hostname,search.webstie.net,
```

Note that while the CSV file contains a header field titled “Description”, that field in this particular file contains no data.

Let’s say that in addition to the raw indicators, we know that the indicators came from a blog post describing the activity of the Vicious Wombat threat group, and that the SHA256 hashes are samples of the UMPTYSCRUNCH malware family. To provide additional context for the data in our Cortex, we want to:

- Tag all of the indicators as associated with Vicious Wombat (`#cno.threat.viciouswombat`).
- Tag all of the SHA256 hashes as associated with UMPTYSCRUNCH malware (`#cno.mal.umptyscrunch`).

Stormfile:

Similar to our first example, we need to define a set of variables to represent each column (field) for each row and set up the “for” loop:

```
for ($type, $value, $desc) in $rows
```

In this case, the rows contain different types of data that will be used to create different nodes (forms). The `Indicator type` column (`$type`) tells us what type of data is available and what type of node we should create. We can use a

"switch" statement to tell Storm how to handle each type of data (i.e., each value in the `$type` field). Since we know the SHA256 hashes refer to UMPTYSCRUNCH malware samples, we want to add tags to those nodes:

```
switch $type {

    URL: {
        [ inet:url = $value ]
    }

    FileHash-SHA256: {
        [ hash:sha256 = $value +#cno.mal.umptyscrunch ]
    }

    hostname: {
        [ inet:fqdn = $value ]
    }
}
```

Finally, because we know all of the indicators are associated with the Vicious Wombat threat group, we want to add a tag to all of the indicators. We can add that after the "switch" statement:

```
[ +#cno.threat.viciouswombat ]
```

So our full `stormfile` script looks like this:

```
for ($type, $value, $desc) in $rows {

    switch $type {

        URL: {
            [ inet:url = $value ]
        }

        FileHash-SHA256: {
            [ hash:sha256 = $value +#cno.mal.umptyscrunch ]
        }

        hostname: {
            [ inet:fqdn = $value ]
        }
    }

    [ +#cno.threat.viciouswombat ]
}
```

Testing the Ingest:

We can now test our ingest by loading the data into a test Cortex (line is wrapped for readability):

```
python -m synapse.tools.csvtool --logfile mylog.json --csv-header --cli --test
  stormfile testfile.csv
```

From the `cmdr` CLI, we can now query the data to make sure the nodes were created and the tags applied correctly. For example:

Check that two `inet:fqdn` nodes were created and given the `#cno.threat.viciouswombat` tag:

```
cli> storm inet:fqdn#cno

inet:fqdn=search.webstie.net
    .created = 2019/07/05 14:49:20.110
    :domain = webstie.net
    :host = search
    :issuffix = False
    :iszone = False
    :zone = webstie.net
    #cno.threat.viciouswombat
inet:fqdn=dns.domain-resolve.org
    .created = 2019/07/05 14:49:20.117
    :domain = domain-resolve.org
    :host = dns
    :issuffix = False
    :iszone = False
    :zone = domain-resolve.org
    #cno.threat.viciouswombat
complete. 2 nodes in 14 ms (142/sec).
```

Check that four `hash:sha256` nodes were created and given both the Vicious Wombat and the UMPTYSCRUNCH tags:

```
cli> storm hash:sha256

hash:sha256=7fd526e1a190c10c060bac21de17d2c90eb2985633c9ab74020a2b78acd8a4c8
    .created = 2019/07/05 14:49:20.115
    #cno.mal.umptyscrunch
    #cno.threat.viciouswombat
hash:sha256=b20327c03703ebad191c0ba025a3f26494ff12c5908749e33e71589ae1e1f6b3
    .created = 2019/07/05 14:49:20.115
    #cno.mal.umptyscrunch
    #cno.threat.viciouswombat
hash:sha256=b214c7a127cb669a523791806353da5c5c04832f123a0a6df118642eee1632a3
    .created = 2019/07/05 14:49:20.113
    #cno.mal.umptyscrunch
    #cno.threat.viciouswombat
hash:sha256=b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bfb8405
    .created = 2019/07/05 14:49:20.116
    #cno.mal.umptyscrunch
    #cno.threat.viciouswombat
complete. 4 nodes in 3 ms (1333/sec).
```

Loading the Data:

Once the data has been validated, we can load it into our live Cortex (replace the Cortex path below with the path to your Cortex; line is wrapped for readability):

```
python -m synapse.tools.csvtool --logfile mylog.json --csv-header
  --cortex tcp://cortex.vertex.link:4444/cortex00 stormfile testfile.csv
```

Export Examples - Overview

The `--export` option allows you to export a set of data from a Cortex into a CSV file.

When `--export` is used:

- `stormfile` contains:
  - the Storm query that specifies the data to be exported; and
  - a statement telling Storm how to format and generate the rows of the CSV file.
- `csvfile` is the location where the data should be written.

The Storm `$lib.csv` library includes functions for working with CSV files. The `$lib.csv.emit()` function will emit CSV rows; the parameters passed to the function define the data that should be included in each row.

`$lib.csv.emit()` will create one row for each node that it processes (i.e., each node in the Storm "pipeline" that passes through the `$lib.csv.emit()` command), as determined by the preceding Storm query.

Export Example 1

For this example, we will export the data we imported in *Ingest Example 2*. For this simple example, we want to export the set of malicious indicators associated with the Vicious Wombat threat group.

Stormfile:

To lift all the indicators associated with Vicious Wombat, we can use the following Storm query:

```
#cno.threat.viciouswombat
```

We then need to tell `$lib.csv.emit()` how to format our exported data. We want to list the indicator type (its form) and the indicator itself (the node's primary property value).

While this seems pretty straightforward, there are two considerations:

- Given our example above, we have multiple node types to export (`inet:url`, `hash:sha256`, `inet:fqdn`).
- While we can reference any secondary property directly using its relative property name (i.e., `:zone` for `inet:fqdn:zone`), referencing the primary property value is a bit trickier, as is referencing the form of the node.

$node is a built-in Storm variable that represents the **current node** passing through the Storm pipeline. `$node` supports a number of methods (*Storm Reference - Advanced - Methods*) that allow Storm to access various attributes of the current node. In this case:

- The *$node.form()* method will access (return) the current node's form.
- The *$node.value()* method will access (return) the current node's primary property value.

This means we can tell `$lib.csv.emit()` to create a CSV file with a list of indicators as follows:

```
$lib.csv.emit($node.form(), $node.value())
```

So our overall `stormfile` to lift and export all of the Vicious Wombat indicators is relatively simple:

```
#cno.threat.viciouswombat
$lib.csv.emit($node.form(), $node.value())
```

Exporting the Data:

We can now test our export of the data we ingested in *Ingest Example 2* (replace the Cortex path below with the path to your Cortex; line is wrapped for readability):

```
python -m synapse.tools.csvtool --debug --export
  --cortex tcp://cortex.vertex.link:4444/cortex00 stormfile export.csv
```

If we view the contents of `export.csv`, we should see our list of indicators:

```
inet:fqdn,search.webstie.net
hash:sha256,7fd526e1a190c10c060bac21de17d2c90eb2985633c9ab74020a2b78acd8a4c8
inet:fqdn,dns.domain-resolve.org
hash:sha256,b20327c03703ebad191c0ba025a3f26494ff12c5908749e33e71589ae1e1f6b3
hash:sha256,b214c7a127cb669a523791806353da5c5c04832f123a0a6df118642eee1632a3
hash:sha256,b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bfb8405
inet:url,http://search.webstie.net/
```

Export Example 2

For this example, we will export the DNS A records we imported in *Ingest Example 1*. We will create a CSV file that matches the format of our original ingest file, with columns for domain, IP, and first / last resolution times.

Stormfile:

To lift the DNS A records for the domains `woot.com`, `hurr.net`, and `derp.org`, we can use the following Storm query:

```
inet:dns:a:fqdn=woot.com inet:dns:a:fqdn=hurr.net inet:dns:a:fqdn=derp.org
```

In this case we want `$lib.csv.emit()` to include:

- the domain (`:fqdn` property of the `inet:dns:a` node).
- the IP (`:ipv4` property of the `inet:dns:a` node).
- the first observed resolution (the first half of the `.seen` property).
- the most recently observed resolution (the second half of the `.seen` property).

As a first attempt, we could specify our output format as follows to export those properties:

```
$lib.csv.emit(:fqdn, :ipv4, .seen)
```

This exports the data from the relevant nodes as expected, but does so in the following format:

```
woot.com,16909060,"(1524057167000, 1529747112000)"
```

We have a few potential issues with our current output:

- The IP address is exported using its raw integer value instead of in human-friendly dotted-decimal format.
- The `.seen` value is exported into a single field as a combined `"(<min>, <max>)"` pair, not as individual comma-separated timestamps.
- The `.seen` values are exported using their raw Epoch millis format instead of in human-friendly datetime strings.

We need to do some additional formatting to get the output we want in the CSV file.

IP Address

Synapse stores IP addresses as integers, so specifying `:ipv4` for our output definition gives us the raw integer value for that property. If we want the human-readable value, we need to use the human-friendly representation (*Repr*) of the value. We can do this using the *$node.repr()* method to tell Storm to obtain and use the repr value of a node instead of its raw value (*$node.value()*).

`$node.repr()` by itself (e.g., with no parameters passed to the method) returns the repr of the primary property value of the node passing through the runtime. Our original Storm query, above, lifts DNS A records - so the nodes passing through the runtime are `inet:dns:a` nodes, not IPv4 nodes. This means that using `$node.repr()` by itself will return the repr of the `inet:dns:a` node, not the `:ipv4` property.

We can tell `$node.repr()` to return the repr of a specific secondary property of the node by passing the **string** of the property name to the method:

```
$node.repr(ipv4)
```

.seen times

`.seen` is an *ival* (interval) type whose property value is a paired set of minimum and maximum timestamps. To export the minimum and maximum as separate fields in our CSV file, we need to split the `.seen` value into two parts by assigning each timestamp to its own variable. We can do this as follows:

```
($first, $last) = .seen
```

However, simply splitting the value will result in the variables `$first` and `$last` storing (and emitting) the raw Epoch millis value of the time, not the human-readable repr value. Similar to the way in which we obtained the repr value for the `:ipv4` property, we need to assign the human-readable repr values of the `.seen` property to `$first` and `$last`:

```
($first, $last) = $node.repr(".seen")
```

Stormfile

We can now combine all of these elements into a Storm query that:

- Lifts the `inet:dns:a` nodes we want to export.
- Splits the human-readable version of the `.seen` property into two time values and assigns them to variables.
- Generates `$lib.csv.emit()` messages to create the CSV rows.

Our full stormfile query looks like this:

```
inet:dns:a:fqdn=woot.com inet:dns:a:fqdn=hurr.net inet:dns:a:fqdn=derp.org

($first, $last) = $node.repr(".seen")

$lib.csv.emit(:fqdn, $node.repr(ipv4), $first, $last)
```

Warning: The data submitted to `$lib.csv.emit()` to create the CSV rows **must** exist for every node processed by the function. For example, if one of the `inet:dns:a` nodes lifted by the Storm query and submitted to `$lib.csv.emit()` does not have a `.seen` property, Storm will generate an error and halt further processing, which may result in a partial export of the desired data.

Subqueries (*Storm Reference - Subqueries*) or various flow control processes (*Storm Reference - Advanced - Control Flow*) can be used to conditionally account for the presence or absence of data for a given node.

Exporting the Data:

We can now test our export of the data we ingested in *Ingest Example 1* (replace the Cortex path below with the path to your Cortex; line is wrapped for readability):

```
python -m synapse.tools.csvtool --debug --export
  --cortex tcp://cortex.vertex.link:4444/cortex00 stormfile export.csv
```

If we view the contents of `export.csv`, we should see the following:

```
woot.com,1.2.3.4,2018/04/18 13:12:47.000,2018/06/23 09:45:12.000
hurr.net,5.6.7.8,2018/10/03 00:47:29.000,2018/10/04 18:26:06.000
derp.org,4.4.4.4,2019/06/09 09:00:18.000,2019/07/03 15:07:52.000
```

3.5.6 genpkg

The Synapse `genpkg` tool can be used to generate a Storm *Package* containing new Storm commands and Storm modules from a YAML definition and optionally push it to a Cortex or PkgRepo.

Syntax

`genpkg` is executed from an operating system command shell. The command usage is as follows:

```
usage: synapse.tools.genpkg [-h] [--push <url>] [--save <path>] [--optic <path>]
↪<pkgfile>
```

Where:

- `pkgfile` is the path to the Storm Package YAML file.
- `--save` takes a file name to save the completed package JSON as.
- `--push` takes an optional Telepath URL to a Cortex or PkgRepo for the package to be pushed to.
- `--optic` takes an optional path to a directory containing Optic module files.

Package Layout

The expected filesystem layout for a Storm package is:

```
foopkg.yml
storm/
├── commands/
│   └── foocmd
├── modules/
│   └── foomod
└── optic/
    └── index.html
```

Commands and modules defined in the package YAML file are expected to have corresponding files containing the Storm code for their implementation. It is not required to have both commands and modules in a Storm package; you may have a package with only commands, or only modules.

Package YAML

A Storm package YAML may contain the following definitions:

- `name`: Name of the Storm package.
- `version`: Version of the Storm package. A Cortex may contain multiple versions of the same package.
- `synapse_minversion`: Optional minimum required Synapse version a Cortex must be running to load the package.
- `onload`: Optional Storm code to run in a Cortex when the package is loaded.
- `modules`: Storm module definitions.
- `commands`: Storm command definitions.

The example below shows the YAML included in the `foopkg.yml` file.

foopkg.yml

```
name: foopkg
version: 1.0.0
synapse_minversion: [2, 23, 0]

onload: $lib.import(foomod).onload()

modules:
  - name: foomod
    modconf:
      srcguid: f751f9ad20e75547be230ae1a425fb9f

commands:
  - name: foocmd
    descr: |
      One line description on the first line.
      Followed by a more detailed description talking about what the command does and any
      useful additional information.

      Examples:
        # A couple examples of the command
        inet:ipv4 | foocmd
        inet:ipv4 | limit 1 | foocmd --yield
    asroot: true
    cmdargs:
      - - --debug
        - default: false
          action: store_true
          help: Show verbose debug output.

      - - --yield
        - default: false
          action: store_true
          help: Yield the newly created nodes.
```

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```
    - - --timeout
      - default: 0
        type: int
        help: Specify a timeout in seconds.
  cmdconf:
    srcguid: f751f9ad20e75547be230ae1a425fb9f
  forms:
    input:
      - inet:ipv4
    output:
      - inet:ipv4
    nodedata:
      - [ foodata, file:bytes ]
```

Modules

Modules can be used to expose reusable Storm functions. Each module defines a `name`, which is used for importing elsewhere via `$lib.import()`, and optionally a `modconf` dictionary containing additional configuration values which will be accessible in the module's Storm via `$modconf`.

The example below shows the Storm code included in the `foomod` file.

foomod

```
function onload() {
    [ meta:source=$modconf.srcguid
          :name="foomod"
          :type="foo"
    ]
    fini { return($lib.null) }
}

function bar(x, y) {
    return ($($x + $y))
}
```

Commands

Multiple Storm commands can be added to a Storm service package, with each defining the following attributes:

- `name`: Name of the Storm command to expose in the Cortex.
- `descr`: Description of the command which will be available in `help` displays.
- `asroot`: Whether the command should be run with root permissions. This allows users to be granted access to run the command without requiring them to have all the permissions needed by the Storm command. An example `asroot` permission for `foocmd` would be `('storm', 'asroot', 'cmd', 'asroot', 'foocmd')`.
- `cmdargs`: An optional list of arguments for the command.
- `cmdconf`: An optional dictionary of additional configuration variables to provide to the command Storm execution.

- `forms`: List of input and output forms for the command, as well as a list of nodedata keys and the corresponding form on which they may be set by the service.

The example below shows the Storm code included in the `foocmd` file.

foocmd

```
$foo = $lib.import(foomod)

[:asn = $foo.bar(:asn, $(20))]

$node.data.set(foodata, $lib.time.now())
```

Building the Example Package

To build the package and push it directly to a Cortex:

```
python -m synapse.tools.genpkg --push tcp://user:pass@127.0.0.1:27492 foopkg.yml
```

Note: Users must have the `pkg.add` permission to add a package to a Cortex.

Once the package has been successfully pushed to the Cortex, the additional Storm Commands will be listed in the output of `storm help` under the package they were loaded from:

```
package: foopkg
foocmd                      : One line description on the first line.
```

The new commands may now be used like any other Storm command:

```
cli> storm inet:ipv4=192.168.0.113 | foocmd
Executing query at 2023/07/12 15:13:58.668
....
inet:ipv4=192.168.0.113
        .created = 2023/07/12 15:13:58.651
        :asn = 40
        :type = private
complete. 1 nodes in 48 ms (20/sec).
```

If immediately pushing the package to a Cortex is not desired, it can instead be built and saved to `foo.json` to load later:

```
python -m synapse.tools.genpkg --save foo.json foopkg.yml
```

3.5.7 easycert

The Synapse `easycert` tool can be used to manage CA, host, and user certificates.

Syntax

`easycert` is executed using `python -m synapse.tools.easycert`. The command usage is as follows:

```
usage: easycert [-h] [--certdir CERTDIR] [--importfile {cas,hosts,users}] [--ca] [--p12]␣
↪[--server] [--server-sans SERVER_SANS] [--csr] [--sign-csr] [--signas SIGNAS]
                name

Command line tool to generate simple x509 certs

positional arguments:
  name                  common name for the certificate (or filename for CSR signing)

optional arguments:
  -h, --help            show this help message and exit
  --certdir CERTDIR     Directory for certs/keys
  --importfile {cas,hosts,users}
                        import certs and/or keys into local certdir
  --ca                  mark the certificate as a CA/CRL signer
  --p12                 mark the certificate as a p12 archive
  --server              mark the certificate as a server
  --server-sans SERVER_SANS
                        server cert subject alternate names
  --csr                 generate a cert signing request
  --sign-csr            sign a cert signing request
  --signas SIGNAS       sign the new cert with the given cert name
```

3.6 Storm Reference

Synapse uses the Storm Query language to do lifting and modification of data in the graph. Basic Storm usage is documented in the following sections.

3.6.1 Storm Reference - Introduction

Storm is the query language used to interact with data in Synapse. Storm allows you to ask about, retrieve, annotate, add, modify, and delete data within a Synapse Cortex. If you are using the community version of Synapse, you will access Synapse via the Storm command-line interface (**Storm CLI**) (see *storm*):

```
storm> <query>
```

If you are a Vertex Project customer, you will access Synapse via the Synapse webUI (also known as Optic.

Note: If you're just getting started with Synapse, you can use the Synapse Quickstart to quickly set up and connect to a local Cortex using the Storm CLI.

This section covers several important high-level Storm concepts:

Storm Background

In designing Storm, we needed it to be flexible and powerful enough to allow interaction with large amounts of data and a wide range of disparate data types. However, we also needed Storm to be intuitive and efficient so it would be accessible to a wide range of users. We wrote Storm specifically to be used by analysts and other users from a variety of knowledge domains who are not necessarily programmers and who would not want to use what felt like a "programming language".

Wherever possible, we masked Storm's underlying programmatic complexity. The intent is for Storm to act more like a "data language", allowing users to:

- **Reference data and query operations in an intuitive form.** We took a "do what I mean" approach for how users interact with and use Storm so that users can focus on the **data** and the relationships among the data, not the query language. Once you get the gist of it, Storm "just works"! This is because Storm and Synapse make use of a number of features "under the hood" such as property normalization, type enforcement / type awareness, and syntax and query optimization, to make Storm easier for you to use. Synapse and Storm do the work in the background so you can focus on analysis.
- **Use a simple yet powerful syntax to run Storm queries.** Storm uses intuitive keyboard symbols (such as an "arrow" (`->`) for pivot operations) for efficient querying, as well as a natural language-like syntax. This makes using Storm feel more like "asking a question" than "constructing a data query". In fact, one method we use to teach Storm to new users is to practice "translating" questions into queries (you'll be surprised how straightforward it is!).

Analysts still need to learn the Storm "language" - forms (*Form*) and tags (*Tag*) are Storm's "words", and Storm operators allows you to construct "sentences". That said, the intent is for Storm to function more like "how do I ask this question about the data?" and not "how do I write a program to get the data I need?"

Finally – and most importantly – **giving analysts direct access to Storm allows them to create arbitrary queries and provides them with an extraordinarily powerful analytical tool.** Analysts are not constrained to a set of "canned" queries provided through a GUI or an API. Instead, they can follow their analysis wherever it takes them, creating queries as needed and working with the data in whatever manner is most appropriate to their research.

Basic Storm Operations

Storm allows users to perform all of the common operations used to interact with data in Synapse:

- **Lift:** – retrieve data based on specified criteria. (*Storm Reference - Lifting*)
- **Filter:** – refine your results by including or excluding a subset of nodes based on specified criteria. (*Storm Reference - Filtering*)
- **Pivot:** – take a set of nodes and identify other nodes that share one or more property values with the lifted set. (*Storm Reference - Pivoting*)
- **Data modification:** – add, modify, annotate, and delete nodes from Synapse. (*Storm Reference - Data Modification*)

Additional operations include:

- **Traverse** light edges. (*Lightweight (Light) Edge*, *Traverse (Walk) Light Edges*)
- **Pipe** (send) nodes to Storm commands (*Storm Reference - Storm Commands*). Storm supports an extensible set of commands such as *limit*, *max*, or *uniq*. These commands provide specific functionality to further extend the analytical power of Storm. Additional Storm commands allow management of permissions for users and roles, Synapse views and layers, and Synapse's automation features (*Storm Reference - Automation*). Available commands can be displayed by running `help` from the Storm CLI.

Storm also incorporates a number of *Advanced Storm Operations* that provide even greater power and flexibility.

Note: While Storm queries can range from the very simple to the highly complex, all Storm queries are constructed from this relatively small set of "building blocks". Most users, especially when they first start, only need the handful of blocks listed above!

Lift, Filter, and Pivot Criteria

The main operations carried out with Storm are lifting, filtering, and pivoting (we include traversing light edges as part of "pivoting"). When conducting these operations, you need to be able to clearly specify the data you are interested in – your selection criteria. In most cases, the criteria you specify will be based on one or more of the following:

- A **property** (primary or secondary) on a node.
- A specific **value** for a property (<*form*> = <*valu*> or <*prop*> = <*pval*>) on a node.
- A **tag** on a node.
- The existence of a **light edge** linking nodes.
- The name ("verb") of a specific **light edge** linking nodes.

All of the above elements – nodes, properties, values, and tags – are the fundamental building blocks of the Synapse data model (see *Data Model - Terminology*). **As such, an understanding of the Synapse data model is essential to effective use of Storm.**

Whitespace and Literals in Storm

Storm allows (and in some cases requires) whitespace within Storm to separate syntax elements such as commands and command arguments.

Quotation marks are used to **preserve** whitespace characters and other special characters in literals used within Storm.

Using Whitespace Characters

Whitespace characters (i.e., spaces) are used within Storm to separate command line arguments. Specifically, whitespace characters are used to separate commands, command arguments, command operators, variables and literals.

When entering a query/command in Storm, one or more whitespace characters are **required** between the following command line arguments:

- A command (such as `max`) and command line parameters (in this case, the property `:asof`):

```
storm> inet:whois:rec:fqdn=vertex.link | max :asof
```

- An unquoted literal and any subsequent argument or operator:

```
storm> inet:email=support@vertex.link | count

storm> inet:email=support@vertex.link -> *
```

Whitespace characters can **optionally** be used when performing the following operations:

- Assigning values using the equals sign assignment operator:

```
storm> [inet:ipv4=192.168.0.1]

storm> [inet:ipv4 = 192.168.0.1]
```

- Comparison operations:

```
storm> file:bytes:size>65536

storm> file:bytes:size > 65536
```

- Pivot operations:

```
storm> inet:ipv4->*

storm> inet:ipv4 -> *
```

- Specifying the content of edit brackets or edit parentheses:

```
storm> [inet:fqdn=vertex.link]

storm> [ inet:fqdn=vertex.link ]

storm> [ inet:fqdn=vertx.link (inet:ipv4=1.2.3.4 :asn=5678) ]

storm> [ inet:fqdn=vertex.link ( inet:ipv4=1.2.3.4 :asn=5678 ) ]
```

Whitespace characters **cannot** be used between reserved characters when performing the following CLI operations:

- Add and remove tag operations. The plus (+) and minus (-) sign characters are used to add and remove tags to and from nodes in Synapse respectively. When performing tag operations using these characters, a whitespace character cannot be used between the actual character and the tag name (e.g., +#<tag>).

```
storm> inet:ipv4 = 192.168.0.1 [ -#oldtag +#newtag ]
```

Entering Literals

Storm uses quotation marks (single and double) to preserve whitespace and other special characters that represent literals. If values with these characters are not quoted, Synapse may misinterpret them and throw a syntax error.

Single (' ') or double (" ") quotation marks can be used when specifying a literal in Storm during an assignment or comparison operation. Enclosing a literal in quotation marks is **required** when the literal:

- begins with a non-alphanumeric character,
- contains a space (\s), tab (\t) or newline(\n) character, or
- contains a reserved Synapse character (for example, \ ) , =] } |).

Enclosing a literal in **single** quotation marks will preserve the literal meaning of **each character.** That is, each character in the literal is interpreted exactly as entered.

- Note that if a literal (such as a string) **includes** a single quotation mark / tick mark, it must be enclosed in double quotes.
- Wrong: 'Storm's intuitive syntax makes it easy to learn and use.'
- Right: "Storm's intuitive syntax makes it easy to learn and use."

Enclosing a literal in **double** quotation marks will preserve the literal meaning of all characters **except for** the backslash (\ ) character, which is interpreted as an 'escape' character. The backslash can be used to include special characters such as tab (\t) or newline (\n) within a literal.

- If you need to include a literal backslash within a double-quoted literal, you must enter it as a "double backslash" (the first backslash "escapes" the following backslash character):
  - Wrong: "C:\Program Files\Mozilla Firefox\firefox.exe"
  - Right: "C:\\Program Files\\Mozilla Firefox\\firefox.exe"

  Note that because the above example does not include a single quote / tick mark as part of the literal, you can simply enclose the file path in single quotes:
  - Also right: 'C:\Program Files\Mozilla Firefox\firefox.exe'

The Storm queries below demonstrate assignment and comparison operations that **do not require** quotation marks:

- Lifting the domain vtx.lk:

```
storm> inet:fqdn = vtx.lk
```

- Lifting the file name windowsupdate.exe:

```
storm> file:base = windowsupdate.exe
```

The commands below demonstrate assignment and comparison operations that **require** the use of quotation marks. Failing to enclose the literals below in quotation marks will result in a syntax error.

- Lift the file name windows update.exe which contains a whitespace character:

```
storm> file:base = 'windows update.exe'
```

- Lift the file name `windows,update.exe` which contains the comma special character:

```
storm> file:base = "windows,update.exe"
```

Backtick Format Strings

Backticks (` `) can be used to specify a format string in Storm, with curly braces used to specify expressions which will be substituted into the string at runtime. Any valid Storm expression may be used in a format string, such as variables, node properties, tags, or function calls.

- Use a variable in a string:

```
storm> $ip = "1.2.3.4" $str = `The IP is {$ip}`
```

- Use node properties in a string:

```
storm> inet:ipv4=1.2.3.4 $lib.print(`IP {$node.repr()}: asn={:asn} .seen={.seen} foo={
↪#foo}`)
```

- Lift a node using a format string:

```
storm> $ip=1.2.3.4 $port=22 inet:client=`{$ip}:{$port}`
```

Backtick format strings may also span multiple lines, which will include the newlines when displayed:

```
storm> inet:ipv4=1.2.3.4 $lib.print(`
IP {$node.repr()}:
asn={:asn}
.seen={.seen}
foo={#foo}`)
```

Like double quotes, backticks will preserve the literal meaning of all characters **except for** the backslash (\ ) character, which is interpreted as an 'escape' character. The backslash can be used to include special characters such as tab (`\t`) or newline (`\n`), or to include a backtick (`) or curly brace ({) in the string.

Storm Operating Concepts

Storm has several notable features in the way it interacts with and operates on data. We mention these concepts briefly here to familiarize you with them; they're important but also pretty intuitive, so you don't need to worry about them too much for standard Storm queries and operations. These concepts are much more important if you're using more advanced Storm constructs such as variables or control flow, but we want to introduce the concepts here.

Working Set

Most objects in Synapse are **nodes**. Most Storm operations start by **lifting** (selecting) a node or set of nodes.

- The set of nodes that you start with is called your **initial working set**.
- The set of nodes at any given point in your Storm query is called your **current working set**.

Operation Chaining

Users commonly interact with data (nodes) in Synapse using operations such as lift, filter, and pivot. Storm allows multiple operations to be **chained** together to form increasingly complex queries:

```
storm> inet:fqdn=vertex.link

storm> inet:fqdn=vertex.link -> inet:dns:a

storm> inet:fqdn=vertex.link -> inet:dns:a -> inet:ipv4

storm> inet:fqdn=vertex.link -> inet:dns:a -> inet:ipv4 +:type=unicast
```

The above example demonstrates chaining a lift (`inet:fqdn=vetex.link`) with two pivots (`-> inet:dns:a`, `-> inet:ipv4`) and a filter (`+:type=unicast`).

When Storm operations are concatenated in this manner, they are processed **in order from left to right** with each operation (lift, filter, or pivot) acting on the output of the previous operation. A Storm query is not evaluated as a single whole; Storm evaluates your working set of nodes against each operation in order before moving to the next operation.

Note: Technically, any query you construct is first evaluated as a whole **to ensure it is a syntactically valid query** - Synapse will complain if your Storm syntax is incorrect. But once Synapse has checked your Storm syntax, nodes are processed by each Storm operation in order.

You do not have to write (or execute) Storm queries "one operation at a time" - this example is simply meant to illustrate how you can chain individual Storm operations together to form longer queries. If you know that the question you want Storm to answer is "show me the unicast IPv4 addresses that the FQDN vertex.link has resolved to", you can simply run the final query. But you can also "build" queries one operation at a time if you're exploring the data or aren't sure yet where your analysis can take you.

The ability to build queries operation by operation means that a Storm query can parallel an analyst's natural thought process: you perform one Storm operation and then consider the "next step" you want to take in your analysis. "Show me X data…that's interesting, now show me Y data that relates to X…hm, now take a subset of Y and show me any relationship to Z data…" and so on. Each "now show me…" commonly corresponds to a new Storm operation that can be added to your existing Storm query to navigate through the data.

Node Consumption

Storm operations typically **transform** your working set in some way. That is, the nodes that "go into" (are inbound) to a given Storm operation are not necessarily the nodes that "come out" of that operation.

Take our operation chaining example above:

- Our **initial working set** consists of the single node `inet:fqdn=vertex.link`, which we selected with a lift operation.
- When we pivot to the DNS A records for that FQDN, we navigate away from (drop) our initial `inet:fqdn` node, and navigate to (add) the DNS A nodes. Our **current working set** now consists of the DNS A records (`inet:dns:a` nodes) for vertex.link.
- Similarly, when we pivot to the IPv4 addresses, we navigate away from (drop) the DNS A nodes and navigate to (add) the IPv4 nodes. Our current working set is made up of the `inet:ipv4` nodes.
- Finally, when we perform our filter operation, we may discard (drop) any IPv4 nodes representing non-unicast IPs (such as `inet:ipv4=127.0.0.1`) if present.

We refer to this transformation (in particular, dropping) of some or all nodes by a given Storm operation as **consuming** nodes. Most Storm operations consume nodes (that is, change your working set in some way - what comes out of the operation is not the same set of nodes that goes in).

For standard Storm queries this process should be fairly intuitive ("now that you point that out... of course that is what's happening"). However, the idea of node consumption and the transformation of your current working set is important to keep in mind for more advanced Storm.

Storm as a Pipeline

Just as each Storm **operation** in the chain is processed individually from left to right, **each node** in your working set is evaluated **individually** against a given Storm operation. You can think of your Storm query as a **pipeline** of operations, with each node "fired" one at a time through the pipeline. Whether you start with one node or 10,000 nodes, they are evaluated against your Storm query one by one.

A key advantage to processing nodes one by one is that it significantly reduces Synapse's latency and memory use - this is a big part of what makes Synapse so fast and responsive. Synapse can start providing you with results for the initial nodes processed right away, while it continues processing the remaining nodes. In other words, you don't have to wait for your entire query to complete for **all** of your nodes before getting your answer.

For standard Storm, this behavior is transparent to you as the user - you run a Storm query, you get a response. However, this pipeline behavior can be important to understand when working with (or troubleshooting) Storm queries that leverage features such as subqueries, variables, or control flow operations.

Advanced Storm Operations

In our experience, the more analysts use Storm, the more they want even greater power and flexibility from the language to support their analytical workflow! To meet these demands, Storm evolved a number of advanced features, including:

- Variables (*Storm Reference - Advanced - Variables*)
- Methods (*Storm Reference - Advanced - Methods*)
- Control Flow (*Storm Reference - Advanced - Control Flow*)
- *Storm Libraries*
- *Storm Types*

Analysts do not need to use or understand these more advanced concepts in order to use Storm or Synapse. Basic Storm functions are sufficient for a wide range of analytical needs and workflows. However, these additional features are available to both "power users" and developers as needed:

- For analysts, once they are comfortable with Storm basics, many of them want to expand their Storm skills **specifically because it facilitates their analysis.**
- For developers, writing extensions to Synapse in Storm has the advantage that the extension **can be deployed or updated on the fly.** Contrast this with extensions written in Python, for example, which would require restarting the system during a maintenance window in order to deploy or update the code.

Note: Synapse's **Rapid Power-Ups** (*Power-Up*), are written entirely in Storm and exposed to Synapse users as Storm commands!

3.6.2 Storm Reference - Document Syntax Conventions

This section covers the following important conventions used within the Storm Reference Documents:

Storm and Layers

The Storm Reference documentation provides basic syntax examples that assume a simple Storm environment - that is, a Cortex with a single Layer. For multi-Layer Cortexes, the effects of specific Storm commands - particularly data modification commands - may vary based on the specific arrangement of read / write Layers, the Layer in which the command is executed, and the permissions of the user.

Storm Syntax Conventions

The Storm Reference documentation provides numerous examples of both abstract Storm syntax (usage statements) and specific Storm queries. The following conventions are used for Storm **usage statements:**

- Items that must be entered literally on the command line are in **bold.** These items include command names and literal characters.
- Items that represent "variables" that must be replaced with a name or value are placed within angle brackets (< >) in *italics*. Most "variables" are self-explanatory, however a few commonly used variable terms are defined here for convenience:
  - <*form*> refers to a form / node primary property, such as `inet:fqdn`.
  - <*valu*> refers to the value of a primary property, such as `woot.com` in `inet:fqdn=woot.com`.
  - <*prop*> refers to a node secondary property (including universal properties) such as `inet:ipv4:asn` or `inet:ipv4.created`.
  - <*pval*> refers to the value of a secondary property, such as `4808` in `inet:ipv4:asn=4808`.
  - <*query*> refers to a Storm query.

  - <*inet:fqdn*> refers to a Storm query whose results contain the specified form(s)
  - <*tag*> refers to a tag (`#sometag` as opposed to a `syn:tag` form).
- **Bold brackets** are literal characters. Parameters enclosed in non-bolded brackets are optional.
- Parameters **not** enclosed in brackets are required.
- A vertical bar signifies that you choose only one parameter. For example:
  - `a | b` indicates that you must choose a or b.
  - `[ a | b ]` indicates that you can choose a, b, or nothing (the non-bolded brackets indicate the parameter is optional).
- Ellipses (…) signify the parameter can be repeated on the command line.
- The `storm` command that must precede a Storm query is assumed and is omitted from examples.

Example:

[<*form*> **=** <*valu*> [**:** <*prop*> **=** <*pval*> …] **]**

The Storm query above adds a new node.

- The outer brackets are in **bold** and are required literal characters to specify a data modification (add) operation. Similarly, the equals signs are in **bold** to indicate literal characters.
- <*form*> and <*valu*> would need to be replaced by the specific form (such as `inet:ipv4`) and primary property value (such as `1.2.3.4`) for the node being created.
- The inner brackets are not bolded and indicate that one or more secondary properties can **optionally** be specified.
- <*prop*> and <*pval*> would need to be replaced by the specific secondary property and value to add to the node, such as `:loc = us`.
- The ellipsis (`...`) indicate that additional secondary properties can optionally be specified.

Usage Statements vs. Specific Storm Queries

Examples of specific queries represent fully literal input, but are not shown in bold for readability. For example:

Usage statement:

[<*form*> **=** <*valu*> [**:** <*prop*> **=** <*pval*> …] **]**

Example query:

[inet:ipv4 = 1.2.3.4 :loc = us]

Type-Specific Behavior

Some data types within the Synapse data model have been optimized in ways that impact their behavior within Storm queries (e.g., how types can be input, lifted, filtered, etc.) See *Storm Reference - Type-Specific Storm Behavior* for details.

Whitespace

Whitespace may be used in the examples for formatting and readability.

3.6.3 Storm Reference - Lifting

Lift operations retrieve a set of nodes from a Synapse Cortex based on specified criteria. While all lift operations are retrieval operations, they can be broken down into "types" of lifts based on the criteria, comparison operator, or special handler used:

- *Simple Lifts*
- *Try Lifts*
- *Lifts Using Standard Comparison Operators*
- *Lifts Using Extended Comparison Operators*

See *Storm Reference - Document Syntax Conventions* for an explanation of the syntax format used below.

See *Storm Reference - Type-Specific Storm Behavior* for details on special syntax or handling for specific data types.

Simple Lifts

"Simple" lifts refers to the most "basic" lift operations. That is, operations to retrieve a set of nodes based on:

- The presence of a specific primary or secondary property.
- The presence of a specific primary property value or secondary property value.
- The presence of a specific tag or tag property.

The only difference between "simple" lifts and "lifts using comparison operators" is that we have defined simple lifts as those that use the equals (=) comparator, which is the easiest comparator to use to explain basic lift concepts.

Syntax:

<form> [**=** *<valu>*]

<form> **=** *<valu>* **:** *<prop>* [**=** *<pval>*]

*<tag>* [**:** *<tagprop>* [*<operator>* *<pval>*]]

#: *<tagprop>* [*<operator>* *<pval>*]

Examples:

Lift by primary property (<form>):

- Lift all domain nodes:

```
storm> inet:fqdn
```

- Lift all mutex nodes:

```
storm> it:dev:mutex
```

Lift a specific node (<form> = <valu>):

- Lift the node for the domain `google.com`:

```
storm> inet:fqdn = google.com
```

- Lift the node for a specific MD5 hash:

```
storm> hash:md5 = d41d8cd98f00b204e9800998ecf8427e
```

Lift a specific compound node:

- Lift the DNS A record showing that domain `woot.com` resolved to IP `1.2.3.4`:

```
storm> inet:dns:a = (woot.com, 1.2.3.4)
```

Lift a specific GUID node:

- Lift the organization node with the specified GUID:

```
storm> ou:org=2f92bc913918f6598bcf310972ebf32e
```

Lift a specific digraph (edge) node:

- Lift the `edge:has` node linking the person node representing "Bob Smith" to his email address:

```
storm> edge:has=((ps:person,12af06294ddf1a0ac8d6da34e1dabee4),(inet:email, bob.
↪smith@gmail.com))
```

Lift by the presence of a secondaray property (<prop>):

- Lift the DNS SOA record nodes that have an email property:

```
storm> inet:dns:soa:email
```

Lift by a specific property value (<prop> = <pval>):

- Lift the organization node with the alias `vertex`:

```
storm> ou:org:alias = vertex
```

- Lift all DNS A records for the domain `blackcake.net`:

```
storm> inet:dns:a:fqdn = blackcake.net
```

- Lift all the files with a PE compiled time of `1992-06-19 22:22:17`:

```
storm> file:bytes:mime:pe:compiled = "1992/06/19 22:22:17"
```

- Lift all the files with a PE compiled time that falls within the year 2019:

```
storm> file:bytes:mime:pe:compiled=2019*
```

Lift all nodes with a specific tag:

- Lift all nodes with the tag `#cno.infra.anon.tor`:

```
storm> #cno.infra.anon.tor
```

Lift all nodes with a specific tag property:

- Lift all nodes with a tag that has a `:risk` tag property:

Lift all nodes with a specific tag and tag property:

- Lift all nodes with a `#rep.symantec` tag that has a `:risk` tag property:

```
storm> #rep.symantec:risk
```

Lift all nodes with a specific tag, tag property, and value:

- Lift all nodes with a `#rep.symantec` tag with a `:risk` tag property and a value greater than 10:

```
storm> #rep.symantec:risk>10
```

Usage Notes:

- Lifting nodes by form alone (e.g., lifting all `inet:fqdn` nodes or all `inet:email` nodes) is possible but generally impractical / undesirable as it will potentially return an extremely large data set.
- Lifting by form alone when piped to the Storm *limit* command may be useful for returning a small number of "exemplar" nodes.
- Lifting nodes by `<form> = <valu>` is the most common method of lifting a single node.
- When lifting a form whose `<valu>` consists of multiple components (e.g., a compound node or digraph node), the components must be passed as a comma-separated list enclosed in parentheses.
- Lifting nodes by the presence of a secondary property alone (`<prop>`) may be impractical / undesirable (similar to lifting by form alone), but may be feasible in limited cases (i.e., where it is known that only a relatively small number of nodes have a given secondary property).
- Lifting nodes by the value of a secondary property (`<prop> = <pval>`) is useful for lifting all nodes that share a secondary property with the same value; and may be used to lift individual nodes with unique or relatively unique secondary properties in cases where entering the primary property is impractical (such as for GUID nodes).
- When lifting nodes by secondary property value where the value is a time (date / time), you do not need to use full `YYYY/MM/DD hh:mm:ss.mmm` syntax. Synapse allows the use of both lower resolution values (e.g., `YYYY/MM/DD`) and wildcard values (e.g., `YYYY/MM*`). In particular, wildcard syntax can be used to specify any values that match the wildcard expression. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.
- Lifting nodes by tag alone (`#<tag>`) lifts nodes of **all** forms with that tag. To lift specific forms only, use *Lift by Tag (#)* or an additional filter (see *Storm Reference - Filtering*).
- Tag properties are supported in Synapse, but no tag properties are included by default. See *Tag Properties* for additional detail.

Try Lifts

Try lifts refer to lifts that "try" to perform a Cortex lift operation, and fail silently if *Type* normalization is not successful. Try lifts prevent a Cortex from throwing a runtime execution error, and terminating query execution if an invalid Type is encountered.

When lifting nodes by property value using the equals (=) comparator, if Type validation fails for a supplied property value, the Cortex will throw a `BadTypeValu` error, and terminate the query as shown below.

```
storm> inet:ipv4 = evil.com inet:ipv4 = 8.8.8.8
ERROR: illegal IP address string passed to inet_aton
```

To suppress errors, and prevent premature query termination, Storm supports the use of the try operator (?=) when performing property value lifts. This operator is useful when you are performing multiple Cortex operations in succession within a single query, lifting nodes using external data that has not been normalized, or lifting nodes during automation, and do not want a query to terminate if an invalid Type is encountered.

Syntax:

<form>[:<prop>] ?= *<pval>*

Examples:

- Try to lift the MD5 node `174cc541c8d9e1accef73025293923a6`:

```
storm> hash:md5 ?= 174cc541c8d9e1accef73025293923a6
```

- Try to lift the DNS nodes whose `inet:dns:a:ipv4` secondary property value equals `'192.168.0.100'`. Notice that an error message is not displayed, despite an invalid IPv4 address `'192.168.0.1000'` being entered:

```
storm> inet:dns:a:ipv4 ?= 192.168.0.1000
```

- Try to lift the email address nodes `'jack@soso.net'` and `'jane@goodgirl.com'`. Notice that despite the first email address being entered incorrectly, the error message is suppressed, and the query executes to completion.

```
storm> inet:email ?= "jack[at]soso.net" inet:email ?= "jane@goodgirl.com"
inet:email=jane@goodgirl.com
        :fqdn = goodgirl.com
        :user = jane
        .created = 2023/07/12 15:15:21.469
```

Usage Notes:

- The try operator should be used when you want Storm query execution to continue even if an invalid Type is encountered.
- It is not recommended to use the try operator when you want to raise an error, or stop query execution if an invalid Type is encountered.

Lifts Using Standard Comparison Operators

Lift operations can be performed using most of the standard mathematical / logical comparison operators (comparators):

- = : equals (described above)
- < : less than
- > : greater than
- <= : less than or equal to
- >= : greater than or equal to

Lifting by "not equal to" (!=) is not supported.

Syntax:

<prop> <comparator> <pval>

Examples:

Lift using less than comparator:

- Lift domain WHOIS records where the domain's registration (created) date was before June 1, 2014:

```
storm> inet:whois:rec:created < 2014/06/01
```

Lift using greater than comparator:

- Lift files whose size is larger than 1MB:

```
storm> file:bytes:size > 1048576
```

Lift using less than or equal to comparator:

- Lift people (person nodes) born on or before January 1, 1980:

```
storm> ps:person:dob <= 1980/01/01
```

- Lift files that were compiled in 2012 or earlier:

```
storm> file:bytes:mime:pe:compiled<=2012*
```

Lift using greater than or equal to comparator:

- Lift WHOIS records retrieved on or after December 1, 2018 at 12:00:

```
storm> inet:whois:rec:asof >= "2018/12/01 12:00"
```

Usage Notes:

- When lifting nodes by secondary property value where the value is a time (date / time), you do not need to use full `YYYY/MM/DD hh:mm:ss.mmm` syntax. Synapse allows the use of both lower resolution values (e.g., `YYYY/MM/DD`) and wildcard values (e.g., `YYYY/MM*`). In particular, wildcard syntax can be used to specify any values that match the wildcard expression. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Lifts Using Extended Comparison Operators

Storm supports a set of extended comparison operators (comparators) for specialized lift operations. In most cases, the same extended comparators are available for both lifting and filtering:

- *Lift by Regular Expression (~=)*
- *Lift by Prefix (^=)*
- *Lift by Time or Interval (@=)*
- *Lift by Range (*range=)*
- *Lift by Set Membership (*in=)*
- *Lift by Proximity (*near=)*
- *Lift by (Arrays) (*[ ])*
- *Lift by Tag (#)*
- *Recursive Tag Lift (##)*

Lift by Regular Expression (~=)

The extended comparator ~= is used to lift nodes based on standard regular expressions.

Note: *Lift by Prefix (^=)* is supported for string types and can be used to match the beginning of string properties.

Syntax:

<form> [**:** *<prop>*] **~=** *<regex>*

Example:

- Lift files with PDB paths containing the string `rouji`:

```
storm> file:bytes:mime:pe:pdbpath ~= "rouji"
```

Lift by Prefix (^=)

Synapse performs prefix indexing on string types, which optimizes lifting nodes whose *<valu>* or *<pval>* starts with a given prefix. The extended comparator ^= is used to lift nodes by prefix.

Syntax:

<form> [**:** *<prop>*] **^=** *<prefix>*

Examples:

Lift primary property by prefix:

- Lift all usernames that start with "pinky":

```
storm> inet:user^=pinky
```

Lift secondary property by prefix:

- Lift all organizations whose name starts with "International":

```
storm> ou:org:name^=international
```

Usage Notes:

- Extended string types that support dotted notation (such as the *loc* or *syn:tag* types) have custom behaviors with respect to lifting and filtering by prefix. See the respective sections in *Storm Reference - Type-Specific Storm Behavior* for additional details.

Lift by Time or Interval (@=)

Synapse supports numerous data forms whose properties are date / time values (*<ptype>* = *<time>*) or time windows / intervals (*<ptype>* = *<ival>*). Storm supports the custom @= comparator to allow lifting based on comparisons among various combinations of times and intervals.

See *Storm Reference - Type-Specific Storm Behavior* for additional detail on the use of *time* and *ival* data types.

Syntax:

<prop> **@=(** *<ival_min>* **,** *<ival_max>* **)**

<prop> **@=** *<time>*

Examples:

Lift by comparing an interval to an interval:

- Lift all DNS A records whose `.seen` values fall between July 1, 2018 and August 1, 2018:

```
storm> inet:dns:a.seen@=(2018/07/01, 2018/08/01)
```

Lift by comparing a time to an interval:

- Lift DNS requests that occurred on May 3, 2018 (between 05/03/2018 00:00:00 and 05/03/2018 23:59:59):

```
storm> inet:dns:request:time@=("2018/05/03 00:00:00", "2018/05/04 00:00:00")
```

Lift by comparing a time to a time:

- Lift all WHOIS records that were retrieved on July 17, 2017:

```
storm> inet:whois:rec:asof@=2017/07/17
```

Lift using an interval with relative times:

- Lift the WHOIS email nodes that were observed between January 1, 2019 and the present:

```
storm> inet:whois:email.seen@=(2019/01/01, now)
```

- Lift the DNS requests that occurred within one day after October 15, 2018:

```
storm> inet:dns:request:time@=(2018/10/15,"+1 day")
```

Lift by comparing tag time intervals:

- Lift all the domain nodes that were associated with Threat Group 43 between January 2013 and January 2015:

```
storm> inet:fqdn#cno.threat.t43.tc@=(2013/01/01, 2015/01/01)
```

Usage Notes:

- When specifying an interval, the minimum value is included in the interval but the maximum value is **not** (the equivalent of "greater than or equal to <*min*> and less than <*max*>"). This behavior is slightly different than that for `*range=`, which includes **both** the minimum and maximum.
- When comparing an **interval to an interval,** Storm will return nodes whose interval has **any** overlap with the specified interval.
  - For example, a lift interval of September 1, 2018 to October 1, 2018 (2018/09/01, 2018/10/01) will match nodes with any of the following intervals:
    - August 12, 2018 to September 6, 2018.
    - September 13, 2018 to September 17, 2018.
    - September 30, 2018 to November 5, 2018.
- When comparing a **time to an interval,** Storm will return nodes whose time falls **within** the specified interval.
- When comparing a **time to a time,** Storm will return nodes whose timestamp is an **exact match.** (Interval (`@=`) syntax is supported for this comparison, but the regular equals comparator (=) can also be used.)
- When specifying interval date/time values, Synapse allows the use of both lower resolution values (e.g., `YYYY/MM/DD`) and wildcard values (e.g., `YYYY/MM*`) for the minimum and/or maximum interval values. In addition,

plain wildcard time syntax may provide a simpler and more intuitive means to specify some intervals. For example `inet:whois:rec:asof=2018*` is equivalent to `inet:whois:rec:asof@=('2018/01/01', '2019/01/01')`. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Lift by Range (*range=)

The range extended comparator (`*range=`) supports lifting nodes whose <*form*> = <*valu*> or <*prop*> = <*pval*> fall within a specified range of values. The comparator can be used with types such as integers and times (including types that are extensions of those types, such as IP addresses).

Syntax:

<*form*> [**:** <*prop*>] ***range =** (<*range_min*> **,** <*range_max*>)

Examples:

Lift by primary property in range:

- Lift all IP addresses between 192.168.0.0 and 192.168.0.10:

```
storm> inet:ipv4*range=(192.168.0.0, 192.168.0.10)
```

Lift by secondary property in range:

- Lift files whose size is between 1000 and 100000 bytes:

```
storm> file:bytes:size*range=(1000,100000)
```

- Lift WHOIS records that were captured between November 29, 2013 and June 14, 2016:

```
storm> inet:whois:rec:asof*range=(2013/11/29, 2016/06/14)
```

- Lift DNS requests made within one day of 12/01/2018:

```
storm> inet:dns:request:time*range=(2018/12/01, "+-1 day")
```

Usage Notes:

- When specifying a range, both the minimum and maximum values are included in the range (the equivalent of "greater than or equal to <*min*> and less than or equal to <*max*>").
- When specifying a range of time values, Synapse allows the use of both lower resolution values (e.g., `YYYY/MM/DD`) and wildcard values (e.g., `YYYY/MM*`) for the minimum and/or maximum range values. In addition, plain wildcard time syntax may provide a simpler and more intuitive means to specify some time ranges. For example `inet:whois:rec:asof=2018*` is equivalent to `inet:whois:rec:asof*range=('2018/01/01', '2018/12/31 23:59:59.999')`. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Lift by Set Membership (*in=)

The set membership extended comparator (`*in=`) supports lifting nodes whose <*form*> = <*valu*> or <*prop*> = <*pval*> matches any of a set of specified values. The comparator can be used with any type.

Syntax:

<*form*> [**:** <*prop*>] ***in =** (<*set_1*> **,** <*set_2*> **,** ...)

Examples:

Lift by primary property in a set:

- Lift IP addresses matching any of the specified values:

```
storm> inet:ipv4*in=(127.0.0.1, 192.168.0.100, 255.255.255.254)
```

Lift by secondary property in a set:

- Lift files whose size in bytes matches any of the specified values:

```
storm> file:bytes:size*in=(4096, 16384, 65536)
```

- Lift tags that end in `foo`, `bar`, or `baz`:

```
storm> syn:tag:base*in=(foo,bar,baz)
```

Lift by Proximity (*near=)

The proximity extended comparator (`*near=`) supports lifting nodes by "nearness" to another node based on a specified property type. Currently, `*near=` supports proximity based on geospatial location (that is, nodes within a given radius of a specified latitude / longitude).

Syntax:

<*form*> [**:** <*prop*>] ***near =** **((** <*lat*> **,** <*long*> **),** <*radius*>)

Examples:

- Lift locations (`geo:place` nodes) within 500 meters of the Eiffel Tower:

```
storm> geo:place:latlong*near=((48.8583701,2.2944813),500m)
```

Usage Notes:

- In the example above, the latitude and longitude of the desired location (i.e., the Eiffel Tower) are explicitly specified as parameters to `*near=`.
- Radius can be specified in the following metric units:
  - Kilometers (km)
  - Meters (m)
  - Centimeters (cm)
  - Millimeters (mm)
- Numeric values of less than 1 (e.g., 0.5km) must be specified with a leading zero.

- The `*near=` comparator works for geospatial data by lifting nodes within a square bounding box centered at *<lat>,<long>*, then filters the nodes to be returned by ensuring that they are within the great-circle distance given by the *<radius>* argument.

Lift by (Arrays) (*[ ])

Storm uses a special "by" syntax to lift (or filter) by comparison with one or more elements of an *array* type. The syntax consists of an asterisk (*) preceding a set of square brackets ([ ]), where the square brackets contain a comparison operator and a value that can match one or more elements in the array. This allows users to match values in the array list without needing to know the exact order or values of the array itself.

Syntax:

<form> **:** *<prop>* **[** *<operator>* *<pval>* **]**

Examples:

- Lift the organization(s) (`ou:org` nodes) whose names include "IBM":

```
storm> ou:org:names*[=ibm]
```

- Lift the x509 certificates (`crypto:x509:cert`) that reference domains ending with `.biz`:

```
storm> crypto:x509:cert:identities:fqdns*[="*.biz"]
```

- Lift the organizations whose names start with "tech":

```
storm> ou:org:names*[^=tech]
```

Usage Notes:

- The comparison operator used must be valid for lift operations for the type used in the array. For example, *inet:fqdn* suffix matching (i.e., `crypto:x509:cert:identities:fqdns*[="*.com"]`), can be used to lift arrays consisting of domains, but the prefix operator (`^=`), which is only valid when **filtering** `inet:fqdns`, cannot.
- The standard equals (=) operator can be used to filter nodes based on array properties, but the value specified must **exactly match** the **full** property value in question:
  - For example: `ou:org:names=("the vertex project","the vertex project llc",vertex)`
- See the *array* section of the *Storm Reference - Type-Specific Storm Behavior* document for additional details.

Lift by Tag (#)

The tag extended comparator (`#`) supports lifting nodes based on a form combined with a given tag; tag and tag property; tag, tag property, and tag property value; or tag and associated timestamp being applied to the node.

Note: Lifting by form and tag (`<form>#<tag>`), including similar lifts using tag properties / timestamps / etc., is actually a Synapse-optimized "lift and filter" operation as opposed to a standard lift. The operation is equivalent to *<form> +#<tag>* except that the lift by tag syntax is optimized for performance.

- Using the explicit filter (*<form> +#<tag>*) lifts **all** nodes of the specified form and **then** downselects to only those forms with the specified tag.
- Storm optimizes the lift by tag syntax to lift **only** those nodes of the specified form that have the specified tag.

See *Filter by Tag (#)* for additional detail on filtering with tags.

Syntax:

<form> **#** *<tag>*

<form> **#** *<tag>* [**:** *<tagprop>* [*<operator>* *<pval>*]]

<form> **#** *<tag>* **@=** *<time>* | (*<min_time>* **,** *<max_time>* **)**

Examples:

Lift forms by tag:

- Lift the IPv4 addresses associated with Tor infrastructure:

```
storm> inet:ipv4#cno.infra.anon.tor
```

Lift forms by tag and tag property:

- Lift the domains that have a risk score reported by DomainTools:

```
storm> inet:fqdn#rep.domaintools:risk
```

Lift forms by tag, tag property, and value:

- Lift the domains that have a risk score from DomainTools of 90 or higher:

```
storm> inet:fqdn#rep.domaintools:risk>=90
```

Lift forms by tag and time:

- Lift domains that were associated with Threat Cluster 15 as of October 30, 2009:

```
storm> inet:fqdn#cno.threat.t15.tc@=2009/10/30
```

Lift forms by tag and time interval:

- Lift IP addresses that were part of Tor infrastructure between October 1, 2018 and December 31, 2018:

```
storm> inet:ipv4#cno.infra.anon.tor@=(2018/10/01,2018/12/31)
```

Usage Notes:

- Tag properties are supported in Synapse, but no tag properties are included by default. See *Tag Properties* for additional detail.
- Currently it is not possible to lift forms by tag property alone. That is, `inet:fqdn#:risk` is invalid.
  - It is possible to perform an equivalent operation using a lift and filter operation, i.e., `#:risk +inet:fqdn`.
- Tag timestamps are interval (`ival`) types. See the *time* and *ival* sections of the *Storm Reference - Type-Specific Storm Behavior* document for additional details on working with times and intervals.

Recursive Tag Lift (##)

The recursive tag extended comparator (##) supports lifting nodes with any tag whose `syn:tag` node is itself tagged with a specific tag.

Tags can be applied to `syn:tag` nodes; that is, tags can be used to tag other tags. The ability to "tag the tags" can be used to represent certain types of analytical relationships. For example:

- `syn:tag` nodes representing threat groups can be tagged to indicate their assessed country of origin.
- `syn:tag` nodes representing malware or tools can be tagged with their assessed availability (e.g., public, private, private but shared, etc.)

A recursive tag lift performs the following actions:

1. For the specified tag (`##<sometag>`), lift the nodes that have that tag (i.e., the equivalent of `#<sometag>`), including any `syn:tag` nodes.
2. For any lifted `syn:tag` nodes, lift all nodes tagged with those tags (including any additional `syn:tag` nodes).
3. Repeat #2 until no more `syn:tag` nodes are lifted.
4. Return the tagged nodes. Note that `syn:tag` nodes themselves are **not** returned.

Syntax:

<tag>

Examples:

- Lift all nodes tagged with any tags (such as threat group tags) that FireEye claims are associated with Russia:

```
storm> ##aka.feye.cc.ru
```

Usage Notes:

In the example above, the tag `aka.feye.cc.ru` could be applied to `syn:tag` nodes representing FireEye's "Russian" threat groups (e.g., `aka.feye.thr.apt28`, `aka.feye.thr.apt29`, etc.) Using a recursive tag lift allows you to easily lift all nodes tagged by **any** of those tags.

3.6.4 Storm Reference - Filtering

Filter operations are performed on the output of a previous Storm operation such as a lift or pivot. A filter operation downselects from the working set of nodes by either including or excluding a subset of nodes based on a set of criteria.

- + specifies an **inclusion** filter. The filter downselects the working set to **only** those nodes that match the specified criteria.
- - specifies an **exclusion** filter. The filter downselects the working set to all nodes **except** those that match the specified criteria.

The types of filter operations within Storm are highly flexible and consist of the following:

- *Simple Filters*
- *Filters Using Standard Comparison Operators*
- *Filters Using Extended Comparison Operators*
- *Compound Filters*
- *Subquery Filters*
- *Expression Filters*

- *Embedded Property Syntax*

In most cases, the criteria and available comparators for lift operations (*Storm Reference - Lifting*) are also available for filter operations.

Note: When filtering based on a secondary property (<*prop*>) or secondary property value (<*prop*> = <*pval*>), you can specify the property using either the relative property name (`:baz`) or the full form and property name (`foo:bar:baz`).

Using the relative property name allows for simplified syntax and more efficient data entry ("less typing") within the CLI. Full property names can be used for clarity (i.e., specifying **exactly** what you want to filter on).

Full property names may be **required** in cases where multiple nodes in the inbound node set have the same secondary property (e.g., `inet:dns:a:ipv4` and `inet:url:ipv4`) and you only wish to filter based on the property / property value of one of the forms.

In the examples below, both syntaxes (full and relative) are provided where appropriate for completeness and clarity. See the *Property* section of *Data Model - Terminology* for additional discussion of properties.

See *Storm Reference - Document Syntax Conventions* for an explanation of the syntax format used below.

See *Storm Reference - Type-Specific Storm Behavior* for details on special syntax or handling for specific data types.

Simple Filters

"Simple" filters refers to the most "basic" filter operations: that is, operations to include (+) or exclude (-) a subset of nodes based on:

- The presence of a specific primary or secondary property in the working set of nodes.
- The presence of a specific primary property value or secondary property value in the working set of nodes.

Note: *Filter by Tag (#)* is addressed below.

The only difference between "simple" filters and "filters using comparison operators" is that we define simple filters as those that use the equals (=) comparator, which is the "simplest" comparator to use to explain basic filtering concepts.

Syntax:

<*query*> **+** | **-** <*form*> [**=** <*valu*>]

<*query*> **+** | **-** [<*form*>] **:** <*prop*> [**=** <*pval*>]

Examples:

Filter by Form (<form>):

- Filter results to only include domains:

```
<query> +inet:fqdn
```

Filter by Primary Property Value:

- Filter results to exclude the domain `google.com`:

```
<query> -inet:fqdn=google.com
```

Filter by Presence of Secondary Property:

- Filter results to exclude any DNS SOA records with an "email" property:

```
<query> -inet:dns:soa:email
```

```
<query> -:email
```

Filter by Secondary Property Value:

- Filter results to include only those domains that are also logical zones:

```
<query> +inet:fqdn:iszone=1
```

```
<query> +:iszone=1
```

- Filter results to exclude any files with a PE compiled time of `1992-06-19 22:22:17`:

```
<query> -file:bytes:mime:pe:compiled="1992/06/19 22:22:17"
```

```
<query> -:mime:pe:compiled="1992/06/19 22:22:17"
```

- Filter results to include only those files compiled in 2019:

```
<query> +file:bytes:mime:pe:compiled=2019*
```

```
<query> +:mime:pe:compiled=2019*
```

Filter by Presence of Universal Property:

- Filter results to include only those domains with a `.seen` property:

```
<query> +inet:fqdn.seen
```

```
<query> +.seen
```

Usage Notes:

- The comparator (comparison operator) specifies how <*form*> or <*prop*> is evaluated with respect to <*valu*> or <*pval*>. The most common comparator is equals (=), although other comparators are available (see below).
- When filtering nodes by secondary property value where the value is a time (date / time), you do not need to use full `YYYY/MM/DD hh:mm:ss.mmm` syntax. Synapse allows you to use either lower resolution values (e.g., `YYYY/MM/DD`) or wildcard values (e.g., `YYYY/MM*`). In particular, wildcard syntax can be used to specify any values that match the wildcard expression. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Filters Using Standard Comparison Operators

Filter operations can be performed using any of the standard mathematical / logical comparison operators (comparators):

- =: equals (described above)
- `!=` : not equals
- < : less than
- > : greater than
- <= : less than or equal to

- >= : greater than or equal to

Syntax:

<query> **+** | **-** *<form>* | *<prop>* *<comparator>* *<valu>* | *<pval>*

Examples:

Filter by Not Equals:

- Filter results to exclude the domain `google.com`:

```
<query> +inet:fqdn != google.com
```

Filter by Less Than:

- Filter results to include only WHOIS records collected prior to January 1, 2017:

```
<query> +inet:whois:rec:asof < 2017/01/01
```

```
<query> +:asof < 2017/01/01
```

Filter by Greater Than:

- Filter results to exclude files larger than 4096 bytes:

```
<query> -file:bytes:size > 4096
```

```
<query> -:size > 4096
```

Filter by Less Than or Equal To:

- Filter results to include only WHOIS nodes for domains created on or before noon on January 1, 2018:

```
<query> +inet:whois:rec:created <= "2018/01/01 12:00"
```

```
<query> +:created <= "2018/01/01 12:00"
```

Filter by Greater Than or Equal To:

- Filter results to include only people born on or after January 1, 1980:

```
<query> +ps:person:dob >= 1980/01/01
```

```
<query> +:dob >= 1980/01/01
```

Usage Notes:

- Storm supports both equals (`=`) and not equals (`!=`) comparators for filtering, although use of not equals is not strictly necessary. Because filters are either inclusive (`+`) or exclusive (`-`), you can use an "equals" filter to create equivalent logic for any "not equals" expression. That is, "**include** domains **not equal** to google.com" (`+inet:fqdn != google.com`) is equivalent to "**exclude** the domain google.com" (`-inet:fqdn = google.com`).
- When filtering nodes by secondary property value where the value is a time (date / time), you do not need to use full `YYYY/MM/DD hh:mm:ss.mmm` syntax. Synapse allows you to use either lower resolution values (e.g., `YYYY/MM/DD`) or wildcard values (e.g., `YYYY/MM*`). In particular, wildcard syntax can be used to specify any values that match the wildcard expression. See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Filters Using Extended Comparison Operators

Storm supports a set of extended comparison operators (comparators) for specialized filter operations. In most cases, the same extended comparators are available for both lifting and filtering:

- *Filter by Regular Expression (~=)*
- *Filter by Prefix (^=)*
- *Filter by Time or Interval (@=)*
- *Filter by Range (*range=)*
- *Filter by Set Membership (*in=)*
- *Filter by Proximity (*near=)*
- *Filter by (Arrays) (*[ ])*
- *Filter by Tag (#)*

Filter by Regular Expression (~=)

The extended comparator ~= is used to filter nodes based on regular expressions (PCRE / Perl compatible regular expressions).

Syntax:

<query> **+ | -** *<form>* **|** *<prop>* **~=** *<regex>*

Examples:

Filter by Regular Expression:

- Filter results to include only mutexes that start with the string "Net":

```
<query> +it:dev:mutex ~= "^Net"
```

Usage Notes:

- Filtering using regular expressions is performed by matching the regex against the relevant property of each node in the working set. Note that **prefix filtering** (see below) is supported for string types and can be used as a more efficient alternative in some cases.

Filter by Prefix (^=)

Synapse performs prefix indexing on strings (and string-derived types), which optimizes filtering nodes whose *<valu>* or *<pval>* starts with a given prefix. The extended comparator ^= is used to filter nodes by prefix.

Syntax:

<query> **+ | -** *<form>* **|** *<prop>* **^=** *<prefix>*

Examples:

Filter by primary property by prefix:

- Filter results to include only usernames that start with "pinky":

```
<query> +inet:user ^= pinky
```

Filter by secondary property by prefix:

- Filter results to include only organizations whose name starts with "International":

```
<query> +ou:org:name ^= international
```

```
<query> +:name ^= international
```

Usage Notes:

- Extended string types that support dotted notation (such as the `loc` or `syn:tag` types) have custom behaviors with respect to lifting and filtering by prefix. See the respective sections in *Storm Reference - Type-Specific Storm Behavior* for additional details.

Filter by Time or Interval (@=)

The time extended comparator (`@=`) supports filtering nodes based on comparisons among various combinations of times and intervals.

See *Storm Reference - Type-Specific Storm Behavior* for additional detail on the use of `time` and `ival` data types.

Syntax:

<query> **+ | -** *<prop>* **@=(** *<ival_min>* **,** *<ival_max>* **)**

<query> **+ | -** *<prop>* **@=** *<time>*

Examples:

Filter by comparing an interval to an interval:

- Filter results to include only those DNS A records whose `.seen` values fall between July 1, 2018 and August 1, 2018:

```
<query> +inet:dns:a.seen@=(2018/07/01, 2018/08/01)
```

```
<query> +.seen@=(2018/07/01, 2018/08/01)
```

- Filter results to include only those nodes (e.g., IP addresses) that were associated with TOR network infrastructure between June 1, 2016 and September 30, 2016 (note the interval here applies to the timestamps for the **tag** that indicates a node was associated with TOR):

```
<query> +#cno.infra.anon.tor@=(2016/06/01, 2016/09/30)
```

Filter by comparing a time to an interval:

- Filter results to include only those DNS request nodes whose requests occurred between 2:00 PM November 12, 2017 and 9:30 AM November 14, 2017:

```
<query> +inet:dns:request:time@=("2017/11/12 14:00:00", "2017/11/14 09:30:00")
```

```
<query> +:time@=("2017/11/12 14:00:00", "2017/11/14 09:30:00")
```

Filter by comparing an interval to a time:

- Filter results to include only those DNS A records whose resolution time windows include the date December 1, 2017:

```
<query> +inet:dns:a.seen@=2017/12/01
```

```
<query> +.seen@=2017/12/01
```

Filter by comparing a time to a time:

- Filter results to include only those WHOIS records whose domain was registered (created) **exactly** on March 19, 1986 at 5:00 AM:

```
<query> +inet:whois:rec:created@="1986/03/19 05:00:00"
```

```
<query> +:created@="1986/03/19 05:00:00"
```

Filter using an interval with relative times:

- Filter results to include only those `inet:whois:email` nodes that were observed between January 1, 2018 and the present:

```
<query> +inet:whois:email.seen@=(2018/01/01, now)
```

```
<query> +.seen@=(2018/01/01, now)
```

- Filter results to include only DNS requests whose requests occurred within one week after October 15, 2018:

```
<query> +inet:dns:request:time@=(2018/10/15, "+ 7 days")
```

```
<query> +:time@=(2018/10/15, "+ 7 days")
```

Usage Notes:

- When specifying an interval, the minimum value is **included** in the interval but the maximum value is **excluded** (the equivalent of "greater than or equal to <*min*> and less than <*max*>"). This behavior is slightly different than that for `*range=`, which includes **both** the minimum and maximum.
- When comparing an **interval to an interval,** Storm will return nodes whose interval has **any** overlap with the specified interval.
  - For example, a filter interval of September 1, 2018 to October 1, 2018 (2018/09/01, 2018/10/01) will match nodes with **any** of the following intervals:
    - 2018/08/12 to 2018/09/06 (range overlaps with the <*min*> value).
    - 2018/09/13 to 2018/09/17 (range falls between <*min*> and <*max*> values).
    - 2018/09/30 to 2018/11/05 (range overlaps with the <*max*> value).
- When comparing a **time to an interval,** Storm will return nodes whose timestamp falls **within** the specified interval.
- When comparing a **time to a time,** Storm will return nodes whose timestamp is an **exact match.** Interval syntax (e.g., `:time@=<time>`) syntax is supported when specifying an exact time match, although you can simply use the equals comparator instead (e.g., `:time=<time>`).
- Because tags can have optional timestamps (min / max interval values), interval filters can also be used to filter based on tag timestamps.
- When specifying interval date/time values, Synapse allows you to use either lower resolution values (e.g., `YYYY/MM/DD`) or wildcard values (e.g., `YYYY/MM*`) for the minimum and/or maximum interval values. In addition, plain wildcard time syntax may provide a simpler and more intuitive means to specify some intervals. For example

`+inet:whois:rec:asof=2018*` (or `+:asof=2018*`) is equivalent to `+inet:whois:rec:asof@=('2018/01/01', '2019/01/01')` (or `+:asof@=('2018/01/01, '2019/01/01')`). See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Filter by Range (*range=)

The range extended comparator (`*range=`) supports filtering nodes whose *<form> = <valu>* or *<prop> = <pval>* fall within a specified range of values. The comparator can be used with types such as integers and times, including types that are extensions of those types, such as IP addresses.

Syntax:

***<query>* + | - *<form>* | *<prop>* *range = (*<range_min>* , *<range_max>*)**

Examples:

Filter by primary property in range:

- Filter results to include all IP addresses between 192.168.0.0 and 192.168.0.10:

```
<query> +inet:ipv4*range=(192.168.0.0, 192.168.0.10)
```

Filter by secondary property in range:

- Filter results to include files whose size in bytes is within the specified range:

```
<query> +file:bytes:size*range=(1000, 100000)
```

```
<query> +:size*range=(1000, 100000)
```

- Filter results to include WHOIS records that were captured between the specified dates:

```
<query> +inet:whois:rec:asof*range=(2013/11/29, 2016/06/14)
```

```
<query> +:asof*range=(2013/11/29, 2016/06/14)
```

- Filter results to include DNS requests made within 1 day of December 1, 2018:

```
<query> +inet:dns:request:time*range=(2018/12/01, "+-1 day")
```

```
<query> +:time*range=(2018/12/01, "+-1 day")
```

Usage Notes:

- When specifying a range (`*range=`), both the minimum and maximum values are **included** in the range (the equivalent of "greater than or equal to *<min>* and less than or equal to *<max>*"). This behavior is slightly different than that for time interval (`@=`), which includes the minimum but not the maximum.
- The `*range=` extended comparator can be used with time types, although the time / interval extended comparator (`@=`) is preferred.
- When specifying a range of time values, Synapse allows you to use either lower resolution values (e.g., `YYYY/MM/DD`) or wildcard values (e.g., `YYYY/MM*`) for the minimum and/or maximum range values. In addition, plain wildcard time syntax may provide a simpler and more intuitive means to specify some time ranges. For example `+inet:whois:rec:asof=2018*` (or `+:asof=2018*`) is equivalent to `+inet:whois:rec:asof*range=('2018/01/01', '2018/12/31 23:59:59.999')` (or `+:asof*range=('2018/01/01', '2018/12/31 23:59:59.999')`). See the type-specific documentation for *time* types for a detailed discussion of these behaviors.

Filter by Set Membership (*in=)

The set membership extended comparator (`*in=`) supports filtering nodes whose <*form*> = <*valu*> or <*prop*> = <*pval*> matches any of a set of specified values. The comparator can be used with any type.

Syntax:

<*query*> **+ | -** <*form*> | <*prop*> ***in = (** <*set_1*> **,** <*set_2*> **,** ... **)**

Examples:

Filter by primary property in set:

- Filter results to include IP addresses matching any of the specified values:

```
<query> +inet:ipv4*in=(127.0.0.1, 192.168.0.100, 255.255.255.254)
```

Filter by secondary property in set:

- Filter results to include files whose size in bytes matches any of the specified values:

```
<query> +file:bytes:size*in=(4096, 16384, 65536)
```

```
<query> +:size*in=(4096, 16384, 65536)
```

- Filter results to exclude tags that end in `foo`, `bar`, or `baz`:

```
<query> -syn:tag:base*in=(foo, bar, baz)
```

```
<query> -:base*in=(foo, bar, baz)
```

Filter by Proximity (*near=)

The proximity extended comparator (`*near=`) supports filtering nodes by "nearness" to another node based on a specified property type. Currently, `*near=` supports proximity based on geospatial location (that is, nodes within a given radius of a specified latitude / longitude).

Syntax:

<*query*> **+ | -** <*form*> | <*prop*> ***near = ((** <*lat*> **,** <*long*> **),** <*radius*> **)**

Examples:

Filter by proximity:

- Filter results to include only Acme Corporation offices within 1 km of a specific coffee shop:

```
<query> +geo:place:latlong*near=((47.6050632,-122.3339756),1 km)
```

```
<query> +:latlong*near=((47.6050632,-122.3339756),1 km)
```

- Filter results to include only Acme Corporation offices within 1 mile of a specific coffee shop:

```
<query> +geo:place:latlong*near=((47.6050632,-122.3339756), 1 mile)
```

```
<query> +:latlong*near=((47.6050632,-122.3339756), 1 mile)
```

Usage Notes:

- In the example above, the latitude and longitude of the desired location (i.e., the coffee shop) are explicitly specified as parameters to `*near=`.
- Radius can be specified in the following units. The values in parentheses are the acceptable terms for specifying a given unit:
  - Kilometers (km / kilometer / kilometers)
  - Meters (m / meter / meters)
  - Centimeters (cm / centimeter / centimeters)
  - Millimeters (mm / millimeter / millimeters)
  - Miles (mile / miles)
  - Yards (yard / yards)
  - Feet (foot / feet)
- When specifying a radius, values of less than 1 must be specified with a leading zero (e.g., `0.5 km` is valid; `.5 km` is not).
- The `*near=` comparator works by identifying nodes within a square bounding box centered at *<lat>, <long>*, then filters the nodes to be returned by ensuring that they are within the great-circle distance given by the *<radius>* argument.

Filter by (Arrays) (*[ ])

Storm uses a special "by" syntax to filter (or lift) by comparison with one or more elements of an *array* type. The syntax consists of an asterisk (*) preceding a set of square brackets ([ ]), where the square brackets contain a comparison operator and a value that can match one or more elements in the array. This allows users to match any value in the array list without needing to know the exact order or values of the array itself.

Syntax:

<query> **+** | **-** *<prop>* ***[** *<operator>* *<pval>* **]**

Examples:

- Filter results to include only x509 certificates that reference a specific email address:

```
<query> +:identities:emails*[=root@localhost.localdomain]
```

- Filter results to exclude organizations whose names start with "ministry":

```
<query> -:names*[^=ministry]
```

Usage Notes:

- Filter operations using secondary properties of type *array* must specify the property using its relative property name. Filtering using the full property syntax will generate an error.
  - `ou:org | limit 10 | +:names*[=vertex]` is valid syntax.
  - `ou:org | limit 10 | +ou:org:names*[=vertex]` is invalid syntax.
- The comparison operator used must be valid for filter operations for the type used in the array.
- The standard equals (=) operator can be used to filter nodes based on array properties, but the value specified must **exactly match** the **full** property value in question:

  - For example: `ou:org +:names=("the vertex project","the vertex project llc",vertex)` will filter to any `ou:org` nodes whose `:names` property consists of **exactly** those names in **exactly** that order.

- See the *array* section of the *Storm Reference - Type-Specific Storm Behavior* document for additional details on working with arrays.

Filter by Tag (#)

The tag extended comparator (#) supports filtering nodes based on the tags applied to a node. You can filter based on a given tag or on the timestamps associated with a given tag (using the interval comparator, @=).

Note: You can also use "filter by tag" to filter nodes based on any tags with tag properties, or tags with tag properties and specific tag property values, if tag properties are present in your data model.

Tag Properties are still supported by Synapse, but their use has largely been deprecated in favor of extended model properties where needed.

Syntax:

<query> **+ | - #** *<tag>*

<query> **+ | - #** *<tag>* **@=** *<time>* **|** **(** *<min>* **,** *<max>* **)**

Examples:

Filter by tag:

- Filter results to include only nodes that ESET says are part of the Seduploader malware family:

```
<query> +#rep.eset.seduploader
```

- Filter results to exclude nodes tagged as being associated with the TOR network:

```
<query> -#cno.infra.anon.tor
```

- Filter results to exclude nodes tagged as sinkholes:

```
<query> -#cno.infra.dns.sinkhole
```

Filter by tag and time:

- Filter results to include only nodes that were associated with TOR infrastructure as of December 12, 2019:

```
<query> +#cno.infra.anon.tor@=2019/12/12
```

Filter by tag and time interval:

- Filter results to include only those nodes associated with sinkhole infrastructure between January 1, 2017 and January 1, 2018:

```
<query> +#cno.infra.dns.sinkhole@=(2017/01/01, 2018/01/01)
```

- Filter results to exclude nodes associated with threat cluster 17 after January 1, 2019:

```
<query> -#cno.threat.t17.own@=(2019/01/01, now)
```

Usage Notes

- When filtering by tag, you can only specify a single tag (though you can specify a tag "higher up" in a tag tree to encompass any / all tags lower in the tree - e.g., `+#foo.bar` will include any nodes with the tag `#foo.bar.hurr`, `#foo.bar.derp`, etc.). To filter on multiple different tags, use *Compound Filters*.
- Tag timestamps are interval (`ival`) types. See the *time* and *ival* sections of the *Storm Reference - Type-Specific Storm Behavior* document for additional details on working with times and intervals.

Compound Filters

Storm allows you to use the logical operators **and**, **or**, and **not** (including **and not**) to construct compound filters. You can use parentheses to group portions of the filter statement to indicate order of precedence and clarify logical operations when evaluating the filter.

Syntax:

<*query***> + | - (** *<filter>* **and | or | not | and not** ... **)**

Examples:

- Filter results to exclude files that are less than or equal to 16384 bytes in size and were compiled prior to January 1, 2014:

```
<query> -(file:bytes:size <= 16384 and file:bytes:mime:pe:compiled < 2014/01/01)
```

```
<query> -(:size <= 16384 and :mime:pe:compiled < 2014/01/01)
```

- Filter results to include only files or domains that ESET claims are associated with Sednit:

```
<query> +((file:bytes or inet:fqdn) and #rep.eset.sednit)
```

- Filter results to include only files and domains that ESET claims are associated with Sednit that are **not** sinkholed:

```
<query> +((file:bytes or inet:fqdn) and (#rep.eset.sednit and not #cno.infra.dns.
↪sinkhole))
```

Usage Notes:

- Logical operators must be specified in lower case.
- Synapse evalutes compound filters **in order from left to right**. Depending on the specific filter, left-to-right order may differ from the standard Boolean order of operations (**not** then **and** then **or**).
- Parentheses should be used to logically group portions of the filter statement if necessary to clarify order of operations.

Subquery Filters

You can use Storm's subquery syntax (*Storm Reference - Subqueries*) to create filters. A subquery (enclosed in curly braces (`{ }`)) can be placed within a larger Storm query.

When nodes are passed to a subquery filter, they are evaluated against the filter's criteria:

- Nodes are **excluded** ("consumed", discarded) if they evaluate **false.**
- Nodes are **included** (not "consumed", retained) if they evaluate **true.**

Most filter operations in Storm will modify (reduce) your current set of nodes based on some criteria of the **nodes themselves** (e.g., a node's form, property, or tag).

Subquery filters allow you to filter your **current** set of nodes based on some criteria of **nearby** nodes. You use the subquery filter to effectively "look ahead" at nodes one or more pivots away from your current nodes, and filter your current nodes based on the properties of those "nearby" nodes.

The subquery pivot operation (used to "look ahead" at other nodes) is effectively performed in the background (without navigating away from your current working set), which provides a more powerful and efficent way to filter your data. (The alternative would be to **actually** navigate to the nearby nodes, filter those nodes, and then navigate **back** to the data you are interested in.)

You can optionally use a mathematical comparison operation with a subquery filter, in order to filter your current set of nodes based on the **number of results** returned by executing the subfilter's Storm query (see example below).

Refer to the *Storm Reference - Subqueries* guide for additional information on subqueries and subquery filters.

Syntax:

<query> **+ | - { <***query***> }**

<query> **+ | - { <***query***> }** [*<mathematical operator> <value>*]

Examples:

- From an initial set of domains, filter results to only those domains that resolve to an IP address that Trend Micro associates with the Pawn Storm threat group (i.e., an IP address tagged `#rep.trend.pawnstorm`):

```
<inet:fqdn> +{ -> inet:dns:a:fqdn :ipv4 -> inet:ipv4 +#rep.trend.pawnstorm }
```

- From an initial set of IPv4 addresses, filter results to only those IPv4s registered to an Autonomous System (AS) whose name starts with "makonix":

```
<inet:ipv4> +{ :asn -> inet:asn +:name^="makonix" }
```

- From an initial set of `file:bytes` nodes, filter results to only those that are detected as malicious by ten (10) or more antivirus / malscanner vendors (i.e., files that are associated with 10 or more `it:av:filehit` nodes):

```
<file:bytes> +{ -> it:av:filehit }>=10
```

- From an initial set of x509 certificates (`crypto:x509:cert`), filter results to only those certificates linked to more than one FQDN (`inet:fqdn`) identity:

```
<crypto:x509:cert> +{ :identities:fqdns -> inet:fqdn }>1
```

Expression Filters

You can filter your current set of data (nodes) based on the evaluation of a particular expression. Expression filters are useful when you need to compute a value that you want to use for the filter, or when you want to filter based on a value that may change (e.g., when using Storm queries that assign variables - see *Storm Reference - Advanced - Variables*).

Syntax:

<query> **+ | - $(** *<expression>* **)**

Examples:

- From an initial set of network flows (`inet:flow` nodes), filter results to only those flows where the total number of bytes transferred in the flow between the source (`inet:flow:src:txbytes`) and destination (`inet:flow:dst:txbytes`) is greater than 100MB (~100,000,000 bytes):

```
<inet:flow> +$( :src:txbytes + :dst:txbytes >=100000000 )
```

- From an initial set of x509 certificates (`crypto:x509:cert`), filter results to only those certificates linked to more than one FQDN (`inet:fqdn`) identity:

```
<crypto:x509:cert> $fqdns=:identities:fqdns +$( $fqdns.size() > 1 )
```

This example assigns the list of domains in the `crypto:x509:cert:identities:fqdns` property to the user-defined variable `$fqdns`, computes the number of domains in the list using *size()*, and checks to see if the result is greater than 1.

(See the *Storm Library Documentation* for additional detail on Storm types and Storm libraries.)

Note: This certificates example is identical to the final example under *Subquery Filters* above, and shows an alternate way to return the same data.

The expression filter above is more efficient than the subquery filter because the expression filter simply evaluates the expression, where the subquery filter needs to pivot to the adjacent nodes in order to evaluate the results. This difference in performance is negligible for small data sets but more pronounced when working with large numbers of nodes.

- From the set of nodes associated with any threat group or threat cluster (e.g., tagged `#cno.threat.<threat_name>`), filter results to those nodes that are attributed to more than one threat (e.g., that have more than one `#cno.threat.<threat_name>` tag. This may identify nodes that are incorrectly attributed to more than one group; or instances where two threat clusters overlap, which may indicate that the clusters actually represent a single set of activity):

```
#cno.threat +$( $node.globtags(cno.threat.*).size() > 1 )
```

This example uses the *$node.globtags()* method to select the set of tags on each node that match the specified expression (`cno.threat.*`) and *size()* to count the number of matches.

Embedded Property Syntax

Storm includes a shortened syntax consisting of two colons (`::`) that can be used to reference a secondary property of an **adjacent** node. Because the syntax can be used to "pull in" a property or property value from a nearby node, it is known as "embedded property syntax".

Embedded property syntax expresses something that is similar (in concept, though not in practice) to a secondary-to-secondary property pivot (see *Storm Reference - Pivoting*). The syntax expresses navigation:

- From a **secondary property** of a form (such as `inet:ipv4:asn`), to
- The **form** for that secondary property (i.e., `inet:asn`), to
- A **secondary property** (or property value) of that **target form** (such as `inet:asn:name`).

This process can be repeated to reference properties of forms more than one pivot away.

Despite its similarity to a pivot operation, embedded property syntax is commonly used for:

- **Filter operations** (specifically, as a more concise alternative to certain *Subquery Filters*)
- **Variable assignment** (see *Storm Reference - Advanced - Variables*)
- Defining an *Embed Column* in the Synapse UI (Optic)

Syntax:

<query> [**+** | **-**] **:** *<prop>* **::** *<prop>*

<query> [**+** | **-**] **:** *<prop>* **::** *<prop>* **=** *<pval>*

Note: In Storm, the leading colon (i.e., the colon before the name of the initial secondary property) is **required**. When using this syntax to create an embed column in Optic, the initial colon should be **omitted** (i.e., `asn::name` vs `:asn::name`). Optic will prepend the initial colon for you.

Examples:

Filter Example - Single Pivot

- From an initial set of IPv4 addresses, filter results to only those IPv4s registered to an Autonomous System (AS) whose name starts with "makonix":

```
<inet:ipv4> +:asn::name^="makonix"
```

Note that this example of embedded property syntax is equivalent to the following subquery filter (referenced above):

```
<inet:ipv4> +{ :asn -> inet:asn +:name^="makonix" }
```

Filter Example - Multiple Pivots

- From an initial set of `it:exec:file:read` operations, filter results to only those operations where the base file name of the PDB path of the file performing the read operation is `moonclient2.pdb`:

```
<it:exec:file:read> +:sandbox:file::mime:pe:pdbpath::base=moonclient2.pdb
```

Variable Assignment Example

- Set the variable `$name` to the name of the Autonomous System (AS) associated with a given IPv4 address:

```
<inet:ipv4> $name=:asn::name
```

3.6.5 Storm Reference - Pivoting

Pivot operations are performed on the output of a previous Storm operation such as a lift or filter. Pivot operators are used to perform pivot operations by navigating from one set of nodes to another based on a specified relationship. Most often, this relationship is two properties (primary and / or secondary) that share the same **value**, and that may also share the same *Type*.

That is, other than some specialized use cases (such as pivoting to or from tags), most pivots involve navigating between the following kinds of properties:

- primary to secondary;
- secondary to primary;
- secondary to secondary; or
- primary to primary.

Note: Primary to primary property pivots are a specialized use case that is commonly handled using *Raw Pivot Syntax*, below.

Where the source and target properties have the same value **and** the same type, Storm can leverage Synapse's *Type Awareness* to simplify pivot operations and identify implicit relationships. For example, type awareness is used for *Implicit Pivot Syntax* and also for "wildcard" pivot operations (specialized use cases for the *Pivot Out Operator* and the *Pivot In Operator*).

The pivot operations available within Storm are:

- *Pivot Out Operator*
- *Pivot In Operator*
- *Pivot With Join*
- *Traverse (Walk) Light Edges*
- *Pivot Out and Walk*
- *Pivot In and Walk*
- *Pivot to Digraph (Edge) Nodes*
- *Pivot Across Digraph (Edge) Nodes*
- *Pivot to Tags*
- *Pivot from Tags*
- *Implicit Pivot Syntax*
- *Raw Pivot Syntax*

Note: Light edges represent a special use case within the Synapse hypergraph; navigating (traversing) light edges (*Lightweight (Light) Edge*) is included here as a "pivot-like" operation.

See *Storm Reference - Document Syntax Conventions* for an explanation of the syntax format used below.

See *Storm Reference - Type-Specific Storm Behavior* for details on special syntax or handling for specific data types.

Pivot Out Operator

The pivot out operator (->) is the primary Storm pivot operator. The pivot out operator is used for:

- primary to secondary property pivots,
- secondary to primary property pivots,
- secondary to secondary property pivots, and
- "wildcard" pivot out - pivot from any / all **secondary** properties of the inbound set of nodes to the equivalent **primary** property of any nodes, leveraging Synapse's *Type Awareness*.

Pivot to Digraph (Edge) Nodes and *Pivot Across Digraph (Edge) Nodes* are covered separately below.

Syntax:

- *Primary to Secondary:*

  <query> **->** *<form>* **:** *<prop>*

- *Secondary to Primary:*

  <query> **:** *<prop>* **->** *<form>*

- *Secondary to Secondary:*

  <query> **:** *<prop>* **->** *<form>* **:** *<prop>*

- *"Wildcard" Pivot Out:*

  <query> **->** ***

Examples:

Pivot from primary property (<form> = <valu>) to secondary property (<prop> = <pval>):

- Pivot from a set of domains to all of their subdomains regardless of depth (i.e., from a domain to all of the domains where the inbound domain is a zone):

```
<inet:fqdn> -> inet:fqdn:zone
```

- Pivot from a set of domains to the DNS A records for those domains:

```
<inet:fqdn> -> inet:dns:a:fqdn
```

Pivot from secondary property (<prop> = <pval>) to primary property (<form> = <valu>):

- Pivot from a set of DNS A records to the resolution IP addresses contained in those records:

```
<inet:dns:a> :ipv4 -> inet:ipv4
```

Pivot from secondary property (<prop> = <pval>) to secondary property (<prop> = <pval>):

- Pivot from the WHOIS records for a set of domains to the DNS A records for the same domains:

```
<inet:whois:rec> :fqdn -> inet:dns:a:fqdn
```

"Wildcard" pivot out - pivot from all secondary properties to the primary properties of the equivalent forms (<prop> = <pval> to <form> = <valu>):

- Pivot from a set of WHOIS records to all nodes whose primary property equals *any* of the secondary properties of the WHOIS record:

```
<inet:whois:rec> -> *
```

In the example above, the pivot would navigate from the `:fqdn`, `:registrar`, and `:registrant` secondary properties of the `inet:whois:rec` nodes (for example) to the associated `inet:fqdn`, `inet:whois:rar`, and `inet:whois:reg` nodes.

Usage Notes:

- When pivoting **from** a secondary property (<*prop*> = <*pval*>), the secondary property **must** be specified using the relative property name only (`:baz` vs. `foo:bar:baz`). If you specify the full property name before the pivot, Storm interprets that as an additional lift (i.e., `<inet:dns:a> inet:dns:a:fqdn -> inet:fqdn` would be interpreted as "take a set of DNS A records from an initial query, lift **all** DNS A records with an :fqdn property (i.e., every DNS A node in the Cortex), and then pivot to the associated FQDN nodes").
- Pivoting out using the asterisk wildcard (`*`) is sometimes called a **refs out** pivot because it pivots from **all** secondary properties of the inbound nodes to **all nodes referenced by** those properties. That is, for each inbound node, the "refs out" pivot will pivot from the node's **secondary properties** to all the nodes that have a **primary property** equal to that type and value.
- Pivoting using the wildcard is based on strong data typing within the Synapse data model and Synapse's **type awareness**, so will only pivot out to properties that match both <*type*> and <*valu*> / <*pval*>. This means that the following nodes will **not** be returned by a wildcard pivot out:
  - Nodes with matching <*valu*> / <*pval*> but of different <*type*>. For example, if a node's secondary property is a string (type <*str*>) that happens to contain a valid domain (type <*inet:fqdn*>), a wildcard pivot out from the node with the string value will **not** return the `inet:fqdn` node.
  - Digraph (edge) nodes, whose properties are of type <*ndef*> (node definition, or <*form*>,<*valu*> tuples). See *Pivot to Digraph (Edge) Nodes* and *Pivot Across Digraph (Edge) Nodes* for details on pivoting to / through those forms.

- It is possible to perform an explicit pivot between properties of different types. For example: `<inet:dns:query> :name -> inet:fqdn`
- See *Pivot Out and Walk* for a more comprehensive alternative to the wildcard pivot out.

Pivot In Operator

The pivot in (`<-`) operator is similar to but separate from the pivot out (`->`) operator. The pivot in operator pivots to the set of nodes that **reference** the current set of nodes.

Logically, any pivot in operation can be expressed as an equivalent pivot out operation. For example, the following two pivots would be functionally equivalent:

- Pivot from a set of domains to their associated DNS A records:

  `<inet:fqdn> -> inet:dns:a:fqdn`

- Use "pivot in" to navigate from a set of domains to the DNS A records that **reference** a set of domains:

  `<inet:fqdn> <- inet:dns:a:fqdn`

Because of this equivalence, and because "left to right" logic is generally more intuitive, **only pivot out has been fully implemented in Storm.** (The second example, above, will actually return an error.) The pivot in operator exists, but is only used for certain special case pivot operations:

- "wildcard" pivot in - pivot from any / all **primary** properties of the inbound set of nodes to the equivalent **secondary** property of any nodes, leveraging Synapse's *Type Awareness*, and
- reverse *Pivot to Digraph (Edge) Nodes* and reverse *Pivot Across Digraph (Edge) Nodes* (covered separately below).

Syntax:

- *"Wildcard" Pivot In*

  <query> **<- ***

Example:

Pivot from all primary properties to all nodes with an equivalent secondary property (<form> = <valu> to <prop> = <pval>):

- Pivot from a set of domains to all nodes with a secondary property that references the domains:

```
<inet:fqdn> <- *
```

In this example, the pivot might return nodes with secondary properties such as `inet:whois:email:fqdn`, `inet:dns:ns:zone`, `inet:dns:query:name:fqdn`, and so on.

Usage Notes:

- Pivoting in using the asterisk wildcard (`*`) is sometimes called a **refs in** pivot because it pivots from the inbound nodes to **all nodes that reference** those nodes. That is, for each inbound node, the "refs in" pivot will pivot from the **primary property** of a node to all nodes that have a **secondary property** equal to that type and value.
- Pivoting in using the wildcard will return an instance of a node for **each** matching secondary property. For example, where a node may have the same *<pval>* for two different secondary properties (such as `:domain` and `:zone` on an `inet:fqdn` node), the pivot in will return two copies of the node. Results can be de-duplicated using the Storm *uniq* command.
- Pivoting using the wildcard is based on strong data typing within the Synapse data model and Synapse's **type awareness**, so will only pivot in from properties that match both *<type>* and *<valu>* / *<pval>*. This means that the following nodes will **not** be returned by a wildcard pivot in:

  - Nodes with matching <*valu*> / <*pval*> but of different <*type*>. For example, if a node's primary property (such as a domain, type <*inet:fqdn*>) - happens to be referenced as as a different type (such as a string, type <*str*>) as a secondary property of another node, a wildcard pivot in to the `inet:fqdn` node will **not** return the node with the string value.
  - Digraph (edge) nodes, whose properties are of type <*ndef*> (node definition, or <*form*>,<*valu*> tuples). See *Pivot to Digraph (Edge) Nodes* and *Pivot Across Digraph (Edge) Nodes* for details on pivoting to / through those forms.

- Other than digraph (edge) node navigation / traversal, **pivot in can only be used with the wildcard** (`*`). That is, pivot in does not support specifying a particular target form:

  ```
  inet:fqdn=woot.com <- inet:dns:a:fqdn
  ```

  The above query will return an error. A filter operation (see *Storm Reference - Filtering*) can be used to downselect the results of a wildcard pivot in operation to a specific set of forms:

  ```
  inet:fqdn=woot.com <- * +inet:dns:a
  ```

- See *Pivot In and Walk* for a more comprehensive alternative to the wildcard pivot in.

Pivot With Join

The pivot and join operator (`-+>`) performs the specified pivot operation but joins the results with the inbound set of nodes. That is, the inbound nodes are retained and combined with the results of the pivot.

Another way to look at the difference between a pivot and a join is that a pivot operation **consumes** nodes (the inbound set is discarded and only nodes resulting from the pivot operation are returned) but a pivot and join does **not** consume the inbound nodes.

The pivot and join operator is used to retain the inbound nodes in any of the following cases:

- primary to secondary property pivots,
- secondary to primary property pivots,
- secondary to secondary property pivots, and
- "wildcard" pivot out - pivot from any / all **secondary** properties of the inbound set of nodes to the equivalent **primary** property of any nodes.

Syntax:

- *Primary to Secondary*

  <*query*> **-+>** <*form*> **:** <*prop*>

- *Secondary to Primary*

  <*query*> **:** <*prop*> **-+>** <*form*>

- *Secondary to Secondary*

  <*query*> **:** <*prop*> **-+>** <*form*> **:** <*prop*>

- *"Wildcard" Pivot Out and Join*

  <*query*> **-+>** ***

Examples:

Pivot and join from primary property (<form> = <valu>) to secondary property (<prop> = <pval>):

- Return a set of domains and all of their immediate subdomains:

```
<inet:fqdn> -+> inet:fqdn:domain
```

Pivot and join from secondary property (<prop> = <pval>) to primary property (<form> = <valu>):

- Return a set of DNS A records and their associated IP addresses:

```
<inet:dns:a> :ipv4 -+> inet:ipv4
```

Pivot and join from secondary property (<prop> = <pval>) to secondary property (<prop> = <pval>):

- Return the WHOIS records for a set of domains and the DNS A records for the same domains:

```
<inet:whois:rec> :fqdn -+> inet:dns:a:fqdn
```

"Wildcard" pivot out and join - pivot from all secondary properties to the primary properties of the equivalent forms (<prop> = <pval> to <form> = <valu>):

- Return a set of WHOIS records and all nodes whose primary property equals any of the secondary properties of the WHOIS record:

```
<inet:whois:rec> -+> *
```

Usage Notes:

- A pivot out and join operation follows the same caveats and constraints as the standard *Pivot Out Operator*.

Traverse (Walk) Light Edges

The traverse (walk) light edges operator (-(<verb>)> or <(<verb>)-) is used to traverse from a set of inbound nodes to the set of nodes they are linked to by the specified light edge(s). Because a light edge is not a node, the navigation is technically a "traversal" of the light edge as opposed to a property-to-property pivot.

Similar to an edge in a traditional directed graph, light edges have a "direction" (i.e., the relationship represented by a light edge is "one way"). From a Storm syntax perspective, light edges can be traversed in either direction.

Syntax:

- *Walk - Single Light Edge*

  <query> **-(** *<verb>* **)> *** | *<form>*

  <query> **<(** *<verb>* **)- *** | *<form>*

- *Walk - Multiple Light Edges*

  <query> **-((** *<verb1>* **,** *<verb2>* **[,** *<verb3>* **...]))> *** | *<form>*

  <query> **<((** *<verb1>* **,** *<verb2>* **[,** *<verb3>* **...]))- *** | *<form>*

- *Walk - Any Light Edge (Wildcard)*

  <query> **-(*)> *** | *<form>*

  <query> **<(*)- *** | *<form>*

Examples:

Traverse the "refs" light edge from an article to the FQDNs "referenced" by the article:

```
<media:news> -(refs)> inet:fqdn
```

Traverse the "refs" light edge from an article to all of the nodes "referenced" by the article:

```
<media:news> -(refs)> *
```

Traverse the "hasip" light edge from an IPv4 address to the CIDR block(s) the IP is part of:

```
<inet:ipv4> <(hasip)- inet:cidr4
```

Traverse the "hasip" and "ipwhois" light edges from an IPv4 address to any nodes linked via those light edges (i.e., typically the CIDR block(s) the IP is part of and the netblock registration record(s) for the IP):

```
<inet:ipv4> <((hasip, ipwhois))- *
```

Traverse any / all light edges from an article to all nodes linked by any light edge:

```
<media:news> -(*)> *
```

Usage Notes:

- The traversal syntax allows specification of a single verb, a list of verbs, or the "wildcard" / asterisk (`*`) to reference any / all light edge verbs that may be present.
- There are no light edges (i.e., specific light edge verbs) defined in a Cortex by default. Users can create and define their own according to their needs.
- The Storm *model*, *edges*, and *lift.byverb* commands can be used to work with light edges in a Cortex.

Pivot Out and Walk

The pivot out and walk (traverse) light edges operator (`--> *`) combines a wildcard pivot out ("refs out") operation (`-> *`) with a wildcard walk light edges operation (`-(*)>`).

Syntax:

<*query*> —-> *

Examples:

Pivot from an IP netblock registration record to all nodes referenced by the record's secondary properties and all nodes linked to the record by light edges:

```
<inet:whois:iprec> --> *
```

Usage Notes:

- The pivot out and walk operator can only be used with a wildcard (`*`); it is not possible to specify a particular form as the target of the operation. A filter operation can be used to refine the results of the pivot and walk operation if necessary.
- The pivot and walk operators (pivot out and walk / pivot in and walk) are useful for "exploring" data in a Cortex as they will return all the nodes "next to" the working set of nodes (subject to *Type Awareness*) without requiring the user to have specific knowledge of the data model.
- The Storm *tee* command can be used to perform concurrent pivot in and walk / pivot out and walk operations on an inbound set of nodes:

```
<query> | tee { --> * } { <-- * }
```

Pivot In and Walk

The pivot in and walk (traverse) light edges operator (`<--  *`) combines a wildcard pivot in ("refs in") operation (`<- *`) with a wildcard walk light edges operation (`<(*)-`).

Syntax:

<query> **<—- ***

Examples:

Pivot from a set of IP addresses to all nodes that reference the IPs and all nodes linked to the IPs by light edges:

```
<inet:ipv4> <-- *
```

Usage Notes:

- The pivot in and walk operator can only be used with a wildcard (*); it is not possible to specify a particular form as the target of the operation. A filter operation can be used to refine the results of the pivot and walk operation if necessary.
- The pivot and walk operators (pivot out and walk / pivot in and walk) are useful for "exploring" data in a Cortex as they will return all the nodes "next to" the working set of nodes (subject to *Type Awareness*) without requiring the user to have specific knowledge of the data model.
- The Storm *tee* command can be used to perform concurrent pivot in and walk / pivot out and walk operations on an inbound set of nodes:

```
<query> | tee { --> * } { <-- * }
```

Pivot to Digraph (Edge) Nodes

Digraph (edge) nodes (*Digraph (Edge) Form*) are of type `edge` or `timeedge`. These nodes (forms) are unique in that their primary property value is a pair of **node definitions** (type *Ndef*) - that is, *<form>, <valu>* tuples. (`timeedge` forms are comprised of two *<form>, <valu>* tuples and an additional *<time>* value). Each *<form>, <valu>* tuple from the primary property is broken out as secondary property `:n1` or `:n2` of type *<ndef>*. This means that pivoting to and from digraph nodes is a bit different than pivoting to and from nodes whose properties are a simple *<valu>* or *<pval>*.

Note: Edge nodes are not formally deprecated, but the use of light edges (see *Lightweight (Light) Edge*) is now preferred over edge nodes.

Syntax:

<query> **->** *<edge>* | *<timeedge>* [**:n2**]

<query> **-+>** *<edge>* | *<timeedge>* [**:n2**]

<query> **<-** *<edge>* | *<timeedge>*

Examples:

Pivot out from a set of nodes whose ndefs (<form>, <valu>) are the first element (:n1) in a set of a digraph nodes:

- Pivot out from a person node to the set of digraph nodes representing things that person "has":

```
<ps:person> -> edge:has
```

- Pivot out from a person node to the set of `timeedge` digraph nodes representing places that person has been to (and when):

```
<ps:person> -> edge:wentto
```

Pivot in from a set of nodes whose ndefs (<form>, <valu>) are the second element (:n2) in a set of a digraph nodes:

- Pivot in from an article to the set of digraph nodes representing things that "have" the article (e.g., people or organizations who authored the article):

```
<media:news> <- edge:has
```

Usage Notes:

- To simplify working with digraph nodes and their `ndef` properties, Storm makes some assumptions (optimizations) when using the pivot out and pivot in operators:
  - When pivoting to or from a set of nodes to a set of digraph nodes, pivot using the `ndef` (*<form>*,*<valu>*) of the inbound nodes and not their primary property (*<valu>*) alone.
  - When pivoting **out** to a digraph node, the inbound nodes' *<form>*,*<valu>* `ndef` will be the **first** element (`:n1`) of the digraph. You must explicitly specify `:n2` as the target property to pivot using the second element.
  - When pivoting **in** to a digraph node, the inbound nodes' *<form>*,*<valu>* `ndef` will be the **second** element (`:n2`) of the digraph. It is not possible to pivot into the `:n1` value.
- Pivoting to / from digraph nodes is one of the specialized use cases for the pivot in (<-) operator, however the primary use case of pivot in with digraph nodes is reverse edge traversal (see *Pivot Across Digraph (Edge) Nodes*). See *Pivot In Operator* for general limitations of the pivot in operator.

Pivot Across Digraph (Edge) Nodes

Because digraph nodes represent generic edge relationships, analytically we are often more interested in the nodes on "either side" of the edge than in the digraph node itself. For this reason, the pivot operators have been optimized to allow a syntax for easily navigating "across" these digraphs (edges).

Note: Edge nodes are not formally deprecated, but the use of light edges (see *Lightweight (Light) Edge*) is now preferred over edge nodes.

Syntax:

<query> **->** *<edge>* | *<timeedge>* **->** ***** | *<form>*

<query> **<-** *<edge>* | *<timeedge>* **<-** ***** | *<form>*

Examples:

- Traverse a set of `edge:has` nodes to pivot from a person to all the things the person "has":

```
<ps:person> -> edge:has -> *
```

- Traverse a set of `edge:wentto` nodes to pivot from a person to the locations the person has visited:

```
<ps:person> -> edge:wentto -> *
```

Usage Notes:

- Storm makes the following assumptions to optimize the two pivots:

  - For pivots out, the first pivot is to the digraph nodes' `:n1` property and the second pivot is from the digraph nodes' `:n2` property.
  - For pivots in, the first pivot is to the digraph nodes' `:n2` property and the second pivot is from the digraph nodes' `:n1` property.
- Pivoting "across" the digraph nodes still performs two pivot operations (i.e., to the digraph nodes and then from them). As such it is still possible to apply an optional filter to the digraph nodes themselves before the second pivot.

Pivot to Tags

Pivot to tags syntax allows you to pivot from a set of nodes with tags to the set of `syn:tag` nodes representing those tags. This includes:

- pivot to all leaf tag nodes,
- pivot to all tag nodes,
- pivot to all tag nodes matching a specified pattern, and
- pivot to tag nodes matching an exact tag.

See the *Analytical Model - Tag Concepts* document for additional discussion of tags as nodes (`syn:tag` nodes) and tags as labels applied to other nodes.

Syntax:

<query> **->** **#** [* | *<tag>* **.*** | *<tag>*]

Examples:

Pivot to all leaf tag nodes:

- Pivot from a set of domains to the `syn:tag` nodes for all **leaf** tags applied to those domains (i.e., the longest / final tag in each tree applied to each node):

```
<inet:fqdn> -> #
```

Pivot to ALL tag nodes:

- Pivot from a set of files to the `syn:tag` nodes for **all** tags applied to those files (i.e., each tag in each tag tree applied to each node, from root to leaf):

```
<file:bytes> -> #*
```

Pivot to all tag nodes matching the specified pattern:

- Pivot from a set of IP addresses to the `syn:tag` nodes for all tags applied to those IPs that are part of the anonymized infrastructure tag tree:

```
<inet:ipv4> -> #cno.infra.anon.*
```

Pivot to tag nodes exactly matching the specified tag:

- Pivot from a set of nodes to the `syn:tag` node for `#foo.bar` (if present on the inbound set of nodes):

```
<query> -> #foo.bar
```

Usage Notes:

- Pivot to all tags (`#*`) and pivot by matching an initial pattern (`#<tag>.*`) will match **all** tags in the relevant tag trees from the inbound nodes, not just the leaf tags. For example, for an inbound node with tag `#foo.bar.baz`, `#*` will return the `syn:tag` nodes for `foo`, `foo.bar`, and `foo.bar.baz`.
- When using the asterisk / wildcard (`*`) to match a pattern, the wildcard(s) can be used anywhere within the tag name (value); they are not limited to matching elements within the tag's dotted namespace. For example, all of the following are valid (though may return different results):
  - `-> #aka.thr.*`
  - `-> #aka.t*`
  - `-> #a*`
  - `-> #*thr*`
  - `-> #*.thr.*`
- The pivot to tags operator does not support pivoting directly to a set of tags specified by a prefix match (`^`) or regular expression (`~`). However, these operators can be used as part of a subsequent filter operation to further refine the results of the pivot.

Pivot from Tags

Pivot from tags syntax allows you to pivot from a set of `syn:tag` nodes to the set of nodes that have those tags.

Syntax:

<*syn:tag*> **->** * | <*form*>

Examples:

- Pivot to all domains tagged with tags from any of the inbound `syn:tag` nodes:

```
<syn:tag> -> inet:fqdn
```

- Pivot to **all** nodes tagged with tags from any of the inbound `syn:tag` nodes:

```
<syn:tag> -> *
```

Usage Notes:

- In many cases, pivot from tags is functionally equivalent to *Lift by Tag (#)*. That is, the following queries will both return all nodes tagged with `#aka.feye.thr.apt1`:

  `syn:tag=aka.feye.thr.apt1 -> *`

  `#aka.feye.thr.apt1`

  Pivoting from tags is most useful when used in conjunction with *Pivot to Tags* - that is, taking a set of inbound nodes, pivoting to the `syn:tag` nodes for any associated tags (pivot to tags), and then pivoting out again to other nodes tagged with some or all of those tags (pivot from tags).

Implicit Pivot Syntax

Pivot operations in Storm can always be executed by **explicitly** specifying the source and target properties for the pivot. This is referred to as **explicit pivot syntax** or explicit syntax. For example:

```
inet:fqdn=vertex.link -> inet:dns:a:fqdn :ipv4 -> inet:ipv4
```

The above query:

- lifts the FQDN `vertex.link`,
- explicitly pivots from the primary property of the FQDN to any `inet:dns:a:fqdn` secondary property with the same value, and
- explicitly pivots from the `:ipv4` secondary property of the `inet:dns:a` nodes to the primary property of any `inet:ipv4` nodes with the same value.

Using explicit pivot syntax tells Storm **exactly** what you want to do; there is no ambiguity in the query. (Explicit syntax may also be useful when first learning Storm to reinforce exactly what navigation is being carried out when you perform a pivot operation.) However, the need to fully specify target properties (using form and property names) and specifically reference source properties (using relative property names) can add overhead ("more typing") to a Storm query that is not necessary if the query is unambiguous (i.e., based on the inbound and outbound forms).

For this reason, Storm also supports **implicit pivot syntax** for certain types of pivots. Implicit pivot syntax takes advantage of Synapse's *Type Awareness* to "know" which properties can be pivoted to (or from), given the forms that are inbound to and outbound from the pivot operation. In these cases, the source and/or target do not need to be explicitly specified. This allows for more concise Storm syntax in cases where the source and / or target of the pivot is self-evident given the forms used.

Implicit pivot syntax can be used in the following cases where the source and target properties have both the same **type** AND the same **value**:

- Primary to secondary property pivots.
- Secondary to primary property pivots.

Implicit pivot syntax **cannot** be used for the following:

- Primary to primary property pivots (see *Raw Pivot Syntax*, below)
- Secondary to secondary property pivots.
- Pivots between primary and secondary (or secondary and primary) properties with the same value but of different **types**.

Examples:

Pivot from primary property (<form> = <valu>) to secondary property (<prop> = <pval>) using implicit syntax:

- Pivot from a set of domains to their associated DNS A records:

Explicit syntax:

```
<inet:fqdn> -> inet:dns:a:fqdn
```

Implicit syntax:

```
<inet:fqdn> -> inet:dns:a
```

With implicit syntax, the target property `:fqdn` can be omitted because it is the only logical target given `inet:fqdn` nodes as the source and `inet:dns:a` nodes as the target of the pivot.

Note: While the `inet:fqdn` form has secondary properties that are also of type `inet:fqdn` (e.g., both `:domain` and `:zone`) implicit syntax can only be used to pivot between primary and secondary OR secondary and primary properties, but not both. That is, implicit syntax does not allow you to go from any / all properties of a given type in the source nodes to any / all properties with the same type and value in the target nodes. Because the target of the pivot is `inet:dns:a` nodes, the only logical target given the inbound nodes is the `:fqdn` **secondary** property, which means the only logical source is the **primary** property of the `inet:fqdn`.

Pivot from secondary property (<prop> = <pval>) to primary property (<form> = <valu>) using implicit syntax:

- Pivot from a set of DNS A records to their associated IP addresses:

Explicit syntax:

```
<inet:dns:a> :ipv4 -> inet:ipv4
```

Implicit syntax:

```
<inet:dns:a> -> inet:ipv4
```

With implicit syntax, the source property `:ipv4` can be omitted because it is the only logical source given a set of `inet:ipv4` nodes as the target.

Note: Similar to the last example, while the `inet:dns:a` form has both `:ipv4` and `:fqdn` secondary properties, implicit syntax can only be used to pivot between primary and secondary OR secondary and primary properties, but not both. Because the target of the pivot is `inet:ipv4` nodes, the only logical source property is the `:ipv4` secondary property of the `inet:dns:a` node.

Use of multiple implicit pivots:

- Pivot from a set of domains to their DNS A records and then to the associated IP addresses:

Regular (full) syntax:

```
<inet:fqdn> -> inet:dns:a:fqdn :ipv4 -> inet:ipv4
```

Implicit syntax:

```
<inet:fqdn> -> inet:dns:a -> inet:ipv4
```

The above example simply combines the previous two examples to illustrate the use of multiple implicit pivot operations in a longer query.

Implicit syntax with multiple target properties:

- Pivot from a set of domains to the associated DNS MX records:

Implicit syntax:

```
<inet:fqdn> -> inet:dns:mx
```

In the example above, given the source and target forms, the logical pivot for implicit syntax is from the primary property of the inbound FQDN to the secondary properties of the DNS MX nodes. However, an `inet:dns:mx` form has **two** secondary properties of type `inet:fqdn`: the mail exchange server (`inet:dns:mx:mx`) and the domain that uses the MX (`inet:dns:mx:fqdn`).

Using implicit syntax, Storm wil pivot from the source FQDN(s) to any DNS MX records where the domain matches **either** of those secondary properties. For example, querying the FQDN `google.com` will return DNS MX records **for**

Google (i.e., `inet:dns:mx:fqdn=google.com`) as well as MX records that may **use** Google as their mail exchange (i.e., `inet:dns:mx:mx=google.com`).

If you want only one or the other of those types of records, you need to use explicit syntax to specify the target property, i.e.:

```
<inet:fqdn> -> inet:dns:mx:fqdn

or

<inet:fqdn> -> inet:dns:mx:mx
```

Implicit syntax with multiple source properties:

- Pivot from a set of files to their associated SHA256 hashes:

Implicit syntax:

```
<file:bytes> -> hash:sha256
```

In the example above, given the source and target forms, the logical pivot for implicit syntax is from the secondary properties of the inbound file to the primary property of the SHA256 nodes. However, a `file:bytes` form has **two** secondary properties of type `hash:sha256`: the file's SHA256 hash (`file:bytes:sha256`) and the hash of the file's rich header data (if the file is a PE executable - `file:bytes:mime:pe:richhdr`).

Using implicit syntax, Storm will pivot from **both** source properties (where present) to **all** of the associated SHA256 nodes - that is, those that match either the `:sha256` or `:mime:pe:richhdr` value.

If you want only one or the other of those types of records, you need to use explicit syntax to specify the source property, i.e.:

```
<file:bytes> :sha256 -> hash:sha256

or

<file:bytes> :mime:pe:richhdr -> hash:sha256
```

Raw Pivot Syntax

For certain edge cases, standard Storm pivot syntax (explicit or implicit) is insufficient. In these instances raw pivot syntax acts as a "get out of jail free" card to perform specialized pivot operations. These include:

- primary-to-primary property pivots;
- pivots where the value of the target property (primary or secondary) is computed from the input node(s);
- extramodel pivots.

In raw pivot syntax, the target of the pivot is specified as a Storm query enclosed in curly braces. Raw pivots often involve specifying a variable derived from the inbound node(s) and performing the raw pivot using the variable, though this is not technically required. (See *Storm Reference - Advanced - Variables* for a discussion of using variables in Storm).

For some raw pivot syntax use cases, you can compose an equivalent Storm query using lift and filter operations. For example:

- lift a set of nodes;
- define a variable based on those nodes;

- lift a second set of nodes using the variable;
- filter out the original nodes you lifted, thus leaving only the second set of lifted nodes.

However, executing this type of query using raw pivot syntax is slightly more efficient; the Storm query within the raw pivot's curly braces may still be a lift operation, but performing it inside a raw pivot means you do not have to explicitly drop (filter out) your original nodes. (As with a regular pivot, the inbound nodes are consumed by the pivot operation itself, eliminating the need for the filter.)

As always, these efficiencies may be trivial for smaller queries but can be significant for larger queries.

Syntax:

<query> **->** { *<query>* }

Examples:

- Pivot from a string (`it:dev:str`) representing an FQDN to the `inet:fqdn` node for that FQDN (i.e., pivot between two primary properties of different types).

Standard syntax (no raw pivot, lift / filter only):

```
<it:dev:str> $fqdn=$node.value() inet:fqdn=$fqdn -it:dev:str
```

Raw pivot syntax:

```
<it:dev:str> $fqdn=$node.value() -> { inet:fqdn=$fqdn }
```

3.6.6 Storm Reference - Data Modification

Storm can be used to directly modify the Synapse hypergraph by:

- adding or deleting nodes;
- setting, modifying, or deleting properties on nodes; and
- adding or deleting tags from nodes.

Users gain a powerful degree of flexibility and efficiency through the ability to create or modify data on the fly.

(**Note:** For adding or modifying data at scale, we recommend use of the Synapse `csvtool` (*csvtool*), the Synapse `feed` utility (*feed*), or the programmatic ingest of data.)

Warning: The ability to add and modify data directly from Storm is powerful and convenient, but also means users can inadvertently modify (or even delete) data inappropriately through mistyped syntax or premature striking of the "enter" key. While some built-in protections exist within Synapse itself it is important to remember that **there is no "are you sure?" prompt before a Storm query executes.**

The following recommended best practices will help prevent inadvertent changes to a Cortex:

- Use extreme caution when constructing complex Storm queries that may modify (or delete) large numbers of nodes. It is **strongly recommended** that you validate the output of a query by first running the query on its own to ensure it returns the expected results (set of nodes) before permanently modifying (or deleting) those nodes.
- Use the Synapse permissions system to enforce least privilege. Limit users to permissions appropriate for tasks they have been trained for / are responsible for.

See *Storm Reference - Document Syntax Conventions* for an explanation of the syntax format used below.

See *Storm Reference - Type-Specific Storm Behavior* for details on special syntax or handling for specific data types (*Type*).

Edit Mode

To modify data in a Cortex using Storm, you must enter "edit mode". Edit mode makes use of several conventions to specify what changes should be made and to what data:

- *Edit Brackets*
- *Edit Parentheses*
- *Edit "Try" Operator (?=)*
- *Autoadds and Depadds*

Edit Brackets

The use of square brackets (`[ ]`) within a Storm query can be thought of as entering edit mode. The data in the brackets specifies the changes to be made and includes changes involving nodes, properties, and tags. The only exception is the deletion of nodes, which is done using the Storm *delnode* command.

The square brackets used for the Storm data modification syntax indicate "perform the enclosed changes" in a generic way. The brackets are shorthand to request any of the following:

- *Add Nodes*
- *Add or Modify Properties*
- *Add or Modify Properties Using Subqueries*
- *Delete Properties*
- *Add Light Edges*
- *Delete Light Edges*
- *Add Tags*
- *Modify Tags*
- *Remove Tags*

This means that all of the above directives can be specified within a single set of brackets, in any combination and in any order. The only caveat is that a node must exist before it can be modified, so you must add a node inside the brackets (or lift a node outside of the brackets) before you add a secondary property or a tag.

Warning: It is critical to remember that **the brackets are NOT a boundary that segregates nodes;** the brackets simply indicate the start and end of data modification operations. They do **NOT** separate "nodes the modifications should apply to" from "nodes they should not apply to". Storm *Operation Chaining* with left-to-right processing order still applies. Editing is simply another Storm operation, so **the specified edits will be performed on ALL nodes "to the left of" the edit brackets - i.e., everything "inbound" to the edit operation** as part of the Storm pipeline, regardless of whether those nodes are within or outside the brackets.

The exception is modifications that are placed within *Edit Parentheses* which can be used to segregate specific edit operations. Storm will also throw an error if you attempt to perform an edit operation on a node that cannot be modified in that way - for example, attempting to set an `:asn` property on an inbound `inet:fqdn` node will fail because there is no `:asn` secondary property on an `inet:fqdn`.

Note: For simplicity, syntax examples below demonstrating how to add nodes, modify properties, etc. only use edit brackets.

See *Combining Data Modification Operations* below for examples showing the use of edit brackets with and without edit parentheses.

Edit Parentheses

Inside of *Edit Brackets*, Storm supports the use of edit parentheses (`(` `)`). Edit parentheses ("parens") are used to explicitly limit a set of modifications to a specific node or nodes by enclosing the node(s) and their associated modification(s) within the parentheses. This "overrides" the default behavior for edit brackets, which is that every change specified within the brackets applies to every node generated by the previous Storm output (i.e., every node in the Storm pipeline), whether the node is referenced inside or outside the brackets themselves. Edit parens thus allow you to make limited changes "inline" with a more complex Storm query instead of having to use a smaller, separate query to make those changes.

Note that multiple sets of edit parens can be used within a single set of edit brackets; each set of edit parens will delimit a separate set of edits.

See *Combining Data Modification Operations* below for examples showing the use of edit brackets with and without edit parentheses.

Edit "Try" Operator (?=)

Most edit operations will involve explicitly setting a primary or secondary property value using the equivalent (=) comparison operator:

```
[ inet:fqdn = woot.com ]
```

```
inet:ipv4 = 1.2.3.4 [ :asn = 444 ]
```

Storm also supports the optional "try" operator (?=) within edit brackets or edit parens. The try operator will **attempt** to set a value that may or may not pass *Type* enforcement for that property. Similarly, the try operator can also be used when setting tags, e.g. `[ +?#mytag ]`.

Incorrectly specifying a property value is unlikely to occur for users entering Storm data modification queries at the command line (barring outright user error), as users are directly vetting the data they are entering. However, the try operator may be useful for Storm-based automated ingest of data (such as *csvtool* or *feed*) where the data source may contain "bad" data.

Use of the try operator allows Storm to fail silently in the event it encounters a `BadTypeValu` error (i.e., skip the bad event but continue processing). Contrast this behavior with using the standard equivalent operator (=), where if Storm encounters an error it will halt processing.

See the *array* section of the *Storm Reference - Type-Specific Storm Behavior* for specialized "edit try" syntax when working with arrays.

Autoadds and Depadds

Synapse makes use of two optimization features when adding nodes or setting secondary properties: automatic additions (*Autoadd*) and dependent additions (*Depadd*).

Autoadd is the process where, on node creation, Synapse will automatically set any secondary properties that are derived from a node's primary property. Because these secondary properties are based on the node's primary property (which cannot be changed once set), the secondary properties are read-only.

Depadd is the process where, on setting a node's secondary property value, if that property is of a type that is also a form, Synapse will automatically create the form with the corresponding primary property value. (You can view this as the secondary property "depending on" the existence of a node with the corresponding primary property.)

Autoadd and depadd work together (and recursively) to simplify adding data to a Cortex. Properties set via autoadd may result in the creation of nodes via depadd; the new nodes may have secondary properties set via autoadd that result in the creation of additional nodes via depadd, and so on.

Examples:

Note: The specific syntax and process of node creation, modification, etc. are described in detail below. The examples here are simply meant to illustrate the autoadd and depadd concepts.

Create a node for the email address user@vertex.link. Note the secondary properties (:fqdn and :user) that are set via autoadd.

```
storm> [ inet:email = user@vertex.link ]
inet:email=user@vertex.link
        :fqdn = vertex.link
        :user = user
        .created = 2023/07/12 15:15:12.814
```

Create a node to represent the twitter account for The Vertex Project. Synapse creates the account itself (``inet:web:acct``) with secondary properties for ``:webpage`` (explicitly set) as well as ``:site`` and ``:user`` (via autoadd). Note the additional nodes that are created from those secondary properties via deppadd (``inet:url``, ``inet:user``, multiple FQDNs, etc.).

```
storm> [ inet:web:acct=(twitter.com,vtxproject) :webpage=https://vertex.link/]
inet:web:acct=twitter.com/vtxproject
        :site = twitter.com
        :user = vtxproject
        :webpage = https://vertex.link/
        .created = 2023/07/12 15:15:12.906
```

```
storm> .created
inet:fqdn=link
        :host = link
        :issuffix = true
        :iszone = false
        .created = 2023/07/12 15:15:12.814
inet:fqdn=vertex.link
        :domain = link
        :host = vertex
        :issuffix = false
        :iszone = true
```

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```
        :zone = vertex.link
        .created = 2023/07/12 15:15:12.814
inet:user=user
        .created = 2023/07/12 15:15:12.814
inet:user=vtxproject
        .created = 2023/07/12 15:15:12.906
inet:fqdn=twitter.com
        :domain = com
        :host = twitter
        :issuffix = false
        :iszone = true
        :zone = twitter.com
        .created = 2023/07/12 15:15:12.906
inet:fqdn=com
        :host = com
        :issuffix = true
        :iszone = false
        .created = 2023/07/12 15:15:12.906
inet:web:acct=twitter.com/vtxproject
        :site = twitter.com
        :user = vtxproject
        :webpage = https://vertex.link/
        .created = 2023/07/12 15:15:12.906
inet:url=https://vertex.link/
        :base = https://vertex.link/
        :fqdn = vertex.link
        :params =
        :path = /
        :port = 443
        :proto = https
        .created = 2023/07/12 15:15:12.909
```

Add Nodes

Operation to add the specified node(s) to a Cortex.

Syntax:

[<*form*> **=** | **?=** <*valu*> … **]**

Examples:

Create a simple node:

```
[ inet:fqdn = woot.com ]
```

Create a composite (comp) node:

```
[ inet:dns:a=(woot.com, 12.34.56.78) ]
```

Create a GUID node:

```
[ ou:org=2f92bc913918f6598bcf310972ebf32e ]
```

```
[ ou:org="*" ]
```

Create a digraph (edge) node:

```
[ edge:refs=((media:news, 00a1f0d928e25729b9e86e2d08c127ce), (inet:fqdn, woot.com)) ]
```

Create multiple nodes:

```
[ inet:fqdn=woot.com inet:ipv4=12.34.56.78 hash:md5=d41d8cd98f00b204e9800998ecf8427e ]
```

Usage Notes:

- Storm can create as many nodes as are specified within the brackets. It is not necessary to create only one node at a time.
- For nodes specified within the brackets that do not already exist, Storm will create and return the node. For nodes that already exist, Storm will simply return that node.
- When creating a *<form>* whose *<valu>* consists of multiple components, the components must be passed as a comma-separated list enclosed in parentheses.
- Once a node is created, its primary property (*<form>* = *<valu>*) **cannot be modified.** The only way to "change" a node's primary property is to create a new node (and optionally delete the old node). "Modifying" nodes therefore consists of adding, modifying, or deleting secondary properties (including universal properties) or adding or removing tags.

Add or Modify Properties

Operation to add (set) or change one or more properties on the specified node(s).

The same syntax is used to apply a new property or modify an existing property.

Syntax:

<query> **[** **:** *<prop>* **=** | **?=** *<pval>* ... **]**

Note: Synapse supports secondary properties that are **arrays** (lists or sets of typed forms), such as `ou:org:names`. See the *array* section of the *Storm Reference - Type-Specific Storm Behavior* guide for slightly modified syntax used to add or modify array properties.

Examples:

Add (or modify) secondary property:

```
<inet:ipv4> [ :loc=us.oh.wilmington ]
```

Add (or modify) universal property:

```
<inet:dns:a> [ .seen=("2017/08/01 01:23", "2017/08/01 04:56") ]
```

Add (or modify) a string property to an empty string value:

```
<media:news> [ :summary="" ]
```

Usage Notes:

- Additions or modifications to properties are performed on the output of a previous Storm query.

- Storm will set or change the specified properties for all nodes in the current working set (i.e., all nodes inbound to the *<prop> = <pval>* edit statement(s)) for which that property is valid, **whether those nodes are within or outside of the brackets** unless *Edit Parentheses* are used to limit the scope of the modifications.
- Specifying a property will set the *<prop> = <pval>* if it does not exist, or modify (overwrite) the *<prop> = <pval>* if it already exists. **There is no prompt to confirm overwriting of an existing property.**
- Storm will return an error if the inbound set of nodes contains any forms for which *<prop>* is not a valid property. For example, attempting to set a `:loc` property when the inbound nodes contain both domains and IP addresses will return an error as `:loc` is not a valid secondary property for a domain (`inet:fqdn`).
- Secondary properties **must** be specified by their relative property name. For example, for the form `foo:bar` with the property `baz` (i.e., `foo:bar:baz`) the relative property name is specified as `:baz`.
- Storm can set or modify any secondary property (including universal properties) except those explicitly defined as read-only (`'ro' : 1`) in the data model. Attempts to modify read only properties will return an error.

Add or Modify Properties Using Subqueries

Property values can also be set using a **subquery** to assign the secondary property's value. The subquery executes a Storm query to lift the node(s) whose primary property should be assigned as the value of the specified secondary property.

This is a specialized use case that is most useful when working with property values that are guids (see *GUID*) as it avoids the need to type or copy and paste the guid value. Using a subquery allows you to reference the guid node using a more "human friendly" method (typically a secondary property).

(See *Storm Reference - Subqueries* for additional detail on subqueries.)

Syntax:

<query> **[:** *<prop>* **= | ?= {** *<query>* **}** *...* **]**

Examples:

Use a subquery to assign an organization's (ou:org) guid as the secondary property of a ps:contact node:

```
storm> ps:contact=d41d8cd98f00b204e9800998ecf8427e [ :org={ ou:org:alias=usgovdoj } ]
ps:contact=d41d8cd98f00b204e9800998ecf8427e
        :address = 950 pennsylvania avenue nw, washington, dc, 20530-0001
        :loc = us.dc.washington
        :org = 0fa690c06970d2d2ae74e43a18f46c2a
        :orgname = u.s. department of justice
        :phone = +1 (202) 514-2000
        .created = 2023/07/12 15:15:13.212
```

In the example above, the subquery is used to lift the organization whose `:alias` property value is `usgovdoj` and assign the organization's (`ou:org` node) primary property (a guid value) to the `:org` property of the `ps:contact` node.

Use a subquery to assign one or more industries (ou:industry) to an organization (ou:org):

```
storm> ou:org:alias=apple [ :industries+={ ou:industry:sic*[=3571]␣
↪ou:industry:sic*[=3663] } ]
ou:org=2848b564bf1e68563e3fea4ce27299f3
        :alias = apple
        :industries = ['23cb136e41eb8391d85f6a9497ca268e',
↪'360d50beaffb1a623ad29ff492754a64']
```

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```
        :loc = us.ca.cupertino
        :name = apple
        :names = ['apple', 'apple, inc.']
        :phone = +1 (408) 996-1010
        .created = 2023/07/12 15:15:13.276
```

In the example above, the subquery is used to lift the industry node(s) whose `:sic` property (Standard Industrial Classification) includes the values `3571` and `3663` and adds the industry (`ou:industry`) nodes' primary properties (guid values) to the `:industries` secondary property of the `ou:org` node.

Note: Both the `ou:org:industries` and `ou:industry:sic` properties are **arrays** (lists or sets of typed forms), so the query above uses some array-specific syntax. See the *array* section of the *Storm Reference - Type-Specific Storm Behavior* guide for specialized syntax used to add or modify array properties.

Usage Notes:

- The usage notes specified under *Add or Modify Properties* above also apply when adding or modifying properties using subqueries.
- When using a subquery to assign a property value, Storm will throw an error if the subquery fails to lift any nodes.
- When using a subquery to assign a value to a property that takes only a single value, Storm will throw an error if the subquery returns more than one node. For example, if the subquery `{ ou:org:alias=usgovdoj }` is meant to set a single `:org` property and the query returns more than one `ou:org` node with that alias, Storm will error and the property will not be set.
  - The *Edit "Try" Operator (?=)* can be used instead (`[ :org?={ ou:org:alias=usgovdoj } ]`); in this case, if an error condition occurs, Storm will fail silently - the property will not be set but no error is thrown and any subsequent Storm operations will continue.
- When using a subquery to assign a property value, the subquery cannot iterate more than 128 times or Storm will throw an error. For example, attempting to assign "all the industries" to a single organization (`ou:org=<guid> [ :industries+={ ou:industry } ]`) will error if there are more than 128 `ou:industry` nodes.

Delete Properties

Operation to delete (fully remove) one or more properties from the specified node(s).

Warning: Storm syntax to delete properties has the potential to be destructive if executed following an incorrect, badly formed, or mistyped query. Users are **strongly encouraged** to validate their query by first executing it on its own (without the delete property operation) to confirm it returns the expected nodes before adding the delete syntax. While the property deletion syntax cannot fully remove a node from the hypergraph, it is possible for a bad property deletion operation to irreversibly damage hypergraph pivoting and traversal.

Syntax:

<query> **[-:** *<prop>* ... **]**

Examples:

Delete a property:

```
<inet:ipv4> [ -:loc ]
```

Delete multiple properties:

```
<media:news> [ -:author -:summary ]
```

Usage Notes:

- Property deletions are performed on the output of a previous Storm query.
- Storm will delete the specified property / properties for all nodes in the current working set (i.e., all nodes resulting from Storm syntax to the left of the *-:<prop>* statement), **whether those nodes are within or outside of the brackets** unless *Edit Parentheses* are used to limit the scope of the modifications.
- Deleting a property fully removes the property from the node; it does not set the property to a null value.
- Properties which are read-only (`'ro' : 1`) as specified in the data model cannot be deleted.

Delete Nodes

Nodes can be deleted from a Cortex using the Storm *delnode* command.

Add Light Edges

Operation that links the specified node(s) to another node or set of nodes (as specified by a Storm expression) using a lightweight edge (light edge).

See *Lightweight (Light) Edge* for details on light edges.

Syntax:

<query> **[+(** *<verb>* **)> {** *<storm>* **}]**

<query> **[<(** *<verb>* **)+ {** *<storm>* **}]**

Note: The nodes specified by the Storm expression (`{ <storm> }`) must either already exist in the Cortex or must be created as part of the Storm expression in order for the light edges to be created.

Note: The query syntax used to create light edges will **yield the nodes that are inbound to the edit brackets** (that is, the nodes represented by *<query>*).

Examples:

Link the specified FQDN and IPv4 to the media:news node referenced by the Storm expression using a "refs" light edge:

```
inet:fqdn=woot.com inet:ipv4=1.2.3.4 [ <(refs)+ {␣
↪media:news=a3759709982377809f28fc0555a38193 } ]
```

Link the specified media:news node to the set of indicators tagged APT1 (#aka.feye.thr.apt1) using a "refs" light edge:

```
media:news=a3759709982377809f28fc0555a38193 [ +(refs)> { +#aka.feye.thr.apt1 } ]
```

Link the specified inet:cidr4 netblock to any IP address within that netblock that already exists in the Cortex (as referenced by the Storm expression) using a "hasip" light edge:

```
inet:cidr4=123.120.96.0/24 [ +(hasip)> { inet:ipv4=123.120.96.0/24 } ]
```

Link the specified inet:cidr4 netblock to every IP in its range (as referenced by the Storm expression) using a "hasip" light edge, creating the IPs if they don't exist:

```
inet:cidr4=123.120.96.0/24 [ +(hasip)> { [ inet:ipv4=123.120.96.0/24 ] } ]
```

Usage Notes:

- No light edge verbs exist in a Cortex by default; they must be created.
- Light edge verbs are created at the user's discretion "on the fly" (i.e., when they are first used to link nodes); they do not need to be created manually before they can be used.
  - We recommend that users agree on a consistent set of light edge verbs and their meanings.
  - The Storm *model* commands can be used to list and work with any light edge verbs in a Cortex.
- A light edge's verb typically has a logical direction (a report "references" a set of indicators that it contains, but the indicators do not "reference" the report). However, it is up to the user to create the light edges in the correct direction and use forms that are sensical for the light edge verb. That is, there is nothing in the Storm syntax itself to prevent users linking any arbitrary nodes in arbitrary directions using arbitrary light edge verbs.
- The plus sign (+) used with the light edge expression within the edit brackets is used to create the light edge(s).
- Light edges can be created in either "direction" (e.g., with the directional arrow pointing either right (`+(<verb>)>`) or left (`<(<verb>)+`) - whichever syntax is easier.

Delete Light Edges

Operation that deletes the light edge linking the specified node(s) to the set of nodes specified by a given Storm expression.

See *Lightweight (Light) Edge* for details on light edges.

Syntax:

<query> **[-(** *<verb>* **)> {** *<storm>* **}]**

<query> **[<(** *<verb>* **)- {** *<storm>* **}]**

Caution: The minus sign (-) used to reference a light edge **outside** of edit brackets simply instructs Storm to traverse ("walk") the specified light edge; for example, `inet:cidr4=192.168.0.0/24 -(hasip)> inet:ipv4` (see *Traverse (Walk) Light Edges*). The minus sign used to reference a light edge **inside** of edit brackets instructs Storm to **delete** the specified edges (i.e., `inet:cidr4=192.168.0.0/24 [ -(hasip)> { inet:ipv4=192.168.0.0/24 } ]`).

Examples:

Delete the "refs" light edge linking the MD5 hash of the empty file to the specified media:news node:

```
hash:md5=d41d8cd98f00b204e9800998ecf8427e [ <(refs)- {␣
↪media:news=a3759709982377809f28fc0555a38193 } ]
```

Delete the "hasip" light edge linking IP 1.2.3.4 to the specified CIDR block:

```
inet:cidr4=123.120.96.0/24 [ -(hasip)> { inet:ipv4=1.2.3.4 } ]
```

Usage Notes:

- The minus sign (-) used with the light edge expression within the edit brackets is used to delete the light edge(s).
- Light edges can be deleted in either "direction" (e.g., with the directional arrow pointing either right (-(<verb>)>) or left (<(<verb>)-) - whichever syntax is easier.

Add Tags

Operation to add one or more tags to the specified node(s).

Syntax:

<query> **[+#** *<tag>* **...** **]**

Example:

Add multiple tags:

```
<inet:fqdn> [ +#aka.feye.thr.apt1 +#cno.infra.sink.holed ]
```

Usage Notes:

- Tag additions are performed on the output of a previous Storm query.
- Storm will add the specified tag(s) to all nodes in the current working set (i.e., all nodes resulting from Storm syntax to the left of the *+#<tag>* statement) **whether those nodes are within or outside of the brackets** unless *Edit Parentheses* are used to limit the scope of the modifications.

Add Tag Timestamps or Tag Properties

Synapse supports the use of *Tag Timestamps* and *Tag Properties* to provide additional context to tags where appropriate.

Syntax:

Add tag timestamps:

<query> **[+#** *<tag>* **=** *<time>* **|** **(** *<min_time>* **,** *<max_time>* **)** **...** **]**

Add tag property:

<query> **[+#** *<tag>* **:** *<tagprop>* **=** *<pval>* **...** **]**

Examples:

Add tag with single timestamp:

```
<inet:fqdn> [ +#cno.infra.sink.holed=2018/11/27 ]
```

Add tag with a time interval (min / max):

```
<inet:fqdn> [ +#cno.infra.sink.holed=(2014/11/06, 2016/11/06) ]
```

Add tag with custom tag property:

```
<inet:fqdn> [ +#rep.symantec:risk = 87 ]
```

Usage Notes:

- *Tag Timestamps* and *Tag Properties* are applied only to the tags to which they are explicitly added. For example, adding a timestamp to the tag `#foo.bar.baz` does **not** add the timestamp to tags `#foo.bar` and `#foo`.

- Tag timestamps are interval (`ival`) types and exhibit behavior specific to that type. See the *ival* section of the *Storm Reference - Type-Specific Storm Behavior* document for additional detail on working with interval types.

Modify Tags

Tags are "binary" in that they are either applied to a node or they are not. Tag names cannot be changed once set.

To "change" the tag applied to a node, you must add the new tag and delete the old one.

The Storm *movetag* command can be used to modify tags in bulk - that is, rename an entire set of tags, or move a tag to a different tag tree.

Modify Tag Timestamps or Tag Properties

Tag timestamps or tag properties can be modified using the same syntax used to add the timestamp or property.

Modifications are constrained by the *Type* of the timestamp (i.e., *ival*) or property. For example:

- modifying an existing custom property of type integer (`int`) will simply overwrite the old tag property value with the new one.
- modifying an existing timestamp will only change the timestamp if the new minimum is smaller than the current minimum and / or the new maximum is larger than the current maximum, in accordance with type-specific behavior for intervals (`ival`).

See *Storm Reference - Type-Specific Storm Behavior* for details.

Remove Tags

Operation to delete one or more tags from the specified node(s).

Removing a tag from a node differs from deleting the node representing a tag (a `syn:tag` node), which can be done using the Storm *delnode* command.

> **Warning:** Storm syntax to remove tags has the potential to be destructive if executed on an incorrect, badly formed, or mistyped query. Users are **strongly encouraged** to validate their query by first executing it on its own to confirm it returns the expected nodes before adding the tag deletion syntax.
>
> In addition, it is **essential** to understand how removing a tag at a given position in a tag tree affects other tags within that tree. Otherwise, tags may be improperly left in place ("orphaned") or inadvertently removed.

Syntax:

<*query*> **[-#** <*tag*> ... **]**

Examples:

Remove a leaf tag:

```
<inet:ipv4> [ -#cno.infra.anon.tor ]
```

Usage Notes:

- Tag deletions are performed on the output of a previous Storm query.

- Storm will delete the specified tag(s) from all nodes in the current working set (i.e., all nodes resulting from Storm syntax to the left of the -#<tag> statement), **whether those nodes are within or outside of the brackets** unless *Edit Parentheses* are used to limit the scope of the modifications.
- Deleting a leaf tag deletes **only** the leaf tag from the node. For example, `[ -#foo.bar.baz ]` will delete the tag `#foo.bar.baz` but leave the tags `#foo.bar` and `#foo` on the node.
- Deleting a non-leaf tag deletes that tag and **all tags below it in the tag hierarchy** from the node. For example, `[ -#foo ]` used on a node with tags `#foo.bar.baz` and `#foo.hurr.derp` will remove **all** of the following tags:
  - `#foo.bar.baz`
  - `#foo.hurr.derp`
  - `#foo.bar`
  - `#foo.hurr`
  - `#foo`
- See the Storm *tag.prune* command for recursive removal of tags (i.e., from a leaf tag up through parent tags that do not have other children).

Remove Tag Timestamps or Tag Properties

Currently, it is not possible to remove a tag timestamp or tag property from a tag once it has been applied. Instead, the entire tag must be removed and re-added without the timestamp or property.

Combining Data Modification Operations

The square brackets representing edit mode are used for a wide range of operations, meaning it is possible to combine operations within a single set of brackets.

Simple Examples

Create a node and add secondary properties:

```
[ inet:ipv4=94.75.194.194 :loc=nl :asn=60781 ]
```

Create a node and add a tag:

```
[ inet:fqdn=blackcake.net +#aka.feye.thr.apt1 ]
```

Edit Brackets and Edit Parentheses Examples

The following examples illustrate the differences in Storm behavior when using *Edit Brackets* alone vs. with *Edit Parentheses*.

When performing simple edit operations (i.e., Storm queries that add / modify a single node, or apply a tag to the nodes retrieved by a Storm lift operation) users can typically use only edit brackets and not worry about delimiting edit operations within additional edit parens.

That said, edit parens may be necessary when creating and modifying multiple nodes in a single query, or performing edits within a longer or more complex Storm query. In these cases, understanding the difference between edit brackets' "operate on everything inbound" vs. edit parens' "limit modifications to the specified nodes" is critical to avoid unintended data modifications.

Example 1:

Consider the following Storm query that uses only edit brackets:

```
inet:fqdn#aka.feye.thr.apt1 [ inet:fqdn=somedomain.com +#aka.eset.thr.sednit ]
```

The query will perform the following:

- Lift all domains that FireEye associates with APT1 (i.e., tagged `#aka.feye.thr.apt1`).
- Create the new domain `somedomain.com` (if it does not already exist) or lift it (if it does).
- Apply the tag `#aka.eset.thr.sednit` to the domain `somedomain.com` **and** to all of the domains tagged `#aka.feye.thr.apt1` (because those FQDNs are inbound to the edit operation / edit brackets).

We can see the effects in the output of our example query:

```
storm> inet:fqdn#aka.feye.thr.apt1 [ inet:fqdn=somedomain.com +#aka.eset.thr.sednit ]
inet:fqdn=newsonet.net
        :domain = net
        :host = newsonet
        :issuffix = false
        :iszone = true
        :zone = newsonet.net
        .created = 2023/07/12 15:15:13.532
        #aka.eset.thr.sednit
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=staycools.net
        :domain = net
        :host = staycools
        :issuffix = false
        :iszone = true
        :zone = staycools.net
        .created = 2023/07/12 15:15:13.541
        #aka.eset.thr.sednit
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=blackcake.net
        :domain = net
        :host = blackcake
        :issuffix = false
        :iszone = true
        :zone = blackcake.net
        .created = 2023/07/12 15:15:13.680
        #aka.eset.thr.sednit
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=purpledaily.com
        :domain = com
        :host = purpledaily
        :issuffix = false
```

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```
        :iszone = true
        :zone = purpledaily.com
        .created = 2023/07/12 15:15:13.555
        #aka.eset.thr.sednit
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=hugesoft.org
        :domain = org
        :host = hugesoft
        :issuffix = false
        :iszone = true
        :zone = hugesoft.org
        .created = 2023/07/12 15:15:13.548
        #aka.eset.thr.sednit
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=somedomain.com
        :domain = com
        :host = somedomain
        :issuffix = false
        :iszone = true
        :zone = somedomain.com
        .created = 2023/07/12 15:15:13.888
        #aka.eset.thr.sednit
```

Consider the same query using edit parens inside the brackets:

```
inet:fqdn#aka.feye.thr.apt1 [(inet:fqdn=somedomain.com +#aka.eset.thr.sednit)]
```

Because we used the edit parens, the query will now perform the following:

- Lift all domains that FireEye associates with APT1 (i.e., tagged `#aka.feye.thr.apt1`).
- Create the new domain `somedomain.com` (if it does not already exist) or lift it (if it does).
- Apply the tag `aka.eset.thr.sednit` **only** to the domain `somedomain.com`.

We can see the difference in the output of the example query:

```
storm> inet:fqdn#aka.feye.thr.apt1 [(inet:fqdn=somedomain.com +#aka.eset.thr.sednit)]
inet:fqdn=newsonet.net
        :domain = net
        :host = newsonet
        :issuffix = false
        :iszone = true
        :zone = newsonet.net
        .created = 2023/07/12 15:15:13.532
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=staycools.net
        :domain = net
        :host = staycools
        :issuffix = false
        :iszone = true
```

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```
        :zone = staycools.net
        .created = 2023/07/12 15:15:13.541
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=blackcake.net
        :domain = net
        :host = blackcake
        :issuffix = false
        :iszone = true
        :zone = blackcake.net
        .created = 2023/07/12 15:15:13.680
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=purpledaily.com
        :domain = com
        :host = purpledaily
        :issuffix = false
        :iszone = true
        :zone = purpledaily.com
        .created = 2023/07/12 15:15:13.555
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=hugesoft.org
        :domain = org
        :host = hugesoft
        :issuffix = false
        :iszone = true
        :zone = hugesoft.org
        .created = 2023/07/12 15:15:13.548
        #aka.feye.thr.apt1
        #cno.infra.sink.holed = (2014/11/06 00:00:00.000, 2018/11/27 00:00:00.001)
inet:fqdn=somedomain.com
        :domain = com
        :host = somedomain
        :issuffix = false
        :iszone = true
        :zone = somedomain.com
        .created = 2023/07/12 15:15:13.888
        #aka.eset.thr.sednit
```

Example 2:

Consider the following Storm query that uses only edit brackets:

```
[inet:ipv4=1.2.3.4 :asn=1111 inet:ipv4=5.6.7.8 :asn=2222]
```

The query will perform the following:

- Create (or lift) the IP address `1.2.3.4`.
- Set the IP's `:asn` property to `1111`.
- Create (or lift) the IP address `5.6.7.8`.
- Set the `:asn` property for **both** IP addresses to `2222`.

We can see the effects in the output of our example query:

```
storm> [inet:ipv4=1.2.3.4 :asn=1111 inet:ipv4=5.6.7.8 :asn=2222]
inet:ipv4=1.2.3.4
        :asn = 2222
        :type = unicast
        .created = 2023/07/12 15:15:14.010
inet:ipv4=5.6.7.8
        :asn = 2222
        :type = unicast
        .created = 2023/07/12 15:15:14.016
```

Consider the same query using edit parens inside the brackets:

```
[ (inet:ipv4=1.2.3.4 :asn=1111) (inet:ipv4=5.6.7.8 :asn=2222) ]
```

Because the brackets separate the two sets of modifications, IP `1.2.3.4` has its `:asn` property set to `1111` while IP `5.6.7.8` has its `:asn` property set to `2222`:

```
storm> [ (inet:ipv4=1.2.3.4 :asn=1111) (inet:ipv4=5.6.7.8 :asn=2222) ]
inet:ipv4=1.2.3.4
        :asn = 1111
        :type = unicast
        .created = 2023/07/12 15:15:14.010
inet:ipv4=5.6.7.8
        :asn = 2222
        :type = unicast
        .created = 2023/07/12 15:15:14.016
```

3.6.7 Storm Reference - Subqueries

This section discusses the following topics:

- *Subquery*
- *Subquery Filter*
- *Setting Properties with Subqueries*

Subquery

A **subquery** is a Storm query that is executed inside of another Storm query. Curly braces (`{ }`) are used to enclose the embedded query.

Note: Curly braces are a Storm syntax element that simply indicates "a Storm query is enclosed here". They can be used to denote a subquery, but have other uses as well.

Recall from *Storm Operating Concepts* that a Storm query can consist of multiple elements (lift, filter, pivot, pipe to command, etc.). This sequence of Storm operations acts as a "pipeline" through which the nodes in the query pass. Regardless of the number of nodes you start with (i.e., the number of nodes in your initial lift), each node is processed individually by each element in the query, from left to right.

The elements in the query can be thought of as "gates". The nodes "inbound" to each gate are processed by that gate in some way. For example, if the "gate" is a filter operation, some nodes may be allowed to pass, while others are dropped

("consumed"), based on the filter. If the gate is a pivot, the inbound node is dropped while the node that is the "target" of the pivot is picked up and added to the pipeline.

Note that in a standard Storm query (as described above) the set of nodes at any given point in the query is constantly changing - the "working set" of nodes is transformed by the various operations. The nodes that "go in" to a particular operation in the query are generally not the same ones that "come out". Note also that as described, this process is **linear** (hence "pipeline").

A **subquery** is another element that can be used as part of a longer Storm query, only in this case the "element" is itself an entire Storm query (as opposed to a filter, pivot, or Storm command).

One advantage of a subquery is that the actions that occur inside the subquery do not affect the "main" Storm execution pipeline - the nodes that "go in" to a subquery are the same nodes that "come out", regardless of what operations occur within the subquery itself. (In terms of the *Storm Operating Concepts*, subqueries do not **consume** nodes by default.) In this way, a subquery can allow you to "branch off" the main Storm execution pipeline, "do a thing" off to the side, and then return to the main execution pipeline as though nothing happened; you resume at the point you left off, with the same set of nodes in the pipeline as when you left.

If you want the nodes that result from the subquery operations to be returned, the `yield` option can be used to do so. Note that yielding the subquery nodes is **in addition to** the set of nodes that passed in to the subquery (not "instead of" the inbound nodes). If you **only** want the nodes resulting from the subquery, you probably don't need a subquery and can just use a standard Storm query instead.

Note: Any **actions** performed inside of a subquery will persist. For example, any modifications made to nodes inside a subquery (setting or modifying properties, applying tags, even creating new nodes) will remain; those changes will be present in the Cortex.

In addition, when setting or updating a *Variable* inside a subquery, the variable can pass back "out" of the subquery and be available to the main Storm query.

What remains unchanged is that the set of nodes inbound to the subquery will be the same set of nodes available (inbound) to the next element in the main Storm query - whatever happens inside the subquery does not affect the set of nodes in the **pipeline** (barring the use of `yield` of course).

This ability to "do a thing off to the side" inside of a Storm query pipeline can add efficiencies to certain queries, allowing you to perform some action inline that would otherwise require a second, separate query to perform. While subqueries have their uses in "standard" Storm, they are particularly useful for more advanced Storm use cases involving variables and control flow.

Note: A subquery is typically used to perform some action related to the Storm query in which it is embedded. But there is no requirement for this to be the case. The subquery can contain any valid Storm, so you could (for example) write a subquery that lifts ten arbitrary email addresses (`{ inet:email | limit 10 }`) in the middle of a longer query. There's not much point to this, but Storm will dutifully lift the nodes, discard them (unless the `yield` option is used), and continue on.

Finally, one important characteristic of a subquery is that **it requires inbound nodes in order to execute.** That is, the subquery is meant to be an element in a larger Storm pipeline, not a stand-alone query, and not the first element in a longer query. Even though the subquery does not affect the inbound nodes (that is, the nodes "pass through" the subquery and are still available as inbound nodes to the next query element), nodes must still be "fired into" the subquery for the subquery action(s) to take place.

For example, the following query will return zero nodes, even though the `yield` directive is present. Because no nodes are "inbound" to cause the subquery to execute, the embedded Storm is never run:

```
storm> yield { inet:email | limit 10 }
```

Syntax:

<*query*> [**yield**] **{** <*query*> **}** [<*query*>]

<*query*> [**yield**] **{** <*query*> [**{** <*query*> **}**] **}** [<*query*>]

Examples:

- Pivot from a set of DNS A records to their associated IPs and then to additional DNS A records associated with those IPs. Use a subquery to check whether any of the IPs are RFC1918 addresses (i.e., have `:type=private`) and if so, tag the IP as non-routable.

```
<inet:dns:a> -> inet:ipv4 { +:type=private [ +#nonroutable ] } -> inet:dns:a
```

- Pivot from a set of IP addresses to any servers associated with those IPs. Use a subquery to check whether the IP has a location (`:loc`) property, and if not, call a third-party geolocation service to attempt to identify a location and set the property. (**Note:** Synapse does not include a geolocation service in its public distribution; this example assumes such a service has been implemented and is called using an extended Storm command named `ipgeoloc`.)

```
<inet:ipv4> { -:loc | ipgeoloc } -> inet:server
```

- Pivot from a set of FQDNs to any files (binaries) that query those FQDNs. Use a subquery with the `yield` option to return the file nodes as well as the original FQDNs.

```
<inet:fqdn> yield { -> inet:dns:request:query:name +:exe -> file:bytes }
```

Note: The "pivot and join" operator (`-+>`) allows you to combine a set of inbound nodes with the set of nodes reached by the pivot into a single result set. However, the operator only allows you to join sets of nodes that are "one degree" (one pivot) apart. The subquery syntax above effectively allows you to join two sets of nodes that are more than one pivot apart.

Usage Notes:

- Subqueries can be nested; you can place subqueries inside of subqueries.
- When the `yield` option is used, Storm will return the nodes from the subquery first, followed by the nodes from the original working set.

Subquery Filter

A **subquery filter** is a filter where the filter itself is a Storm expression.

Standard Storm filter operations are designed to operate on the nodes in the current working set, that is, the nodes actively passing through the Storm pipeline. Regardless of whether the filter uses a *Standard Comparison Operator* or *Extended Comparison Operator*, the filter evaluates some aspect of the node itself such as its primary or secondary property(ies), or whether or not the node has a particular tag.

A subquery filter allows you to use a subquery to filter the current set of nodes based on their relationship to other nodes, or on the properties or tags of "nearby" nodes. The subquery content is still evaluated "off to the side"; any pivots, filters, or other operations performed inside the subquery are still "contained within" the subquery. But the nodes passing through the main Storm pipeline are **evaluated against** the contents of the subquery, and are then filtered - passed or dropped - based on that evaluation.

For additional detail on subquery filters and examples of their use, refer to the *Subquery Filters* section of the *Storm Reference - Filtering* guide.

Setting Properties with Subqueries

A subquery can be used in data modification (i.e., edit) operations to specify the value that should be assigned to a node's secondary property. This is useful when the value to be assigned is a *GUID* that would be inconvenient to type or copy and paste. See the *Add or Modify Properties Using Subqueries* section of the *Storm Reference - Data Modification* document for examples and additional detail.

3.6.8 Storm Reference - Model Introspection

This section provides a brief overview / tutorial of some basic Storm queries to allow introspection / navigation of Synapse's:

- *Data Model*
- *Analytical Model*

The sample queries below are meant to help users new to Synapse and Storm get started examining forms and tags within a Cortex. The queries all use standard Storm syntax and operations (such as pivots). For more detail on using Storm, see *Storm Reference - Introduction* and related Storm topics.

Data Model

Analysts working with the data in the Synapse hypergraph will quickly become familiar with the forms they work with most often. However, as the model expands - or when first learning Synapse - it is helpful to be able to easily reference forms that may be less familiar, as well as how different forms relate to each other.

While the data model can be referenced within the Synapse source code or via the auto-generated *Synapse Data Model* documentation, it can be inconvenient to stop in the middle of an analytical workflow to search for the correct documentation. It is even more challenging to stop and browse through extensive documentation when you're not sure what you're looking for (or whether an appropriate form exists for your needs).

For these reasons Synapse supports **data model introspection** within the Synapse hypergraph itself - that is, the Synapse data model is itself data stored within the Cortex. Introspection allows users to obtain the model definition for a given Cortex at run-time. The model definition contains a list of all native and custom types, forms, and properties supported by the current Cortex.

These model elements are generated as nodes in the Cortex from the current Synapse data model when a Cortex is initialized or when a new module is loaded. As nodes, they can be lifted, filtered, and pivoted across just like other nodes. However, the model-specific nodes do not persist permanently in storage and they cannot be modified (edited) or tagged. Because they are generated at run-time they are known as run-time nodes or **runt nodes.**

The following runt node forms are used to represent the Synapse data model for types, forms, and properties, respectively.

- `syn:type`
- `syn:form`
- `syn:prop`

As nodes within the Cortex, these forms can be lifted, filtered, and pivoted across using the Storm query language, just like any other nodes (with the exception of editing or tagging). Refer to the various Storm documents for details on Storm syntax. A few simple example queries are provided below to illustrate some common operations for model introspection.

Example Queries

- Display all current types / forms / properties:

```
storm> syn:type | limit 2
syn:type=int
        :ctor = synapse.lib.types.Int
        :doc = The base 64 bit signed integer type.
        :opts = {'size': 8, 'signed': True, 'fmt': '%d', 'min': None, 'max': None, 'ismin
↪': False, 'ismax': False}
syn:type=float
        :ctor = synapse.lib.types.Float
        :doc = The base floating point type.
        :opts = {'fmt': '%f', 'min': None, 'minisvalid': True, 'max': None, 'maxisvalid
↪': True}
```

```
storm> syn:form | limit 2
syn:form=inet:dns:a
        :doc = The result of a DNS A record lookup.
        :runt = false
        :type = inet:dns:a
syn:form=inet:dns:aaaa
        :doc = The result of a DNS AAAA record lookup.
        :runt = false
        :type = inet:dns:aaaa
```

```
storm> syn:prop | limit 2
syn:prop=.seen
        :base = .seen
        :doc = The time interval for first/last observation of the node.
        :extmodel = false
        :relname = .seen
        :ro = false
        :type = ival
        :univ = true
syn:prop=.created
        :base = .created
        :doc = The time the node was created in the cortex.
        :extmodel = false
        :relname = .created
        :ro = true
        :type = time
        :univ = true
```

- Display all types that are sub-types of 'string':

```
storm> syn:type:subof = str | limit 2
syn:type=ou:sic
        :ctor = synapse.lib.types.Str
        :doc = The four digit Standard Industrial Classification Code.
        :opts = {'enums': None, 'regex': '^[0-9]{4}$', 'lower': False, 'strip': False,
↪'replace': (), 'onespace': False, 'globsuffix': False}
        :subof = str
```

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```
syn:type=ou:naics
        :ctor = synapse.lib.types.Str
        :doc = North American Industry Classification System codes and prefixes.
        :opts = {'enums': None, 'regex': '^[1-9][0-9]{1,5}?$', 'lower': False, 'strip':␣
↪True, 'replace': (), 'onespace': False, 'globsuffix': False}
        :subof = str
```

- Display a specific type:

```
storm> syn:type = inet:fqdn
syn:type=inet:fqdn
        :ctor = synapse.models.inet.Fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
```

- Display a specific form:

```
storm> syn:form = inet:fqdn
syn:form=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :runt = false
        :type = inet:fqdn
```

- Display a specific property of a specific form:

```
storm> syn:prop = inet:ipv4:loc
syn:prop=inet:ipv4:loc
        :base = loc
        :doc = The geo-political location string for the IPv4.
        :extmodel = false
        :form = inet:ipv4
        :relname = loc
        :ro = false
        :type = loc
        :univ = false
```

- Display a specific form and all its secondary properties (including universal properties):

```
storm> syn:prop:form = inet:fqdn | limit 2
syn:prop=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :extmodel = false
        :form = inet:fqdn
        :type = inet:fqdn
        :univ = false
syn:prop=inet:fqdn.seen
        :base = .seen
        :doc = The time interval for first/last observation of the node.
        :extmodel = false
        :form = inet:fqdn
        :relname = .seen
        :ro = false
        :type = ival
        :univ = false
```

- Display all properties whose type is `inet:fqdn`:

```
storm> syn:prop:type = inet:fqdn | limit 2
syn:prop=inet:dns:a:fqdn
        :base = fqdn
        :doc = The domain queried for its DNS A record.
        :extmodel = false
        :form = inet:dns:a
        :relname = fqdn
        :ro = true
        :type = inet:fqdn
        :univ = false
syn:prop=inet:dns:aaaa:fqdn
        :base = fqdn
        :doc = The domain queried for its DNS AAAA record.
        :extmodel = false
        :form = inet:dns:aaaa
        :relname = fqdn
        :ro = true
        :type = inet:fqdn
        :univ = false
```

- Display all forms **referenced by** a specific form (i.e., the specified form contains secondary properties that are themselves forms):

```
storm> syn:prop:form = inet:whois:rec :type -> syn:form
syn:form=inet:whois:rec
        :doc = A domain whois record.
        :runt = false
        :type = inet:whois:rec
syn:form=inet:fqdn
        :doc = A Fully Qualified Domain Name (FQDN).
        :runt = false
        :type = inet:fqdn
syn:form=inet:whois:rar
        :doc = A domain registrar.
        :runt = false
        :type = inet:whois:rar
syn:form=inet:whois:reg
        :doc = A domain registrant.
        :runt = false
        :type = inet:whois:reg
```

- Display all forms that **reference** a specific form (i.e., the specified form is a secondary property of another form):

```
storm> syn:form = inet:whois:rec -> syn:prop:type :form -> syn:form
syn:form=inet:whois:contact
        :doc = An individual contact from a domain whois record.
        :runt = false
        :type = inet:whois:contact
syn:form=inet:whois:rec
        :doc = A domain whois record.
        :runt = false
        :type = inet:whois:rec
```

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```
syn:form=inet:whois:recns
        :doc = A nameserver associated with a domain whois record.
        :runt = false
        :type = inet:whois:recns
```

Analytical Model

As the number of tags used in the hypergraph increases, analysts must be able to readily identify tags, tag hierarchies, and the precise meaning of individual tags so they can be applied and interpreted correctly.

Unlike the runt nodes used for the Synapse data model, the `syn:tag` nodes that represent tags are regular objects in the Cortex that can be lifted, filtered, and pivoted across (as well as edited, tagged, and deleted) just like any other nodes. In a sense it is possible to perform **"analytical model introspection"** by examining the nodes representing a Cortex's analytical model (i.e., tags).

Lifting, filtering, and pivoting across `syn:tag` nodes is performed using the standard Storm query syntax; refer to the various Storm documents for details on using Storm. See also the `syn:tag` section of *Storm Reference - Type-Specific Storm Behavior* for additional details on working with `syn:tag` nodes.

A few simple example queries are provided below to illustrate some common operations for working with tags. As Synapse does not include any pre-populated `syn:tag` nodes, these examples assume you have a Cortex where some number of tags have been created.

Example Queries

- Lift a single tag:

```
storm> syn:tag = cno.infra.anon.tor
syn:tag=cno.infra.anon.tor
        :base = tor
        :depth = 3
        :doc = Various types of Tor infrastructure, including: a server representing a␣
↪Tor service or the associated IP address; a host known to be a Tor node / hosting a␣
↪Tor service; contact information associated with an entity responsible for a given Tor␣
↪node.
        :title = Tor Infrastructure
        :up = cno.infra.anon
        .created = 2023/07/12 15:16:04.419
```

- Lift all root tags:

```
storm> syn:tag:depth = 0
syn:tag=cno
        :base = cno
        :depth = 0
        .created = 2023/07/12 15:16:04.405
```

- Lift all tags one level "down" from the specified tag:

```
storm> syn:tag:up = cno.infra.anon
syn:tag=cno.infra.anon.vpn
        :base = vpn
```

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```
        :depth = 3
        :doc = A server representing an anonymous VPN service, or the associated IP␣
↪address. Alternately, an FQDN explicilty denoting an anonymous VPN that resolves to␣
↪the associated IP.
        :title = Anonymous VPN
        :up = cno.infra.anon
        .created = 2023/07/12 15:16:04.425
syn:tag=cno.infra.anon.tor
        :base = tor
        :depth = 3
        :doc = Various types of Tor infrastructure, including: a server representing a␣
↪Tor service or the associated IP address; a host known to be a Tor node / hosting a␣
↪Tor service; contact information associated with an entity responsible for a given Tor␣
↪node.
        :title = Tor Infrastructure
        :up = cno.infra.anon
        .created = 2023/07/12 15:16:04.419
```

- Lift all tags that start with a given prefix, regardless of depth:

```
storm> syn:tag ^= cno.infra
syn:tag=cno.infra
        :base = infra
        :depth = 1
        :doc = Top-level tag for infrastructre.
        :title = Infrastructure
        :up = cno
        .created = 2023/07/12 15:16:04.405
syn:tag=cno.infra.anon
        :base = anon
        :depth = 2
        :doc = Top-level tag for anonymization services.
        :title = Anonymization services
        :up = cno.infra
        .created = 2023/07/12 15:16:04.412
syn:tag=cno.infra.anon.tor
        :base = tor
        :depth = 3
        :doc = Various types of Tor infrastructure, including: a server representing a␣
↪Tor service or the associated IP address; a host known to be a Tor node / hosting a␣
↪Tor service; contact information associated with an entity responsible for a given Tor␣
↪node.
        :title = Tor Infrastructure
        :up = cno.infra.anon
        .created = 2023/07/12 15:16:04.419
syn:tag=cno.infra.anon.vpn
        :base = vpn
        :depth = 3
        :doc = A server representing an anonymous VPN service, or the associated IP␣
↪address. Alternately, an FQDN explicilty denoting an anonymous VPN that resolves to␣
↪the associated IP.
        :title = Anonymous VPN
```

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```
        :up = cno.infra.anon
        .created = 2023/07/12 15:16:04.425
```

- Lift all tags that share the same base (rightmost) element:

```
storm> syn:tag:base = sofacy
syn:tag=rep.talos.sofacy
        :base = sofacy
        :depth = 2
        :doc = Indicator or activity talos calls (or associates with) sofacy.
        :title = sofacy(talos)
        :up = rep.talos
        .created = 2023/07/12 15:16:04.542
syn:tag=rep.uscert.sofacy
        :base = sofacy
        :depth = 2
        :doc = Indicator or activity uscert calls (or associates with) sofacy.
        :title = sofacy(uscert)
        :up = rep.uscert
        .created = 2023/07/12 15:16:04.535
```

3.6.9 Storm Reference - Type-Specific Storm Behavior

Some data types (*Type*) within Synapse have additional optimizations. These include optimizations for:

- indexing (how the type is stored for retrieval);
- parsing (how the type can be specified for input);
- insertion (how the type can be used to create or modify nodes);
- operations (how the type can be lifted, filtered, or otherwise compared).

Types that have been optimized in various ways are documented below along with any specialized operations that may be available for those types.

This section is **not** a complete reference of all available types. In addition, this section does **not** address the full range of type enforcement constraints that may restrict the values that can be specified for a given type (such as via a constructor (`ctor`)). For details on available types and type constraints or enforcement, see the online documentation or the Synapse source code.

- *array* (array)
- *file:bytes* (file)
- *guid* (globally unique identifier)
- *inet:fqdn* (FQDN)
- *inet:ipv4* (IPv4)
- *ival* (time interval)
- *loc* (location)
- *str* (string)
- *syn:tag* (tag)
- *time* (date/time)

array

An `array` is a specialized type that consists of either a list or a set of typed values. That is, an array is a type that consists of one or more values that are themselves all of a single, defined type.

Tip: An array that is a **list** can have duplicate entries in the list. An array that is a **set** consists of a unique group of entries.

`Array` types can be used for properties where that property is likely to have multiple values, but it is undesirable to represent those values using multiple *Relationship* nodes. Examples of array secondary properties include `media:news:authors`, `inet:email:message:headers`, and `ps:person:names`. You can view all secondary properties that are `array` types using the following Storm query:

```
syn:prop:type=array
```

Indexing

N/A

Parsing

Because an `array` is a list or set of typed values, `array` elements can be input in any format supported by the type of the elements themselves. For example, if an `array` consists of `inet:ipv4` values, the values can be input in any supported `inet:ipv4` format (e.g., integer, hex, dotted-decimal string, etc.).

Insertion

Because it may contain multiple values, an `array` property must be set using comma-separated values enclosed in parentheses (this is true even if the array contains only a single element; you must still use parentheses, and the single element must still be followed by a trailing comma). Single or double quotes are required in accordance with the standard rules for using *Whitespace and Literals in Storm*.

Example:

Set the `:names` property of an organization (`ou:org`) node to a single value:

```
storm> ou:org:name=vertex [ :names=('The Vertex Project',) ]
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
```

Example:

Set the `:names` property of an organization (`ou:org`) node to contain multiple variations of the organization name:

```
storm> ou:org:name=vertex [ :names=('The Vertex Project', 'The Vertex Project, LLC',␣
↪Vertex) ]
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
```

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```
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
```

Warning: Using the equals (=) operator to set an array property value will set or update (overwrite) the **entire** property value. To add or remove individual elements from an array, use the += or -= operators.

Example:

Add a name to the array of names associated with an organization:

```
storm> ou:org:name='Monty Python' [ :names+='The Spanish Inquisition' ]
ou:org=9c7ff324f28c6dd145133a51fcb0fba4
        :name = monty python
        :names = ['monty python', 'the spanish inquisition']
        .created = 2023/07/12 15:15:04.114
```

Remove a name from the array of names associated with an organization:

```
storm> ou:org:name='Monty Python' [ :names-='The Spanish Inquisition' ]
ou:org=9c7ff324f28c6dd145133a51fcb0fba4
        :name = monty python
        :names = ['monty python']
        .created = 2023/07/12 15:15:04.114
```

Tip: The standard "edit try" operator (?=) (see *Edit "Try" Operator (?=)* in the *Storm Reference - Data Modification*) can be used to attempt to set a **full** array property value where you are unsure whether the value will succeed. The specialized ?+= or ?-= operators can be used to attempt to add or remove a **single** array value in a similar manner.

Example:

Use the specialized "edit try" operator to attempt to add a single value to the `:authors` array property of an article (`media:news` node). (**Note:** a type-inappropriate value (a name) is used below to show the "fail silently" behavior for the "edit try" operator. The `:authors` property is an array of `ps:contact` nodes and requires `ps:contact` guid values.)

```
storm> media:news:org=kaspersky [ :authors?+='john smith' ]
media:news=0531160afc90305ae909e46845d30614
        :org = kaspersky
        :title = new report on really bad threat
        .created = 2023/07/12 15:15:04.181
```

Usage Notes:

- When using the standard "edit try" operator (?=) to attempt to set the **full** value of an array property (vs. adding or removing an element from an array), the **entire** attempt will fail if **any** value in the list of values fails. For example, if you try to set `[ :identities:emails?=(alice@vertex.link, bob) ]` on an X509 certificate (`crypto:x509:cert`), Synapse will fail to set the property altogether because `bob` is not a valid email address type (even though `alice@vertex.link` is).
- The "edit try" operator for **removing** individual elements from an array (?-=) is unique to arrays as they are the only type that allows removal of a single element from a property. (Properties with a single value are either set,

modified (updated), or the property is deleted altogether.) As with other uses of "edit try", use of the operator allows the operation to silently fail (vs. error and halt) if the operation attempts to remove a value from an array that does not match the array's defined type. For example, attempting to remove an IPv4 from an array of email addresses will halt with a `BadTypeValu` error if the standard remove operator (`-=`) is used, but silently fail (do nothing and continue) if the "edit try" version (`?-=`) is used.

Operations

Lifting and Filtering

Lifting or filtering array properties using the equals (`=`) operator requires an **exact match** of the full array property value. This makes sense for forms with simple values like `inet:ipv4=1.2.3.4`, but is often infeasible for arrays because lifting by the **full** array value requires you to know the **exact** values of each of the array elements as well as their **exact** order:

```
storm> ou:org:names=("The Vertex Project", "The Vertex Project, LLC", Vertex)
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
```

For this reason, Storm offers a special "by" syntax for lifting and filtering with `array` types. The syntax consists of an asterisk (`*`) preceding a set of square brackets (`[ ]`), where the square brackets contain a comparison operator and a value that can match one or more elements in the array. This allows users to match one or more elements in the array similarly to how they would match individual property values.

Note: The square brackets used to lift or filter based on values in an array should not be confused with square brackets used to add or modify nodes or properties in *Edit Mode*.

Examples:

Lift the `ou:org` node(s) whose `:names` property contains a name that exactly matches `vertex`:

```
storm> ou:org:names*[=vertex]
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
```

Lift the `ou:org` node(s) whose `:names` property contains a name that includes the string `vertex`:

```
storm> ou:org:names*[~=vertex]
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
```

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```
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
ou:org=29b6e7bad25fc3538503ba94bd89365a
        :name = vertex
        :names = ['the vertex project', 'the vertex project, llc', 'vertex']
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.016
```

Lift the x509 certificate nodes that reference the domain `microsoft.com`:

```
storm> crypto:x509:cert:identities:fqdns*[=microsoft.com]
crypto:x509:cert=a4e2461cd3b72962f454a49d3519a577
        :identities:fqdns = ['microsoft.com', 'verisign.com']
        .created = 2023/07/12 15:15:04.294
```

Downselect a set of `ou:org` nodes to include only those with a name that starts with "acme":

```
storm> ou:org +:names*[^=acme]
ou:org=affb950ff2eef793dd29e5b50b072418
        :name = acme construction
        :names = ['acme construction']
        .created = 2023/07/12 15:15:04.357
ou:org=ec8a6a72e149bda5c16d6bf95c265387
        :name = acme consulting
        :names = ['acme consulting']
        .created = 2023/07/12 15:15:04.351
```

See *Lift by (Arrays) (*[ ])* and *Filter by (Arrays) (*[ ])* for additional details.

Pivoting

Synapse and Storm are type-aware and will facilitate pivoting between properties of the same type. This includes pivoting between individual typed properties and array properties consisting of those same types. Type awareness for arrays includes both standard form and property pivots as well as wildcard pivots.

Examples:

Pivot from a set of x509 certificate nodes to the set of domains referenced by the certificates (such as in the `:identities:fqdns` array property):

```
storm> crypto:x509:cert -> inet:fqdn
inet:fqdn=microsoft.com
        :domain = com
        :host = microsoft
        :issuffix = false
        :iszone = true
        :zone = microsoft.com
        .created = 2023/07/12 15:15:04.298
inet:fqdn=verisign.com
        :domain = com
        :host = verisign
        :issuffix = false
        :iszone = true
```

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```
        :zone = verisign.com
        .created = 2023/07/12 15:15:04.298
```

Pivot from a set of `ou:name` nodes to any nodes that reference those names (this would include `ou:org` nodes where the `ou:name` is present in the `:name` property or as an element in the `:names` array):

```
storm> ou:name^=acme <- *
ou:org=affb950ff2eef793dd29e5b50b072418
        :name = acme construction
        :names = ['acme construction']
        .created = 2023/07/12 15:15:04.357
ou:org=affb950ff2eef793dd29e5b50b072418
        :name = acme construction
        :names = ['acme construction']
        .created = 2023/07/12 15:15:04.357
ou:org=ec8a6a72e149bda5c16d6bf95c265387
        :name = acme consulting
        :names = ['acme consulting']
        .created = 2023/07/12 15:15:04.351
ou:org=ec8a6a72e149bda5c16d6bf95c265387
        :name = acme consulting
        :names = ['acme consulting']
        .created = 2023/07/12 15:15:04.351
```

file:bytes

`file:bytes` is a special type used to represent any file (i.e., any arbitrary set of bytes). Note that a file can be represented as a node within a Cortex regardless of whether the file itself (the specific set of bytes) is available (i.e., stored in an Axon). This is essential as many other data model elements allow (or depend on) the concept of a file (as opposed to a hash).

The `file:bytes` type is a specialized *guid* type. A file can be uniquely represented by the specific contents of the file itself. As it is impractical to use "all the bytes" as a primary property value, it makes sense to use a shortened representation of those bytes - that is, a hash. MD5 collisions can now be generated with ease, and SHA1 collisions were demonstrated in 2017. For this reason, Synapse uses the SHA256 hash of a file (considered sufficiently immune from collision attacks for the time being) as "unique enough" to act as the primary property of a `file:bytes` node if available. Otherwise, a `guid` is generated and used.

Indexing

N/A

Parsing

`file:bytes` must be input using their complete primary property. It is impractical to manually type a SHA256 hash or 128-bit `guid` value. For this reason `file:bytes` forms are most often specified by referencing the node via a more human-friendly secondary property or by pivoting to the node. Alternately, the `file:bytes` value can be copied and pasted for use in a query.

The primary property of a `file:bytes` node indicates how the node was created (i.e., via the SHA256 hash or via a guid):

- A node created using the SHA256 hash will have a primary property value consisting of `sha256:` prepended

to the SHA256 hash:

```
file:bytes=sha256:e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
```

- A node created using a `guid` will have a primary property value consisting of `guid:` prepended to the

`guid` value:

```
file:bytes=guid:22d4ed1b75c9eb5ff8070e0df1e8ed6b
```

Note: When specifying a SHA256-based `file:bytes` node, entering the `sha256:` prefix is optional. The following are equivalent representations of the same file:

```
file:bytes=sha256:e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855

file:bytes=e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
```

Insertion

A `file:bytes` node can be created in one of three ways:

SHA256 Hash

A SHA256 hash can be specified as the node's primary property. The `sha256:` prefix can optionally be specified, but is not required (it will be added automatically on node creation). Storm will recognize the primary property value as a SHA256 hash and also set the `:sha256` secondary property. Any other secondary properties must be set manually.

```
storm> [ file:bytes = 44daad9dbd84c92fa9ec52649b028b4c0f7d285407685778d09bad4b397747d0 ]
file:bytes=sha256:44daad9dbd84c92fa9ec52649b028b4c0f7d285407685778d09bad4b397747d0
        :sha256 = 44daad9dbd84c92fa9ec52649b028b4c0f7d285407685778d09bad4b397747d0
        .created = 2023/07/12 15:15:04.459
```

Because the SHA256 is considered unique (for now) for our purposes, the node is fully deconflictable. If additional secondary properties such as `:size` or other hashes are obtained later, or if the actual file is obtained, the node can be updated with the additional properties based on deconfliction with the SHA256 hash.

GUID Value

The asterisk can be used to generate a `file:bytes` node with an arbitrary guid value:

```
storm> [ file:bytes = * ]
file:bytes=guid:df047617b109f8076c666c0546a458ab
        .created = 2023/07/12 15:15:04.486
```

Alternately, a potentially deconflictable `guid` can be generated by specifying a list of one or more values to the `guid` generator (for example, an MD5 and / or SHA1 hash). This will generate a predictable `guid`:

```
storm> [ file:bytes = (63fcc49b2ac6cbd686f4d9704446c673,)␣
↪:md5=63fcc49b2ac6cbd686f4d9704446c673 ]
file:bytes=guid:34f71d05b9e06558b184aac6f4010a12
        :md5 = 63fcc49b2ac6cbd686f4d9704446c673
        .created = 2023/07/12 15:15:04.513
```

Synapse does not recognize any strings passed to the `guid` generator as specific types or properties and will not use values used to generate the `guid` to set any secondary property values; those properties must be explicitly set (e.g., the `:md5` property in the example above).

See the section on type-specific behavior for *guid* types for additional discussion of arbitrary (non-deconflictable) vs. deconflictable `guids`.

Note: "Deconflicting" `file:bytes` nodes based on an MD5 or SHA1 hash alone is potentially risky because both of those hashes are subject to collision attacks. In other words, two files that have the same MD5 hash or the same SHA1 hash are not guaranteed to be the same file based on that single hash alone.

In short, creating `file:bytes` nodes using the MD5 and / or SHA1 hash can allow the creation of "potentially" deconflictable nodes when no other data is available. However, this deconfliction is subject to some limitations, as noted above. In addition, if the actual file (full bytes) or corresponding SHA256 hash is obtained later, it is not possible to "convert" a `guid`-based `file:bytes` node to one whose primary property is based on the SHA256 hash.

Actual Bytes

You can also create a `file:bytes` node by adding the actual file (set of bytes) to Synapse (specifically, to Synapse's Axon storage). Adding the file will create the `file:bytes` node in the Cortex based on the file's SHA256 value. Synapse will also calculate and set additional properties for the `file:bytes` node's size and other hashes (e.g., MD5, SHA1, etc.).

Creating `file:bytes` nodes in this manner is often done programmatically (such as via a Synapse *Power-Up*) that can download or ingest files. Other options include:

- the built-in Synapse *wget* command;
- the **Upload File** menu option available from the Synapse UI (Optic), which allows you to either upload a file from local disk, or download a file from a specified URL; or
- the `pushfile` tool, available from the CLI in the community version of Synapse (see *pushfile*).

Tip: Like other external (to Storm) commands, the pushfile tool is accessible from the Storm CLI (see *storm*) as `!pushfile`.

Similarly, Storm's HTTP library (*$lib.inet.http*) could be leveraged to retrieve a web-based file and use the returned bytes as input (potentially using Storm variables - see *Storm Reference - Advanced - Variables*) to the `guid` generator. A detailed discussion of this method is beyond the scope of this section; see the *Storm Libraries* technical documentation for additional detail.

Operations

For some lift and filter operations, you may optionally specify `file:bytes` nodes using a "sufficiently unique" partial match of the node's primary property. For example, the prefix operator (`^=`) may be used to specify a unique prefix for the `file:bytes` node's SHA256 or guid value:

```
storm> file:bytes^=sha256:021b4ce5
file:bytes=sha256:021b4ce5c4d9eb45ed016fe7d87abe745ea961b712a08ea4c6b1b81d791f1eca
        :md5 = 8934aeed5d213fe29e858eee616a6ec7
        :name = adobeupdater.exe
        :sha1 = a7e576f41f7f100c1d03f478b05c7812c1db48ad
        :sha256 = 021b4ce5c4d9eb45ed016fe7d87abe745ea961b712a08ea4c6b1b81d791f1eca
        :size = 182820
        .created = 2023/07/12 15:15:04.539
```

Usage Notes:

- When using the prefix operator, the `sha256:` or `guid:` prefix string must be included.
- The length of the value that is "sufficiently unique" to select a single `file:bytes` will vary depending on the data in your instance of Synapse. If your selection criteria matches more than one `file:bytes` node, Synapse will return all matches.
- Alternatively, the regular expression operator (`~=`) may be used to specify a partial string match anywhere in the `file:bytes` node's primary property value (though this is an inefficient way to specify a `file:bytes` node).

guid

Within Synapse, a Globally Unique Identifier (`guid`) as a *Type* explicitly refers to a 128-bit value used as a form's primary property.

The term should not be confused with the definition of GUID used by Microsoft, or with other types of identifiers (node ID, task ID) used within Synapse.

The `guid` type is used as the primary property for forms that cannot be uniquely defined by any set of specific properties. See the background documents on the Synapse data model for additional details on the *Guid Form*.

A guid value may be generated arbitrarily or in a predictable (i.e., repeatable) manner based on a defined set of inputs.

See the section on *file:bytes* types for discussion of `file:bytes` as a specialized instance of a `guid` type.

Indexing

N/A

Parsing

Guids must be input using their complete 128-bit value. It is generally impractical to manually type a guid. Guid forms are most often specified by referencing the node via a more human-friendly secondary property. Alternately, the guid value can be copied and pasted.

Insertion

Guids can be generated **arbitrarily** or as **predictable** values. When choosing a method, you should consider how you will **deconflict** guid-based nodes. See *Guid Best Practices* below for additional discussion.

Arbitrary Values

When creating a new guid node, you can specify the asterisk (*) as the primary property value of the new node. This tells Synapse to generate a unique, **arbitrary** guid for the node. For example:

```
storm> [ ou:org=* :alias=vertex :name="The Vertex Project" :url=https://vertex.link/ ]
ou:org=333256989f15df7f99d0facdce3752ad
        :alias = vertex
        :name = the vertex project
        :url = https://vertex.link/
        .created = 2023/07/12 15:15:04.590
```

The above query creates a new organization node with a unique arbitrary guid for its primary property, and sets the specified secondary properties.

Warning: Because the guid generated by the asterisk is **arbitrary,** running the above query a second time will create a second `ou:org` node with a **new** unique guid (potentially resulting in two nodes representing the same organization within the same Cortex).

The advantage of arbitrary values is that they are simple to generate. This is particularly useful for analysts who need to manually create guid nodes (organizations, contacts, threats) on a regular basis as part of their workflow.

The disadvantage is that arbitrary values are truly arbitrary; there is no easy way to deconflict the nodes.

- Users may inadvertently create duplicate nodes. That is, two users can independently create nodes with different guids to represent the same object. The only way to prevent this is by convention - for example, establishing internal processes where users "check first" before creating certain nodes. Note that while this may limit duplication, it is unlikely to eliminate it entirely.
- Bulk data that is ingested using arbitraty guids cannot be reingested, at least not in the same way. Reingesting the same data will create a second set of nodes for the same data but with different arbitrary guids.

Predictable Values

You can generate a guid value in a predictable manner based on a defined set of inputs. The inputs are specified as a comma-separated list within a set of parentheses. The guid generator uses these values as "seed" data to create a **predictable** guid value; the same set of seed data always generates the same guid.

For example:

```
storm> [ ou:org=('the vertex project',https://vertex.link) :name='the vertex project'␣
↪:url=https://vertex.link ]
ou:org=6f08c79ef95d73102af8b4ebca9c22f9
        :name = the vertex project
        :url = https://vertex.link
        .created = 2023/07/12 15:15:04.619
```

The query above creates a new organization node whose guid is generated using the company name and web site as a set of (presumably) unique inputs that will result in a unique (but predictable / deterministic) guid.

The advantage of predictable guids is that they are re-encounterable and therefore deconflictable: if you ingest data using a predictable guid, the same data can be reingested without creating duplicate nodes. This is helpful in cases where a preliminary data set is loaded into Synapse for analysis, and subsequent changes (improvements to the ingest logic, additions to the Synapse data model) allow you to capture additional detail from the original data set.

The disadvantage is that this method is more complicated for users who need to manually create guid nodes. Expecting a group of users to all remember to specify the same set of inputs in the same order (and without typos) each time they create a guid node is unrealistic.

In addition, predictable guids may not fully address challenges associated with ingesting similar data from different sources. Multiple vendors may provide similar information on the same entity. If you obtain data for the same object (an organization, a person, a certificate) from different sources, you may end up with two different nodes if the "predictable" guids are generated with different seed data from each source.

Guid Best Practices

When selecting a method to create guids, a key consideration is how you will **deconflict** data represented by guid forms. Guid forms are unique in that their primary property has no direct or obvious relationship to the object it represents. The primary property `ou:org=44db774d29f27684add0d892931c6e86` tells me this is an organization node, but provides no clue as to whether the organization is The Vertex Project, the World Bank, or the University of Michigan marching band.

The important information about "what" a guid form represents is stored in the form's secondary properties. So from a deconfliction standpoint, the best way to see if a guid node already exists is to use **secondary property deconfliction:**

- Query for an existing node based on one or more meaningful secondary properties.
- The query will lift (return) the selected node(s), if found; otherwise
- Create a new guid node using an arbitrary guid (*).

Example

> SSL/TLS certificate data is available from various data sources / APIs; different sites or vendors may provide similar information about the same certificate. Certificate metadata (i.e., information such as fingerprints, validity dates, etc.) is represented as a `crypto:x509:cert` node, which is a guid form. If you obtain data about the same certificate from different data sources, you risk the creation of duplicate nodes.

Instead, when ingesting data about a specific certificate, a user (or process) can first check for a `crypto:x509:cert` node based on a unique property, such as a certificate fingerprint (e.g., `crypto:x509:cert:sha1`, or ideally `crypto:x509:cert:sha256` to avoid hash collisions). If an existing node is found, that node can be selected and updated (or otherwise operated on); otherwise a new node for that certificate can be created using an arbitrary guid (`*`) with the appropriate secondary properties set.

Using secondary property deconfliction for guid nodes has the advantage of deconflicting on meaningful properties (those likely to uniquely identify an object), without relying on knowledge of any specific method used to create predictable guids. (Note that "predictable guids" are often generated using these same secondary properties; so deconflicting on the properties directly is both more straightforward and more transparent.)

Tip: When choosing a secondary property (or properties) to deconflict on, you should select ones that can sufficiently deconflict the form **and** are likely to be present in the data source(s) you may use to obtain information about the form.

Secondary property deconfliction is not guaranteed to eliminate all duplications, but is highly effective in many cases. This method can be used both programmatically (i.e., in any ingest scripts or Power-Ups (*Power-Up*)) and by users who can "spot check" for the existence of a node before manually creating one.

Tip: Synapse implements several Storm commands known as generator ("gen") commands. These commands simplify secondary property deconfliction and node creation for several common guid nodes.

For example, the *gen.ou.org* command takes an organization name as input (e.g, "vertex"), checks for any `ou:org` nodes with that name (i.e., in the `:name` or `:names` properties) and either lifts the existing node, or creates a new one.

See the *gen* section in the *Storm Reference - Storm Commands* for available generator commands (or run `help` from your Synapse CLI).

Arbitrary Guids

For some use cases, the use of arbitrary guids (without secondary property deconfliction) may be reasonable. This approach may be suitable when:

- The data you are ingesting is truly unique (i.e., the same or similar data is not available from another source). For example, log or alert data that is specific to a unique sensor or host.
- You need to perform a one-time ingest of the data (i.e., you do not plan to reingest the same data in the future).

If the data is unique, but you may need to reingest it at some point, secondary property deconfliction or predictable guids are more appropriate.

Predictable Guids

For some use cases, the use of predictable guids (without secondary property deconfliction) may be reasonable. This approach may be suitable when:

- You have a unique set of data (not available from another data source) to ingest and want the option to reingest it in the future without creating duplicate nodes.
- The data is sufficiently unique that nodes representing the data will not already exist in Synapse.
- You cannot use secondary property deconfliction given the nature of the data. In this case, deconfliction based on predictable guids may be the "next best" option.

When using predictable guids, the "seed" data to generate the guid should be unique to both the node being created and the specific data source. For example, your inputs could include:

- A string representing the **data source.**
- The **timestamp** associated with the data, if one exists.
- The values of one or more **secondary properties** for the node you are creating. Be sure to choose properties where:
  - the property / properties will **always** be present for the given data source; and
  - the set of properties is sufficient to create a unique node.

For example, a `media:news` node might be created using:

- A data source string (e.g., `my_data_source`).
- The publication date of the article (e.g., `2022/09/12`)
- The URL where the article was published (e.g., `https://www.example.com/my_article.html`)

Predictable guid values can be generated directly (as part of Storm *Edit Mode* syntax):

```
storm> [ media:news=(my_data_source,2022/09/12,https://www.example.com/my_article.html) ]
media:news=f9515b24f615448ed44601645d547f6a
        .created = 2023/07/12 15:15:04.647
```

Alternately, guid values can be generated and assigned to a variable using the Storm `$lib.guid()` library (see *$lib.guid(*args)*). The values provided as arguments to `$lib.guid()` can be either specific values or variables:

```
storm> $guid=$lib.guid(my_data_source,2022/09/12,https://www.example.com/my_article.
↪html) [ media:news=$guid ]
media:news=f9515b24f615448ed44601645d547f6a
        .created = 2023/07/12 15:15:04.647
```

```
storm> $source=my_data_source $published=2022/09/12 $url=https://www.example.com/my_
↪article.html $guid=$lib.guid($source,$published,$url) [ media:news=$guid ]
media:news=f9515b24f615448ed44601645d547f6a
        .created = 2023/07/12 15:15:04.647
```

Note that the same guid value is generated in each of the three examples above.

Note: The input to the `guid` generator is interpreted as a **structured list,** specifically, a list of string values (i.e., `(str_0, str_1, str_2...str_n)`). Deconfliction depends on the same list being submitted to the generator in the same order each time.

The `guid` generator is **not** "model aware" and will not recognize items in the list as having a particular data type or representing a particular property value. That is, Synapse will not set any secondary property values based on data provided to the `guid` generator. Any property values must be set as part of the node creation process.

A full discussion of writing ingest code (particulary for Storm packages, services, or Power-Ups) is beyond the scope of this User Guide. For more information, see the *Synapse Developer Guide*.

Operations

Because guid values are unwieldy to use on the command line (outside of copy and paste operations), guid nodes may be more easily lifted by a unique secondary property.

Examples:

Lift an org node by its alias:

```
storm> ou:org:alias=choam
ou:org=4a5482dce2423c6b745a6638f7ed1bc4
        :alias = choam
        :name = combine honnete ober advancer mercantiles
        .created = 2023/07/12 15:15:04.753
```

Lift a DNS request node by the name used in the DNS query:

```
storm> inet:dns:request:query:name=pop.seznam.cz
inet:dns:request=a08ff3364325d339e6db5fcb2bc85627
        :query:name = pop.seznam.cz
        :query:name:fqdn = pop.seznam.cz
        :time = 2020/04/30 09:30:33.000
        .created = 2023/07/12 15:15:04.797
```

It is also possible to lift and filter guid nodes using a "sufficiently unique" prefix match of the guid value.

Example:

Lift a `ps:contact` node by a partial prefix match:

```
storm> ps:contact^=13c9663e
ps:contact=13c9663e5f553014eb50d00bb7c6945a
        :name = seongsu park
        :orgname = kaspersky lab
        .created = 2023/07/12 15:15:04.846
```

The length of the value that is "sufficiently unique" will vary depending on the data in your instance of Synapse. If your selection criteria matches more than one node, Synapse will return all matches.

When **setting** or **updating** a secondary property that is a guid value, you may use a "human friendly" Storm query (specifically a subquery) to reference the node whose primary property (guid value) you wish to set for the secondary property.

Example:

Set the `:org` property for a `ps:contact` node to the guid value of the associated `ou:org` node using a Storm query:

```
storm> ps:contact:name='ron the cat' [ :org={ ou:org:name=vertex } ]
ps:contact=a26423c169770d2bdbda2cf0e7bb6a50
        :name = ron the cat
        :org = 29b6e7bad25fc3538503ba94bd89365a
        :title = cattribution analyst
        .created = 2023/07/12 15:15:04.890
```

Note: The Storm query used to specify the guid node must return exactly one node. If the query returns more than one node, or does not return any nodes, Synapse will generate an error.

See *Add or Modify Properties Using Subqueries* for additional details.

inet:fqdn

Fully qualified domain names (FQDNs) are structured as a set of string elements separated by the dot (`.`) character. The Domain Name System acts as a "reverse hierarchy" (operating from right to left instead of from left to right) separated along the dot boundaries - i.e., `com` is the hierarchical root for domains such as `google.com` or `microsoft.com`.

Because of this logical structure, Synapse includes certain optimizations for working with `inet:fqdn` types:

- Reverse string indexing on `inet:fqdn` types.
- Default values for the secondary properties `:issuffix` and `:iszone` of a given `inet:fqdn` node based on the values of those properties for the node's parent domain.

Indexing

Synapse performs **reverse string indexing** on `inet:fqdn` types. Domains are indexed in full reverse order - that is, the domain `this.is.my.domain.com` is indexed as `moc.niamod.ym.si.siht` to account for the "reverse hierarchy" implicit in the DNS structure.

Parsing

N/A

Insertion

When `inet:fqdn` nodes are created (or modifications to certain properties are made), Synapse uses some built-in logic to set certain secondary properties related to zones of control (specifically, `:issuffix`, `:iszone`, and `:zone`).

The reverse hierarchy implicit in dotted FQDNs represents elements such as <*host*>.<*domain*>.<*suffix*>, but can also represent implicit or explicit **zones of control.** The term "zone of control" is loosely defined, and is not meant to represent control or authority by any specific organization or entity. Instead, "zone of control" can be thought of as a boundary within an individual FQDN hierarchy where control of a portion of the domain namespace shifts from one entity or owner to another.

A simple example is the `com` top-level domain (managed by Verisign) vs. the domain `microsoft.com` (controlled by Microsoft Corporation). `Com` represents one zone of control where `microsoft.com` represents another.

The `inet:fqdn` form in the Synapse data model uses several secondary properties that relate to zones of control:

- `:issuffix` = primary zone of control
- `:iszone` = secondary zone of control
- `:zone` = authoritative zone for a given domain or subdomain

(**Note:** contrast `:zone` with `:domain` which simply represents the next level "up" in the hierarchy from the current domain).

Synapse uses the following logic for suffixes and zones upon `inet:fqdn` creation:

1. All domains consisting of a single element (such as `com`, `museum`, `us`, `br`, etc.) are considered **suffixes** and receive the following default values:
    - `:issuffix = 1`

- `:iszone = 0`
- `:zone = <none / property not created>`
- `:domain = <none / property not created>`

2. Any domain whose **parent domain is a suffix** is considered a **zone** and receives the following default values:
   - `:issuffix = 0`
   - `:iszone = 1`
   - `:zone = <set to self>`
   - `:domain = <set to parent domain>`
3. Any domain whose **parent domain is a zone** is considered a "normal" subdomain and receives the following default values:
   - `:issuffix = 0`
   - `:iszone = 0`
   - `:zone = <set to parent domain>`
   - `:domain = <set to parent domain>`
4. Any domain whose parent domain is a "normal" subdomain receives the following default values:
   - `:issuffix = 0`
   - `:iszone = 0`
   - `:zone = <set to first fqdn "up" the domain hierarchy with :iszone = 1>`
   - `:domain = <set to parent domain>`

Note: The above logic is **recursive** over all nodes in a Cortex. Changing an `:issuffix` or `:iszone` property on an existing `inet:fqdn` node will not only modify that node, but also propagate any changes associated with those properties to any existing subdomains.

Potential Limitations

This logic works well for single-element top-level domains (TLDs) (such as `com` vs `microsoft.com`). However, it does not address cases that may be relevant for certain types of analysis, such as:

- **Top-level country code domains and their subdomains.** Under Synapse's default logic `uk` is a suffix and `co.uk` is a zone. However, `co.uk` could **also** be considered a suffix in its own right, because subdomains such as `somecompany.co.uk` are under the control of the organization that registers them. In this case, `uk` would be a suffix, `com.uk` could be considered both a suffix **and** a zone, and `somecompany.co.uk` could be considered a zone.
- **Special-case zones of control.** Some domains (such as those used to host web-based services) can be considered specialized zones of control. In these cases, the service provider typically owns the "main" domain (such as `wordpress.com`) but individual customers can register personal subdomains for their hosted services (such as `joesblog.wordpress.com`). The division between `wordpress.com` and individual customer subdomains could represent different zones of control. In this case, `com` would be a suffix, `wordpress.com` could be considered both a suffix **and** a zone, and `joesblog.wordpress.com` could be considered a zone.

Examples such as these are **not accounted for** by Synapse's suffix / zone logic. The definition of additional domains as suffixes and / or zones is an implementation decision (though once the relevant properties are set, the changes are propagated recursively as noted above).

Operations

Because of Synapse's reverse string indexing for `inet:fqdn` types, domains can be lifted or filtered based on matching any partial domain suffix string. The asterisk (`*`) is the extended operator used to perform this operation. The asterisk does **not** have to be used along dot boundaries but can match anywhere in any FQDN element.

Examples

Lift all domains that end with `yahooapis.com`:

```
storm> inet:fqdn='*yahooapis.com'
inet:fqdn=ayuisyahooapis.com
        :domain = com
        :host = ayuisyahooapis
        :issuffix = false
        :iszone = true
        :zone = ayuisyahooapis.com
        .created = 2023/07/12 15:15:05.017
inet:fqdn=micyuisyahooapis.com
        :domain = com
        :host = micyuisyahooapis
        :issuffix = false
        :iszone = true
        :zone = micyuisyahooapis.com
        .created = 2023/07/12 15:15:05.023
inet:fqdn=usyahooapis.com
        :domain = com
        :host = usyahooapis
        :issuffix = false
        :iszone = true
        :zone = usyahooapis.com
        .created = 2023/07/12 15:15:05.030
```

Lift all domains ending with `s.wordpress.com`:

```
storm> inet:fqdn="*s.wordpress.com"
inet:fqdn=s.wordpress.com
        :domain = wordpress.com
        :host = s
        :issuffix = false
        :iszone = false
        :zone = wordpress.com
        .created = 2023/07/12 15:15:05.091
inet:fqdn=dogs.wordpress.com
        :domain = wordpress.com
        :host = dogs
        :issuffix = false
        :iszone = false
        :zone = wordpress.com
        .created = 2023/07/12 15:15:05.084
```

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```
inet:fqdn=sss.wordpress.com
        :domain = wordpress.com
        :host = sss
        :issuffix = false
        :iszone = false
        :zone = wordpress.com
        .created = 2023/07/12 15:15:05.099
inet:fqdn=www.sss.wordpress.com
        :domain = sss.wordpress.com
        :host = www
        :issuffix = false
        :iszone = false
        :zone = wordpress.com
        .created = 2023/07/12 15:15:05.099
inet:fqdn=cats.wordpress.com
        :domain = wordpress.com
        :host = cats
        :issuffix = false
        :iszone = false
        :zone = wordpress.com
        .created = 2023/07/12 15:15:05.076
```

Downselect a set of DNS A records to those with domains ending with `.museum`:

```
storm> inet:dns:a +:fqdn="*.museum"
inet:dns:a=('woot.museum', '5.6.7.8')
        :fqdn = woot.museum
        :ipv4 = 5.6.7.8
        .created = 2023/07/12 15:15:05.158
```

Usage Notes

- Because the asterisk is a non-alphanumeric character, the string to be matched must be enclosed in single or double quotes (see *Whitespace and Literals in Storm*).
- Because domains are reverse-indexed instead of prefix indexed, for **lift** operations, partial string matching can only occur based on the end (suffix) of a domain. It is not possible to **lift** FQDNs by prefix. For example, `inet:fqdn^=yahoo` is invalid.
- Domains can be **filtered** by prefix (`^=`). For example, `inet:fqdn="*.biz" +inet:fqdn^=smtp` is valid.
- Domains cannot be **filtered** based on suffix matching (note that a "lift by suffix" is effectively a combined "lift and filter" operation).
- Domains can be lifted or filtered using the regular expression (regex) extended operator (`~=`). For example `inet:fqdn~=google` is valid (see *Lift by Regular Expression (~=)* and *Filter by Regular Expression (~=)*).

inet:ipv4

IPv4 addresses are stored as integers and represented (displayed) to users as dotted-decimal strings.

Indexing

IPv4 addresses are indexed as integers. This optimizes various comparison operations, including greater than / less than, range, etc.

Parsing

While IPv4 addresses are stored and indexed as integers, they can be input into Storm (and used within Storm operations) as any of the following.

- integer: `inet:ipv4 = 3232235521`
- hex: `inet:ipv4 = 0xC0A80001`
- dotted-decimal string: `inet:ipv4 = 192.168.0.1`
- range: `inet:ipv4 = 192.168.0.1-192.167.0.10`
- CIDR: `inet:ipv4 = 192.168.0.0/24`

Insertion

The ability to specify IPv4 values using either range or CIDR format allows you to "bulk create" sets of `inet:ipv4` nodes without the need to specify each address individually.

Examples

Note: results (output) not shown below due to length.

Create ten `inet:ipv4` nodes:

```
[ inet:ipv4 = 192.168.0.1-192.168.0.10 ]
```

Create the 256 addresses in the range 192.168.0.0/24:

```
[ inet:ipv4 = 192.168.0.0/24 ]
```

Operations

Similar to node insertion, lifting or filtering IPV4 addresses by range or by CIDR notation will operate on every `inet:ipv4` node that exists within the Cortex and falls within the specified range or CIDR block. This allows operating on multiple contiguous IP addresses without the need to specify them individually.

Examples

Lift all `inet:ipv4` nodes within the specified range that exist within the Cortex:

```
storm> inet:ipv4 = 169.254.18.24-169.254.18.64
inet:ipv4=169.254.18.30
        :type = linklocal
        .created = 2023/07/12 15:15:05.346
inet:ipv4=169.254.18.36
        :type = linklocal
        .created = 2023/07/12 15:15:05.351
inet:ipv4=169.254.18.53
        :type = linklocal
        .created = 2023/07/12 15:15:05.362
```

Filter a set of DNS A records to only include those whose IPv4 value is within the 172.16.* RFC1918 range:

```
storm> inet:dns:a:fqdn=woot.com +:ipv4=172.16.0.0/12
inet:dns:a=('woot.com', '172.16.47.12')
        :fqdn = woot.com
        :ipv4 = 172.16.47.12
        .created = 2023/07/12 15:15:05.417
```

ival

`ival` is a specialized type consisting of two `time` types in a paired (`<min>`, `<max>`) relationship. As such, the individual values in an `ival` are subject to the same specialized handling as individual *time* values.

`ival` types have their own optimizations in addition to those related to `time` types.

Indexing

N/A

Parsing

An `ival` type is typically specified as two comma-separated time values enclosed in parentheses. Alternately, an `ival` can be specified as a single time value with no parentheses (see **Insertion** below for `ival` behavior when specifying a single time value).

Single or double quotes are required in accordance with the standard rules for using *Whitespace and Literals in Storm*. For example:

- `.seen=("2017/03/24 12:13:27", "2017/08/05 17:23:46")`
- `+#sometag=(2018/09/15, "+24 hours")`
- `.seen=2019/03/24`

As `ival` types are a pair of values (i.e., an explicit minimum and maximum), the values must be placed in parentheses and separated by a comma: (`<min>`, `<max>`). The parser expects two **explicit** values.

An `ival` can also be specified as a single time value, in which case the value must be specified **without** parentheses: `<time>`. See **Insertion** below for `ival` behavior when adding vs. modifying using a single time value vs. a (`<min>`, `<max>`) pair.

When entering an `ival` type, each time value can be input using most of the acceptable formats for *time* types, including explicit times (including lower resolution times and wildcard times), relative times, and the special values `now` and `?`.

`ival` types also support relative times using `+-` format to represent both a positive and negative offset from a given point (i.e., `"+-1 hour"`).

When entering relative times in an `ival` type:

- A relative time in the **first** (`<min>`) position is calculated relative to the **current time** (`now`).
- A relative time in the **second** (`<max>`) position is calculated relative to the **first** (`<min>`) time.

For example:

- `.seen="+1 hour"` means from the current time (now) to one hour after the current time.
- `.seen=(2018/12/01, "+1 day")` means from 12:00 AM December 1, 2018 to 12:00 AM December 2, 2018.
- `.seen=(2018/12/01, "-1 day")` means from 12:00 AM November 30, 2018 to 12:00 AM December 1, 2018.
- `.seen=(now, "+-5 minutes")` means from 5 minutes ago to 5 minutes from now.
- `.seen=("-30 minutes", "+1 hour")` means from 30 minutes ago to 30 minutes from now.

When specifying minimum and maximum times for an `ival` type (or when specifying minimum and maximum `time` values to the `*range=` comparator), the following restrictions should be kept in mind:

- Minimums and maximums that use explicit times and / or special terms (`now`, `?`) should be specified in `<min>, <max>` order.
  - Specifying a `<max>, <min>` order will **not** result in an error message, but because it results in an exclusionary time window, it will not return any nodes (i.e., no time / interval can be both greater than a max value and less than a min value).
  - Similarly, combinations of relative times that result in an effective `<max>, <min>` after relative offsets are calculated are allowed (will not generate an error), but will result in an exclusionary time window that does not return any nodes.
- Values that result in a nonsensical `<min>, <max>` are not allowed and will generate an error. For example:
  - The special value `?` cannot be used as a minimum value in a `(<min>, <max>)` pair.
  - A `+-` relative time cannot be used as a minimum value in a `(<min>, <max>)` pair.
  - When specifying a `+-` relative time as the maximum value in a `(<min>, <max>)` pair, an explicit `<min>` value is also required (i.e., either an explicit time or `now`).

Insertion

- When **adding** an `ival` as a `(<min>, <max>)` pair, the `ival` can be specified as described above.
  - If the values for `<min>` and `<max>` are identical, then `<min>` will be set to the specified value and `<max>` will be set to `<min>` plus 1 ms.
- When **adding** an `ival` as a single time value, it must be specified **without** parentheses.
  - When a single time value is used, the `<min>` value will be set to the specified time and the `<max>` will be set to the `<min>` time plus 1 ms.
- When **modifying** an existing `ival` property (including tag timestamps) with either a `(<min>, <max>)` pair or a single time value, the existing `ival` is **not** simply overwritten (as is the norm for modifying properties - see *Storm Reference - Data Modification*). Instead, the `<min>` and / or `<max>` are **only** updated if the new value(s) are:
  - Less than the current `<min>`, and / or

- Greater than the current <max>.

This means that once set, <min> and <max> can only be "pushed out" to a lower minimum and / or a higher maximum. Specifying a time or times that fall **within** the current minimum and maximum will have no effect (i.e., the current values will be retained).

This means that it is not possible to "shrink" an ival directly; to specify a higher minimum or a lower maximum (or to remove the timestamps altogether), you must delete the ival property (or remove the timestamped tag) and re-add it with the updated values.

Operations

ival types can be lifted and filtered (see *Storm Reference - Lifting* and *Storm Reference - Filtering*) with the standard equivalent (=) operator, which will match the **exact** <min> and <max> values specified.

Example:

Lift the DNS A nodes whose observation window is **exactly** from 2018/12/13 01:05 to 2018/12/16 12:57:

```
storm> inet:dns:a.seen=("2018/12/13 01:05", "2018/12/16 12:57")
inet:dns:a=('yoyodyne.com', '16.16.16.16')
        :fqdn = yoyodyne.com
        :ipv4 = 16.16.16.16
        .created = 2023/07/12 15:15:05.472
        .seen = ('2018/12/13 01:05:00.000', '2018/12/16 12:57:00.000')
```

ival types cannot be used with comparison operators such as "less than" or "greater than or equal to".

ival types are most often lifted or filtered using the custom interval comparator (@=) (see *Lift by Time or Interval (@=)* and *Filter by Time or Interval (@=)*). @= is intended for time-based comparisons (including comparing ival types with time types).

Example:

Lift all the DNS A nodes whose observation window overlaps with the interval of March 1, 2019 through April 1, 2019:

```
storm> inet:dns:a.seen@=(2019/03/01, 2019/04/01)
inet:dns:a=('hurr.com', '4.4.4.4')
        :fqdn = hurr.com
        :ipv4 = 4.4.4.4
        .created = 2023/07/12 15:15:05.521
        .seen = ('2019/01/05 09:38:00.000', '2019/03/12 18:17:00.000')
inet:dns:a=('derp.net', '8.8.8.8')
        :fqdn = derp.net
        :ipv4 = 8.8.8.8
        .created = 2023/07/12 15:15:05.529
        .seen = ('2019/03/08 07:26:00.000', '2019/03/22 10:14:00.000')
inet:dns:a=('blergh.org', '2.2.2.2')
        :fqdn = blergh.org
        :ipv4 = 2.2.2.2
        .created = 2023/07/12 15:15:05.537
        .seen = ('2019/03/28 22:22:00.000', '2019/04/27 00:03:00.000')
```

ival types cannot be used with the *range= custom comparator. *range= can only be used to specify a range of individual values (such as time or int).

loc

`Loc` is a specialized type used to represent geopolitical locations (i.e., locations within geopolitical boundaries) as a series of user-defined dot-separated hierarchical strings - for example, <*country*>.<*state / province*>.<*city*>. This allows specifying locations such as `us.fl.miami`, `gb.london`, and `ca.on.toronto`.

`Loc` is an extension of the *str* type. However, because `loc` types use strings that comprise a dot-separated hierarchy, they exhibit slightly modified behavior from standard string types for certain operations.

Indexing

The `loc` type is an extension of the *str* type and so is **prefix-indexed** like other strings. However, the use of dot-separated boundaries impacts operations using `loc` values.

`loc` values are normalized to lowercase.

Parsing

`loc` values can be input using any case (uppercase, lowercase, mixed case) but will normalized to lowercase.

Components of a `loc` value must be separated by the dot (`.`) character. The dot is a reserved character for the `loc` type and is used to separate string elements along hierarchical boundaries. The use of the dot as a reserved boundary marker impacts operations using the `loc` type. Note that this means the dot cannot be used as part of a location string. For example, the following location value would be interpreted as a hierarchical location with four elements (`us`, `fl`, `st`, and `petersburg`):

- `:loc = us.fl.st.petersburg`

To appropriately represent the "city" element of the above location, an alternate syntax must be used. For example:

- `:loc = us.fl.stpetersburg`
- `:loc = "us.fl.saint petersburg"`
- …etc.

As an extension of the `str` type, `loc` types are subject to Synapse's restrictions regarding using *Whitespace and Literals in Storm*.

Insertion

Same as for parsing.

As `loc` values are simply dot-separated strings, the use or enforcement of any specific convention for geolocation values and hierarchies is an implementation decision.

Operations

The use of the dot character (`.`) as a reserved boundary marker impacts prefix (`^=`) and equivalent (=) operations using the `loc` type.

String and string-derived types are **prefix-indexed** to optimize lifting or filtering strings that start with a given substring using the prefix (`^=`) extended comparator. For standard strings, the prefix comparator can be used with strings of arbitrary length. However, for string-derived types (including `loc`) that use dotted hierarchical notation, **the prefix comparator operates along dot boundaries.**

This is because the analytical significance of a location string is likely to fall on these hierarchical boundaries as opposed to an arbitrary substring prefix match. That is, it is more likely to be analytically meaningful to lift all locations within the US (`^=us`) or within Florida (`^=us.fl`) than it is to lift all locations in the US within states that start with "V" (`^=us.v`).

Prefix comparison for `loc` types is useful because it easily allows lifting or filtering at any appropriate level of resolution within the dotted hierarchy:

Examples:

Lift all organizations with locations in Turkey:

```
storm> ou:org:loc^=tr
ou:org=dbbaa304c58e0e1275e121ee15602f94
        :loc = tr.ankara
        :name = republic of turkey ministry of foreign affairs
        .created = 2023/07/12 15:15:05.586
ou:org=9458ef606e0048459c0d2bae2c477c84
        :loc = tr.istanbul
        :name = adeo it consulting services
        .created = 2023/07/12 15:15:05.592
```

Lift all IP addresses geolocated in the the province of Ontario, Canada:

```
storm> inet:ipv4:loc^=ca.on
inet:ipv4=149.248.52.240
        :loc = ca.on
        :type = unicast
        .created = 2023/07/12 15:15:05.637
inet:ipv4=49.51.12.195
        :loc = ca.on.barrie
        :type = unicast
        .created = 2023/07/12 15:15:05.643
inet:ipv4=199.201.123.200
        :loc = ca.on.keswick
        :type = unicast
        .created = 2023/07/12 15:15:05.649
```

Note: Specifying a more granular prefix value will **not** match values that are less granular. That is `:loc^=ca.on` will fail to match `:loc=ca`.

Lift all places in the city of Seattle:

```
storm> geo:place:loc=us.wa.seattle
geo:place=048daeddec97f56e612e875babdc750f
        :latlong = 47.6205099,-122.3514714
        :loc = us.wa.seattle
        :name = space needle
        .created = 2023/07/12 15:15:05.695
geo:place=579368f235745b60514bb479cf78bfa4
        :latlong = 47.4502535,-122.3110105
        :loc = us.wa.seattle
        :name = seattle-tacoma international airport
        .created = 2023/07/12 15:15:05.701
```

Usage Notes

- Use of the equals comparator (=) with `loc` types will match the **exact value only.** So `:loc = us` will match **only** `:loc = us` but not `:loc = us.ca` or `:loc = us.il.chicago`.
- Because the prefix match operates on the dot boundary, attempting to lift or filter by a prefix string match that does **not** fall on a dot boundary will not return any nodes. For example, the filter syntax `+:loc^=us.v` will fail to return any nodes even if nodes with `:loc = us.vt` or `:loc = us.va` exist. (However, it would return nodes with `:loc = us.v` or `:loc = us.v.foo` if such nodes exist.)

str

Indexing

String (and string-derived) types are indexed by **prefix** (character-by-character from the beginning of the string). This allows matching on any initial substring.

Parsing

Some string types and string-derived types are normalized to all lowercase to facilitate pivoting across like values without case-sensitivity. For types that are normalized in this fashion, the string can be entered in mixed-case and will be automatically converted to lowercase.

Strings are subject to Synapse's restrictions regarding using *Whitespace and Literals in Storm*.

Insertion

Same as for parsing.

Operations

Because of Synapse's use of **prefix indexing,** string and string-derived types can be lifted or filtered based on matching an initial substring of any string using the prefix extended comparator (^=) (see *Lift by Prefix (^=)* and *Filter by Prefix (^=)*).

Prefix matching is case-sensitive based on the specific type being matched. If the target property's type is case-sensitive, the string to match must be entered in case-sensitive form. If the target property is case-insensitive (i.e., normalized to lowercase) the string to match can be entered in any case (upper, lower, or mixed) and will be automatically normalized by Synapse.

Examples

Lift all organizations whose name starts with the word "Acme ":

```
storm> ou:org:name^='acme '
ou:org=affb950ff2eef793dd29e5b50b072418
        :name = acme construction
        :names = ['acme construction']
        .created = 2023/07/12 15:15:04.357
ou:org=ec8a6a72e149bda5c16d6bf95c265387
        :name = acme consulting
        :names = ['acme consulting']
        .created = 2023/07/12 15:15:04.351
```

Filter a set of Internet accounts to those with usernames starting with 'matrix':

```
storm> inet:web:acct:site=twitter.com +:user^=matrix
inet:web:acct=twitter.com/matrixneo
        :site = twitter.com
        :user = matrixneo
        .created = 2023/07/12 15:15:05.773
inet:web:acct=twitter.com/matrixmaster
        :site = twitter.com
        :user = matrixmaster
        .created = 2023/07/12 15:15:05.766
```

Strings and string-derived types can also be lifted or filtered using the regular expression extended comparator (~=) (see *Lift by Regular Expression (~=)* and *Filter by Regular Expression (~=)*).

syn:tag

`syn:tag` is a specialized type used for *Tag* nodes within Synapse. Tags represent domain-specific, analytically relevant observations or assessments. They support a hierarchical namespace based on user-defined dot-separated strings. This hierarchy allows recording classes or categories of analytical observations that can be defined with increasing specificity. (See *Analytical Model - Tag Concepts* for more information.)

`syn:tag` is an extension of the *str* type. However, because `syn:tag` types use strings that comprise a dot-separated hierarchy, they exhibit slightly modified behavior from standard string types for certain operations.

Indexing

The `syn:tag` type is an extension of the *str* type and so is **prefix-indexed** like other strings. However, the use of dot-separated boundaries impacts some operations using `syn:tag` values.

`syn:tag` values are normalized to lowercase.

Parsing

syn:tag values can contain lowercase characters, numerals, and underscores. Spaces and ASCII symbols (other than the underscore) are not allowed. If you attempt to create a tag name that includes a dash character (-) it will automatically be converted to an underscore (_).

Note: Synapse includes support for Unicode words in tag strings; this includes most characters that can be part of a word in any language.

Components of a syn:tag value must be separated by the dot (.) character. The dot is a reserved character for the syn:tag type and is used to separate string elements along hierarchical boundaries. The use of the dot as a reserved boundary marker impacts some operations using the syn:tag type.

syn:tag values can be input using any case (uppercase, lowercase, mixed case) but will be normalized to lowercase. As noted above, dashes are automatically converted to underscores.

As syn:tag values cannot contain whitespace (spaces) or escaped characters, the Synapse restrictions regarding using *Whitespace and Literals in Storm* do **not** apply.

Examples

The following are all allowed syn:tag values:

- syn:tag = rep.vt.exploit
- syn:tag = aka.kaspersky.mal.shamoon.2
- syn:tag = cno.tgt.cn_mil_pla

The following syn:tag values are not allowed and will generate BadTypeValu errors:

- syn:tag = this.is.my.@#$*(.tag (contains disallowed characters)
- syn:tag = "some.threat group.tag" (contains whitespace)

Insertion

A syn:tag node does not have to be created before the equivalent tag can be applied to another node. That is, applying a tag to a node will result in the automatic creation of the corresponding syn:tag node or nodes (assuming the appropriate user permissions). For example:

```
storm> [inet:fqdn=woot.com +#some.new.tag ]
inet:fqdn=woot.com
        :domain = com
        :host = woot
        :issuffix = false
        :iszone = true
        :zone = woot.com
        .created = 2023/07/12 15:15:05.148
        #some.new.tag
```

The above Storm syntax will both apply the tag #some.new.tag to the node inet:fqdn = woot.com and automatically create the node syn:tag = some.new.tag if it does not already exist (as well as syn:tag = some and syn:tag = some.new). This behavior (based on creating the FQDN woot.com and applying the tag #some.new.tag in the previous example) is shown below by lifting tags that begin with 'some':

```
storm> syn:tag^=some
syn:tag=some
        :base = some
        :depth = 0
        .created = 2023/07/12 15:15:05.837
syn:tag=some.new
        :base = new
        :depth = 1
        :up = some
        .created = 2023/07/12 15:15:05.837
syn:tag=some.new.tag
        :base = tag
        :depth = 2
        :up = some.new
        .created = 2023/07/12 15:15:05.837
```

Operations

The use of the dot character (`.`) as a reserved boundary marker impacts prefix (`^=`) and equivalent (`=`) operations using the `syn:tag` type.

String and string-derived types are **prefix-indexed** to optimize lifting or filtering strings that start with a given substring using the prefix (`^=`) extended comparator. For standard strings, the prefix comparator can be used with strings of arbitrary length. However, for string-derived types (including `syn:tag`) that use dotted hierarchical notation, **the prefix comparator operates along dot boundaries.**

This is because the analytical significance of a tag is likely to fall on these hierarchical boundaries as opposed to an arbitrary substring prefix match. That is, it is more likely to be analytically meaningful to lift all nodes with that are related to sinkhole infrastructure (`syn:tag^=cno.infra.anon.sink`) than it is to lift all nodes with infrastructure tags that begin with "s" (`syn:tag^=cno.infra.anon.s`).

Prefix comparison for `syn:tag` types is useful because it easily allows lifting or filtering at any appropriate level of resolution within a tag hierarchy:

Lift all tags in the computer network operations (`cno`)tree:

```
storm> syn:tag^=cno
syn:tag=cno
        :base = cno
        :depth = 0
        .created = 2023/07/12 15:15:05.882
syn:tag=cno.mal
        :base = mal
        :depth = 1
        :up = cno
        .created = 2023/07/12 15:15:05.888
syn:tag=cno.mal.redtree
        :base = redtree
        :depth = 2
        :up = cno.mal
        .created = 2023/07/12 15:15:05.888
syn:tag=cno.threat
        :base = threat
```

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```
        :depth = 1
        :up = cno
        .created = 2023/07/12 15:15:05.882
syn:tag=cno.threat.t27
        :base = t27
        :depth = 2
        :up = cno.threat
        .created = 2023/07/12 15:15:05.882
```

Lift all tags representing aliases (e.g., names of malware, threat groups, etc.) reported by Symantec:

```
storm> syn:tag^=aka.symantec
syn:tag=aka.symantec
        :base = symantec
        :depth = 1
        :up = aka
        .created = 2023/07/12 15:15:05.931
syn:tag=aka.symantec.mal
        :base = mal
        :depth = 2
        :up = aka.symantec
        .created = 2023/07/12 15:15:05.931
syn:tag=aka.symantec.mal.bifrose
        :base = bifrose
        :depth = 3
        :up = aka.symantec.mal
        .created = 2023/07/12 15:15:05.931
syn:tag=aka.symantec.thr
        :base = thr
        :depth = 2
        :up = aka.symantec
        .created = 2023/07/12 15:15:05.937
syn:tag=aka.symantec.thr.cadelle
        :base = cadelle
        :depth = 3
        :up = aka.symantec.thr
        .created = 2023/07/12 15:15:05.937
```

Lift all tags representing anonymous VPN infrastructure:

```
storm> syn:tag^=cno.infra.anon.vpn
syn:tag=cno.infra.anon.vpn
        :base = vpn
        :depth = 3
        :up = cno.infra.anon
        .created = 2023/07/12 15:15:05.982
syn:tag=cno.infra.anon.vpn.airvpn
        :base = airvpn
        :depth = 4
        :up = cno.infra.anon.vpn
        .created = 2023/07/12 15:15:05.982
syn:tag=cno.infra.anon.vpn.nordvpn
```

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```
        :base = nordvpn
        :depth = 4
        :up = cno.infra.anon.vpn
        .created = 2023/07/12 15:15:05.988
```

Note that specifying a more granular prefix value will **not** match values that are less granular. That is, `syn:tag^=cno.infra` will fail to match `syn:tag = cno`.

Similarly, use of the equals comparator (=) with `syn:tag` types will match the **exact value only.** So `syn:tag = aka` will match **only** that tag but not `syn:tag = aka.symantec` or `syn:tag = aka.trend.thr.pawnstorm`.

Because the prefix match operates on the dot boundary, attempting to lift or filter by a prefix string match that does **not** fall on a dot boundary will not return any nodes. For example, the syntax `syn:tag^=aka.t` will fail to return any nodes even if nodes `syn:tag = aka.talos` or `syn:tag = aka.trend` exist. (However, it would return nodes `syn:tag = aka.t` or `syn:tag = aka.t.foo` if such nodes exist.)

time

Synapse stores `time` types in Epoch milliseconds (millis) - that is, the number of milliseconds since January 1, 1970. The `time` type is technically a date/time because it encompasses both a date and a time. A time value alone, such as 12:37 PM (12:37:00.000), is invalid.

See also the section on *ival* (interval) types for details on how `time` types are used as minimum / maximum pairs.

Indexing

N/A

Parsing

`time` values can be input into Storm as any of the following:

- **Explicit** times:
  - Human-readable (YYYY/MM/DD hh:mm:ss.mmm):

    `"2018/12/16 09:37:52.324"`

  - Human-readable "Zulu" (YYYY/MM/DDThh:mm:ss.mmmZ):

    `2018/12/16T09:37:52.324Z`

  - Human-readable with time zone (YYYY-MM-DD hh:mm:ss.mmm+/-hh:mm). No spaces are allowed between the time value and the time zone offset:

    `2018-12-16 09:37:52.324-04:00`

    Note: Synapse does not support the **storage** of an explicit time zone with a time value (i.e., +0800). Synapse stores time values in UTC for consistency. If a time zone is specified using an acceptable time zone offset format on input, Synapse will automatically convert the value to UTC for storage. If no time zone is specified, Synapse will assume the value is in UTC.

  - No formatting (YYYYMMDDhhmmssmmm):

    `20181216093752324`

  - Epoch millis:

    `(1544953072324)`

    Note: Synapse expects time values to be entered as parseable time **strings** (such as 2018/12/16 09:37:52.324, which Synapse internally converts to a millis integer for storage). To enter a time in raw epoch millis format, you must enclose it in parentheses so that Synapse interprets the value as a raw integer. (Otherwise, Synapse will attempt to interpret the value as a "no formatting" string, and throw an error.)

- **Relative** (offset) time values in the format:

  +|-|+- <*count*> <*unit*>

  where <*count*> is a numeric value and <*unit*> is one of the following:

  - `minute(s)`
  - `hour(s)`
  - `day(s)`

  Examples:

  - `"+7 days"`
  - `"-15 minutes"`
  - `"+-1 hour"`

- **"Special"** time values:

  - the keyword `now` is used to represent the current date/time.
  - a question mark (`?`) is used to effectively represent an unspecified / indefinite time in the future (technically equivalent to 9223372036854775807 millis, i.e., "some really high value that is probably the heat death of the universe". Note that technically the largest valid millis value is 9999999999999 (thirteen 9's), which represents 2286/11/20 09:46:39.999).

    The question mark can be used as the maximum value of an interval (*ival*) type to specify that the data or assessment associated with the `ival` should be considered valid indefinitely. (Contrast that with a maximum interval value set to the equivalent of `now` that would need to be continually updated over time in order to remain current.)

Standard rules regarding using *Whitespace and Literals in Storm* apply. For example, `"2018/12/16 09:37:52.324"` needs to be entered in single or double quotes, but `2018/12/16` does not. Similarly, relative times starting with + or - and the special time value `?` need to be placed in single or double quotes.

Lower Resolution Time Values and Wildcard Time Values

`time` values (including tag timestamps) must be entered at a minimum resolution of year (`YYYY`) and can be entered up to a maximum resolution of milliseconds (`YYYY/MM/DD hh:mm:ss.mmm`).

Where lower resolution values are entered, Synapse will make logical assumptions about the intended date / time value and zero-fill the remainder of the equivalent epoch mills date / time. For example:

- A value of `2016` will be interpreted as 12:00 AM on January 1, 2016 (`2016/01/01 00:00:00.000`).
- A value of `2018/10/27` will be interpreted as 12:00 AM on that date (`2018/10/27 00:00:00.000`).
- A value of `"2020/03/16 05"` will be interpreted as 05:00 AM on that date (`2020/03/16 05:00:00.000`).

- A value of `"2018/10/27 14:00-04:00"` will be interpreted as 14:00 (2:00 PM) on that date with a 4 hour offset from UTC (`2018/10/27 14:00:00.000-04:00`, stored in UTC as `2018/10/27 18:00:00.000`).

Synapse also supports the use of the wildcard (`*`) character to specify a partial time value match:

- A value of `2016*` will be interpreted as "any date / time within the year 2016".
- A value of `2018/10/27*` will be interpreted as "any time on October 27, 2018".
- A value of `"2020/03/16 05*"` will be interpreted as "any time within the hour of 05:00 on March 16, 2020".

Note: When using wildcard syntax, the wildcard must be used on a sensible time value boundary, such as `YYYYMM*`. You cannot us a wildcard to "split" values (i.e., `YYMMD*` is invaild syntax).

Examples:

Set the time of a DNS request to the current time:

```
storm> [ inet:dns:request="*" :query:name=woot.com :time=now ]
inet:dns:request=ddb9eabeeb1a2128d214d6ea3ac03776
        :query:name = woot.com
        :query:name:fqdn = woot.com
        :time = 2023/07/12 15:15:06.040
        .created = 2023/07/12 15:15:06.039
```

Set the observed time window (technically an `ival` type) for when an IP address was a known sinkhole (via the `#cno.infra.dns.sink.hole` tag) from its known start date to an indefinite future time (i.e., the sinkhole is presumed to remain a sinkhole indefinitely / until the values are manually updated with an explicit end date):

```
storm> [ inet:ipv4=1.2.3.4 +#cno.infra.dns.sink.hole=(2017/06/13, "?") ]
inet:ipv4=1.2.3.4
        :type = unicast
        .created = 2023/07/12 15:15:05.148
        #cno.infra.dns.sink.hole = (2017/06/13 00:00:00.000, ?)
```

- Set the observed time window using a time zone offset:

```
storm> [ inet:ipv4=5.6.7.8 +#cno.infra.dns.sink.hole=(2017/06/13 09:46+04:00, "?") ]
inet:ipv4=5.6.7.8
        :type = unicast
        .created = 2023/07/12 15:15:05.158
        #cno.infra.dns.sink.hole = (2017/06/13 05:46:00.000, ?)
```

Insertion

When adding or modifying `time` types, any of the above formats (explicit / relative / special terms) can be specified.

In addition, when adding or modifying `time` types, a lower resolution time and a wildcard time behave identically. In other words, the following are equivalent Storm queries (both will set the `:time` value of the newly created DNS request node to `2021/01/23 00:00:00.000`):

```
[ inet:dns:request="*" :time=2021/01/23 ]

[ inet:dns:request="*" :time=2021/01/23* ]
```

When specifying a relative time for a `time` value, **the offset will be calculated from the current time** (`now`):

```
storm> [ inet:dns:request="*" :query:name=woot.com :time="-5 minutes" ]
inet:dns:request=8d00cba68474118d07f1cf156d8181ff
        :query:name = woot.com
        :query:name:fqdn = woot.com
        :time = 2023/07/12 15:10:06.170
        .created = 2023/07/12 15:15:06.169
```

Plus / minus (`+-`) relative times cannot be specified for `time` types, as the type requires a single value. See the section on *ival* (interval) types for details on using `+-` times with `ival` types.

Operations

`time` types can be lifted and filtered using:

- Standard logical and mathematical comparison operators (comparators).
- The extended range (`*range=`) custom comparator.
- The extended interval (`@=`) custom comparator.

Standard Operators

`time` types can be lifted and filtered with the standard logical and mathematical comparators (see *Storm Reference - Lifting* and *Storm Reference - Filtering*). This includes the use of lower resolution time values and wildcard time values.

Example:

Downselect a set of DNS request nodes to those that occurred prior to June 1, 2019:

```
storm> inet:dns:request +:time<2019/06/01
inet:dns:request=af9c09872abbb87774190453a7806852
        :query:name = derp.net
        :query:name:fqdn = derp.net
        :time = 2015/12/14 19:22:00.000
        .created = 2023/07/12 15:15:06.199
inet:dns:request=d2b4484d346f8cc388b0818ab5ee82ff
        :query:name = hurr.com
        :query:name:fqdn = hurr.com
        :time = 2018/06/28 17:43:00.000
        .created = 2023/07/12 15:15:06.193
```

Note: It is important to understand the differences in behavior when lifting and filtering `time` types using lower resolution time values (which Synpase zero-fills) or wildcard time values (which Synpase wildcard-matches). These behaviors vary based on the specific operator used.

- When lifting or filtering using the equivalent (`=`) operator, behavior is **different:**
  - `:time=2021/05/13` means equal to **the exact date/time value** `2021/05/13 00:00:00.000`.
  - `:time=2021/05/13*` means equal to **any** time on that date (`2021/05/13 00:00:00.000` through `2021/05/13 23:59:59.999`).

- When lifting or filtering using the greater than (>) / greater than or equal to (>=) operators, behavior is **equivalent:**
  - `:time>2021/05/13` and `:time>2021/05/13*` **both** mean any date / time greater than `2021/05/13 00:00:00.000`.
  - `:time>=2021/05/13` and `:time>=2021/05/13*` **both** mean any date / time greater than or equal to `2021/05/13 00:00:00.000`.

  Both are equivalent because in this case Synapse interprets the wildcard syntax as "greater than or equal to the **lowest** possible wildcard match", which in this case is `2021/05/13 00:00:00.000`.
- When lifting or filtering using the less than (<) / less than or equal to (<=) operators, behavior is **different:**
  - `:time<2021/05/13` / `:time<=2021/05/13` mean any date / time less than (or less than or equal to) `2021/05/13 00:00:00.000`.
  - `:time<2021/05/13*` / `:time<=2021/05/13*` both mean any date / time less than (or less than or equal to) `2021/05/13 23:59:59.999`.

  The behavior differs because in this case Synapse interprets the wildcard syntax as "less than or equal to the **highest** possible wildcard match", which in this case is `2021/05/13 23:59:59.999`.

Tip: The wildcard syntax is useful because it can provide a simplified, more intuitive means to specify certain time ranges / time intervals without needing to use the range (`*range=`) or interval (`@=`) operators. For example, the following three Storm queries are equivalent and will return all files compiled at any time within the year 2019:

```
file:bytes:mime:pe:compiled=2019*

file:bytes:mime:pe:compiled*range=('2019/01/01 00:00:00.000', '2019/12/31 23:59:59.999')

file:bytes:mime:pe:compiled@=('2019/01/01', '2020/01/01')
```

(A **range** maximum value represents "less than or equal to" that value, while an **interval** maximum value represents "less than" that value.)

Range Custom Operator

`time` types can lifted and filtered using the `*range=` custom comparator (see *Lift by Range (*range=)* and *Filter by Range (*range=)*).

Example:

Lift a set of `file:bytes` nodes whose PE compiled time is between January 1, 2019 and today:

```
storm> file:bytes:mime:pe:compiled*range=(2019/01/01, now)
file:bytes=sha256:9f9d96e99cef99cbfe8d02899919a7f7220f2273bb36a084642f492dd3e473da
        :mime:pe:compiled = 2019/10/07 12:42:45.000
        :sha256 = 9f9d96e99cef99cbfe8d02899919a7f7220f2273bb36a084642f492dd3e473da
        .created = 2023/07/12 15:15:06.244
file:bytes=sha256:bd422f912affcf6d0830c13834251634c8b55b5a161c1084deae1f9b5d6830ce
        :mime:pe:compiled = 2021/04/13 00:23:14.000
        :sha256 = bd422f912affcf6d0830c13834251634c8b55b5a161c1084deae1f9b5d6830ce
        .created = 2023/07/12 15:15:06.254
```

Note: Both lower resolution times and wildcard times can be used for values specified within the `*range=` operator. Because the range operator is a shorthand syntax for "greater than or equal to <*range_min*> and less than or equal to <*range_max*>", users should be aware of differences in behavior between each kind of time value with greater than / less than operators.

See the Storm documents referenced above for additional examples using the range (`*range=`) comparator.

Interval Custom Operator

`time` types can be lifted and filtered using the interval (`@=`) custom comparator (see *Lift by Time or Interval (@=)* and *Filter by Time or Interval (@=)*). The comparator is specifically designed to compare `time` types and `ival` types, which can be useful (for example) for filtering to a set of nodes whose `time` properties fall within a specified interval.

Example:

Lift a set of DNS A records whose window of observation includes March 16, 2019 at 13:00 UTC:

```
storm> inet:dns:a.seen@='2019/03/16 13:00'
inet:dns:a=('aaaa.org', '1.2.3.4')
        :fqdn = aaaa.org
        :ipv4 = 1.2.3.4
        .created = 2023/07/12 15:15:06.299
        .seen = ('2018/12/29 12:36:27.000', '2019/06/03 18:14:33.000')
inet:dns:a=('derp.net', '8.8.8.8')
        :fqdn = derp.net
        :ipv4 = 8.8.8.8
        .created = 2023/07/12 15:15:05.529
        .seen = ('2019/03/08 07:26:00.000', '2019/03/22 10:14:00.000')
inet:dns:a=('bbbb.edu', '5.6.7.8')
        :fqdn = bbbb.edu
        :ipv4 = 5.6.7.8
        .created = 2023/07/12 15:15:06.306
        .seen = ('2019/03/16 12:59:59.000', '2019/03/16 13:01:01.000')
```

Note: Both lower resolution times and wildcard time can be used for values specified within the `@=` operator. Because the interval operator is a shorthand syntax for "greater than or equal to <*ival_min*> and less than <*ival_max*>", users should be aware of differences in behavior between each kind of time value with greater than / less than operators.

See the Storm documents referenced above for additional examples using the interval (`@=`) comparator.

3.6.10 Storm Reference - Storm Commands

Storm commands are built-in or custom commands that can be used natively within the Synapse Storm tool / Storm CLI (see *storm*).

Note: The Storm tool / Storm CLI provides a native Storm interpreter and is the preferred tool for interacting with a Synapse Cortex from the CLI.

The pipe symbol (`|`) is used with Storm commands to:

- Return to Storm query syntax after running a Storm command.
- Separate individual Storm commands and their parameters (i.e., if you are "chaining" multiple commands together).

For example:

```
inet:fqdn=woot.com nettools.whois | nettools.dns --type A AAAA NS | -> inet:dns:a
```

The query above:

- lifts the FQDN `woot.com`,
- performs a live "whois" lookup using the Synapse-Nettools *Power-Up*,
- performs a live DNS query for the FQDN's A, AAAA, and NS records, and
- pivots from the FQDN to any associated DNS A records.

The pipe is used to separate the two `nettools.*` commands, and to separate the `nettools.dns` command and its switches from the subsequent query operation (the pivot).

An additional pipe character can optionally be placed between the initial lift (`inet:fqdn=woot.com`) and the `nettools.whois` command, but is not required.

Built-in commands are native to the Storm library and loaded by default within a given Cortex. Built-in commands comprise a set of helper commands that perform a variety of specialized tasks that are useful regardless of the types of data stored in Synapse or the types of analysis performed.

Custom commands are Storm commands that have been added to a Cortex to invoke the execution of dynamically loaded modules. Synapse **Power-Ups** (*Power-Up*) are examples of modules that may install additional Storm commands to implement additional functionality specific to that Power-Up (such as querying a third-party data source to automatically ingest and model the data in Synapse).

The full list of Storm commands (built-in and custom) available in a given instance of Synapse can be displayed with the `help` command.

Help for a specific Storm command can be displayed with `<command> --help`.

Tip: This section details the usage and syntax for **built-in** Storm commands. Many of the commands below - such as `count`, `intersect`, `limit`, `max` / `min`, `uniq`, or the various `gen` (generate) commands - directly support analysis tasks.

Other commands, such as those used to manage daemons, queues, packages, or services, are likely of greater interest to Synapse administrators or developers.

- *dmon*
- *edges*
- *feed*
- *gen*
- *graph*
- *iden*
- *intersect*
- *layer*
- *lift*
- *limit*
- *macro*
- *max*
- *merge*
- *min*
- *model*
- *movetag*
- *nodes*
- *note*
- *once*
- *parallel*
- *pkg*
- *ps*
- *queue*
- *reindex*
- *runas*
- *scrape*
- *service*
- *sleep*
- *spin*
- *splice*
- *tag*
- *tee*
- *tree*
- *trigger*
- *uniq*
- *uptime*

- *version*
- *view*
- *wget*

See *Storm Reference - Document Syntax Conventions* for an explanation of the syntax format used below.

The Storm query language is covered in detail starting with the *Storm Reference - Introduction* section of the Synapse User Guide.

Tip: Storm commands, including custom commands, are added to Synapse as **runtime nodes** ("runt nodes" - see *Node, Runt*) of the form `syn:cmd`. With a few restrictions, these runt nodes can be lifted, filtered, and operated on similar to the way you work with other nodes.

Example

Lift the `syn:cmd` node for the Storm `movetag` command:

```
storm> syn:cmd=movetag
syn:cmd=movetag
        :doc = Rename an entire tag tree and preserve time intervals.
```

help

The `help` command displays the list of available commands within the current instance of Synapse and a brief message describing each command. Help for individual commands is available via `<command> --help`.

Syntax:

```
storm> help --help


    List available commands and a brief description for each.

    Examples:

        // Get all available commands and their brief descriptions.

        help

        // Only get commands which have "model" in the name.

        help model


Usage: help [options] <command>

Options:

  --help                      : Display the command usage.

Arguments:
```

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```
  [command]                   : Only list commands and their brief description whose␣
↪name contains the argument.
```

auth

Storm includes `auth.*` commands that allow you create and manage users and roles, and manage their associated permissions (rules).

- *auth.gate.show*
- *auth.role.add*
- *auth.role.addrule*
- *auth.role.del*
- *auth.role.delrule*
- *auth.role.list*
- *auth.role.mod*
- *auth.role.show*
- *auth.user.add*
- *auth.user.addrule*
- *auth.user.delrule*
- *auth.user.grant*
- *auth.user.list*
- *auth.user.mod*
- *auth.user.revoke*
- *auth.user.show*
- *auth.user.allowed*

Help for individual `auth.*` commands can be displayed using:

```
<command> --help
```

auth.gate.show

The `auth.gate.show` command displays the user, roles, and permissions associated with the specified *Auth Gate*.

Syntax

```
storm> auth.gate.show --help



            Display users, roles, and permissions for an auth gate.

            Examples:
                // Display the users and roles with permissions to the top layer of the␣
```

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```
↪current view.
                auth.gate.show $lib.layer.get().iden

                // Display the users and roles with permissions to the current view.
                auth.gate.show $lib.view.get().iden


Usage: auth.gate.show [options] <gateiden>

Options:

  --help                      : Display the command usage.

Arguments:

  <gateiden>                  : The GUID of the auth gate.
```

auth.role.add

The `auth.role.add` command creates a role.

Syntax:

```
storm> auth.role.add --help


            Add a role.

            Examples:

                // Add a role named "ninjas"
                auth.role.add ninjas


Usage: auth.role.add [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the role.
```

auth.role.addrule

The `auth.role.addrule` command adds a rule (permission) to a role.

Syntax:

```
storm> auth.role.addrule --help


            Add a rule to a role.

            Examples:

                // add an allow rule to the role "ninjas" for permission "foo.bar.baz"
                auth.role.addrule ninjas foo.bar.baz

                // add a deny rule to the role "ninjas" for permission "foo.bar.baz"
                auth.role.addrule ninjas "!foo.bar.baz"

                // add an allow rule to the role "ninjas" for permission "baz" at the␣
↪first index.
                auth.role.addrule ninjas baz --index 0


Usage: auth.role.addrule [options] <name> <rule>

Options:

  --help                      : Display the command usage.
  --gate <gate>               : The auth gate id to add the rule to. (default: None)
  --index <index>             : Specify the rule location as a 0 based index. (default:␣
↪None)

Arguments:

  <name>                      : The name of the role.
  <rule>                      : The rule string.
```

auth.role.del

The `auth.role.del` command deletes a role.

Syntax:

```
storm> auth.role.del --help


            Delete a role.

            Examples:

                // Delete a role named "ninjas"
                auth.role.del ninjas
```

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```
Usage: auth.role.del [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the role.
```

auth.role.delrule

The `auth.role.delrule` command removes a rule (permission) from a role.

Syntax:

```
storm> auth.role.delrule --help


            Remove a rule from a role.

            Examples:

                // Delete the allow rule from the role "ninjas" for permission "foo.bar.
↪baz"
                auth.role.delrule ninjas foo.bar.baz

                // Delete the deny rule from the role "ninjas" for permission "foo.bar.
↪baz"
                auth.role.delrule ninjas "!foo.bar.baz"

                // Delete the rule at index 5 from the role "ninjas"
                auth.role.delrule ninjas --index  5


Usage: auth.role.delrule [options] <name> <rule>

Options:

  --help                      : Display the command usage.
  --gate <gate>               : The auth gate id to remove the rule from. (default: None)
  --index                     : Specify the rule as a 0 based index into the list of␣
↪rules.

Arguments:

  <name>                      : The name of the role.
  <rule>                      : The rule string.
```

auth.role.list

The `auth.role.list` lists all roles in the Cortex.

Syntax:

```
storm> auth.role.list --help


            List all roles.

            Examples:

                // Display the list of all roles
                auth.role.list


Usage: auth.role.list [options]

Options:

  --help                      : Display the command usage.
```

auth.role.mod

The `auth.role.mod` modifies an existing role.

Syntax:

```
storm> auth.role.mod --help


            Modify properties of a role.

            Examples:

                // Rename the "ninjas" role to "admins"
                auth.role.mod ninjas --name admins


Usage: auth.role.mod [options] <rolename>

Options:

  --help                      : Display the command usage.
  --name <name>               : The new name for the role.

Arguments:

  <rolename>                  : The name of the role.
```

auth.role.show

The `auth.role.show` displays the details for a given role.

Syntax:

```
storm> auth.role.show --help



            Display details for a given role by name.

            Examples:

                // Display details about the role "ninjas"
                auth.role.show ninjas


Usage: auth.role.show [options] <rolename>

Options:

  --help                      : Display the command usage.

Arguments:

  <rolename>                  : The name of the role.
```

auth.user.add

The `auth.user.add` command creates a user.

Syntax:

```
storm> auth.user.add --help


            Add a user.

            Examples:

                // Add a user named "visi" with the email address "visi@vertex.link"
                auth.user.add visi --email visi@vertex.link


Usage: auth.user.add [options] <name>

Options:

  --help                      : Display the command usage.
  --email <email>             : The user's email address. (default: None)

Arguments:
```

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```
  <name>                        : The name of the user.
```

auth.user.addrule

The `auth.user.addrule` command adds a rule (permission) to a user.

Syntax:

```
storm> auth.user.addrule --help


            Add a rule to a user.

            Examples:

                // add an allow rule to the user "visi" for permission "foo.bar.baz"
                auth.user.addrule visi foo.bar.baz

                // add a deny rule to the user "visi" for permission "foo.bar.baz"
                auth.user.addrule visi "!foo.bar.baz"

                // add an allow rule to the user "visi" for permission "baz" at the␣
↪first index.
                auth.user.addrule visi baz --index 0


Usage: auth.user.addrule [options] <name> <rule>

Options:

  --help                        : Display the command usage.
  --gate <gate>                 : The auth gate id to grant permission on. (default: None)
  --index <index>               : Specify the rule location as a 0 based index. (default:␣
↪None)

Arguments:

  <name>                        : The name of the user.
  <rule>                        : The rule string.
```

auth.user.delrule

The `auth.user.delrule` command removes a rule (permission) from a user.

Syntax:

```
storm> auth.user.delrule --help


```

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```
            Remove a rule from a user.

            Examples:

                // Delete the allow rule from the user "visi" for permission "foo.bar.baz
↪"
                auth.user.delrule visi foo.bar.baz

                // Delete the deny rule from the user "visi" for permission "foo.bar.baz"
                auth.user.delrule visi "!foo.bar.baz"

                // Delete the rule at index 5 from the user "visi"
                auth.user.delrule visi --index  5


Usage: auth.user.delrule [options] <name> <rule>

Options:

  --help                      : Display the command usage.
  --gate <gate>               : The auth gate id to grant permission on. (default: None)
  --index                     : Specify the rule as a 0 based index into the list of␣
↪rules.

Arguments:

  <name>                      : The name of the user.
  <rule>                      : The rule string.
```

auth.user.grant

The `auth.user.grant` command grants a role (and its associated permissions) to a user.

Syntax:

```
storm> auth.user.grant --help


            Grant a role to a user.

            Examples:

                // Grant the role "ninjas" to the user "visi"
                auth.user.grant visi ninjas

                // Grant the role "ninjas" to the user "visi" at the first index.
                auth.user.grant visi ninjas --index 0



Usage: auth.user.grant [options] <username> <rolename>
```

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```
Options:

  --help                      : Display the command usage.
  --index <index>             : Specify the role location as a 0 based index. (default:␣
↪None)

Arguments:

  <username>                  : The name of the user.
  <rolename>                  : The name of the role.
```

auth.user.list

The `auth.user.list` command displays all users in the Cortex.

Syntax:

```
storm> auth.user.list --help


            List all users.

            Examples:

                // Display the list of all users
                auth.user.list


Usage: auth.user.list [options]

Options:

  --help                      : Display the command usage.
```

auth.user.mod

The `auth.user.mod` command modifies a user account.

Syntax:

```
storm> auth.user.mod --help


            Modify properties of a user.

            Examples:

                // Rename the user "foo" to "bar"
                auth.user.mod foo --name bar
```

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```
                // Make the user "visi" an admin
                auth.user.mod visi --admin $lib.true

                // Unlock the user "visi" and set their email to "visi@vertex.link"
                auth.user.mod visi --locked $lib.false --email visi@vertex.link


Usage: auth.user.mod [options] <username>

Options:

  --help                      : Display the command usage.
  --name <name>               : The new name for the user.
  --email <email>             : The email address to set for the user.
  --passwd <passwd>           : The new password for the user. This is best passed into␣
↪the runtime as a variable.
  --admin <admin>             : True to make the user and admin, false to remove their␣
↪remove their admin status.
  --locked <locked>           : True to lock the user, false to unlock them.

Arguments:

  <username>                  : The name of the user.
```

auth.user.revoke

The `auth.user.revoke` command revokes a role (and its associated permissions) from a user.

Syntax:

```
storm> auth.user.revoke --help


            Revoke a role from a user.

            Examples:

                // Revoke the role "ninjas" from the user "visi"
                auth.user.revoke visi ninjas



Usage: auth.user.revoke [options] <username> <rolename>

Options:

  --help                      : Display the command usage.

Arguments:
```

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```
  <username>                  : The name of the user.
  <rolename>                  : The name of the role.
```

auth.user.show

The `auth.user.show` command displays information for a specific user.

Syntax:

```
storm> auth.user.show --help


            Display details for a given user by name.

            Examples:

                // Display details about the user "visi"
                auth.user.show visi


Usage: auth.user.show [options] <username>

Options:

  --help                      : Display the command usage.

Arguments:

  <username>                  : The name of the user.
```

auth.user.allowed

The `auth.user.allowed` command checks whether a user has a permission for the specified scope (view or layer; if no scope is specified with the `--gate` option, the permission is checked globally).

The command retuns whether the permission is allowed (true) the source of the permission (e.g., if the permission is due to having a particular role).

Syntax:

```
storm> auth.user.allowed --help


            Show whether the user is allowed the given permission and why.

            Examples:

                auth.user.allowed visi foo.bar


Usage: auth.user.allowed [options] <username> <permname>
```

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```
Options:

  --help                      : Display the command usage.
  --gate <gate>               : An auth gate to test the perms against.

Arguments:

  <username>                  : The name of the user.
  <permname>                  : The permission string.
```

background

The `background` command allows you to execute a Storm query as a background task (e.g., to free up the CLI / Storm runtime for additional queries).

Note: Use of `background` is a "fire-and-forget" process - any status messages (warnings or errors) are not returned to the console, and if the query is interrupted for any reason, it will not resume.

See also *parallel*.

Syntax:

```
storm> background --help


    Execute a query pipeline as a background task.
    NOTE: Variables are passed through but nodes are not


Usage: background [options] <query>

Options:

  --help                      : Display the command usage.

Arguments:

  <query>                     : The query to execute in the background.
```

batch

The `batch` command allows you to run a Storm query with batched sets of nodes.

Note that in most cases, Storm queries are meant to operate in a "streaming" manner on individual nodes. This command is intended to be used in cases such as querying external APIs that support aggregate queries (i.e., an API that allows you to query 100 objects in a single API call as part of the API's quota system).

Syntax:

```
storm> batch --help


    Run a query with batched sets of nodes.

    The batched query will have the set of inbound nodes available in the
    variable $nodes.

    This command also takes a conditional as an argument. If the conditional
    evaluates to true, the nodes returned by the batched query will be yielded,
    if it evaluates to false, the inbound nodes will be yielded after executing the
    batched query.

    NOTE: This command is intended to facilitate use cases such as queries to external
          APIs with aggregate node values to reduce quota consumption. As this command
          interrupts the node stream, it should be used carefully to avoid unintended
          slowdowns in the pipeline.

    Example:

        // Execute a query with batches of 5 nodes, then yield the inbound nodes
        batch $lib.false --size 5 { $lib.print($nodes) }


Usage: batch [options] <cond> <query>

Options:

  --help                      : Display the command usage.
  --size <size>               : The number of nodes to collect before running the␣
↪batched query (max 10000). (default: 10)

Arguments:

  <cond>                      : The conditional value for the yield option.
  <query>                     : The query to execute with batched nodes.
```

count

The `count` command enumerates the number of nodes returned from a given Storm query and displays the final tally. The associated nodes can optionally be displayed with the `--yield` switch.

Syntax:

```
storm> count --help


    Iterate through query results, and print the resulting number of nodes
    which were lifted. This does not yield the nodes counted, unless the
    --yield switch is provided.

    Example:
```

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```
        # Count the number of IPV4 nodes with a given ASN.
        inet:ipv4:asn=20 | count

        # Count the number of IPV4 nodes with a given ASN and yield them.
        inet:ipv4:asn=20 | count --yield



Usage: count [options]

Options:

  --help                      : Display the command usage.
  --yield                     : Yield inbound nodes.
```

Examples:

- Count the number of IP address nodes that Trend Micro reports are associated with the threat group Earth Preta:

```
storm> inet:ipv4#rep.trend.earthpreta | count
Counted 5 nodes.
```

- Count nodes from a lift and yield the output:

```
storm> inet:ipv4#rep.trend.earthpreta | count --yield
inet:ipv4=66.129.222.1
        :type = unicast
        .created = 2023/07/12 15:16:11.570
        #rep.trend.earthpreta
inet:ipv4=184.82.164.104
        :type = unicast
        .created = 2023/07/12 15:16:11.578
        #rep.trend.earthpreta
inet:ipv4=209.161.249.125
        :type = unicast
        .created = 2023/07/12 15:16:11.585
        #rep.trend.earthpreta
inet:ipv4=69.90.65.240
        :type = unicast
        .created = 2023/07/12 15:16:11.594
        #rep.trend.earthpreta
inet:ipv4=70.62.232.98
        :type = unicast
        .created = 2023/07/12 15:16:11.600
        #rep.trend.earthpreta
Counted 5 nodes.
```

- Count the number of DNS A records for the domain woot.com where the lift produces no results:

```
storm> inet:dns:a:fqdn=woot.com | count
Counted 0 nodes.
```

cron

Note: See the *Storm Reference - Automation* guide for additional background on cron jobs (as well as triggers and macros), including examples.

Storm includes `cron.*` commands that allow you to create and manage scheduled *Cron* jobs. Within Synapse, jobs are Storm queries that execute on a recurring or one-time (`cron.at`) basis.

- *cron.add*
- *cron.at*
- *cron.cleanup*
- *cron.list*
- *cron.stat*
- *cron.mod*
- *cron.move*
- *cron.disable*
- *cron.enable*
- *cron.del*

Help for individual `cron.*` commands can be displayed using:

```
<command> --help
```

Tip: Cron jobs (including jobs created with `cron.at`) are added to Synapse as **runtime nodes** ("runt nodes" - see *Node, Runt*) of the form `syn:cron`. With a few restrictions, these runt nodes can be lifted, filtered, and operated on similar to the way you work with other nodes.

cron.add

The `cron.add` command creates an individual cron job within a Cortex.

Syntax:

```
storm> cron.add --help


Add a recurring cron job to a cortex.

Notes:
    All times are interpreted as UTC.

    All arguments are interpreted as the job period, unless the value ends in
    an equals sign, in which case the argument is interpreted as the recurrence
    period.  Only one recurrence period parameter may be specified.

    Currently, a fixed unit must not be larger than a specified recurrence
    period.  i.e. '--hour 7 --minute +15' (every 15 minutes from 7-8am?) is not
```

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```
    supported.

    Value values for fixed hours are 0-23 on a 24-hour clock where midnight is 0.

    If the --day parameter value does not start with a '+' and is an integer, it is
    interpreted as a fixed day of the month.  A negative integer may be
    specified to count from the end of the month with -1 meaning the last day
    of the month.  All fixed day values are clamped to valid days, so for
    example '-d 31' will run on February 28.
    If the fixed day parameter is a value in ([Mon, Tue, Wed, Thu, Fri, Sat,
    Sun] if locale is set to English) it is interpreted as a fixed day of the
    week.

    Otherwise, if the parameter value starts with a '+', then it is interpreted
    as a recurrence interval of that many days.

    If no plus-sign-starting parameter is specified, the recurrence period
    defaults to the unit larger than all the fixed parameters.   e.g. '--minute 5'
    means every hour at 5 minutes past, and --hour 3, --minute 1 means 3:01 every day.

    At least one optional parameter must be provided.

    All parameters accept multiple comma-separated values.  If multiple
    parameters have multiple values, all combinations of those values are used.

    All fixed units not specified lower than the recurrence period default to
    the lowest valid value, e.g. --month +2 will be scheduled at 12:00am the first of
    every other month.  One exception is if the largest fixed value is day of the
    week, then the default period is set to be a week.

    A month period with a day of week fixed value is not currently supported.

    Fixed-value year (i.e. --year 2019) is not supported.  See the 'at'
    command for one-time cron jobs.

    As an alternative to the above options, one may use exactly one of
    --hourly, --daily, --monthly, --yearly with a colon-separated list of
    fixed parameters for the value.  It is an error to use both the individual
    options and these aliases at the same time.

Examples:
    Run a query every last day of the month at 3 am
    cron.add --hour 3 --day -1 {#foo}

    Run a query every 8 hours
    cron.add --hour +8 {#foo}

    Run a query every Wednesday and Sunday at midnight and noon
    cron.add --hour 0,12 --day Wed,Sun {#foo}

    Run a query every other day at 3:57pm
    cron.add --day +2 --minute 57 --hour 15 {#foo}
```

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```
Usage: cron.add [options] <query>

Options:

  --help                      : Display the command usage.
  --minute <minute>           : Minute value for job or recurrence period.
  --name <name>               : An optional name for the cron job.
  --doc <doc>                 : An optional doc string for the cron job.
  --hour <hour>               : Hour value for job or recurrence period.
  --day <day>                 : Day value for job or recurrence period.
  --month <month>             : Month value for job or recurrence period.
  --year <year>               : Year value for recurrence period.
  --hourly <hourly>           : Fixed parameters for an hourly job.
  --daily <daily>             : Fixed parameters for a daily job.
  --monthly <monthly>         : Fixed parameters for a monthly job.
  --yearly <yearly>           : Fixed parameters for a yearly job.
  --iden <iden>               : Fixed iden to assign to the cron job
  --view <view>               : View to run the cron job against

Arguments:

  <query>                     : Query for the cron job to execute.
```

cron.at

The `cron.at` command creates a non-recurring (one-time) cron job within a Cortex. Just like standard (recurring) cron jobs, jobs created with `cron.at` will persist (remain in the list of cron jobs and as `syn:cron` runt nodes) until they are explicitly removed using `cron.del`.

Syntax:

```
storm> cron.at --help


Adds a non-recurring cron job.

Notes:
    This command accepts one or more time specifications followed by exactly
    one storm query in curly braces.  Each time specification may be in synapse
    time delta format (e.g --day +1) or synapse time format (e.g.
    20501217030432101).  Seconds will be ignored, as cron jobs' granularity is
    limited to minutes.

    All times are interpreted as UTC.

    The other option for time specification is a relative time from now.  This
    consists of a plus sign, a positive integer, then one of 'minutes, hours,
    days'.
```

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```
    Note that the record for a cron job is stored until explicitly deleted via
    "cron.del".

Examples:
    # Run a storm query in 5 minutes
    cron.at --minute +5 {[inet:ipv4=1]}

    # Run a storm query tomorrow and in a week
    cron.at --day +1,+7 {[inet:ipv4=1]}

    # Run a query at the end of the year Zulu
    cron.at --dt 20181231Z2359 {[inet:ipv4=1]}


Usage: cron.at [options] <query>

Options:

  --help                      : Display the command usage.
  --minute <minute>           : Minute(s) to execute at.
  --hour <hour>               : Hour(s) to execute at.
  --day <day>                 : Day(s) to execute at.
  --dt <dt>                   : Datetime(s) to execute at.
  --now                       : Execute immediately.
  --iden <iden>               : A set iden to assign to the new cron job
  --view <view>               : View to run the cron job against

Arguments:

  <query>                     : Query for the cron job to execute.
```

cron.cleanup

The `cron.cleanup` command can be used to remove any one-time cron jobs ("at" jobs) that have completed.

Syntax:

```
storm> cron.cleanup --help

Delete all completed at jobs

Usage: cron.cleanup [options]

Options:

  --help                      : Display the command usage.
```

cron.list

The `cron.list` command displays the set of cron jobs in the Cortex that the current user can view / modify based on their permissions.

Cron jobs are displayed in alphanumeric order by job *Iden*. Jobs are sorted upon Cortex initialization, so newly-created jobs will be displayed at the bottom of the list until the list is re-sorted the next time the Cortex is restarted.

Syntax:

```
storm> cron.list --help

List existing cron jobs in the cortex.

Usage: cron.list [options]

Options:

  --help                      : Display the command usage.
```

cron.stat

The `cron.stat` command displays statistics for an individual cron job and provides more detail on an individual job vs. `cron.list`, including any errors and the interval at which the job executes. To view the stats for a job, you must provide the first portion of the job's iden (i.e., enough of the iden that the job can be uniquely identified), which can be obtained using `cron.list` or by lifting the appropriate `syn:cron` node.

Syntax:

```
storm> cron.stat --help

Gives detailed information about a cron job.

Usage: cron.stat [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
```

cron.mod

The `cron.mod` command modifies the Storm query associated with a specific cron job. To modify a job, you must provide the first portion of the job's iden (i.e., enough of the iden that the job can be uniquely identified), which can be obtained using `cron.list` or by lifting the appropriate `syn:cron` node.

Note: Other aspects of the cron job, such as its schedule for execution, cannot be modified once the job has been created. To change these aspects you must delete and re-add the job.

Syntax:

```
storm> cron.mod --help

Modify an existing cron job's query.

Usage: cron.mod [options] <iden> <query>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
  <query>                     : New storm query for the cron job.
```

cron.move

The `cron.move` command moves a cron job from one *View* to another.

Syntax:

```
storm> cron.move --help

Move a cron job from one view to another

Usage: cron.move [options] <iden> <view>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
  <view>                      : View to move the cron job to.
```

cron.disable

The `cron.disable` command disables a job and prevents it from executing without removing it from the Cortex. To disable a job, you must provide the first portion of the job's iden (i.e., enough of the iden that the job can be uniquely identified), which can be obtained using `cron.list` or by lifting the appropriate `syn:cron` node.

Syntax:

```
storm> cron.disable --help

Disable a cron job in the cortex.

Usage: cron.disable [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
```

cron.enable

The `cron.enable` command enables a disabled cron job. To enable a job, you must provide the first portion of the job's iden (i.e., enough of the iden that the job can be uniquely identified), which can be obtained using `cron.list` or by lifting the appropriate `syn:cron` node.

Note: Cron jobs, including non-recurring jobs added with `cron.at`, are enabled by default upon creation.

Syntax:

```
storm> cron.enable --help

Enable a cron job in the cortex.

Usage: cron.enable [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
```

cron.del

The `cron.del` command permanently removes a cron job from the Cortex. To delete a job, you must provide the first portion of the job's iden (i.e., enough of the iden that the job can be uniquely identified), which can be obtained using `cron.list` or by lifting the appropriate `syn:cron` node.

Syntax:

```
storm> cron.del --help

Delete a cron job from the cortex.

Usage: cron.del [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid cron job iden␣
↪is accepted.
```

delnode

The `delnode` command deletes a node or set of nodes from a Cortex.

> **Warning:** The Storm `delnode` command includes some limited checks (see below) to try and prevent the accidental deletion of nodes that are still connected to other nodes in the knowledge graph. However, these checks are not foolproof, and `delnode` has the potential to be destructive if executed on an incorrect, badly formed, or mistyped query.
>
> Users are **strongly encouraged** to validate their query by first executing it on its own to confirm it returns the expected nodes before piping the query to the `delnode` command.
>
> In addition, use of the `--force` switch with `delnode` will override all safety checks and forcibly delete ALL nodes input to the command.
>
> **This parameter should be used with extreme caution as it may result in broken references (e.g., "holes" in the graph) within Synapse.**

Syntax:

```
storm> delnode --help


    Delete nodes produced by the previous query logic.

    (no nodes are returned)

    Example

        inet:fqdn=vertex.link | delnode
```

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```
Usage: delnode [options]

Options:

  --help                      : Display the command usage.
  --force                     : Force delete even if it causes broken references␣
↪(requires admin).
  --delbytes                  : For file:bytes nodes, remove the bytes associated with␣
↪the sha256 property from the axon as well if present.
```

Examples:

- Delete the node for the domain woowoo.com:

```
storm> inet:fqdn=woowoo.com | delnode
```

- Forcibly delete all nodes with the #testing tag:

```
storm> #testing | delnode --force
```

Usage Notes:

- `delnode` operates on the output of a previous Storm query.
- `delnode` performs some basic sanity-checking to help prevent egregious mistakes, and will generate an error in cases such as:
  - attempting to delete a node (such as `inet:fqdn=woot.com`) that is still referenced by (i.e., is a secondary property of) another node (such as `inet:dns:a=(woot.com, 1.1.1.1)`.
  - attmpting to delete a `syn:tag` node where that tag still exists on other nodes.

  However, it is important to keep in mind that **delnode cannot prevent all mistakes.**

diff

The `diff` command generates a list of nodes with changes (i.e., newly created or modified nodes) present in the top *Layer* of the current *View*. The `diff` command may be useful before performing a *merge* operation.

Syntax:

```
storm> diff --help


    Generate a list of nodes with changes in the top layer of the current view.

    Examples:

        // Lift all nodes with any changes

        diff

        // Lift ou:org nodes that were added in the top layer.
```

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```
        diff --prop ou:org

        // Lift inet:ipv4 nodes with the :asn property modified in the top layer.

        diff --prop inet:ipv4:asn

        // Lift the nodes with the tag #cno.mal.redtree added in the top layer.

        diff --tag cno.mal.redtree


Usage: diff [options]

Options:

  --help                      : Display the command usage.
  --tag <tag>                 : Lift only nodes with the given tag in the top layer.␣
↪(default: None)
  --prop <prop>               : Lift nodes with changes to the given property the top␣
↪layer. (default: None)
```

divert

The `divert` command allows Storm to either consume a generator or yield its results based on a conditional.

Syntax:

```
storm> divert --help


    Either consume a generator or yield it's results based on a conditional.

    NOTE: This command is purpose built to facilitate the --yield convention
          common to storm commands.

    NOTE: The genr argument must not be a function that returns, else it will
          be invoked for each inbound node.

    Example:
        divert $cmdopts.yield $fooBarBaz()


Usage: divert [options] <cond> <genr>

Options:

  --help                      : Display the command usage.
  --size <size>               : The max number of times to iterate the generator.␣
↪(default: None)
```

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```
Arguments:

  <cond>                      : The conditional value for the yield option.
  <genr>                      : The generator function value that yields nodes.
```

dmon

Storm includes `dmon.*` commands that allow you to work with daemons (see *Daemon*).

- *dmon.list*

Help for individual `dmon.*` commands can be displayed using:

```
<command> --help
```

dmon.list

The `dmon.list` command displays the set of running dmon queries in the Cortex.

Syntax:

```
storm> dmon.list --help

List the storm daemon queries running in the cortex.

Usage: dmon.list [options]

Options:

  --help                      : Display the command usage.
```

edges

Storm includes `edges.*` commands that allow you to work with lightweight (light) edges. Also see the `lift.byverb` and `model.edge.*` commands under *lift* and *model* below.

- *edges.del*

Help for individual `edge.*` commands can be displayed using:

```
<command> --help
```

edges.del

The `edges.del` command is designed to delete multiple light edges to (or from) a set of nodes (contrast with using Storm edit syntax - see *Delete Light Edges*).

Syntax:

```
storm> edges.del --help


```

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```
    Bulk delete light edges from input nodes.

    Examples:

        # Delete all "foo" light edges from an inet:ipv4
        inet:ipv4=1.2.3.4 | edges.del foo

        # Delete light edges with any verb from a node
        inet:ipv4=1.2.3.4 | edges.del *

        # Delete all "foo" light edges to an inet:ipv4
        inet:ipv4=1.2.3.4 | edges.del foo --n2


Usage: edges.del [options] <verb>

Options:

  --help                     : Display the command usage.
  --n2                       : Delete light edges where input node is N2 instead of N1.

Arguments:

  <verb>                     : The verb of light edges to delete.
```

feed

Storm includes `feed.*` commands that allow you to work with feeds (see *Feed*).

- *feed.list*

Help for individual `feed.*` commands can be displayed using:

```
<command> --help
```

feed.list

The `feed.list` command displays available feed functions in the Cortex.

Syntax:

```
storm> feed.list --help

List the feed functions available in the Cortex

Usage: feed.list [options]

Options:

  --help                     : Display the command usage.
```

gen

Storm includes various `gen.*` ("generate") commands that allow you to easily query for common guid-based nodes (see *Form, GUID*) based on one or more "human friendly" secondary properties, and create (generate) the specified node if it does not already exist.

Because guid nodes have a primary property that may be arbitrary, `gen.*` commands simplify the process of **deconflicting on secondary properties** before creating certain guid nodes.

Note: See the *guid* section of the *Storm Reference - Type-Specific Storm Behavior* for a detailed discussion of guids, guid behavior, and deconfliction considerations for guid forms.

Nodes created using generate commands will have a limited subset of properties set (e.g., an organization node deconflicted and created based on a name will only have its `ou:org:name` property set). Users can set additional property values as they see fit.

Help for individual `gen.*` commands can be displayed using:

```
<command> --help
```

Note: New `gen.*` commands are added to Synapse on an ongoing basis as we identify new cases where such commands are helpful. Use the `help` command for the current list of `gen.*` commands available in your instance of Synapse.

---

gen.it.prod.soft

The `gen.it.prod.soft` command locates (lifts) or creates an `it:prod:soft` node based on the software name (`it:prod:soft:name` and / or `it:prod:soft:names`).

```
storm> gen.it.prod.soft --help

Lift (or create) an it:prod:soft node based on the software name.

Usage: gen.it.prod.soft [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the software.
```

gen.lang.language

The gen.lang.language command locates (lifts) or creates a lang:language node based on the language name (lang:language:name and / or lang:language:names).

```
storm> gen.lang.language --help

Lift (or create) a lang:language node based on the name.

Usage: gen.lang.language [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the language.
```

gen.ou.industry

The gen.ou.industry commands locates (lifts) or creates an ou:industry node based on the industry name (ou:industry:name and / or ou:industry:names).

```
storm> gen.ou.industry --help


            Lift (or create) an ou:industry node based on the industry name.


Usage: gen.ou.industry [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The industry name.
```

gen.ou.org

The gen.ou.org command locates (lifts) or creates an ou:org node based on the organization name (ou:org:name and / or ou:org:names).

```
storm> gen.ou.org --help

Lift (or create) an ou:org node based on the organization name.

Usage: gen.ou.org [options] <name>
```

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```
Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the organization.
```

gen.ou.org.hq

The `gen.ou.org.hq` command locates (lifts) the primary `ps:contact` node for an organization (i.e., the contact set for the `ou:org:hq` property) or creates the contact node (and sets the `ou:org:hq` property) if it does not exist, based on the organization name (`ou:org:name` and / or `ou:org:names`).

```
storm> gen.ou.org.hq --help

Lift (or create) the primary ps:contact node for the ou:org based on the organization␣
↪name.

Usage: gen.ou.org.hq [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the organization.
```

gen.pol.country

The `gen.pol.country` command locates (lifts) or creates a `pol:country` node based on the two-letter ISO-3166 country code (`pol:country:iso2`) .

```
storm> gen.pol.country --help


            Lift (or create) a pol:country node based on the 2 letter ISO-3166 country␣
↪code.

            Examples:

                // Yield the pol:country node which represents the country of Ukraine.
                gen.pol.country ua


Usage: gen.pol.country [options] <iso2>
```

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```
Options:

  --help                      : Display the command usage.
  --try                       : Type normalization will fail silently instead of raising␣
↪an exception.

Arguments:

  <iso2>                      : The 2 letter ISO-3166 country code.
```

gen.pol.country.government

The `gen.pol.country.government` command locates (lifts) the `ou:org` node representing a country's government (i.e., the organization set for the `pol:country:government` property) or creates the node (and sets the `pol:country:government` property) if it does not exist, based on the two-letter ISO-3166 country code (`pol:country:iso2`).

```
storm> gen.pol.country.government --help


            Lift (or create) the ou:org node representing a country's
            government based on the 2 letter ISO-3166 country code.

            Examples:

                // Yield the ou:org node which represents the Government of Ukraine.
                gen.pol.country.government ua


Usage: gen.pol.country.government [options] <iso2>

Options:

  --help                      : Display the command usage.
  --try                       : Type normalization will fail silently instead of raising␣
↪an exception.

Arguments:

  <iso2>                      : The 2 letter ISO-3166 country code.
```

gen.ps.contact.email

The `gen.ps.contact.email` command locates (lifts) or creates a `ps:contact` node using the contact's primary email address (`ps:contact:email`) and type (`ps:contact:type`).

```
storm> gen.ps.contact.email --help


            Lift (or create) the ps:contact node by deconflicting the email and type.

            Examples:

                // Yield the ps:contact node for the type and email
                gen.ps.contact.email vertex.employee visi@vertex.link


Usage: gen.ps.contact.email [options] <type> <email>

Options:

  --help                     : Display the command usage.
  --try                      : Type normalization will fail silently instead of raising␣
↪an exception.

Arguments:

  <type>                     : The contact type.
  <email>                    : The contact email address.
```

gen.risk.threat

The `gen.risk.threat` command locates (lifts) or creates a `risk:threat` node using the name of the threat group (`risk:threat:org:name`) and the name of the entity reporting on the threat (`risk:threat:reporter:name`).

```
storm> gen.risk.threat --help


            Lift (or create) a risk:threat node based on the threat name and reporter␣
↪name.

            Examples:

                // Yield a risk:threat node for the threat cluster "APT1" reported by
↪"Mandiant".
                gen.risk.threat apt1 mandiant


Usage: gen.risk.threat [options] <name> <reporter>

Options:

  --help                     : Display the command usage.
```

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```
Arguments:

  <name>                        : The name of the threat cluster. For example: APT1
  <reporter>                    : The name of the reporting organization. For example:␣
↪Mandiant
```

gen.risk.tool.software

The `gen.risk.tool.software` command locates (lifts) or creates a `risk:tool:software` node using the name of the software / malware (`risk:tool:software:soft:name`) and the name of the entity reporting on the software / malware (`risk:tool:software:reporter:name`).

```
storm> gen.risk.tool.software --help


            Lift (or create) a risk:tool:software node based on the tool name and␣
↪reporter name.

            Examples:

                // Yield a risk:tool:software node for the "redtree" tool reported by
↪"vertex".
                gen.risk.tool.software redtree vertex


Usage: gen.risk.tool.software [options] <name> <reporter>

Options:

  --help                        : Display the command usage.

Arguments:

  <name>                        : The tool name.
  <reporter>                    : The name of the reporting organization. For example:
↪"recorded future"
```

gen.risk.vuln

The `gen.risk.vuln` command locates (lifts) or creates a `risk:tool:vuln` node using the Common Vulnerabilities and Exposures (CVE) number associated with the vulnerability (`risk:vuln:cve`).

```
storm> gen.risk.vuln --help


            Lift (or create) a risk:vuln node based on the CVE.


```

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```
Usage: gen.risk.vuln [options] <cve>

Options:

  --help                      : Display the command usage.
  --try                       : Type normalization will fail silently instead of raising␣
↪an exception.

Arguments:

  <cve>                       : The CVE identifier.
```

graph

The graph command generates a subgraph based on a specified set of nodes and parameters.

Syntax:

```
storm> graph --help


    Generate a subgraph from the given input nodes and command line options.

    Example:

        Using the graph command::

            inet:fqdn | graph
                        --degrees 2
                        --filter { -#nope }
                        --pivot { <- meta:seen <- meta:source }
                        --form-pivot inet:fqdn {<- * | limit 20}
                        --form-pivot inet:fqdn {-> * | limit 20}
                        --form-filter inet:fqdn {-inet:fqdn:issuffix=1}
                        --form-pivot syn:tag {-> *}
                        --form-pivot * {-> #}



Usage: graph [options]

Options:

  --help                      : Display the command usage.
  --degrees <degrees>         : How many degrees to graph out. (default: 1)
  --pivot <pivot>             : Specify a storm pivot for all nodes. (must quote)␣
↪(default: [])
  --filter <filter>           : Specify a storm filter for all nodes. (must quote)␣
↪(default: [])
  --no-edges                  : Do not include light weight edges in the per-node output.
  --form-pivot <form_pivot>   : Specify a <form> <pivot> form specific pivot. (default:␣
```

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```
↪[])
  --form-filter <form_filter> : Specify a <form> <filter> form specific filter.␣
↪(default: [])
  --refs                      : Do automatic in-model pivoting with node.getNodeRefs().
  --yield-filtered            : Yield nodes which would be filtered. This still performs␣
↪pivots to collect edge data,but does not yield pivoted nodes.
  --no-filter-input           : Do not drop input nodes if they would match a filter.
```

iden

The `iden` command lifts one or more nodes by their node identifier (node ID / iden).

Syntax:

```
storm> iden --help


    Lift nodes by iden.

    Example:

        iden b25bc9eec7e159dce879f9ec85fb791f83b505ac55b346fcb64c3c51e98d1175 | count


Usage: iden [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  [<iden> ...]                : Iden to lift nodes by. May be specified multiple times.
```

Example:

- Lift the node with node ID 20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f:

```
storm> iden 20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f
inet:ipv4=1.2.3.4
        :type = unicast
        .created = 2023/07/12 15:16:12.414
```

intersect

The `intersect` command returns the intersection of the results from performing a pivot operation on multiple inbound nodes. In other words, `intersect` will return the subset of pivot results that are **common** to each of the inbound nodes.

Syntax:

```
storm> intersect --help


    Yield an intersection of the results of running inbound nodes through a pivot.

    NOTE:
        This command must consume the entire inbound stream to produce the intersection.
        This type of stream consuming before yielding results can cause the query to␣
↪appear
        laggy in comparison with normal incremental stream operations.

    Examples:

        // Show the it:mitre:attack:technique nodes common to several groups

        it:mitre:attack:group*in=(G0006, G0007) | intersect { ->␣
↪it:mitre:attack:technique }


Usage: intersect [options] <query>

Options:

  --help                      : Display the command usage.

Arguments:

  <query>                     : The pivot query to run each inbound node through.
```

layer

Storm includes `layer.*` commands that allow you to work with layers (see *Layer*).

- *layer.add*
- *layer.set*
- *layer.get*
- *layer.list*
- *layer.del*
- *layer.pull.add*
- *layer.pull.list*
- *layer.pull.del*
- *layer.push.add*

- *layer.push.list*
- *layer.push.del*

Help for individual `layer.*` commands can be displayed using:

```
<command> --help
```

layer.add

The `layer.add` command adds a layer to the Cortex.

Syntax

```
storm> layer.add --help

Add a layer to the cortex.

Usage: layer.add [options]

Options:

  --help                      : Display the command usage.
  --lockmemory                : Should the layer lock memory for performance.
  --readonly                  : Should the layer be readonly.
  --mirror <mirror>           : A telepath URL of an upstream layer/view to mirror.
  --growsize <growsize>       : Amount to grow the map size when necessary.
  --upstream <upstream>       : One or more telepath urls to receive updates from.
  --name <name>               : The name of the layer.
```

layer.set

The `layer.set` command sets an option for the specified layer.

Syntax

```
storm> layer.set --help

Set a layer option.

Usage: layer.set [options] <iden> <name> <valu>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Iden of the layer to modify.
  <name>                      : The name of the layer property to set.
  <valu>                      : The value to set the layer property to.
```

layer.get

The `layer.get` command retrieves the specified layer from a Cortex.

Syntax

```
storm> layer.get --help

Get a layer from the cortex.

Usage: layer.get [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  [iden]                      : Iden of the layer to get. If no iden is provided, the␣
↪main layer will be returned.
```

layer.list

The `layer.list` command lists the available layers in a Cortex.

Syntax

```
storm> layer.list --help

List the layers in the cortex.

Usage: layer.list [options]

Options:

  --help                      : Display the command usage.
```

layer.del

The `layer.del` command deletes a layer from a Cortex.

Syntax

```
storm> layer.del --help

Delete a layer from the cortex.

Usage: layer.del [options] <iden>

Options:

  --help                      : Display the command usage.
```

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```
Arguments:

  <iden>                        : Iden of the layer to delete.
```

layer.pull.add

The `layer.pull.add` command adds a pull configuration to a layer.

Syntax

```
storm> layer.pull.add --help

Add a pull configuration to a layer.

Usage: layer.pull.add [options] <layr> <src>

Options:

  --help                        : Display the command usage.
  --offset <offset>             : Layer offset to begin pulling from (default: 0)

Arguments:

  <layr>                        : Iden of the layer to pull to.
  <src>                         : Telepath url of the source layer to pull from.
```

layer.pull.list

The `layer.pull.list` command lists the pull configurations for a layer.

Syntax

```
storm> layer.pull.list --help

Get a list of the pull configurations for a layer.

Usage: layer.pull.list [options] <layr>

Options:

  --help                        : Display the command usage.

Arguments:

  <layr>                        : Iden of the layer to retrieve pull configurations for.
```

layer.pull.del

The `layer.pull.del` command deletes a pull configuration from a layer.

Syntax

```
storm> layer.pull.del --help

Delete a pull configuration from a layer.

Usage: layer.pull.del [options] <layr> <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <layr>                      : Iden of the layer to modify.
  <iden>                      : Iden of the pull configuration to delete.
```

layer.push.add

The `layer.push.add` command adds a push configuration to a layer.

Syntax

```
storm> layer.push.add --help

Add a push configuration to a layer.

Usage: layer.push.add [options] <layr> <dest>

Options:

  --help                      : Display the command usage.
  --offset <offset>           : Layer offset to begin pushing from. (default: 0)

Arguments:

  <layr>                      : Iden of the layer to push from.
  <dest>                      : Telepath url of the layer to push to.
```

layer.push.list

The `layer.push.list` command lists the push configurations for a layer.

Syntax

```
storm> layer.push.list --help

Get a list of the push configurations for a layer.

Usage: layer.push.list [options] <layr>

Options:

  --help                      : Display the command usage.

Arguments:

  <layr>                      : Iden of the layer to retrieve push configurations for.
```

layer.push.del

The `layer.push.del` command deletes a push configuration from a layer.

Syntax

```
storm> layer.push.del --help

Delete a push configuration from a layer.

Usage: layer.push.del [options] <layr> <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <layr>                      : Iden of the layer to modify.
  <iden>                      : Iden of the push configuration to delete.
```

lift

Storm includes `lift.*` commands that allow you to perform specialized lift operations.

- *lift.byverb*

Help for individual `lift.*` commands can be displayed using:

```
<command> --help
```

lift.byverb

The `lift.byverb` command lifts nodes that are connected by the specified lightweight (light) edge. By default, the command lifts the N1 nodes (i.e., the nodes on the left side of the directional light edge relationship: `n1 -(<verb>)> n2`)

Note: For other commands associated with light edges, see `edges.del` and `model.edge.*` under *edges* and *model* respectively.

Syntax:

```
storm> lift.byverb --help


    Lift nodes from the current view by an light edge verb.

    Examples:

        # Lift all the n1 nodes for the light edge "foo"
        lift.byverb "foo"

        # Lift all the n2 nodes for the light edge "foo"
        lift.byverb --n2 "foo"

    Notes:

        Only a single instance of a node will be yielded from this command
        when that node is lifted via the light edge membership.


Usage: lift.byverb [options] <verb>

Options:

  --help                      : Display the command usage.
  --n2                        : Lift by the N2 value instead of N1 value.

Arguments:

  <verb>                      : The edge verb to lift nodes by.
```

limit

The `limit` command restricts the number of nodes returned from a given Storm query to the specified number of nodes.

Syntax:

```
storm> limit --help


    Limit the number of nodes generated by the query in the given position.
```

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```
    Example:

        inet:ipv4 | limit 10


Usage: limit [options] <count>

Options:

  --help                      : Display the command usage.

Arguments:

  <count>                     : The maximum number of nodes to yield.
```

Example:

- Lift a single IP address that FireEye associates with the threat group APT1:

```
storm> inet:ipv4#aka.feye.thr.apt1 | limit 1
```

Usage Notes:

- If the limit number specified (i.e., `limit 100`) is greater than the total number of nodes returned from the Storm query, no limit will be applied to the resultant nodes (i.e., all nodes will be returned).
- By design, `limit` imposes an artificial limit on the nodes returned by a query, which may impair effective analysis of data by restricting results. As such, `limit` is most useful for viewing a subset of a large result set or an exemplar node for a given form.
- While `limit` returns a sampling of nodes, it is not statistically random for the purposes of population sampling for algorithmic use.

macro

Note: See the *Storm Reference - Automation* guide for additional background on macros (as well as triggers and cron jobs), including examples.

Storm includes `macro.*` commands that allow you to work with macros (see *Macro*).

- *macro.list*
- *macro.set*
- *macro.get*
- *macro.exec*
- *macro.del*

Help for individual `macro.*` commands can be displayed using:

```
<command> --help
```

macro.list

The `macro.list` command lists the macros in a Cortex.

Syntax:

```
storm> macro.list --help


List the macros set on the cortex.


Usage: macro.list [options]

Options:

  --help                      : Display the command usage.
```

macro.set

The `macro.set` command creates (or modifies) a macro in a Cortex.

Syntax:

```
storm> macro.set --help


Set a macro definition in the cortex.

Variables can also be used that are defined outside the definition.

Examples:
    macro.set foobar ${ [+#foo] }

    # Use variable from parent scope
    macro.set bam ${ [ inet:ipv4=$val ] }
    $val=1.2.3.4 macro.exec bam


Usage: macro.set [options] <name> <storm>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the macro to set.
  <storm>                     : The storm command string or embedded query to set.
```

macro.get

The `macro.get` command retrieves and displays the specified macro.

Syntax:

```
storm> macro.get --help


Display the storm query for a macro in the cortex.


Usage: macro.get [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the macro to display.
```

macro.exec

The `macro.exec` command executes the specified macro.

Syntax:

```
storm> macro.exec --help


    Execute a named macro.

    Example:

        inet:ipv4#cno.threat.t80 | macro.exec enrich_foo



Usage: macro.exec [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the macro to execute
```

macro.del

The `macro.del` command deletes the specified macro from a Cortex.

Syntax:

```
storm> macro.del --help


Remove a macro definition from the cortex.


Usage: macro.del [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the macro to delete.
```

max

The `max` command returns the node from a given set that contains the highest value for a specified secondary property, tag interval, or variable.

Syntax:

```
storm> max --help


    Consume nodes and yield only the one node with the highest value for an expression.

    Examples:

        // Yield the file:bytes node with the highest :size property
        file:bytes#foo.bar | max :size

        // Yield the file:bytes node with the highest value for $tick
        file:bytes#foo.bar +.seen ($tick, $tock) = .seen | max $tick

        // Yield the it:dev:str node with the longest length
        it:dev:str | max $lib.len($node.value())



Usage: max [options] <valu>

Options:

  --help                      : Display the command usage.
```

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```
Arguments:

  <valu>                      : The property or variable to use for comparison.
```

Examples:

- Return the DNS A record for woot.com with the most recent `.seen` value:

```
storm> inet:dns:a:fqdn=woot.com | max .seen
inet:dns:a=('woot.com', '107.21.53.159')
        :fqdn = woot.com
        :ipv4 = 107.21.53.159
        .created = 2023/07/12 15:16:12.943
        .seen = ('2014/08/13 00:00:00.000', '2014/08/14 00:00:00.000')
```

- Return the most recent WHOIS record for domain woot.com:

```
storm> inet:whois:rec:fqdn=woot.com | max :asof
inet:whois:rec=('woot.com', '2018/05/22 00:00:00.000')
        :asof = 2018/05/22 00:00:00.000
        :fqdn = woot.com
        :text = domain name: woot.com
        .created = 2023/07/12 15:16:13.015
```

merge

The `merge` command takes a subset of nodes from a forked view and merges them down to the next layer. The nodes can optionally be reviewed without actually merging them.

Contrast with *view.merge* for merging the entire contents of a forked view.

See the *view* and *layer* commands for working with views and layers.

Syntax:

```
storm> merge --help


    Merge edits from the incoming nodes down to the next layer.

    NOTE: This command requires the current view to be a fork.

    NOTE: The arguments for including/excluding tags can accept tag glob
          expressions for specifying tags. For more information on tag glob
          expressions, check the Synapse documentation for $node.globtags().

    Examples:

        // Having tagged a new #cno.mal.redtree subgraph in a forked view...

        #cno.mal.redtree | merge --apply

        // Print out what the merge command *would* do but dont.
```

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```
        #cno.mal.redtree | merge

        // Merge any org nodes with changes in the top layer.

        diff | +ou:org | merge --apply

        // Merge all tags other than cno.* from ou:org nodes with edits in the
        // top layer.

        diff | +ou:org | merge --only-tags --exclude-tags cno.** --apply

        // Merge only tags rep.vt.* and rep.whoxy.* from ou:org nodes with edits
        // in the top layer.

        diff | +ou:org | merge --include-tags rep.vt.* rep.whoxy.* --apply

        // Lift only inet:ipv4 nodes with a changed :asn property in top layer
        // and merge all changes.

        diff --prop inet:ipv4:asn | merge --apply

        // Lift only nodes with an added #cno.mal.redtree tag in the top layer and merge␣
↪them.

        diff --tag cno.mal.redtree | merge --apply


Usage: merge [options]

Options:

  --help                     : Display the command usage.
  --apply                    : Execute the merge changes.
  --no-tags                  : Do not merge tags/tagprops or syn:tag nodes.
  --only-tags                : Only merge tags/tagprops or syn:tag nodes.
  --include-tags [<include_tags> ...]: Include specific tags/tagprops or syn:tag nodes␣
↪when merging, others are ignored. Tag glob expressions may be used to specify the tags.
↪ (default: [])
  --exclude-tags [<exclude_tags> ...]: Exclude specific tags/tagprops or syn:tag nodes␣
↪from merge.Tag glob expressions may be used to specify the tags. (default: [])
  --include-props [<include_props> ...]: Include specific props when merging, others are␣
↪ignored. (default: [])
  --exclude-props [<exclude_props> ...]: Exclude specific props from merge. (default: [])
  --diff                     : Enumerate all changes in the current layer.
```

min

The `min` command returns the node from a given set that contains the lowest value for a specified secondary property, tag interval, or variable.

Syntax:

```
storm> min --help


    Consume nodes and yield only the one node with the lowest value for an expression.

    Examples:

        // Yield the file:bytes node with the lowest :size property
        file:bytes#foo.bar | min :size

        // Yield the file:bytes node with the lowest value for $tick
        file:bytes#foo.bar +.seen ($tick, $tock) = .seen | min $tick

        // Yield the it:dev:str node with the shortest length
        it:dev:str | min $lib.len($node.value())



Usage: min [options] <valu>

Options:

  --help                      : Display the command usage.

Arguments:

  <valu>                      : The property or variable to use for comparison.
```

Examples:

- Return the DNS A record for woot.com with the oldest `.seen` value:

```
storm> inet:dns:a:fqdn=woot.com | min .seen
inet:dns:a=('woot.com', '75.101.146.4')
        :fqdn = woot.com
        :ipv4 = 75.101.146.4
        .created = 2023/07/12 15:16:12.952
        .seen = ('2013/09/21 00:00:00.000', '2013/09/22 00:00:00.000')
```

- Return the oldest WHOIS record for domain woot.com:

```
storm> inet:whois:rec:fqdn=woot.com | min :asof
inet:whois:rec=('woot.com', '2018/05/22 00:00:00.000')
        :asof = 2018/05/22 00:00:00.000
        :fqdn = woot.com
        :text = domain name: woot.com
        .created = 2023/07/12 15:16:13.015
```

model

Storm includes `model.*` commands that allow you to work with model elements.

`model.deprecated.*` commands allow you to view model elements (forms or properties) that have been marked as "deprecated", determine whether your Cortex contains deprecated nodes / nodes with deprecated properties, and optionally lock / unlock those properties to prevent (or allow) continued creation of deprecated model elements.

`model.edge.*` commands allow you to work with lightweight (light) edges. (See also the `edges.del` and `lift.byverb` commands under *edges* and *lift*, respectively.)

- *model.deprecated.check*
- *model.deprecated.lock*
- *model.deprecated.locks*
- *model.edge.list*
- *model.edge.set*
- *model.edge.get*
- *model.edge.del*

Help for individual `model.*` commands can be displayed using:

```
<command> --help
```

model.deprecated.check

The `model.deprecated.check` command lists deprecated elements, their lock status, and whether deprecated elements exist in the Cortex.

Syntax:

```
storm> model.deprecated.check --help

Check for lock status and the existence of deprecated model elements

Usage: model.deprecated.check [options]

Options:

  --help                      : Display the command usage.
```

model.deprecated.lock

The `model.deprecated.lock` command allows you to lock or unlock (e.g., disallow or allow the use of) deprecated model elements in a Cortex.

Syntax:

```
storm> model.deprecated.lock --help

Edit lock status of deprecated model elements.

```

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```
Usage: model.deprecated.lock [options] <name>

Options:

  --help                      : Display the command usage.
  --unlock                    : Unlock rather than lock the deprecated property.

Arguments:

  <name>                      : The deprecated form or property name to lock or * to␣
↪lock all.
```

model.deprecated.locks

The `model.deprecated.locks` command displays the lock status of all deprecated model elements.

Syntax:

```
storm> model.deprecated.locks --help

Display lock status of deprecated model elements.

Usage: model.deprecated.locks [options]

Options:

  --help                      : Display the command usage.
```

model.edge.list

The `model.edge.list` command displays the set of light edges currently defined in the Cortex and any `doc` values set on them.

Syntax:

```
storm> model.edge.list --help

List all edge verbs in the current view and their doc key (if set).

Usage: model.edge.list [options]

Options:

  --help                      : Display the command usage.
```

model.edge.set

The `model.edge.set` command allows you to set the value of a given key on a light edge (such as a `doc` value to specify a definition for the light edge). The current list of valid keys include the following:

- `doc`

Syntax:

```
storm> model.edge.set --help

Set a key-value for an edge verb that exists in the current view.

Usage: model.edge.set [options] <verb> <key> <valu>

Options:

  --help                      : Display the command usage.

Arguments:

  <verb>                      : The edge verb to add a key to.
  <key>                       : The key name (e.g. doc).
  <valu>                      : The string value to set.
```

model.edge.get

The `model.edge.get` command allows you to retrieve all of the keys that have been set on a light edge.

Syntax:

```
storm> model.edge.get --help

Retrieve key-value pairs for an edge verb in the current view.

Usage: model.edge.get [options] <verb>

Options:

  --help                      : Display the command usage.

Arguments:

  <verb>                      : The edge verb to retrieve.
```

model.edge.del

The `model.edge.del` command allows you to delete the key from a light edge (such as a `doc` property to specify a definition for the light edge). Deleting a key from a specific light edge does not delete the key from Synapse (e.g., the property can be re-added to the light edge or to other light edges).

Syntax:

```
storm> model.edge.del --help

Delete a global key-value pair for an edge verb in the current view.

Usage: model.edge.del [options] <verb> <key>

Options:

  --help                      : Display the command usage.

Arguments:

  <verb>                      : The edge verb to delete documentation for.
  <key>                       : The key name (e.g. doc).
```

movenodes

The `movenodes` command allows you to move nodes between layers (*Layer*) in a Cortex.

The command will move the specified storage nodes (see *Node, Storage*) - "sodes" for short - to the target layer. If a sode is the "left hand" (`n1`) of two nodes joined by a light edge (`n1 -(*)> n2`), then the edge is also moved.

Sodes are fully removed from the source layer(s) and added to (or merged with existing nodes in) the target layer.

By default (i.e., if you do not specify a source and / or target layer), `movenodes` will migrate sodes from the bottom layer in the view, through each intervening layer (if any), and finally into the top layer. If you explicitly specify a source and target layer, `movenodes` migrates the sodes **directly** from the source to the target, skipping any intervening layers (if any).

Similarly, by default as the node is moved "up", any data for that node (property values, tags) in the higher layer will take precedence over (overwrite) data from a lower layer. This precedence behavior can be modified with the appropriate command switch.

Note: The *merge* command specifically moves (merges) nodes from the top layer in a *View* to the underlying layer. Merging is a common **user action** performed in a standard "fork and merge" workflow. The `merge` command should be used to move/merge nodes **down** from a higher layer/view to a lower/underlying one.

The `movenodes` command allows you to move nodes between arbitrary layers and is meant to be used by Synapse **administrators** in very specific use cases (e.g., data that was accidentally merged into a lower layer that should not be there). It can be used to move nodes "up" from a lower layer to a higher one.

Syntax:

```
storm> movenodes --help


```

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```
    Move storage nodes between layers.

    Storage nodes will be removed from the source layers and the resulting
    storage node in the destination layer will contain the merged values (merged
    in bottom up layer order by default).

    Examples:

        // Move storage nodes for ou:org nodes to the top layer

        ou:org | movenodes --apply

        // Print out what the movenodes command *would* do but dont.

        ou:org | movenodes

        // In a view with many layers, only move storage nodes from the bottom layer
        // to the top layer.

        $layers = $lib.view.get().layers
        $top = $layers.0.iden
        $bot = $layers."-1".iden

        ou:org | movenodes --srclayers $bot --destlayer $top

        // In a view with many layers, move storage nodes to the top layer and
        // prioritize values from the bottom layer over the other layers.

        $layers = $lib.view.get().layers
        $top = $layers.0.iden
        $mid = $layers.1.iden
        $bot = $layers.2.iden

        ou:org | movenodes --precedence $bot $top $mid


Usage: movenodes [options]

Options:

  --help                     : Display the command usage.
  --apply                    : Execute the move changes.
  --srclayers [<srclayers> ...]: Specify layers to move storage nodes from (defaults to␣
↪all below the top layer) (default: None)
  --destlayer <destlayer>    : Layer to move storage nodes to (defaults to the top␣
↪layer) (default: None)
  --precedence [<precedence> ...]: Layer precedence for resolving conflicts (defaults to␣
↪bottom up) (default: None)
```

movetag

The `movetag` command moves a Synapse tag and its associated tag tree from one location in a tag hierarchy to another location. It is equivalent to "renaming" a given tag and all of its subtags. Moving a tag consists of:

- Creating the new `syn:tag` node(s).
- Copying the definitions (`:title` and `:doc` properties) from the old `syn:tag` node to the new `syn:tag` node.
- Applying the new tag(s) to the nodes with the old tag(s).
  - If the old tag(s) have associated timestamps / time intervals, they will be applied to the new tag(s).
- Deleting the old tag(s) from the nodes.
- Setting the `:isnow` property of the old `syn:tag` node(s) to reference the new `syn:tag` node.
  - The old `syn:tag` nodes are **not** deleted.
  - Once the `:isnow` property is set, attempts to apply the old tag will automatically result in the new tag being applied.

See also the *tag* command.

Syntax:

```
storm> movetag --help


    Rename an entire tag tree and preserve time intervals.

    Example:

        movetag foo.bar baz.faz.bar


Usage: movetag [options] <oldtag> <newtag>

Options:

  --help                      : Display the command usage.

Arguments:

  <oldtag>                    : The tag tree to rename.
  <newtag>                    : The new tag tree name.
```

Examples:

- Move the tag named #research to #internal.research:

```
storm> movetag research internal.research
moved tags on 1 nodes.
```

- Move the tag tree #aka.fireeye.malware to #rep.feye.mal:

```
storm> movetag aka.fireeye.malware rep.feye.mal
moved tags on 1 nodes.
```

Usage Notes:

> **Warning:** `movetag` should be used with caution as when used incorrectly it can result in "deleted" (inadvertently moved / removed) or orphaned (inadvertently retained) tags. For example, in the second example query above, all `aka.fireeye.malware` tags are renamed `rep.feye.mal`, but the tag `aka.fireeye` still exists and is still applied to all of the original nodes. In other words, the result of the above command will be that nodes previously tagged `aka.fireeye.malware` will now be tagged both `rep.feye.mal` **and** `aka.fireeye`. Users may wish to test the command on sample data first to understand its effects before applying it in a production Cortex.

nodes

Storm includes `nodes.*` commands that allow you to work with nodes and `.nodes` files.

- *nodes.import*

Help for individual `nodes.*` commands can be displayed using:

```
<command> --help
```

nodes.import

The `nodes.import` command will import a Synapse `.nodes` file (i.e., a file containing a set / subgraph of nodes, light edges, and / or tags exported from a Cortex) from a specified URL.

Syntax:

```
storm> nodes.import --help

Import a nodes file hosted at a URL into the cortex. Yields created nodes.

Usage: nodes.import [options] <urls>

Options:

  --help                      : Display the command usage.
  --no-ssl-verify             : Ignore SSL certificate validation errors.

Arguments:

  [<urls> ...]                : URL(s) to fetch nodes file from
```

note

Storm includes `note.*` commands that allow you to work with free form text notes (`meta:note` nodes).

- *note.add*

Help for individual `note.*` commands can be displayed using:

```
<command> --help
```

note.add

The `note.add` command will create a `meta:note` node containing the specified text and link it to the inbound node(s) via an `-(about)>` light edge (i.e., `meta:note=<guid> -(about)> <node(s)>`).

Syntax:

```
storm> note.add --help

Add a new meta:note node and link it to the inbound nodes using an -(about)> edge.

Usage: note.add [options] <text>

Options:

  --help                       : Display the command usage.
  --type <type>                : The note type.

Arguments:

  <text>                       : The note text to add to the nodes.
```

Usage Notes:

Note: Synapse's data and analytical models are meant to represent a broad range of data and information in a structured (and therefore **queryable**) way. As free form notes are counter to this structured approach, we recommend using `meta:note` nodes as an exception rather than a regular practice.

once

The `once` command is used to ensure a given node is processed by the associated Storm command only once, even if the same command is executed in a different, independent Storm query. The `once` command uses *Node Data* to keep track of the associated Storm command's execution, so `once` is specific to the *View* in which it is executed. You can override the single-execution feature of `once` with the `--asof` parameter.

Syntax:

```
storm> once --help


    The once command ensures that a node makes it through the once command but a single␣
↪time,
    even across independent queries. The gating is keyed by a required name parameter to
    the once command, so a node can be run through different queries, each a single time,
↪ so
    long as the names differ.

    For example, to run an enrichment command on a set of nodes just once:

        file:bytes#my.files | once enrich:foo | enrich.foo

    If you insert the once command with the same name on the same nodes, they will be
```

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```
    dropped from the pipeline. So in the above example, if we run it again, the␣
↪enrichment
    will not run a second time, as all the nodes will be dropped from the pipeline before
    reaching the enrich.foo portion of the pipeline.

    Simlarly, running this:

        file:bytes#my.files | once enrich:foo

    Also yields no nodes. And even though the rest of the pipeline is different, this␣
↪query:

        file:bytes#my.files | once enrich:foo | enrich.bar

    would not run the enrich.bar command, as the name "enrich:foo" has already been seen␣
↪to
    occur on the file:bytes passing through the once command, so all of the nodes will be
    dropped from the pipeline.

    However, this query:

        file:bytes#my.files | once look:at:my:nodes

    Would yield all the file:bytes tagged with #my.files, as the name parameter given to
    the once command differs from the original "enrich:foo".

    The once command utilizes a node's nodedata cache, and you can use the --asof␣
↪parameter
    to update the named action's timestamp in order to bypass/update the once timestamp.␣
↪So
    this command:

        inet:ipv4#my.addresses | once node:enrich --asof now | my.enrich.command

    Will yield all the enriched nodes the first time around. The second time that␣
↪command is
    run, all of those nodes will be re-enriched, as the asof timestamp will be greater␣
↪the
    second time around, so no nodes will be dropped.

    As state tracking data for the once command is stored as nodedata, it is stored in␣
↪your
    view's write layer, making it view-specific. So if you have two views, A and B, and␣
↪they
    do not share any layers between them, and you execute this query in view A:

        inet:ipv4=8.8.8.8 | once enrich:address | enrich.baz

    And then you run it in view B, the node will still pass through the once command to␣
↪the
    enrich.baz portion of the pipeline, as the nodedata for the once command does not yet
    exist in view B.
```

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```
Usage: once [options] <name>

Options:

  --help                      : Display the command usage.
  --asof <asof>               : The associated time the name was updated/performed.␣
↪(default: None)

Arguments:

  <name>                      : Name of the action to only perform once.
```

parallel

The Storm `parallel` command allows you to execute a Storm query using a specified number of query pipelines. This can improve performance for some queries.

See also *background*.

Syntax:

```
storm> parallel --help


    Execute part of a query pipeline in parallel.
    This can be useful to minimize round-trip delay during enrichments.

    Examples:
        inet:ipv4#foo | parallel { $place = $lib.import(foobar).lookup(:latlong) [␣
↪:place=$place ] }

    NOTE: Storm variables set within the parallel query pipelines do not interact.


Usage: parallel [options] <query>

Options:

  --help                      : Display the command usage.
  --size <size>               : The number of parallel Storm pipelines to execute.␣
↪(default: 8)

Arguments:

  <query>                     : The query to execute in parallel.
```

pkg

Storm includes `pkg.*` commands that allow you to work with Storm packages (see *Package*).

- *pkg.list*
- *pkg.load*
- *pkg.del*
- *pkg.docs*
- *pkg.perms.list*

Help for individual `pkg.*` commands can be displayed using:

```
<command> --help
```

Packages typically contain Storm commands and Storm library code used to implement a Storm *Service*.

pkg.list

The `pkg.list` command lists each Storm package loaded in the Cortex. Output is displayed in tabular form and includes the package name and version information.

Syntax:

```
storm> pkg.list --help

List the storm packages loaded in the cortex.

Usage: pkg.list [options]

Options:

  --help                      : Display the command usage.
```

pkg.load

The `pgk.load` command loads the specified package into the Cortex.

Syntax:

```
storm> pkg.load --help

Load a storm package from an HTTP URL.

Usage: pkg.load [options] <url>

Options:

  --help                      : Display the command usage.
  --raw                       : Response JSON is a raw package definition without an␣
↪envelope.
  --verify                    : Enforce code signature verification on the storm package.
  --ssl-noverify              : Specify to disable SSL verification of the server.
```

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```
Arguments:

  <url>                         : The HTTP URL to load the package from.
```

pkg.del

The `pkg.del` command removes a Storm package from the Cortex.

Syntax:

```
storm> pkg.del --help

Remove a storm package from the cortex.

Usage: pkg.del [options] <name>

Options:

  --help                        : Display the command usage.

Arguments:

  <name>                        : The name (or name prefix) of the package to remove.
```

pkg.docs

The `pkg.docs` command displays the documentation for a Storm package.

Syntax:

```
storm> pkg.docs --help

Display documentation included in a storm package.

Usage: pkg.docs [options] <name>

Options:

  --help                        : Display the command usage.

Arguments:

  <name>                        : The name (or name prefix) of the package.
```

pkg.perms.list

The `pkg.perms.list` command lists the permissions declared by a Storm package.

Syntax:

```
storm> pkg.perms.list --help

List any permissions declared by the package.

Usage: pkg.perms.list [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name (or name prefix) of the package.
```

ps

Storm includes `ps.*` commands that allow you to work with Storm tasks/queries.

- *ps.list*
- *ps.kill*

Help for individual `ps.*` commands can be displayed using:

```
<command> --help
```

ps.list

The `ps.list` command lists the currently executing tasks/queries. By default, the command displays the first 120 characters of the executing query. The `--verbose` option can be used to display the full query regardless of length.

Syntax:

```
storm> ps.list --help

List running tasks in the cortex.

Usage: ps.list [options]

Options:

  --help                      : Display the command usage.
  --verbose                   : Enable verbose output.
```

ps.kill

The `ps.kill` command can be used to terminate an executing task/query. The command requires the *Iden* of the task to be terminated, which can be obtained with *ps.list*.

Syntax:

```
storm> ps.kill --help

Kill a running task/query within the cortex.

Usage: ps.kill [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid process iden␣
↪is accepted.
```

queue

Storm includes `queue.*` commands that allow you to work with queues (see *Queue*).

- *queue.add*
- *queue.list*
- *queue.del*

Help for individual `queue.*` commands can be displayed using:

```
<command> --help
```

queue.add

The `queue.add` command adds a queue to the Cortex.

Syntax:

```
storm> queue.add --help

Add a queue to the cortex.

Usage: queue.add [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the new queue.
```

queue.list

The `queue.list` command lists each queue in the Cortex.

Syntax:

```
storm> queue.list --help

List the queues in the cortex.

Usage: queue.list [options]

Options:

  --help                      : Display the command usage.
```

queue.del

The `queue.del` command removes a queue from the Cortex.

Syntax:

```
storm> queue.del --help

Remove a queue from the cortex.

Usage: queue.del [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the queue to remove.
```

reindex

The `reindex` command is currently reserved for future use.

The intended purpose of this administrative command is to reindex a given node property. This may be necessary as part of a manual data migration.

Note: Any changes to the Synapse data model are noted in the changelog for the relevant Synapse release. Changes that require data migration are specifically noted and the data migration is typically performed automatically when deploying the new version. See the *Data Migration* section of the *Synapse Devops Guide* for additional detail.

Syntax:

```
storm> reindex --help
```

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```
    Use admin privileges to re index/normalize node properties.

    NOTE: Currently does nothing but is reserved for future use.


Usage: reindex [options]

Options:

  --help                      : Display the command usage.
```

runas

The `runas` command allows you to execute a Storm query as a specified user.

Note: The `runas` commmand requires **admin** permisisons.

Syntax:

```
storm> runas --help


    Execute a storm query as a specified user.

    NOTE: This command requires admin privileges.

    Examples:

        // Create a node as another user.
        runas someuser { [ inet:fqdn=foo.com ] }


Usage: runas [options] <user> <storm>

Options:

  --help                      : Display the command usage.
  --asroot                    : Propagate asroot to query subruntime.

Arguments:

  <user>                      : The user name or iden to execute the storm query as.
  <storm>                     : The storm query to execute.
```

scrape

The `scrape` command parses one or more secondary properties of the inbound node(s) and attempts to identify ("scrape") common forms from the content, creating the nodes if they do not already exist. This is useful (for example) for extracting forms such as email addresses, domains, URLs, hashes, etc. from unstructured text.

The `--refs` switch can be used to optionally link the source nodes(s) to the scraped forms via `refs` light edges.

By default, the `scrape` command will return the nodes that it received as input. The `--yield` option can be used to return the scraped nodes rather than the input nodes.

Syntax:

```
storm> scrape --help


    Use textual properties of existing nodes to find other easily recognizable nodes.

    Examples:

        # Scrape properties from inbound nodes and create standalone nodes.
        inet:search:query | scrape

        # Scrape properties from inbound nodes and make refs light edges to the scraped␣
↪nodes.
        inet:search:query | scrape --refs

        # Scrape only the :engine and :text props from the inbound nodes.
        inet:search:query | scrape :text :engine

        # Scrape properties inbound nodes and yield newly scraped nodes.
        inet:search:query | scrape --yield

        # Skip re-fanging text before scraping.
        inet:search:query | scrape --skiprefang

        # Limit scrape to specific forms.
        inet:search:query | scrape --forms (inet:fqdn, inet:ipv4)


Usage: scrape [options] <values>

Options:

  --help                     : Display the command usage.
  --refs                     : Create refs light edges to any scraped nodes from the␣
↪input node
  --yield                    : Include newly scraped nodes in the output
  --skiprefang               : Do not remove de-fanging from text before scraping
  --forms <forms>            : Only scrape values which match specific forms. (default:␣
↪[])

Arguments:

  [<values> ...]             : Specific relative properties or variables to scrape
```

Example:

- Scrape the text of WHOIS records for the domain `woot.com` and create nodes for common forms found in the text:

```
storm> inet:whois:rec:fqdn=woot.com | scrape :text
inet:whois:rec=('woot.com', '2018/05/22 00:00:00.000')
        :asof = 2018/05/22 00:00:00.000
        :fqdn = woot.com
        :text = domain name: woot.com
        .created = 2023/07/12 15:16:13.015
```

Usage Notes:

- If no properties to scrape are specified, `scrape` will attempt to scrape **all** properties of the inbound nodes by default.
- `scrape` will only scrape node **properties**; it will not scrape files (this includes files that may be referenced by properties, such as `media:news:file`). In other words, `scrape` cannot be used to parse indicators from a file such as a PDF.
- `scrape` extracts the following forms / indicators (note that this list may change as the command is updated):
  - FQDNs
  - IPv4s
  - Servers (IPv4 / port combinations)
  - Hashes (MD5, SHA1, SHA256)
  - URLs
  - Email addresses
  - Cryptocurrency addresses
- `scrape` is able to recognize and account for common "defanging" techniques (such as `evildomain[.]com`, `myemail[@]somedomain.net`, or `hxxp://badwebsite.org/`), and will scrape "defanged" indicators by default. Use the `--skiprefang` switch to ignore defanged indicators.

service

Storm includes `service.*` commands that allow you to work with Storm services (see *Service*).

- *service.add*
- *service.list*
- *service.del*

Help for individual `service.*` commands can be displayed using:

```
<command> --help
```

service.add

The `service.add` command adds a Storm service to the Cortex.

Syntax:

```
storm> service.add --help

Add a storm service to the cortex.

Usage: service.add [options] <name> <url>

Options:

  --help                      : Display the command usage.

Arguments:

  <name>                      : The name of the service.
  <url>                       : The telepath URL for the remote service.
```

service.list

The `service.list` command lists each Storm service in the Cortex.

Syntax:

```
storm> service.list --help

List the storm services configured in the cortex.

Usage: service.list [options]

Options:

  --help                      : Display the command usage.
```

service.del

The `service.del` command removes a Storm service from the Cortex.

Syntax:

```
storm> service.del --help

Remove a storm service from the cortex.

Usage: service.del [options] <iden>

Options:

  --help                      : Display the command usage.
```

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```
Arguments:

  <iden>                        : The service identifier or prefix.
```

sleep

The `sleep` command adds a delay in returning each result for a given Storm query. By default, query results are streamed back and displayed as soon as they arrive for optimal performance. A `sleep` delay effectively slows the display of results.

Syntax:

```
storm> sleep --help


    Introduce a delay between returning each result for the storm query.

    NOTE: This is mostly used for testing / debugging.

    Example:

        #foo.bar | sleep 0.5



Usage: sleep [options] <delay>

Options:

  --help                        : Display the command usage.

Arguments:

  <delay>                       : Delay in floating point seconds.
```

Example:

- Retrieve email nodes from a Cortex every second:

```
storm> inet:email | sleep 1.0
inet:email=bar@gmail.com
        :fqdn = gmail.com
        :user = bar
        .created = 2023/07/12 15:16:13.991
inet:email=baz@gmail.com
        :fqdn = gmail.com
        :user = baz
        .created = 2023/07/12 15:16:13.996
inet:email=foo@gmail.com
        :fqdn = gmail.com
        :user = foo
        .created = 2023/07/12 15:16:13.984
```

spin

The `spin` command is used to suppress the output of a Storm query. `Spin` simply consumes all nodes sent to the command, so no nodes are output to the CLI. This allows you to execute a Storm query and view messages and results without displaying the associated nodes.

Syntax:

```
storm> spin --help


    Iterate through all query results, but do not yield any.
    This can be used to operate on many nodes without returning any.

    Example:

        foo:bar:size=20 [ +#hehe ] | spin



Usage: spin [options]

Options:

  --help                      : Display the command usage.
```

Example:

- Add the tag #int.research to any domain containing the string "firefox" but do not display the nodes.

```
storm> inet:fqdn~=firefox [+#int.research] | spin
```

splice

Note: The Synapse `splice.*` commands are deprecated. The use of views (*View*) and layers (*Layer*) - in particular, the ability to *Fork* a view to create a "scratch space" for changes which can then be merged or discarded - provides greater flexiblity and granularity in managing data and discarding unwanted changes.

Storm includes `splice.*` commands that allow you to work with splices (see *Splice*).

- *splice.list*
- *splice.undo*

Splices are represented as **runtime nodes** ("runt nodes" - see *Node, Runt*) of the form `syn:splice`. These runt nodes can be lifted and filtered just like standard nodes in a Cortex.

Help for individual `splice.*` commands can be displayed using:

```
<command> --help
```

splice.list

`splice.list` is a **deprecated** command. `splice.list` allows you to list (view) splices in the splice log. By default, splices are displayed starting with the most recent and working backwards through the log.

Syntax:

```
storm> splice.list --help


    Deprecated command to retrieve a list of splices backwards from the end of the␣
↪splicelog.

    Examples:

        # Show the last 10 splices.
        splice.list | limit 10

        # Show splices after a specific time.
        splice.list --mintime "2020/01/06 15:38:10.991"

        # Show splices from a specific timeframe.
        splice.list --mintimestamp 1578422719360 --maxtimestamp 1578422719367

    Notes:

        If both a time string and timestamp value are provided for a min or max,
        the timestamp will take precedence over the time string value.


Usage: splice.list [options]

Options:

  --help                      : Display the command usage.
  --maxtimestamp <maxtimestamp>: Only yield splices which occurred on or before this␣
↪timestamp. (default: None)
  --mintimestamp <mintimestamp>: Only yield splices which occurred on or after this␣
↪timestamp. (default: None)
  --maxtime <maxtime>         : Only yield splices which occurred on or before this time.
↪ (default: None)
  --mintime <mintime>         : Only yield splices which occurred on or after this time.␣
↪(default: None)
```

splice.undo

`splice.undo` is a **deprecated** command.. `splice.undo` allows a user with appropriate permissions to roll back or undo the specified set of splices (changes).

Syntax:

```
storm> splice.undo --help


    Deprecated command to reverse the actions of syn:splice runt nodes.

    Examples:

        # Undo the last 5 splices.
        splice.list | limit 5 | splice.undo

        # Undo splices after a specific time.
        splice.list --mintime "2020/01/06 15:38:10.991" | splice.undo

        # Undo splices from a specific timeframe.
        splice.list --mintimestamp 1578422719360 --maxtimestamp 1578422719367 | splice.
↪undo


Usage: splice.undo [options]

Options:

  --help                      : Display the command usage.
  --force                     : Force delete nodes even if it causes broken references␣
↪(requires admin).
```

tag

Storm includes `tag.*` commands that allow you to work with tags (see *Tag*).

- *tag.prune*

Help for individual `tag.*` commands can be displayed using:

```
<command> --help
```

See also the related *movetag* command.

tag.prune

The `tag.prune` command will delete the tags from incoming nodes, as well as all of their parent tags that don't have other tags as children.

Syntax:

```
storm> tag.prune --help


    Prune a tag (or tags) from nodes.

    This command will delete the tags specified as parameters from incoming nodes,
    as well as all of their parent tags that don't have other tags as children.

    For example, given a node with the tags:

        #parent
        #parent.child
        #parent.child.grandchild

    Pruning the parent.child.grandchild tag would remove all tags. If the node had
    the tags:

        #parent
        #parent.child
        #parent.child.step
        #parent.child.grandchild

    Pruning the parent.child.grandchild tag will only remove the parent.child.grandchild
    tag as the parent tags still have other children.

    Examples:

        # Prune the parent.child.grandchild tag
        inet:ipv4=1.2.3.4 | tag.prune parent.child.grandchild


Usage: tag.prune [options] <tags>

Options:

  --help                      : Display the command usage.

Arguments:

  [<tags> ...]                : Names of tags to prune.
```

tee

The `tee` command executes multiple Storm queries on the inbound nodes and returns the combined result set.

Syntax:

```
storm> tee --help


    Execute multiple Storm queries on each node in the input stream, joining output␣
↪streams together.

    Commands are executed in order they are given; unless the ``--parallel`` switch is␣
↪provided.

    Examples:

        # Perform a pivot out and pivot in on a inet:ivp4 node
        inet:ipv4=1.2.3.4 | tee { -> * } { <- * }

        # Also emit the inbound node
        inet:ipv4=1.2.3.4 | tee --join { -> * } { <- * }

        # Execute multiple enrichment queries in parallel.
        inet:ipv4=1.2.3.4 | tee -p { enrich.foo } { enrich.bar } { enrich.baz }



Usage: tee [options] <query>

Options:

  --help                      : Display the command usage.
  --join                      : Emit inbound nodes after processing storm queries.
  --parallel                  : Run the storm queries in parallel instead of sequence.␣
↪The node output order is not guaranteed.

Arguments:

  [<query> ...]               : Specify a query to execute on the input nodes.
```

Examples:

- Return the set of domains and IP addresses associated with a set of DNS A records.

```
storm> inet:fqdn:zone=mydomain.com -> inet:dns:a | tee { -> inet:fqdn } { -> inet:ipv4 }
inet:fqdn=baz.mydomain.com
        :domain = mydomain.com
        :host = baz
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.228
inet:ipv4=127.0.0.2
        :type = loopback
```

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```
        .created = 2023/07/12 15:16:17.228
inet:fqdn=foo.mydomain.com
        :domain = mydomain.com
        :host = foo
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.212
inet:ipv4=8.8.8.8
        :type = unicast
        .created = 2023/07/12 15:16:17.212
inet:fqdn=bar.mydomain.com
        :domain = mydomain.com
        :host = bar
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.221
inet:ipv4=34.56.78.90
        :type = unicast
        .created = 2023/07/12 15:16:17.221
```

- Return the set of domains and IP addresses associated with a set of DNS A records along with the original DNS A records.

```
storm> inet:fqdn:zone=mydomain.com -> inet:dns:a | tee --join { -> inet:fqdn } { ->␣
↪inet:ipv4 }
inet:fqdn=baz.mydomain.com
        :domain = mydomain.com
        :host = baz
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.228
inet:ipv4=127.0.0.2
        :type = loopback
        .created = 2023/07/12 15:16:17.228
inet:dns:a=('baz.mydomain.com', '127.0.0.2')
        :fqdn = baz.mydomain.com
        :ipv4 = 127.0.0.2
        .created = 2023/07/12 15:16:17.228
inet:fqdn=foo.mydomain.com
        :domain = mydomain.com
        :host = foo
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.212
inet:ipv4=8.8.8.8
        :type = unicast
        .created = 2023/07/12 15:16:17.212
inet:dns:a=('foo.mydomain.com', '8.8.8.8')
```

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```
        :fqdn = foo.mydomain.com
        :ipv4 = 8.8.8.8
        .created = 2023/07/12 15:16:17.212
inet:fqdn=bar.mydomain.com
        :domain = mydomain.com
        :host = bar
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:16:17.221
inet:ipv4=34.56.78.90
        :type = unicast
        .created = 2023/07/12 15:16:17.221
inet:dns:a=('bar.mydomain.com', '34.56.78.90')
        :fqdn = bar.mydomain.com
        :ipv4 = 34.56.78.90
        .created = 2023/07/12 15:16:17.221
```

Usage Notes:

- `tee` can take an arbitrary number of Storm queries (i.e., 1 to n queries) as arguments.

tree

The `tree` command recursively performs the specified pivot until no additional nodes are returned.

Syntax:

```
storm> tree --help


    Walk elements of a tree using a recursive pivot.

    Examples:

        # pivot upward yielding each FQDN
        inet:fqdn=www.vertex.link | tree { :domain -> inet:fqdn }


Usage: tree [options] <query>

Options:

  --help                      : Display the command usage.

Arguments:

  <query>                     : The pivot query
```

Example:

- List the full set of tags in the "TTP" tag hierarchy.

```
storm> syn:tag=ttp | tree { $node.value() -> syn:tag:up }
syn:tag=ttp
        :base = ttp
        :depth = 0
        .created = 2023/07/12 15:16:17.358
syn:tag=ttp.phish
        :base = phish
        :depth = 1
        :up = ttp
        .created = 2023/07/12 15:16:17.369
syn:tag=ttp.phish.payload
        :base = payload
        :depth = 2
        :up = ttp.phish
        .created = 2023/07/12 15:16:17.369
syn:tag=ttp.opsec
        :base = opsec
        :depth = 1
        :up = ttp
        .created = 2023/07/12 15:16:17.358
syn:tag=ttp.opsec.anon
        :base = anon
        :depth = 2
        :up = ttp.opsec
        .created = 2023/07/12 15:16:17.358
syn:tag=ttp.se
        :base = se
        :depth = 1
        :up = ttp
        .created = 2023/07/12 15:16:17.364
syn:tag=ttp.se.masq
        :base = masq
        :depth = 2
        :up = ttp.se
        .created = 2023/07/12 15:16:17.364
```

Usage Notes:

- `tree` is useful for "walking" a set of properties with a single command vs. performing an arbitrary number of pivots until the end of the data is reached.

trigger

Note: See the *Storm Reference - Automation* guide for additional background on triggers (as well as cron jobs and macros), including examples.

Storm includes `trigger.*` commands that allow you to create automated event-driven triggers (see *Trigger*) using the Storm query syntax.

- *trigger.add*
- *trigger.list*

- *trigger.mod*
- *trigger.disable*
- *trigger.enable*
- *trigger.del*

Help for individual `trigger.*` commands can be displayed using:

```
<command> --help
```

Triggers are added to the Cortex as **runtime nodes** ("runt nodes" - see *Node, Runt*) of the form `syn:trigger`. These runt nodes can be lifted and filtered just like standard nodes in Synapse.

trigger.add

The `trigger.add` command adds a trigger to a Cortex.

Syntax:

```
storm> trigger.add --help


Add a trigger to the cortex.

Notes:
    Valid values for condition are:
        * tag:add
        * tag:del
        * node:add
        * node:del
        * prop:set

When condition is tag:add or tag:del, you may optionally provide a form name
to restrict the trigger to fire only on tags added or deleted from nodes of
those forms.

The added tag is provided to the query as an embedded variable '$tag'.

Simple one level tag globbing is supported, only at the end after a period,
that is aka.* matches aka.foo and aka.bar but not aka.foo.bar. aka* is not
supported.

Examples:
    # Adds a tag to every inet:ipv4 added
    trigger.add node:add --form inet:ipv4 --query {[ +#mytag ]}

    # Adds a tag #todo to every node as it is tagged #aka
    trigger.add tag:add --tag aka --query {[ +#todo ]}

    # Adds a tag #todo to every inet:ipv4 as it is tagged #aka
    trigger.add tag:add --form inet:ipv4 --tag aka --query {[ +#todo ]}


Usage: trigger.add [options] <condition>
```

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```
Options:

  --help                      : Display the command usage.
  --form <form>               : Form to fire on.
  --tag <tag>                 : Tag to fire on.
  --prop <prop>               : Property to fire on.
  --query <storm>             : Query for the trigger to execute.
  --async                     : Make the trigger run in the background.
  --disabled                  : Create the trigger in disabled state.
  --name <name>               : Human friendly name of the trigger.

Arguments:

  <condition>                 : Condition for the trigger.
```

trigger.list

The `trigger-list` command displays the set of triggers in the Cortex that the current user can view / modify based on their permissions. Triggers are displayed at the Storm CLI in tabular format, with columns including the user who created the trigger, the *Iden* of the trigger, the condition that fires the trigger (i.e., `node:add`), and the Storm query associated with the trigger.

Triggers are displayed in alphanumeric order by iden. Triggers are sorted upon Cortex initialization, so newly-created triggers will be displayed at the bottom of the list until the list is re-sorted the next time the Cortex is restarted.

Note: Triggers can also be viewed in runt node form as `syn:trigger` nodes.

Syntax:

```
storm> trigger.list --help

List existing triggers in the cortex.

Usage: trigger.list [options]

Options:

  --help                      : Display the command usage.
```

trigger.mod

The `trigger.mod` command modifies the Storm query associated with a specific trigger. To modify a trigger, you must provide the first portion of the trigger's iden (i.e., enough of the iden that the trigger can be uniquely identified), which can be obtained using `trigger.list` or by lifting the appropriate `syn:trigger` node.

Note: Other aspects of the trigger, such as the condition used to fire the trigger or the tag or property associated with the trigger, cannot be modified once the trigger has been created. To change these aspects, you must delete and re-add

the trigger.

Syntax:

```
storm> trigger.mod --help

Modify an existing trigger's query.

Usage: trigger.mod [options] <iden> <query>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid trigger iden␣
↪is accepted.
  <query>                     : New storm query for the trigger.
```

trigger.disable

The `trigger.disable` command disables a trigger and prevents it from firing without removing it from the Cortex. To disable a trigger, you must provide the first portion of the trigger's iden (i.e., enough of the iden that the trigger can be uniquely identified), which can be obtained using `trigger.list` or by lifting the appropriate `syn:trigger` node.

Syntax:

```
storm> trigger.disable --help

Disable a trigger in the cortex.

Usage: trigger.disable [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid trigger iden␣
↪is accepted.
```

trigger.enable

The `trigger-enable` command enables a disabled trigger. To enable a trigger, you must provide the first portion of the trigger's iden (i.e., enough of the iden that the trigger can be uniquely identified), which can be obtained using `trigger.list` or by lifting the appropriate `syn:trigger` node.

Note: Triggers are enabled by default upon creation.

Syntax:

```
storm> trigger.enable --help

Enable a trigger in the cortex.

Usage: trigger.enable [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid trigger iden␣
↪is accepted.
```

trigger.del

The `trigger.del` command permanently removes a trigger from the Cortex. To delete a trigger, you must provide the first portion of the trigger's iden (i.e., enough of the iden that the trigger can be uniquely identified), which can be obtained using `trigger.list` or by lifting the appropriate `syn:trigger` node.

Syntax:

```
storm> trigger.del --help

Delete a trigger from the cortex.

Usage: trigger.del [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Any prefix that matches exactly one valid trigger iden␣
↪is accepted.
```

uniq

The `uniq` command removes duplicate results from a Storm query. Results are uniqued based on each node's node identifier (node ID / iden) so that only the first node with a given node ID is returned.

Syntax:

```
storm> uniq --help


    Filter nodes by their uniq iden values.
    When this is used a Storm pipeline, only the first instance of a
    given node is allowed through the pipeline.

    A relative property or variable may also be specified, which will cause
    this command to only allow through the first node with a given value for
    that property or value rather than checking the node iden.

    Examples:

        # Filter duplicate nodes after pivoting from inet:ipv4 nodes tagged with
↪#badstuff
        #badstuff +inet:ipv4 ->* | uniq

        # Unique inet:ipv4 nodes by their :asn property
        #badstuff +inet:ipv4 | uniq :asn


Usage: uniq [options] <value>

Options:

  --help                      : Display the command usage.

Arguments:

  [value]                     : A relative property or variable to uniq by.
```

Examples:

- Lift all of the unique IP addresses that domains associated with the Fancy Bear threat group have resolved to:

```
storm> inet:fqdn#rep.threatconnect.fancybear -> inet:dns:a -> inet:ipv4 | uniq
inet:ipv4=111.90.148.124
        :type = unicast
        .created = 2023/07/12 15:16:17.635
inet:ipv4=209.99.40.222
        :type = unicast
        .created = 2023/07/12 15:16:17.645
inet:ipv4=141.8.224.221
        :type = unicast
        .created = 2023/07/12 15:16:17.654
```

uptime

The `uptime` command displays the uptime for the Cortex or specified service.

Syntax:

```
storm> uptime --help

Print the uptime for the Cortex or a connected service.

Usage: uptime [options] <name>

Options:

  --help                      : Display the command usage.

Arguments:

  [name]                      : The name, or iden, of the service (if not provided
↪defaults to the Cortex).
```

version

The `version` command displays the current version of Synapse and associated metadata.

Syntax:

```
storm> version --help

Show version metadata relating to Synapse.

Usage: version [options]

Options:

  --help                      : Display the command usage.
```

view

Storm includes `view.*` commands that allow you to work with views (see *View*).

- *view.add*
- *view.fork*
- *view.set*
- *view.get*
- *view.list*
- *view.exec*
- *view.merge*
- *view.del*

Help for individual `view.*` commands can be displayed using:

```
<command> --help
```

view.add

The `view.add` command adds a view to the Cortex.

Syntax:

```
storm> view.add --help

Add a view to the cortex.

Usage: view.add [options]

Options:

  --help                      : Display the command usage.
  --name <name>               : The name of the new view. (default: None)
  --layers [<layers> ...]     : Layers for the view. (default: [])
```

view.fork

The `view.fork` command forks an existing view from the Cortex. Forking a view creates a new view with a new writeable layer on top of the set of layers from the previous (forked) view.

Syntax:

```
storm> view.fork --help

Fork a view in the cortex.

Usage: view.fork [options] <iden>

Options:

  --help                      : Display the command usage.
  --name <name>               : Name for the newly forked view. (default: None)

Arguments:

  <iden>                      : Iden of the view to fork.
```

view.set

The `view.set` command sets a property on the specified view.

Syntax:

```
storm> view.set --help

Set a view option.

Usage: view.set [options] <iden> <name> <valu>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Iden of the view to modify.
  <name>                      : The name of the view property to set.
  <valu>                      : The value to set the view property to.
```

view.get

The `view.get` command retrieves an existing view from the Cortex.

Syntax:

```
storm> view.get --help

Get a view from the cortex.

Usage: view.get [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  [iden]                      : Iden of the view to get. If no iden is provided, the␣
↪main view will be returned.
```

view.list

The `view.list` command lists the views in the Cortex.

Syntax:

```
storm> view.list --help

List the views in the cortex.

Usage: view.list [options]

Options:

  --help                      : Display the command usage.
```

view.exec

The `view.exec` command executes a Storm query in the specified view.

Syntax:

```
storm> view.exec --help


    Execute a storm query in a different view.

    NOTE: Variables are passed through but nodes are not

    Examples:

        // Move some tagged nodes to another view
        inet:fqdn#foo.bar $fqdn=$node.value() | view.exec␣
↪95d5f31f0fb414d2b00069d3b1ee64c6 { [ inet:fqdn=$fqdn ] }


Usage: view.exec [options] <view> <storm>

Options:

  --help                      : Display the command usage.

Arguments:

  <view>                      : The GUID of the view in which the query will execute.
  <storm>                     : The storm query to execute on the view.
```

view.merge

The `view.merge` command merges **all** data from a forked view into its parent view.

Contrast with *merge* which can merge a subset of nodes.

Syntax:

```
storm> view.merge --help

Merge a forked view into its parent view.

Usage: view.merge [options] <iden>

Options:

  --help                      : Display the command usage.
  --delete                    : Once the merge is complete, delete the layer and view.

Arguments:

  <iden>                      : Iden of the view to merge.
```

view.del

The `view.del` command permanently deletes a view from the Cortex.

Syntax:

```
storm> view.del --help

Delete a view from the cortex.

Usage: view.del [options] <iden>

Options:

  --help                      : Display the command usage.

Arguments:

  <iden>                      : Iden of the view to delete.
```

wget

The `wget` command retrieves content from one or more specified URLs. The command creates and yields `inet:urlfile` nodes and the retrieved content (`file:bytes`) is stored in the *Axon*.

Syntax:

```
storm> wget --help

Retrieve bytes from a URL and store them in the axon. Yields inet:urlfile nodes.
```

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```
Examples:

    # Specify custom headers and parameters
    inet:url=https://vertex.link/foo.bar.txt | wget --headers $lib.dict("User-Agent"=
↪"Foo/Bar") --params $lib.dict("clientid"="42")

    # Download multiple URL targets without inbound nodes
    wget https://vertex.link https://vtx.lk


Usage: wget [options] <urls>

Options:

  --help                      : Display the command usage.
  --no-ssl-verify             : Ignore SSL certificate validation errors.
  --timeout <timeout>         : Configure the timeout for the download operation.␣
↪(default: 300)
  --params <params>           : Provide a dict containing url parameters. (default: None)
  --headers <headers>         : Provide a Storm dict containing custom request headers.␣
↪(default:
{                                 'Accept': '*/*',
                                  'Accept-Encoding': 'gzip, deflate',
                                  'Accept-Language': 'en-US,en;q=0.9',
                                  'User-Agent': 'Mozilla/5.0 (X11; Linux x86_64) '
                                                'AppleWebKit/537.36 (KHTML, like Gecko) '
                                                'Chrome/92.0.4515.131 Safari/537.36'})
  --no-headers                : Do NOT use any default headers.

Arguments:

  [<urls> ...]                : URLs to download.
```

3.6.11 Storm Reference - Automation

Background

Synapse is designed to support large-scale analysis over disparate data sources with speed and efficiency. Many features that support this analysis are built into Synapse's architecture, from performance-optimized indexing and storage to an extensible data model that allows you to reason over data in a structured manner.

Synapse also supports large-scale analysis through the use of **automation.** Synapse's automation features include:

- *Triggers and Cron*
- *Macros*
- *Dmons*

Automation in Synapse provides significant advantages. It relieves analysts from performing tedious work, freeing them to focus on more detailed analysis and complex tasks. It also allows you to scale analytical operations by limiting the amount of work that must be performed manually.

Automation in Synapse uses the Storm query language. This means that **anything that can be written in Storm can be automated,** from the simple to the more advanced. Actions performed via automation are limited only by imagination and Storm proficiency. Some automation is fairly basic ("if X occurs, do Y" or "once a week, update Z"). However, automation can take advantage of all available Storm features, including subqueries, variables, libraries, control flow logic, and so on.

Considerations

This section is **not** meant as a detailed guide on implementing automation. A few items are listed here for consideration when planning the use of automation in your environment.

Permissions

Permissions impact the use of automation in Synapse in various ways. In some cases, you must explicitly grant permission for users to create and manage automation. In other cases, the permissions that a given automated task runs under may vary based on the type of automation used. See the relevant sections below for additional detail.

Scope

Automation components vary with respect to where they reside and execute within Synapse; some elements are global (within a Cortex) while some reside and execute within a specific *View*, which may impact organizations that use multiple views and / or use Synapse's ability to *Fork* a view and later merge or delete it. See the relevant sections below for additional detail.

Testing

Automation should **always** be tested before being placed into production. Storm used in automation can be syntactically correct (uses proper Storm), but contain logical errors (fail to do what you want it to do). Similarly, new automation may interact with existing automation in unexpected ways. Test your automation in a development environment (either a separate development instance, or a separate *Fork* of your production view) before implementing it in production.

Use Cases

Organizations can implement automation as they see fit. Some automation may be enterprise-wide, used to support an organization's overall mission or analysis efforts. Other automation may be put in place by individual analysts to support their own research efforts, either on an ongoing or temporary basis.

Design

There are varying approaches for "how" to write and implement automation. For example:

- Individual triggers and cron jobs can be kept entirely separate from one another, each executing their own dedicated Storm code. This approach helps keep automation "self-contained" and means the Storm executed by a given trigger or cron job is directly introspectable via Storm itself (as a property of `syn:trigger` or `syn:cron` nodes). However, it may provide less flexibility in executing the associated Storm compared with the use of macros.

  Alternatively, tasks such as triggers and cron jobs can be written to execute minimal Storm queries whose purpose is to call more extensive Storm stored centrally in macros. This approach consolidates much of the associated

Storm, which may make it easier to manage and maintain. Storm placed in macros also provides flexibility as the macro can be called by a trigger, a cron job, or a user as part of a Storm query.

- Automation can be written as many small, individual elements. Each element can perform a relatively simple task, but the elements can work together like building blocks to orchestrate larger-scale operations. This approach keeps tasks "bite sized" and the Storm executed by a given piece of automation generally simpler. However it may result in a larger number of automation elements to maintain, and may make it more challenging to understand the potential interactions of so many different elements.

  Alternatively, automation can be implemented using fewer elements that perform larger, more unified tasks (or that consolidate numerous smaller tasks). This approach results in fewer automation elements overall, but typically requires you to write and maintain more advanced Storm (e.g., to create a small number of macros with switch or if/else statements to each manage a variety of tasks). However, the Storm is consolidated in a few locations, which may make managing and troubleshooting easier.

Each approach has its pros and cons; there is no single "right" way, and what works best in your environment or for a particular task will depend on your needs (and possibly some trial and error).

Governance / Management

Consider any oversight or approval processes that you may need in order to implement and manage automation effectively in your environment. A number of automation use cases may require coordination or deconfliction:

- Where multiple users have the ability to create automated tasks, it is possible for them to create duplicative or even conflicting automation. Consider who should be repsonsible for deconflicting automation to mitigate against these effects.
- Automation is often used to enrich indicators (i.e., query various third-party APIs to pull in more data related to a node). Some third-party APIs may impose query limits, may be subject to a license or subscription fee, or both. Consider how to balance effective use of automation without overusing or exceeding any applicable quotas.
- Some automation may be used to apply tags to nodes or "push" tags from one node to related nodes - effectively automating the process of making an analytical assertion. Consider carefully under what circumstances this should be automated, and who should review or approve the analysis logic used to make the assertion.

Existing Synapse features will help mitigate some of these potential issues. For example, if you inadvertently create looping or recursive automation, it will eventually reach Synapse's recursion limit and error / halt (with the only bad effect being that the automation may only partially complete). In addition, Vertex-provided Synapse Power-Ups (see *Power-Up*) are written to optimize third-party API use where possible (e.g., by caching responses or by checking whether Synapse already has a copy of a file before attempting to download it from an external source). However, it is a good idea to decide on any internal controls that are necessary to ensure automation works well in your organization.

Nodes In and Nodes Out

In cases where automation operates on nodes (the most common scenario), either the automation itself or any Storm executed after the automation may fail if the inbound nodes (that is, the current nodes in the Storm pipeline) are not what is expected by the query.

Users should keep the *Storm Operating Concepts* in mind when writing automation.

Triggers and Cron

Triggers and cron are similar in terms of how they are implemented and managed.

- **Permissions.** Synapse uses permissions to determine who can create, modify, and delete triggers and cron jobs. These permissions must be explicitly granted to users and/or roles.
- **Execution.** Both triggers and cron jobs execute with the permissions **of the user who creates them.** A trigger or cron job can only perform actions that their creator has permissions to perform.
- **Introspection.** Triggers and cron jobs are created as runtime nodes ("runt nodes") in Synapse (`syn:trigger` and `syn:cron` nodes, respectively).
- **Scope.** Both triggers and cron jobs run **within a specific view.** Synapse allows the optional segregation of data in a Cortex into multiple layers (*Layer*) that can be "stacked" to provide a unified *View* of data to users. You must specify the particular view in which each trigger or cron job runs.

Note: This view-specific behavior is transparent when using a simple Synapse implementation consisting of a single Cortex with a single layer and a single view (Synapse's default configuration).

In environments with multiple views, and in particular where users may frequently *Fork* a view) you should take this view-specific behavior into account. Key considerations include determining where (in which view) triggers and cron jobs should reside, and understanding what happens when you merge or delete a view that contains triggers or cron jobs (discussed in more detail in the appropriate sections below).

Triggers

Triggers are **event-driven** automation. As their name implies, they trigger ("fire") their associated Storm when specific events occur in Synapse's data store.

Triggers can fire on the following events:

- Adding a node (`node:add`)
- Deleting a node (`node:del`)
- Setting (or modifying) a property (`prop:set`)
- Adding a tag to a node (`tag:add`)
- Deleting a tag from a node (`tag:del`)

Each event requires an object (a form, property, or tag) to act upon - that is, if you write a trigger to fire on a `node:add` event, you must specify the type of node (form) associated with the event. Similarly, if a trigger should fire on a `tag:del` event, you must specify the tag whose removal fires the trigger.

`tag:add` and `tag:del` events can take an optional form; this allows you to specify that a trigger should fire when a given tag is added (or removed) from a specific form as opposed to any / all forms.

Note: The node(s) that cause a trigger to fire are considered **inbound** to the Storm executed by the trigger.

Example Use Cases

Triggers execute **immediately** when their associated event occurs; the automation occurs in real time as opposed to waiting for a scheduled cron job to execute (or for an analyst to manually perform some task). As such, triggers are most appropriate for automating tasks that should occur right away (e.g., based on efficiency or importance). Example use cases for triggers include:

- **Performing enrichment.** Tags are often used to indicate that a node is "interesting" in some way; if a node is "interesting" we commonly want to know more about it. When an "interesting" tag is applied (`tag:add`), a trigger can execute Storm commands that immediately collect additional data about the node from various Storm services or Power-Ups.
- **Applying assessments.** You may be able to encode the logic you use to apply a tag into Storm. As a simple example, you have identified an IPv4 address as a sinkhole. When a DNS A node (`inet:dns:a`) is created where the associated IPv4 (`:ipv4` property) is the IP of the sinkhole (`prop:set`), a trigger can automatically tag the associated FQDN as sinkholed. If you want an analyst to confirm the assessment (vs. applying it in a fully automated fashion), you can apply a "review" tag instead.
- **"Pushing" tags.** Analysts may identify cases where, when they tag a particular node, they consistently also want to tag a set of "related" nodes. For example, if they tag a `file:bytes` node (as malicious, or as associated with a particular threat group) they may always want to tag the associated hashes (`hash:md5`, etc.) as well. Or, if a `file:bytes` node queries a "known bad" FQDN (via an `inet:dns:request` node), apply the tag from the FQDN to both the DNS request and the file.

Usage Notes

- Users must be granted permissions in order to be able to work with triggers (i.e., to execute the associated `trigger.*` Storm commands).
- Triggers execute **with the permissions of the user who created the trigger**. If a trigger calls a macro, the macro will execute with the permissions of the trigger (macros execute with the permissions of the calling user).

Note: Once a trigger is created, it will execute automatically when the specified event occurs. This means that while the trigger runs with the permissions of its creator, it is possible for lower-privileged users change Synapse's data (e.g., by creating a node or applying a tag) in a way that causes the trigger to fire and execute as the higher-privileged user.

This is by design; triggers should be used for automation tasks that you **always** want to occur, regardless of the user (or process) that generates the condition that fires the trigger.

- Triggers fire immediately when their associated event occurs. However, they **only** execute when that event occurs. This means:
  - Triggers do not operate retroactively on existing data. If you write a new trigger to fire when the tag `my.tag` is applied to a `hash:md5` node, the trigger will have no effect on existing `hash:md5` nodes that already have the tag.
  - If a trigger depends on a resource (process, service, etc.) that is not available when it fires, the trigger will simply fail; it will not "try again".
- By default, triggers execute **inline**. When a process (typically a Storm query) causes a trigger to fire, the Storm associated with the trigger will run **immediately and in full**. Conceptually, it is as though all of the trigger's Storm code and any additional Storm that it calls (such as a macro) are inserted into the middle of the original Storm query that fired the trigger, and executed as part of that query.

> **Warning:** This inline execution can impact your query's performance, depending on the Storm executed by the trigger and the number of nodes causing the trigger to fire. The `--async` option can be used when creating a trigger to specify that the trigger should run in the background as opposed to inline. This will cause the trigger event to be stored in a persistent queue, which will then be consumed automatically by the Cortex.
>
> As an example, you are reviewing a whitepaper on a new threat group that includes 800 indicators of compromise reportedly associated with the group. You tag all of the indicators, which fires a trigger to "enrich" those indicators from multiple third-party APIs and results in the creation of dozens of new nodes for each indicator enriched. This tag-and-enrich process is executed inline for **each** of the 800 indicators, which can slow or appear to "block" the original query you ran in order to apply the tags.
>
> If the trigger is created as an `async` trigger to run in the background, the query to apply the tags will finish quickly. This allows you to continue working while the associated enrichment completes in the background.

- Triggers are **view-specific** - they both reside and execute within a particular *View*. This has implications for environments that use multiple views or that regularly *Fork* and later merge or delete views. For example:
  - Triggers that reside in a **base view** will not fire on changes made to a view that is forked from the base. The trigger will fire when any relevant changes from the fork are merged (written) to the base view.
  - Triggers that are created in a **forked view** are **deleted** by default when you merge or delete the fork. If you want to retain any triggers created in the fork, you must explicitly move them into the base view prior to merging or deleting the fork.
- When viewing triggers (i.e., with the *trigger.list* command), Synapse returns **only those triggers in your current view**.
- In some cases proper trigger execution may depend on the timing and order of events with respect to creating nodes, setting properties, and so on. For example, you may write a trigger based on a `node:add` action that fails to perform as expected because you actually need the trigger to fire on a `prop:set` operation. The detailed technical aspects of Synapse write operations are beyond the scope of this discussion; as always it is good practice to test triggers (or other automation) before putting them into production.
- Creating a trigger will create an associated `syn:trigger` runtime node (runt node). While runt nodes (*Runt Node*) are typically read-only, `syn:trigger` nodes include `:name` and `:doc` secondary properties that can be set and modified via Storm (or configured via *Optic*). This allows you to manage triggers by giving them meaningful names and descriptions. Changes to these properties will persist even after a Cortex restart.
- `syn:trigger` nodes can be lifted, filtered, and pivoted across just like other nodes. However, they cannot be created or modified (e.g., using Storm's data modification / edit syntax) except in the limited ways described above.
- The creator (owner) of a trigger can be modified (with appropriate permissions) using the Storm *$lib.trigger* library and stormprims-storm-trigger-f527 primitive. For example:

```
$trigger=$lib.trigger.get(<trigger_iden>) $trigger.set(user, <new_user_iden>)
```

Variables

Triggers automatically have the Storm variable `$auto` populated when they run. The `$auto` variable is a dictionary which contains the following keys:

`$auto.iden`
The identifier of the Trigger.

`$auto.type`
The type of automation. For a trigger this value will be `trigger`.

`$auto.opts`
Dictionary containing trigger-specific runtime information. This includes the following keys:

`$auto.opts.form`
The form of the triggering node.

`$auto.opts.propfull`
The full name of the property that was set on the node. Only present on `prop:set` triggers.

`$auto.opts.propname`
The relative name of the property that was set on the node. Does not include a leading `:`. Only present on `prop:set` triggers.

`$auto.opts.tag`
The tag which caused the trigger to fire. Only present on `tag:add` and `tag:del` triggers.

`$auto.opts.valu`
The value of the triggering node.

Syntax

Triggers are created, modified, viewed, enabled, disabled, and deleted using the Storm `trigger.*` commands. See the *trigger* command in the *Storm Reference - Storm Commands* document for details.

In *Optic*, triggers can also be managed through either the *Admin Tool* or the *Workspaces Tool*.

Note: Once a trigger is created, you can modify many of its properties (such as its name and description, or the Storm associated with the trigger). However, you cannot modify the trigger conditions (e.g., the type of event that fires the trigger, or the form a trigger operates on). To change those conditions, you must delete and re-create the trigger.

Examples

In the examples below, we show the command to create (add) the specified trigger.

For illustrative purposes, in the **first** example the newly created trigger is displayed using the `trigger.list` command and then by lifting the associated `syn:trigger` runtime ("runt") node.

- Add a trigger that fires when an `inet:whois:email` node is created. If the email address is associated with a privacy-protected registration service (e.g., the email address is tagged `whois.private`), then also tag the `inet:whois:email` node.

```
storm> trigger.add --name "tag privacy protected inet:whois:email" node:add --form␣
↪inet:whois:email --query { +{ -> inet:email +#whois.private } [ +#whois.private ] }
Added trigger: 9a007c0c689c7dd5a360d3c8662e3e7b
```

Newly created trigger via `trigger.list`:

```
storm> trigger.list
user       iden                             en?    async? cond      object             ␣
↪     storm query
root       9a007c0c689c7dd5a360d3c8662e3e7b true   false  node:add  inet:whois:email    ␣
↪       +{ -> inet:email +#whois.private } [ +#whois.private ]
```

The output of `trigger.list` contains the following columns:

- The username used to create the trigger.
- The trigger's identifier (iden).
- Whether the trigger is currently enabled or disabled.
- Whether the trigger will run asynchronously / in the background.
- The condition that causes the trigger to fire.
- The object that the condition operates on, if any.
- The tag or tag expression used by the condition (for `tag:add` or `tag:del` conditions only).
- The query to be executed when the trigger fires.

Newly created trigger as a `syn:trigger` node:

```
storm> syn:trigger
syn:trigger=9a007c0c689c7dd5a360d3c8662e3e7b
        :cond = node:add
        :doc =
        :enabled = true
        :form = inet:whois:email
        :name = tag privacy protected inet:whois:email
        :storm = +{ -> inet:email +#whois.private } [ +#whois.private ]
        :user = 544a04c71a8c4f48a31e9758cb1295a2
        :vers = 1
```

- Add a trigger that fires when the `:exe` property of an `inet:dns:request` node is set. Check to see whether the queried FQDN is malicious; if so, tag the associated `file:bytes` node for analyst review.

```
storm> trigger.add --name "tag file:bytes for review" prop:set --prop␣
↪inet:dns:request:exe --query { +{ :query:name -> inet:fqdn +#malicious } :exe ->␣
↪file:bytes [ +#review ] }
Added trigger: fdfe2be43d5a4b1f499ba0cd01a23050
```

- Add a trigger that fires when the tag `cno.ttp.phish.payload` is applied to a `file:bytes` node (indicating that a file was an attachment to a phishing email). Use the trigger to **also** apply the tag `attack.t1566.001` (representing the MITRE ATT&CK technique "Spearphishing Attachment").

```
storm> trigger.add --name "tag phish attachment with #attack.t1566.001" tag:add --form␣
↪file:bytes --tag cno.ttp.phish.payload --query { [ +#attack.t1566.001 ] }
Added trigger: ed6759ce8cf271d5ff5fc670a8b97cb9
```

- Add a trigger that fires when the tag `osint` (indicating that the node was listed as a malicious indicator in public reporting) is applied to any node. The trigger should call (execute) a macro called `enrich`. The macro contains a Storm query that uses a switch case to call the appropriate Storm commands based on the tagged node's form (e.g., perform different enrichment / call different third-party services based on whether the node is an FQDN, an IPv4, an email address, a URL, etc.).

```
storm> trigger.add --name "enrich osint" tag:add --tag osint --query { | macro.exec␣
↪enrich }
Added trigger: cdcae880d7f459abb08bee5f847379f9
```

Cron

Cron jobs in Synapse are similar to the well-known cron utility. Where triggers are event-driven, cron jobs are **time / schedule based.** Cron jobs can be written to execute once or on a recurring schedule. When creating a cron job, you must specify the job's schedule and the Storm to be executed.

Note: When scheduling cron jobs, Synapse interprets all times as UTC.

Example Use Cases

Because cron jobs are scheduled, they are most appropriate for automating routine, non-urgent tasks; maintenance tasks; or resource-intensive tasks that should run during off-hours.

- **Data ingest.** Cron jobs can be used to ingest / synchronize data that you want to load into Synapse on a regular basis. For example, you can create a cron job to retrieve and load a list of TOR exit nodes every hour.
- **Housekeeping.** You created a trigger to automatically look up and apply geolocation and autonomous system (AS) properties to IPv4 nodes when they are created in Synapse. However, you already have a large number of IPv4 nodes that existed before the trigger was added. You can create a one-time cron job to retrieve and "backfill" this information for IPv4s that already exist.
- **Process intensive jobs.** Data enrichment may be resource intensive where it generates a significant number of write operations. If you reguarly perform routine (non-urgent) enrichment, it can be scheduled to run when it will have less impact on users.

Usage Notes

- Users must be granted permissions in order to be able to work with cron jobs (i.e., to execute the associated `cron.*` Storm commands).
- Cron jobs execute **with the permissions of the user who created the job**. If a cron job calls a macro, the macro will execute with the permissions of the cron job (macros execute with the permissions of the calling user).
- Cron jobs **reside** in the Cortex but **execute** within a particular *View*. This has implications for environments that use multiple views or that regularly *Fork* and later merge or delete views. For example:
  - Cron jobs that execute in a **forked view** are "orphaned" when you merge or delete the fork. The jobs will remain in Synapse (because they reside in the Cortex), but will not execute because they are not assigned to a view. You must assign the jobs to a new view for them to run (or delete them if no longer needed).
- When viewing cron jobs (i.e., with the *cron.list* command), Synapse returns **all cron jobs in the Cortex,** regardless of the view the job executes in.

- Cron jobs are exclusive - if for some reason a job has not finished executing before its next scheduled start, the original job will run to completion and the "new" job will be skipped.
- Creating a cron job will create an associated `syn:cron` runtime node (runt node). While runt nodes (*Runt Node*) are typically read-only, `syn:cron` nodes include `:name` and `:doc` secondary properties that can be set and modified via Storm (or configured via *Optic*). This allows you to manage cron jobs by giving them meaningful names and descriptions. Changes to these properties will persist even after a Cortex restart.
- `syn:cron` nodes can be lifted, filtered, and pivoted across just like other nodes. However, they cannot be created or modified (e.g., using Storm's data modification / edit syntax) except in the limited ways described above.
- The creator (owner) of a cron job can be modified (with appropriate permissions) using the Storm *$lib.cron* library and stormprims-storm-cronjob-f527 primitive. For example:

```
$cron=$lib.cron.get(<cron_iden>) $cron.set(creator, <new_creator_iden>)
```

Variables

Cron jobs automatically have the Storm variable `$auto` populated when they run. The `$auto` variable is a dictionary which contains the following keys:

`$auto.iden`
: The identifier of the cron job.

`$auto.type`
: The type of automation. For a cron job this value will be `cron`.

Syntax

Cron jobs are created, modified, viewed, enabled, disabled, and deleted using the Storm `cron.*` commands. See the *cron* command in the *Storm Reference - Storm Commands* document for details.

In *Optic*, cron jobs can also be managed through the *Admin Tool*.

Note: Once a cron job is created, you can modify many of its properties (such as its name and description, or the Storm associated with the job). However, you cannot modify other aspects of the job, such as its schedule. To change those conditions, you must delete and re-create the cron job.

Examples

In the examples below, we show the command to create (add) the specified cron job.

For illustrative purposes, in the **first** example the newly created cron job is then displayed using the `cron.list` command and by lifting the associated `syn:cron` runtime ("runt") node.

- Add a one-time / non-recurring cron job to run at 7:00 PM to create the RFC1918 IPv4 addresses in the 172.16.0.0/16 range.

```
storm> cron.at --hour 19 { [ inet:ipv4=172.16.0.0/16 ] }
Created cron job: d1e1c17c587a2b66f61f7583d9d20370
```

Newly created cron job via `cron.list`:

```
storm> cron.list
user       iden       view       en? rpt? now? err? # start last start       last end   ␣
↪     query
root       d1e1c17c.. ecb8fbbf.. Y   N    N         0       Never            Never      ␣
↪     [ inet:ipv4=172.16.0.0/16 ]
```

The output of `cron.list` contains the following columns:

- The username used to create the job.
- The first eight characters of the job's identifier (iden).
- The view the cron job resides in. **Note** that for "orphaned" cron jobs, this will be the job's **last** view (before it was orphaned).
- Whether the job is currently enabled or disabled.
- Whether the job is scheduled to repeat.
- Whether the job is currently executing.
- Whether the last job execution encountered an error.
- The number of times the job has started.
- The date and time of the job's last start (or start attempt) and last end.
- The query executed by the cron job.

Newly created cron job as a `syn:cron` node:

```
storm> syn:cron
syn:cron=d1e1c17c587a2b66f61f7583d9d20370
        :doc =
        :name =
        :storm = [ inet:ipv4=172.16.0.0/16 ]
```

- Add a cron job to run on the 15th of every month that lifts all IPv4 address nodes with missing geolocation data (i.e., no `:loc` property) and submits them to a Storm command that calls an IP geolocation service. (**Note:** Synapse does not include a geolocation service in its open source distribution; this cron job assumes such a service has been implemented).

```
storm> cron.add --day 15 { inet:ipv4 -:loc | ipgeoloc }
Created cron job: 71dae8a6e7047ac104a943bff6a7cdc4
```

- Add a cron job to run every Tuesday, Thursday, and Saturday at 2:00 AM UTC to lift all MD5, SHA1, and SHA256 hashes tagged "malicious" that do not have corresponding file (`file:bytes`) nodes and submit them to a Storm command that queries a third-party malware service and attempts to download those files. (**Note:** Synapse does not include a malware service in its open source distribution; this cron job assumes such a service has been implemented).

```
storm> cron.add --day Tue,Thu,Sat --hour 2 { hash:md5#malicious hash:sha1#malicious␣
↪hash:sha256#malicious -{ -> file:bytes } | malwaresvc }
Created cron job: b868908d7dc327366b55a499d2d28f01
```

Macros

A macro is simply a stored Storm query / set of Storm code that can be executed on demand.

Strictly speaking, macros are not automation - they do not execute on their own. However, macros are often used with (called by) triggers or cron jobs.

Macros differ from triggers and cron in some important ways:

- **Permissions.** No special permissions are required to work with macros. Any user can create or call a macro.
- **Execution.** Macros execute with the permissions **of the calling user.** A macro can only perform actions that the calling user has permissions to perform. If a user runs a macro that whose actions exceed the user's permissions, the macro will fail with an `AuthDeny` error.
- **Introspection.** Synapse does not create runtime nodes ("runt nodes") for macros.
- **Scope.** Where triggers and cron jobs are specific to a *View*, macros are specific to a given Cortex. Macros can be viewed, modified, and executed from any view.

Example Use Cases

Macros are a convenient way to save and run frequently used Storm without having to create or type that Storm each time. The Storm can be as simple or advanced as you like.

- **Organizational use.** Macros can be developed for use across entire teams or organizations to support common tasks or workflows such as enrichment or threat hunting. Using a macro makes it easier to perform the task (by calling it with a single Storm command) and also ensures that the task is performed consistently (i.e., in the same way each time) by each user.
- **Personal use.** Users can create macros to store frequently-used or lengthy Storm queries specific to their personal workflow that can be executed easily on demand.
- **Automation.** For triggers or cron jobs that execute longer Storm queries, saving the Storm in a macro may make it easier to set, view, edit, and manage vs. storing the Storm directly as part of the trigger or cron job.
- **Flexibility.** Because macros are composed in Storm and executed via a Storm command, they can be executed any way Storm can be executed (e.g., on demand or called as part of a trigger or cron job). Macros are ideal for Storm that performs a task or set of tasks that you may want to execute in a variety of ways.

Usage Notes

- Macros are specific to an individual Synapse Cortex; they are not limited to an individual *View*. Any macros that exist in a Cortex are visible to all users of that Cortex.
- Any user can create or run a macro. You do not need to explicitly grant any permissions.
- Macros are differentiated by name, and cannot be renamed once created.
- The user who creates a macro is the owner / admin of the macro. Other users can read and execute the macro (within the limitations of their permissions), but cannot modify or delete it.
- Macros execute with the permissions **of the calling user.**
  - While any user can execute any macro, if the macro takes some action that the calling user does not have permission to perform, the macro will fail with an `AuthDeny` error.
  - If a macro is called by a trigger or cron job, the macro will execute with the permissions of **the author of the trigger or cron job.**

- Macros commonly take nodes as input. Similarly, a macro may output nodes based on the Storm it executes. For both of these conditions, Storm's "pipeline" behavior applies. A macro will error if it receives nodes that cannot be processed by the associated Storm code; similarly, if you execute additional Storm after the macro runs, that Storm must be appropriate for any nodes that exit the macro.

Syntax

Macros are created, modified, viewed, and deleted using the Storm `macro.*` commands. See the *macro* command in the *Storm Reference - Storm Commands* document for details.

In *Optic*, macros can also be managed through the *Storm Editor*.

Examples

- Add a macro named `sinkhole.check` that lifts all IPv4 addresses tagged as sinkholes (`#cno.infra.dns.sinkhole`) and submits those nodes to a Storm command that calls a third-party passive DNS service to retrieve any FQDNs currently resolving to the sinkhole IP. (**Note:** Synapse does not include a passive DNS service in its open source distribution; the macro assumes such a service has been implemented.)

```
storm> macro.set sinkhole.check ${ inet:ipv4#cno.infra.dns.sinkhole | pdns }
Set macro: sinkhole.check
```

- Add a macro named `check.c2` that takes an inbound set of `file:bytes` nodes and returns any FQDNs that the files query and any IPv4 addresses the files connect to. Use a filter in the macro to ensure that the macro code only attempts to process inbound `file:bytes` nodes.

```
storm> macro.set check.c2 ${ +file:bytes | tee { -> inet:dns:request :query:name ->␣
↪inet:fqdn | uniq } { -> inet:flow:src:exe :dst:ipv4 -> inet:ipv4 | uniq } }
Set macro: check.c2
```

- Add a macro named `enrich` that takes any node as input and uses a `switch` statement to call Storm commands for third-party services able to enrich a given form (line breaks and indentations used for readability). (**Note:** Synapse does not include third-party services / connectors in its open source distribution; the macro assumes such services have been implemented.)

```
storm> macro.set enrich ${ switch $node.form() {

    /* You can put comments in macros!!! */

    "inet:fqdn": { | whois | pdns | malware }
    "inet:ipv4": { | pdns }
    "inet:email": { | revwhois }
    *: { }
} }
Set macro: enrich
```

Dmons

A *Dmon* is a long-running or recurring query or process that runs continuously in the background, similar to a traditional Linux or Unix daemon.

Variables

Dmons will have the storm variable `$auto` populated when they run. The `$auto` variable is a dictionary which contains the following keys:

`$auto.iden`
: The identifier of the Dmon.

`$auto.type`
: The type of automation. For a Dmon this value will be `dmon`.

Note: If the variable `$auto` was captured during the creation of the Dmon, the variable will **not** be mapped in.

Syntax

Users can interact with dmons using the Storm `dmon.*` commands (see the *dmon* command in the *Storm Reference - Storm Commands* document for details) and the *$lib.dmon* Storm libraries.

3.7 Storm Advanced

The are several more advanced Storm language language concepts which are documented in the following sections.

3.7.1 Storm Reference - Advanced - Variables

Storm supports the use of **variables.** A *Variable* is a value that can change depending on conditions or on information passed to the Storm query. (Contrast this with a *Constant*, which is a value that is fixed and does not change.)

Variables can be used in a variety of ways, from providing simpler or more efficient ways to reference node properties, to facilitating bulk operations, to performing complex tasks or writing extensions such as Power-Ups (see *Power-Up*) to Synapse in Storm.

Note: These documents approach variables and their use from a **user** standpoint and aim to provide sufficient background for users to understand and begin to use variables. They do not provide an in-depth discussion of variables and their use. See the *Synapse Developer Guide* for more developer-focused topics.

- *Storm Operating Concepts*
- *Variable Concepts*
  - *Variable Scope*
  - *Call Frame*
  - *Runtsafe vs. Non-Runtsafe*
- *Types of Variables*

- *Built-In Variables*
- *User-Defined Variables*

Storm Operating Concepts

When using variables in Storm, it is important to keep in mind the high-level *Storm Operating Concepts*. Specifically:

- Storm operations (e.g., lifts, filters, pivots, etc.) are commonly performed on **nodes.**
- Operations can be **chained** and are executed in order from left to right.
- Storm acts as an **execution pipeline,** with each node passed individually and independently through the chain of Storm operations.
- Most Storm operations **consume** nodes — that is, a given operation (such as a filter or pivot) acts upon the inbound node in some way and returns only the node or set of nodes that result from that operation.

These principles apply to variables that reference nodes (or node properties) in Storm just as they apply to nodes, and so affect the way variables behave within Storm queries.

Variable Concepts

Variable Scope

A variable's **scope** is its lifetime and under what conditions it may be accessed. There are two dimensions that impact a variable's scope: its **call frame** and its **runtime safety** ("runtsafety").

Call Frame

A variable's **call frame** is where the variable is used. The main Storm query starts with its own call frame, and each call to a "pure" Storm command, function, or subquery creates a new call frame. The new call frame gets a copy of all the variables from the calling call frame. Changes to existing variables or the creation of new variables within the new call frame do not impact the calling scope.

Runtsafe vs. Non-Runtsafe

An important distinction to keep in mind when using variables in Storm is whether the variable is runtime-safe ("*Runtsafe*") or non-runtime safe ("*Non-Runtsafe*").

A variable that is **runtsafe** has a value independent of any nodes passing through the Storm pipeline. For example, a variable whose value is explicitly set, such as `$string = mystring` or `$ipv4 = 8.8.8.8` is considered runtsafe because the value does not change / is not affected by the specific node passing through the Storm pipeline.

A variable that is **non-runtsafe** has a value derived from a node passing through the Storm pipeline. For example, a variable whose value is set to a node property value may change based on the specific node passing through the Storm pipeline. In other words, if your Storm query is operating on a set of DNS A nodes (`inet:dns:a`) and you define the variable `$fqdn = :fqdn` (setting the variable to the value of the `:fqdn` secondary property), the value of the variable will change based on the specific value of that property for each `inet:dns:a` node in the pipeline.

All non-runtsafe variables are **scoped** to an individual node as it passes through the Storm pipeline. This means that a variable's value based on a given node is not available when processing a different node (at least not without using special commands, methods, or libraries). In other words, the path of a particular node as it passes through the Storm pipeline is its own scope.

Note: The "safe" in non-runtsafe should **not** be interpreted to mean that the use of non-runtsafe variables is somehow "risky" or involves insecure programming or processing of data. It simply means the value of the variable is not safe from changing (i.e., it may change) as the Storm pipeline progresses.

Types of Variables

Storm supports two types of variables:

- **Built-in variables.** Built-in variables facilitate many common Storm operations. They may vary in their scope and in the context in which they can be used.
- **User-defined variables** User-defined variables are named and defined by the user. They are most often limited in scope and facilitate operations within a specific Storm query.

Built-In Variables

Storm includes a set of built-in variables and associated variable methods (*Storm Reference - Advanced - Methods*) and libraries (*Storm Libraries*) that facilitate Cortex-wide, node-specific, and context-specific operations.

Built-in variables differ from user-defined variables in that built-in variable names:

- are initialized at Cortex start,
- are reserved,
- can be accessed automatically (i.e., without needing to define them) from within Storm, and
- persist across user sessions and Cortex reboots.

Tip: We cover a few of the most common built-in variables here. For additional detail on Synapse's Storm types (objects) and libraries, see the *Storm Library Documentation*.

Global Variables

Global variables operate independently of any node. That is, they can be invoked in a Storm query in the absence of any nodes in the Storm execution pipeline (though they can also be used when performing operations on nodes).

$lib

The library variable (`$lib`) is a built-in variable that provides access to the global Storm library. In Storm, libraries are accessed using built-in variable names (e.g., `$lib.print()`).

Libraries provide access to a wide range of additional functionality with Storm. See the *Storm Libraries* technical documentation for descriptions of the libraries available within Storm.

Node-Specific Variables

Storm includes node-specific variables that are designed to operate on or in conjunction with nodes and require one or more nodes in the Storm pipeline.

Note: Node-specific variables are always non-runtsafe.

$node

The node variable (`$node`) is a built-in Storm variable that **references the current node in the Storm pipeline.** Specifically, this variable contains the inbound node's node object, and provides access to the node's attributes, properties, and associated attribute and property values.

Invoking this variable during a Storm query is useful when you want to:

- access the entire raw node object,
- store the value of the current node before pivoting to another node, or
- use an aspect of the current node in subsequent query operations.

The `$node` variable supports a number of built-in **methods** that can be used to access specific data or properties associated with a node. See the technical documentation for the stormprims-storm-node-f527 object or the *$node* section of the *Storm Reference - Advanced - Methods* user documentation for additional detail and examples.

$path

The path variable (`$path`) is a built-in Storm variable that **references the path of a node as it travels through the pipeline of a Storm query.**

The `$path` variable is not used on its own, but in conjunction with its methods. See the technical documentation for the stormprims-storm-path-f527 object or the *$path* section of the *Storm Reference - Advanced - Methods* user documentation for additional detail and examples.

Trigger-Specific Variables

A *Trigger* is used to support automation within a Cortex. Triggers use events (such as creating a node, setting a node's property value, or applying a tag to a node) to fire ("trigger") the execution of a predefined Storm query. Storm uses a built-in variable specifically within the context of trigger-initiated Storm queries.

$tag

For triggers that fire on `tag:add` events, the `$tag` variable represents the name of the tag that caused the trigger to fire.

For example:

You write a trigger to fire when any tag matching the expression `#foo.bar.*` is added to a `file:bytes` node. The trigger executes the following Storm command:

```
-> hash:md5 [ +#$tag ]
```

Because the trigger uses a tag glob ("wildcard") expression, it will fire on any tag that matches that expression (e.g., `#foo.bar.hurr`, `#foo.bar.derp`, etc.). The Storm snippet above will take the inbound `file:bytes` node, pivot to the file's associated MD5 node (`hash:md5`), and apply the same tag that fired the trigger to the MD5.

See the *Triggers* section of the *Storm Reference - Automation* document and the Storm *trigger* command for a more detailed discussion of triggers and associated Storm commands.

Ingest Variables

Synapse's *csvtool* can be used to ingest (import) data into Synapse from a comma-separated value (CSV) file. Storm includes a built-in variable to facilitate bulk data ingest using CSV.

$rows

The `$rows` variable refers to the set of rows in a CSV file. When ingesting data into Synapse, CSVTool (or the Optic Ingest Tool) reads a CSV file and a file containing a Storm query that tells Synapse how to process the CSV data. The Storm query is typically constructed to iterate over the set of rows (`$rows`) using a *For Loop* that uses user-defined variables to reference each field (column) in the CSV data.

For example:

```
for ($var1, $var2, $var3, $var4) in $rows { <do stuff> }
```

Tip: The commercial Synapse UI (*Optic*) includes an Ingest Tool that can ingest data in CSV, JSONL, or JSON format. The `$rows` variable is used in the Ingest Tool to refer to either the set of rows in a CSV file or the set of lines ("rows") in a JSONL file. In addition, the `$blob` variable is used to refer to the entire JSON blob when ingesting JSON data. See the ingest examples section of the Ingest Tool documentation for additional detail.

User-Defined Variables

User-defined variables can be defined in one of two ways:

- At runtime (i.e., within the scope of a specific Storm query). This is the most common use for user-defined variables.
- Mapped via options passed to the Storm runtime (for example, when using the *Cortex* API). This method is less common for everyday users. When defined in this manner, user-defined variables will behave as though they are built-in variables that are runtsafe.

Variable Names

All variable names in Storm (including built-in variables) begin with a dollar sign (`$`). A variable name can be any alphanumeric string, **except for** the name of a built-in variable (see *Built-In Variables*), as those names are reserved. Variable names are case-sensitive; the variable `$MyVar` is different from `$myvar`.

Note: Storm will not **prevent** you from using the name of a built-in variable to define a variable (such as `$node = 7`). However, doing so may result in undesired effects or unexpected errors due to the variable name collision.

Defining Variables

Within Storm, a user-defined variable is defined using the syntax:

```
$<varname> = <value>
```

The variable name must be specified first, followed by the equals sign and the value of the variable itself.

<value> can be:

- an explicit value (literal),
- a node property (secondary or universal),
- a built-in variable or method (e.g., can allow you to access a node's primary property, form name, or other elements),
- a tag (allows you to access timestamps associated with a tag),
- a library function,
- an expression, or
- an embedded Storm query.

Examples

The examples below use the `$lib.print()` library function to display the **value** of the user-defined variable being set. (This is done for illustrative purposes only; `$lib.print()` is not required in order to use variables or methods.)

In some instances we include a second example to illustrate how a particular kind of variable assignment might be used in a real-world scenario. While we have attempted to use relatively simple examples for clarity, some examples may leverage additional Storm features such as subqueries, subquery filters, or control flow elements such as for loops or switch statements.

Tip: Keep Storm's operation chaining, pipeline, and node consumption aspects in mind when reviewing the following examples. When using `$lib.print()` to display the value of a variable, the queries below will:

- Lift the specified node(s).
- Assign the variable. Note that assigning a variable has no impact on the nodes themselves.
- Print the variable's value using `$lib.print()`.
- Return any nodes still in the pipeline. Because variable assignment doesn't impact the node(s), they are not consumed and so are returned (displayed) at the CLI.

The effect of this process is that for each node in the Storm query pipeline, the output of `$lib.print()` is displayed, followed by the relevant node.

In some examples the Storm *spin* command is used to suppress display of the node itself. We do this for cases where displaying the node detracts from illustrating the value of the variable.

Explicit values / literals

You can assign an explicit, unchanging value to a variable.

- Assign the value 5 to the variable `$threshold`:

```
storm> $threshold=5 $lib.print($threshold)
5
```

Example:

- Tag `file:bytes` nodes that have a number of AV signature hits higher than a given threshold for review:

```
storm> $threshold=5 file:bytes +{ -> it:av:filehit } >= $threshold [ +#review ]
file:bytes=sha256:00007694135237ec8dc52340070438146 08f239befdfc8a61b992e4d09e0cf3f
        :sha256 = 00007694135237ec8dc52340070438146 08f239befdfc8a61b992e4d09e0cf3f
        .created = 2023/07/12 15:15:42.151
        #review
```

Tip: The example above uses a subquery filter (*Subquery Filters*) to pivot to the `it:av:filehit` nodes associated with the `file:bytes` node, and compares the number of AV hits to the value of the `$threshold` variable.

Node properties

You can assign the value of a particular node property (secondary or universal) to a variable.

- **Secondary property:** Assign the `:user` property from an Internet-based account (`inet:web:acct`) to the variable `$user`:

```
storm> inet:web:acct=(twitter.com,hacks4cats) $user=:user $lib.print($user)
hacks4cats
inet:web:acct=twitter.com/hacks4cats
        :email = ron@protonmail.com
        :site = twitter.com
        :user = hacks4cats
        .created = 2023/07/12 15:15:42.327
```

- **Universal property:** Assign the `.seen` universal property from a DNS A node to the variable `$time`:

```
storm> inet:dns:a=(woot.com,1.2.3.4) $time=.seen $lib.print($time)
(1543289294000, 1565893967000)
inet:dns:a=('woot.com', '1.2.3.4')
        :fqdn = woot.com
        :ipv4 = 1.2.3.4
        .created = 2023/07/12 15:15:42.392
        .seen = ('2018/11/27 03:28:14.000', '2019/08/15 18:32:47.000')
```

Note: In the output above, the variable value is displayed as a pair of epoch milliseconds, which is how Synapse stores date/time values.

Example:

- Given a DNS A record observed within a specific time period, find other DNS A records that pointed to the same IP address in the same time window:

```
storm> inet:dns:a=(woot.com,1.2.3.4) $time=.seen -> inet:ipv4 -> inet:dns:a +.seen@=$time
inet:dns:a=('woot.com', '1.2.3.4')
        :fqdn = woot.com
```

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```
        :ipv4 = 1.2.3.4
        .created = 2023/07/12 15:15:42.392
        .seen = ('2018/11/27 03:28:14.000', '2019/08/15 18:32:47.000')
inet:dns:a=('hurr.net', '1.2.3.4')
        :fqdn = hurr.net
        :ipv4 = 1.2.3.4
        .created = 2023/07/12 15:15:42.446
        .seen = ('2018/12/09 06:02:53.000', '2019/01/03 11:27:01.000')
```

Tip: An interval (such as a `.seen` property) consists of a **pair** of date/time values. In the example above, the value of the variable `$time` is the combined pair (min / max) of times.

To access the "first seen" (minimum) or "last seen" (maximum) time values separately, use a pair of variables in the assignment:

```
($min, $max) = .seen
```

Built-in variables and methods

Built-In Variables (including *Node-Specific Variables*) allow you to reference common Synapse objects and their associated components. For many common user-facing tasks, the `$node` variable and its methods are the most useful.

- **Node object:** Assign an entire FQDN node to the variable `$fqdn` using the `$node` built-in variable:

```
storm> inet:fqdn=mail.mydomain.com $fqdn=$node $lib.print($fqdn)
Node{(('inet:fqdn', 'mail.mydomain.com'), {'iden':
↪'6511121afd61bf42cb4d14aed4f61daf62ebfc76042dba12d95a6506dd8b6cc4', 'tags': {}, 'props
↪': {'.created': 1689174942502, 'host': 'mail', 'domain': 'mydomain.com', 'issuffix': 0,
↪ 'iszone': 0, 'zone': 'mydomain.com'}, 'tagprops': {}, 'nodedata': {}})}
inet:fqdn=mail.mydomain.com
        :domain = mydomain.com
        :host = mail
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:15:42.502
```

Note: When you use the built-in variable `$node` to assign a value to a variable, the value is set to the **entire node object** (refer to the output above). For common user-facing tasks, it is less likely that users will need "the entire node"; more often, they need to refer to a **component** of the node, such as its primary property value, form name, or associated tags.

For some use cases, Synapse and Storm can "understand" which component of the node you want when referring to the full `$node` object. However, you can always be explicit by using the appropriate **method** to access the specific component you want (such as `$node.value()` or `$node.form()`).

See the technical documentation for the stormprims-storm-node-f527 object or the *$node* section of the *Storm Reference - Advanced - Methods* user documentation for additional detail and examples when using methods associated with the `$node` built-in variable.

- **Node method:** Assign the **primary property value** of a domain node to the variable `$fqdn` using the `$node.value()` method:

```
storm> inet:fqdn=mail.mydomain.com $fqdn=$node.value() $lib.print($fqdn)
mail.mydomain.com
inet:fqdn=mail.mydomain.com
        :domain = mydomain.com
        :host = mail
        :issuffix = false
        :iszone = false
        :zone = mydomain.com
        .created = 2023/07/12 15:15:42.502
```

- Find the DNS A records associated with a given domain where the PTR record for the IP matches the FQDN:

```
storm> inet:fqdn=mail.mydomain.com $fqdn=$node.value() -> inet:dns:a +{ -> inet:ipv4␣
↪+:dns:rev=$fqdn }
inet:dns:a=('mail.mydomain.com', '25.25.25.25')
        :fqdn = mail.mydomain.com
        :ipv4 = 25.25.25.25
        .created = 2023/07/12 15:15:42.557
```

Tip: The example above uses a subquery filter (see *Subquery Filters*) to pivot from the DNS A records to associated IPv4 nodes (`inet:ipv4`) and checks whether the `:dns:rev` property matches the FQDN in the variable `$fqdn`.

Tags

Recall that tags are both **nodes** (`syn:tag=my.tag`) and **labels** that can be applied to other nodes (`#my.tag`). Tags can also have optional timestamps (a time interval) associated with them.

There are various ways to assign tags as variables, depending on what part of the tag you want to access. Many of these use cases are covered above so are briefly illustrated here.

- **Tag value:** Assign an explicit tag value (literal) to the variable `$mytag`:

```
storm> $mytag=cno.infra.dns.sinkhole
```

- **Tag on a node:** Given a `hash:md5` node, assign any malware tags (tags matching the glob pattern `cno.mal.*`) to the variable `$mytags` using the `$node.tags()` method:

```
storm> hash:md5=d41d8cd98f00b204e9800998ecf8427e $mytags=$node.tags(cno.mal.*) $lib.
↪print($mytags)
['cno.mal.foo', 'cno.mal.bar']
hash:md5=d41d8cd98f00b204e9800998ecf8427e
        .created = 2023/07/12 15:15:42.657
        #cno.mal.bar
        #cno.mal.foo
        #cno.threat.baz
```

Tip: In the example above, the value of the variable `$mytags` is the **set** of two tags, `cno.mal.foo` and `cno.mal.bar`, because the MD5 hash node has two tags that match the pattern `cno.mal.*`.

To assign the set of any / all tags on a node to a variable, simply use `$mytags=$node.tags()`.

Note that you can also use `$node.tags()` directly (this method **always** refers to the set of tags on the current node) without explicitly assigning a separate variable.)

Where the value of a variable is a **set**, a *For Loop* is often used to "do something" based on each value in the set.

Example

- Given an MD5 hash, copy any `cno.mal.*` tags from the hash to the associated file (`file:bytes` node):

```
storm> hash:md5=d41d8cd98f00b204e9800998ecf8427e $mytags=$node.tags(cno.mal.*) for $tag␣
↪in $mytags { -> file:bytes [ +#$tag ] }
file:bytes=sha256:e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
        :md5 = d41d8cd98f00b204e9800998ecf8427e
        :sha1 = da39a3ee5e6b4b0d3255bfef95601890afd80709
        :sha256 = e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
        :size = 0
        .created = 2023/07/12 15:15:42.707
        #cno.mal.foo
file:bytes=sha256:e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
        :md5 = d41d8cd98f00b204e9800998ecf8427e
        :sha1 = da39a3ee5e6b4b0d3255bfef95601890afd80709
        :sha256 = e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
        :size = 0
        .created = 2023/07/12 15:15:42.707
        #cno.mal.bar
        #cno.mal.foo
```

The output above includes two "copies" of the `file:bytes` node because the node is output twice - once for each iteration of the for loop. For a detailed explanation of this behavior, see *Advanced Storm - Example*.

Tip: The above example explicitly creates and assigns the variable `$mytags` and then uses that variable in a *For Loop*. In this case you can shorten the syntax by skipping the explicit variable assignment and using the `$node.tags()` method directly:

```
hash:md5=d41d8cd98f00b204e9800998ecf8427e for $tag in $node.tags(cno.mal.*) { ->␣
↪file:bytes [ +#$tag ] }
```

- **Tag timestamps:** Assign the times associated with Threat Group 20's control of a malicious domain to the variable `$time`:

```
storm> inet:fqdn=evildomain.com $time=#cno.threat.t20.own $lib.print($time)
(1567900800000, 1631059200000)
inet:fqdn=evildomain.com
        :domain = com
        :host = evildomain
        :issuffix = false
        :iszone = true
        :zone = evildomain.com
        .created = 2023/07/12 15:15:42.756
        #cno.threat.t20.own = (2019/09/08 00:00:00.000, 2021/09/08 00:00:00.000)
```

Example

- Find DNS A records for any subdomain associated with a Threat Group 20 FQDN (zone) during the time they controlled the domain:

```
storm> inet:fqdn#cno.threat.t20.own $time=#cno.threat.t20.own -> inet:fqdn:zone ->␣
↪inet:dns:a +.seen@=$time
inet:dns:a=('www.evildomain.com', '1.2.3.4')
        :fqdn = www.evildomain.com
        :ipv4 = 1.2.3.4
        .created = 2023/07/12 15:15:42.809
        .seen = ('2020/07/12 00:00:00.000', '2020/12/13 00:00:00.000')
inet:dns:a=('smtp.evildomain.com', '5.6.7.8')
        :fqdn = smtp.evildomain.com
        :ipv4 = 5.6.7.8
        .created = 2023/07/12 15:15:42.817
        .seen = ('2020/04/04 00:00:00.000', '2020/08/02 00:00:00.000')
```

Library Functions

Storm types (Storm objects) and Storm libraries allow you to inspect, edit, and otherwise work with data in Synapse in various ways. You can assign a value to a variable based on the output of a method or library.

A full discussion of this topic is outside of the scope of this user guide. See *Storm Library Documentation* for additional details.

- Assign the current time to the variable `$now` using `$lib.time.now()`:

```
storm> $now=$lib.time.now() $lib.print($now)
1689174942871
```

- Convert an epoch milliseconds integer into a human-readable date/time string using `$lib.str.format()`:

```
storm> $now=$lib.time.now() $time=$lib.time.format($now, '%Y/%m/%d %H:%M:%S') $lib.print(
↪$time)
2023/07/12 15:15:42
```

Expressions

You can assign a value to a variable based on the computed value of an expression:

- Use an expression to increment the variable `$x`:

```
storm> $x=5 $x=($x + 1) $lib.print($x)
6
```

Embedded Storm query

You can assign a value to a variable based on the output of a Storm query. To denote the Storm query to be evaluated, enclose the query in curly braces (`{ <storm query> }`).

- Assign an `ou:org` node's guid value to the variable `$org` by lifting the associated org node by its `:name` property:

```
storm> $org={ ou:org:name=vertex } $lib.print($org)
c8f255b92507c88f18757bbd51e8daa2
```

3.7.2 Storm Reference - Advanced - Methods

Some of Storm's *Built-In Variables* support **methods** used to perform various actions on the object represented by the variable.

A **subset** of the built-in variables / objects that support methods, along with a few commonly used methods and examples, are listed below. For full detail, refer to the *Storm Types* technical reference.

The built-in *$lib* variable is used to access Storm libraries. See the *Storm Libraries* technical reference for additional detail on available libraries.

Note: In the examples below, the `$lib.print()` library function is used to display the value returned when a specific built-in variable or method is called. This is done for illustrative purposes only; `$lib.print()` is not required in order to use variables or methods.

In some instances we have also included "use-case" examples, where the variable or method is used in one or more sample queries to illustrate possible practical use cases. These represent exemplar Storm queries for how a variable or method might be used in practice. While we have attempted to use relatively simple examples for clarity, some examples may leverage additional Storm features such as subqueries (*Storm Reference - Subqueries*), subquery filters (*Subquery Filters*), or flow control elements such as "for" loops or "switch" statements (*Storm Reference - Advanced - Control Flow*).

$node

$node is a built-in Storm variable that references **the current node in the Storm query pipeline.** `$node` can be used as a variable on its own or with the example methods listed below. See the stormprims-storm-node-f527 section of the *Storm Types* technical documentation for a full list.

Note: As the `$node` variable and related methods reference the current node in the Storm pipeline, the variable and its methods will contain (and return) a null value if the inbound result set is empty (i.e., contains no nodes).

Examples

- Print the value of `$node` for an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node) | spin
Node{(('inet:dns:a', ('woot.com', 917309932)), {'iden':
↪'01235b5877954084e798f09ba3fd3f1cda2e7b41d79b752b80acbed1b609cbaa', 'tags': {}, 'props
↪': {'.created': 1689174949556, 'fqdn': 'woot.com', 'ipv4': 917309932, '.seen':␣
↪(1482957991000, 1482957991001)}, 'tagprops': {}, 'nodedata': {}})}
```

- Print the value of `$node` for an `inet:fqdn` node with tags present:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node) | spin
Node{(('inet:fqdn', 'aunewsonline.com'), {'iden':
↪'53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4', 'tags': {'aka':␣
↪(None, None), 'aka.feye': (None, None), 'aka.feye.thr': (None, None), 'aka.feye.thr.
↪apt1': (None, None), 'cno': (None, None), 'cno.infra': (None, None), 'cno.infra.sink':␣
↪(None, None), 'cno.infra.sink.hole': (None, None), 'cno.infra.sink.hole.kleissner':␣
↪(1385424000000, 1480118400000)}, 'props': {'.created': 1689174949672, 'host':
↪'aunewsonline', 'domain': 'com', 'issuffix': 0, 'iszone': 1, 'zone': 'aunewsonline.com
↪'}, 'tagprops': {}, 'nodedata': {}})}
```

Note: The value of `$node` is the entire node object and associated properties and tags, as opposed to a specific aspect of the node, such as its iden or primary property value.

As demonstrated below, some node constructors can "intelligently" leverage the relevant aspects of the full node object (the value of the `$node` variable) when creating new nodes.

- Use the `$node` variable to create an `edge:refs` node showing that a news article references the domain woot[.]com:

```
storm> media:news=a3759709982377809f28fc0555a38193 [ edge:refs=($node,(inet:fqdn,woot.
↪com)) ]
edge:refs=(('media:news', 'a3759709982377809f28fc0555a38193'), ('inet:fqdn', 'woot.com'))
        :n1 = ('media:news', 'a3759709982377809f28fc0555a38193')
        :n1:form = media:news
        :n2 = ('inet:fqdn', 'woot.com')
        :n2:form = inet:fqdn
        .created = 2023/07/12 15:15:49.751
media:news=a3759709982377809f28fc0555a38193
        .created = 2023/07/12 15:15:49.721
```

In the example above, the *$node.ndef()* method could have been used instead of `$node` to create the `edge:refs` node. In this case, the node constructor knows to use the ndef from the `$node` object to create the node.

- Use the `$node` variable to create multiple whois name server records (`inet:whois:recns`) from a set of inbound recent whois record nodes for the domain woot[.]com:

```
storm> inet:whois:rec:fqdn=woot.com +:asof>=2019/06/13 [ inet:whois:recns=(ns1.
↪somedomain.com,$node) ]
inet:whois:recns=('ns1.somedomain.com', ('woot.com', '2019/06/13 00:00:00.000'))
        :ns = ns1.somedomain.com
        :rec = ('woot.com', '2019/06/13 00:00:00.000')
        :rec:asof = 2019/06/13 00:00:00.000
        :rec:fqdn = woot.com
        .created = 2023/07/12 15:15:49.835
inet:whois:rec=('woot.com', '2019/06/13 00:00:00.000')
        :asof = 2019/06/13 00:00:00.000
        :fqdn = woot.com
        :text = ns1.somedomain.com
        .created = 2023/07/12 15:15:49.795
inet:whois:recns=('ns1.somedomain.com', ('woot.com', '2019/09/12 00:00:00.000'))
        :ns = ns1.somedomain.com
        :rec = ('woot.com', '2019/09/12 00:00:00.000')
        :rec:asof = 2019/09/12 00:00:00.000
        :rec:fqdn = woot.com
        .created = 2023/07/12 15:15:49.840
inet:whois:rec=('woot.com', '2019/09/12 00:00:00.000')
        :asof = 2019/09/12 00:00:00.000
        :fqdn = woot.com
        :text = ns1.somedomain.com
        .created = 2023/07/12 15:15:49.801
```

In the example above, the *$node.value()* method could have been used instead of `$node` to create the `inet:whois:recns` nodes. In this case, the node constructor knows to use the primary property value from the `inet:whois:rec` nodes to create the `inet:whois:recns` nodes.

$node.form()

The `$node.form()` method returns the **form** of the current node in the Storm pipeline.

The method takes no arguments.

Examples

- Print the form of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.form()) | spin
inet:dns:a
```

$node.globtags()

The `$node.globtags()` method returns a **list of string matches from the set of tags applied to the current node** in the Storm pipeline.

The method takes a single argument consisting of a wildcard expression for the substring to match.

- The argument requires at least one wildcard (`*`) representing the substring(s) to match.
- The method performs an **exclusive match** and returns **only** the matched substring(s), not the entire tag containing the substring match.
- The wildcard (`*`) character can be used to match full or partial tag elements.
- Single wildcards are constrained by tag element boundaries (i.e., the dot (`.`) character. Single wildcards can match an entire tag element or a partial string within an element.
- The double wildcard (`**`) can be used to match across any number of tag elements; that is, the double wildcard is not constrained by the dot boundary.
- If the string expression starts with a wildcard, it must be enclosed in quotes in accordance with the use of *Entering Literals*.

See *$node.tags()* to access full tags (vs. tag substrings).

Examples

- Print the set of top-level (root) tags from any tags applied to the current node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.globtags("*")) | spin
['aka', 'cno']
```

- Print the list of numbers associated with any threat group tags applied to the current node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.globtags(cno.threat.t*)) | spin
['83']
```

In the example above, `$node.globtags()` returns the matching substring only ("83"), which is the portion matching the wildcard; it does not return the "t" character.

- Print the list of organizations and associated threat group names from any third-party alias ("aka") tags applied to the current node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.globtags(aka.*.thr.*)) | spin
[('feye', 'apt1'), ('symantec', 'commentcrew')]
```

- Print all sub-tags for any tags starting with "foo" applied to the current node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.globtags(foo.**)) | spin
['bar', 'bar.baz', 'derp']
```

$node.iden()

The `$node.iden()` method returns the *Iden* of the current node in the Storm pipeline.

The method takes no arguments.

Examples

- Print the iden of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.iden()) | spin
01235b5877954084e798f09ba3fd3f1cda2e7b41d79b752b80acbed1b609cbaa
```

$node.isform()

The `$node.isform()` method returns a Boolean value (true / false) for whether the current node in the Storm pipeline is of a specified form.

The method takes a single argument of a form name.

Examples

- Print the Boolean value for whether a node is an `inet:dns:a` form:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.isform(inet:dns:a)) | spin
true
```

- Print the Boolean value for whether a node is an `inet:fqdn` form:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.isform(inet:fqdn))  | spin
false
```

$node.ndef()

The `$node.ndef()` method returns the *Ndef* ("node definition") of the current node in the Storm pipeline.

The method takes no arguments.

Examples

- Print the ndef of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.ndef()) | spin
('inet:dns:a', ('woot.com', 917309932))
```

$node.repr()

The `$node.repr()` method returns the human-friendly *Repr* ("representation") of the specified property of the current node in the Storm pipeline.

The method can optionally take one argument.

- If no arguments are provided, the method returns the repr of the node's primary property value.
- If an argument is provided, it should be the string of the secondary property name (i.e., without the leading colon (`:`) from relative property syntax).
- If a universal property string is provided, it must be preceded by the dot / period (`.`) and enclosed in quotes in accordance with the use of *Entering Literals*.

See *$node.value()* to return the raw value of a property.

Examples

- Print the repr of the primary property value of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.repr())  | spin
('woot.com', '54.173.9.236')
```

- Print the repr of the `:ipv4` secondary property value of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.repr(ipv4)) | spin
54.173.9.236
```

- Print the repr of the `.seen` universal property value of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.repr(".seen")) | spin
('2016/12/28 20:46:31.000', '2016/12/28 20:46:31.001')
```

$node.tags()

The `$node.tags()` method returns a **list of the tags applied to the current node** in the Storm pipeline.

The method can optionally take one argument.

- If no arguments are provided, the method returns the full list of all tags applied to the node.
- An optional argument consisting of a wildcard string expression can be used to match a subset of tags.
  - If a string is used with no wildcards, the string must be an exact match for the tag element.
  - The wildcard (`*`) character can be used to match full or partial tag elements.
  - The method performs an **inclusive match** and returns the full tag for all tags that match the provided expression.
  - Single wildcards are constrained by tag element boundaries (i.e., the dot (`.`) character). Single wildcards can match an entire tag element or a partial string within an element.
  - The double wildcard (`**`) can be used to match across any number of tag elements; that is, the double wildcard is not constrained by the dot boundary.
  - If the string expression starts with a wildcard, it must be enclosed in quotes in accordance with the use of *Entering Literals*.

See *$node.globtags()* to access tag substrings (vs. full tags).

Examples

- Print the list of all tags associated with an `inet:fqdn` node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.tags()) | spin
['aka', 'aka.feye', 'aka.feye.thr', 'aka.feye.thr.apt1', 'cno', 'cno.infra', 'cno.infra.
↪sink', 'cno.infra.sink.hole', 'cno.infra.sink.hole.kleissner', 'aka.symantec', 'aka.
↪symantec.thr', 'aka.symantec.thr.commentcrew', 'cno.threat', 'cno.threat.t83', 'cno.
↪threat.t83.tc', 'foo', 'foo.bar', 'foo.bar.baz', 'faz', 'faz.baz', 'foo.derp']
```

- Print the tag matching the string "cno" if present on an `inet:fqdn` node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.tags(cno)) | spin
['cno']
```

- Print the list of all tags two elements in length that start with "foo":

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.tags(foo.*)) | spin
['foo.bar', 'foo.derp']
```

- Print the list of all tags of any length that start with "f":

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.tags(f**)) | spin
['foo', 'foo.bar', 'foo.bar.baz', 'faz', 'faz.baz', 'foo.derp']
```

- Print the list of all tags of any length whose first element starts with "a" and whose third element is "thr":

```
storm> inet:fqdn=aunewsonline.com $lib.print($node.tags(a*.*.thr.**)) | spin
['aka.feye.thr.apt1', 'aka.symantec.thr.commentcrew']
```

$node.value()

The `$node.value()` method returns the raw value of the primary property of the current node in the Storm pipeline.

The method takes no arguments.

See *$node.repr()* to return the human-friendly value of a property.

Note: The `$node.value()` method is only used to return the primary property value of a node. Secondary property values can be accessed via a user-defined variable (i.e., `$myvar = :<prop>`).

Examples

- Print the value of the primary property value of an `inet:dns:a` node:

```
storm> inet:dns:a=(woot.com,54.173.9.236) $lib.print($node.value()) | spin
('woot.com', 917309932)
```

$path

$path is a built-in Storm variable that **references the path of a node as it travels through the pipeline of a Storm query.**

The `$path` variable is generally not used on its own, but in conjunction with its methods. See the stormprims-storm-path-f527 section of the *Storm Types* technical documentation for a full list.

$path.idens()

The `$path.idens()` method returns the list of idens (*Iden*) of each node in a node's path through a Storm query.

The method takes no arguments.

Examples

- Print the list of iden(s) for the path of a single lifted node:

```
storm> inet:fqdn=aunewsonline.com $lib.print($path.idens()) | spin
['53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4']
```

Note: A lift operation contains no pivots (i.e., no "path"), so the method returns only the iden of the lifted node.

- Print the list of idens for the path of a single node through two pivots to a single end node:

```
storm> inet:fqdn=aunewsonline.com -> inet:dns:a +:ipv4=67.215.66.149 -> inet:ipv4 $lib.
↪print($path.idens())
['53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4',
↪'07c79039d00b4391699c9328dc6ccaf864d84d0b38545ded117d1d7ccc6e366c',
↪'9596f5253f25ee7468915770 6ddf3b459874a6d3cb0adfce4e07018ec8162fc1']
inet:ipv4=67.215.66.149
        :type = unicast
        .created = 2023/07/12 15:15:50.367
```

The example above returns the idens of the original `inet:fqdn` node, the `inet:dns:a` node with the specified IP, and the `inet:ipv4` node.

- Print the list of idens for the path of a single node through two pivots to three different end nodes (i.e., three paths):

```
storm> inet:fqdn=aunewsonline.com -> inet:dns:a -> inet:ipv4 $lib.print($path.idens())
['53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4',
↪'07c79039d00b4391699c9328dc6ccaf864d84d0b38545ded117d1d7ccc6e366c',
↪'9596f5253f25ee7468915770 6ddf3b459874a6d3cb0adfce4e07018ec8162fc1']
inet:ipv4=67.215.66.149
        :type = unicast
        .created = 2023/07/12 15:15:50.367
['53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4',
↪'0dde48198d3bcc58b40ab82155b218ecd48b533b964d5d2fa3e7453d990541f5',
↪'5af9ae36456988c24edecafa739da75231c067ba3d104a2746e9616ea7a312d6']
inet:ipv4=184.168.221.92
        :type = unicast
        .created = 2023/07/12 15:15:50.374
['53aa7a2f7125392302c36247b97569dd84a7f3fe9e92eb99abd984349dc53fe4',
```

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```
↪'1c53655a7f3bc67be338cde70d6565d4bc84d343d37513679d4efcd0ec59d3fe',
↪'acecd1f87d1dfc31148bf0ed417b69fde1c77eb2e7effdea434765fe8b759351']
inet:ipv4=104.239.213.7
        :type = unicast
        .created = 2023/07/12 15:15:50.380
```

In the example above, the FQDN has three DNS A records, thus there are three different paths that the original node takes through the query.

3.7.3 Storm Reference - Advanced - Control Flow

Storm includes a number of common programming control flow structures to facilitate more advanced Storm queries. These include:

- *Init Block*
- *Fini Block*
- *If-Else Statement*
- *Switch Statement*
- *For Loop*
- *While Loop*
- *Try... Catch Statement*

The examples below are for illustrative purposes. This guide is **not** meant as a Storm programming tutorial. The intent is to introduce Storm users who may not be familiar with programming concepts (or programmers who are learning to program in Storm) to possible use cases and simple examples for these structures. We've included some *Advanced Storm - Tips* and an *Advanced Storm - Example* to provide some pointers and an illustration of how Storm's "pipeline" behavior and control flow structures may interact.

See the follwing User Guide and Reference sections for additional information:

- *Storm Reference - Advanced - Variables*
- *Storm Reference - Advanced - Methods*
- *Storm Libraries*
- *Storm Types*

Storm Developers may also wish to refer to the *Synapse Developer Guide*.

Advanced Storm - Tips

Storm Operating Concepts - Review

Tip: It is essential to keep the Storm Operating Concepts in mind when using more advanced Storm queries and constructs. For standard Storm queries, these concepts are intuitive - you don't really need to think about them, and Storm just works. However, these concepts are critical to writing more advanced Storm - remembering these fundamentals can save you time and headaches trying to debug a Storm query that is not behaving the way you think it should.

Users are **strongly encouraged** to review the *Storm Operating Concepts* as well as the additional data below.

WORKING SET

- We use the term **working set** to refer to the set of nodes you are operating on in Storm.
  - The nodes you "start with" (often by performing an initial lift operation) are your **initial working set**.
  - The nodes at any given point in a Storm query are your **current working set**.

OPERATION CHAINING

- Storm operations (lifts, filters, pivots, subqueries, commands, control flow elements...) can be **chained** together to form longer queries. However, each operation is executed **individually** and **in sequence**.

NODE CONSUMPTION

- Each Storm operation typically **changes your current working set**. (We sometimes say that Storm operations **consume** nodes. This refers to the fact that in many cases the nodes that "come out" of a Storm operation are not the same nodes that "went in".)

  If you perform a filter operation, the resulting set of nodes is typically a **subset** of the ones you started with. If you use a pivot operation, you typically leave your "original" nodes behind and "move to" the new nodes. In most cases, your current working set is constantly changing.

STORM AS A PIPELINE

- A Storm query made up of multiple chained operations acts as a **pipeline** through which **each** node passes individually.
  - This means that a Storm query is executed once for **each** node that passes through the pipeline - **not** "just once" for the entire set of nodes.
  - The fact that each inbound node is processed **independently** by each Storm operation impacts your current working set.

    A simple example of this impact is the "duplication" of results (nodes) following some pivot operations - this is expected behavior. If you pivot from a set of FQDNs (`inet:fqdn`) to their DNS A records (`inet:dns:a`) and then to the associated IPv4 addresses (`inet:ipv4`), your results may include multiple instances of the same IPv4 node if more than one FQDN resolved to the same IPv4 address. In short, you get one "copy" of the IPv4 for **each** FQDN that resolved to (had a DNS A record for) that address. (The Storm *uniq* command is used to de-duplicate the nodes in the current working set).

The way Storm behaves - these operating concepts - impacts advanced constructs such as control flow, and are important to understand when writing and debugging more advanced Storm.

Tip: See the *Advanced Storm - Example* below for an illustration of how these concepts may impact your Storm in unexpected ways.

Storm Debugging Tips

A few helpful tips when writing and debugging advanced Storm:

Be aware of your pipeline.

That is, understand what is in your **current working set** at any point in your query. A significant part of Storm troubleshooting comes down to figuring out that the current working set is not what you think it is.

Be aware of your variables.

Storm supports both runtime-safe ("runtsafe") and non-runtime-safe ("non-runtsafe") variables. Non-runtsafe variables have values that may **change** based on the current node in the Storm pipeline. Another significant part of Storm

troubleshooting involves understanding the values of any variables at any given point in your Storm code. (See *Variable Concepts* for addditional information.)

Operations may execute multiple times.

Because each node passes through each operation in a Storm query individually, operations execute more than once (typically once for each node in the pipeline as it passes through that operation). This includes control flow operations, such as for loops! If you don't account for this behavior with control flow operations in particular, it can result in behavior such as:

- An exponentially increasing working set (if each node passing through an operation generates multiple results, and the results are not deduplicated / uniq'ed appropriately).
- A variable that is set by an operation being consistently changed (re-set) for each node passing through the operation (commonly resulting in "last node wins" with respect to variable assignment).
- A variable that **fails** to be set for a node that does **not** pass through the operation where the variable is assigned (resulting in a `NoSuchVar` error).

Use subqueries…but understand how they work.

Unlike most Storm operations and commands, subqueries **do not consume** nodes - by default, what goes into a subquery comes out of a subquery, regardless of what happens inside the subquery itself. This means you can use subqueries (see *Storm Reference - Subqueries*) with advanced Storm to isolate certain operations and keep the "primary" nodes passing through the Storm pipeline consistent.

That said, a node still has to pass **into** a subquery for the Storm inside a subquery to run. If your subquery **fails** to execute, it may be because nothing is going in to it.

Start small and add to your Storm incrementally.

It's easier to verify that smaller Storm queries execute correctly and then build on that code than to try and write a more advanced query all at once and try to figure out where things aren't working.

As with all debugging, print statements are your friend.

Scatter `$lib.print()` or `$lib.pprint()` statements (see *$lib.print(mesg, **kwargs)* and *$lib.pprint(item, prefix=, clamp=None)*) generously throughout your Storm during testing. You can print message strings at various points during execution:

```
$lib.print("Hey! This worked!")
```

You can print the value of a variable, to check its value at a given point in your query:

```
inet:ipv4=1.2.3.4
$asn=:asn
$lib.print($asn)
```

You can also print values associated with the node(s) in the current working set, using the various methods associated with the `$node` Storm type. (See *Storm Reference - Advanced - Methods* for a user-focused introduction to methods, or stormprims-storm-node-f527 in the detailed Storm Libraries / Storm Types documentation for a more technical discussion.)

```
$lib.print($node.ndef())
```

Control Flow Operations

Tip: The examples below are Storm excerpts used to illustrate specific concepts, but do not represent complete Storm queries / Storm code.

Init Block

An **init block** allows you to execute the specified Storm **once** at the beginning of your Storm query. This allows you to use Storm to perform a set of operations a single time only. Without the init block, the code would be executed once for **each** node passing through the Storm query.

See also *Fini Block*.

Syntax:

```
init { <storm> }
```

Example:

You want to use an init block to initialize a set of variables that will be used later in the Storm query. Initializing the variables to default values can:

- Explicitly set a variable value up front.
- Specify default values for variables in the event they are **not** set during subsequent execution (e.g., due to a missing node, property, or tag that the variable depends on).
- Initialize variables that will be modified during execution (e.g., lists, sets, tallies, or other 'count' values you expect to change or increment).

```
init {

    $url=https://www.example.com/my_data/
    $threatname=''
    $fqdns=$lib.set()
    $fqdn_count=0
}
```

Fini Block

A **fini block** allows you to execute the specified Storm **once** after all nodes have passed through the preceding code in the Storm pipeline. This allows you to use Storm to perform a set of operations a single time "outside" of the normal Storm pipeline; without the fini block, the code would be executed once for **each** node passing through the query.

See also *Init Block*.

Syntax:

```
fini { <storm> }
```

Example:

You have a Storm query that processes a series of `inet:fqdn` nodes, adding nodes that meet certain criteria to a set (specified with the variable `$fqdns`). After processing the nodes, you want to print a message with the total number of nodes in your set (which you stored in the variable `$fqdn_count`) and return the set of nodes.

```
fini {

    $lib.print(`Total count is {$fqdn_count}`)
    return($fqdns)
}
```

If-Else Statement

An **if-else statement** matches inbound objects against a specified condition. If that condition is met, a set of Storm operations are performed. If the condition is not met, a different set of Storm operations are performed. Storm supports the use of `if` by itself; `if-else`; or `if-elif-else`.

Note that the "Storm operations" performed can include **no** operations / "do nothing" if no Storm is provided (e.g., if the associated curly braces are left empty).

If

Syntax:

```
if <condition> { <storm> }
```

If <condition> is met, execute the Storm query in the curly braces. If <condition> is not met, do nothing. (Note that this is equivalent to an `if` statement followed by an empty `else` statement.)

Note: If <condition> is an expression to be evaluated, it must be enclosed in parentheses `( )`. If the expression includes strings, they must be enclosed in single or double quotes.

```
if ( $str = 'Oh hai!' ) { <storm> }
```

Or:

```
if ( :time > $date ) { <storm> }
```

(Where `:time` represents a property on an inbound node.)

If-Else

Syntax:

```
if <condition> { <storm> }
else { <storm> }
```

If <condition> is met, execute the associated Storm; otherwise, execute the alternate Storm.

Similar to the `if` example above with no `else` option (or an empty query for `else`), you can have an empty `if` query:

```
if <condition> { }
else { <storm> }
```

If <condition> is met, do nothing; otherwise, execute the alternate Storm query.

If-Elif-Else

Syntax:

```
if <condition> { <storm> }
elif <condition> { <storm> }
else { <storm> }
```

If <condition> is met, execute the associated Storm; otherwise, if (else if) the second <condition> is met, execute the associated Storm; otherwise (else) execute the final Storm query.

You can use multiple `elif` statements before the final `else`. `If-elif-else` is helpful because it allows you to handle multiple conditions differently while avoiding "nested" `if-else` statements.

Example:

You have a subscription to a third-party malware service that allows you to download malware binaries via the service's API. However, the service has a query limit, so you don't want to make any unnecessary API requests that might exhaust your limit.

You can use a simple if-else statement to check whether you already have a copy of the binary in your storage Axon before attempting to download it.

```
<inbound file:bytes node(s)>

if $lib.bytes.has(:sha256) { }

else { | malware.download }
```

The Storm query above:

- takes an inbound `file:bytes` node;
- checks for the file in the Axon (*$lib.bytes.has(sha256)*) using the `:sha256` value of the inbound file;
- if `$lib.bytes.has(:sha256)` returns `true` (i.e., we have the file), do nothing (`{ }`);
- otherwise call the `malware.download` service to attempt to download the file.

Note: In the above example, `malware.download` is used as an example Storm service name only; it does not exist in the base Synapse code.

Switch Statement

A **switch statement** matches inbound objects against a set of specified constants. Depending on which constant is matched, a set of Storm operations is performed. The switch statement can include an optional **default case** to perform a set of Storm operations in the case where none of the explicitly defined constants are matched.

Syntax:

```
<inbound nodes>

switch <constant> {

  <case1>: { <storm> }
  <case2>: { <storm> }
  <case3>: { <storm> }
```

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```
  *: { <storm for optional default case> }
}
```

Example:

You want to write a macro (see *Macros*) to automatically enrich a set of indicators (i.e., query third-party data sources for additional data). Instead of writing separate macros for each type of indicator, you want a single macro that can take any type of indicator and send it to the appropriate Storm commands.

A switch statement can send your indicators to the correct services based on the kind of inbound node (e.g., the node's form).

```
<inbound nodes>

switch $node.form() {

    "hash:md5": { | malware.service }

    "hash:sha1": { | malware.service }

    "hash:sha256": { | malware.service }

    "inet:fqdn": { | pdns.service | whois.service }

    "inet:ipv4": { | pdns.service }

    "inet:email": { | whois.service }

    *: { $lib.print("{form} is not supported.", form=$node.form()) }
}
```

The Storm query above:

- takes a set of inbound nodes;
- checks the switch conditions based on the form of the node (see *$node.form()*);
- matches the form name against the list of forms;
- handles each form differently (e.g., hashes are submitted to a malware service, domains are submitted to passive DNS and whois services, etc.)
- if the inbound form does not match any of the specified cases, print (*$lib.print(mesg, **kwargs)*) the specified statement (e.g., `"file:bytes is not supported."`).

The default case above is not strictly necessary - any inbound nodes that fail to match a condition will simply pass through the switch statement with no action taken. It is used above to illustrate the optional use of a default case for any non-matching nodes.

Note: the Storm command names used above are examples only. Commands with those names do not exist in the base Synapse code.

For Loop

A **for loop** will iterate over a set of objects, performing the specified Storm operations on each object in the set.

Syntax:

```
for $<var> in $<vars> {

    <storm>
}
```

Note: The user documentation for the Synapse csvtool (*csvtool*) includes additional examples of using a for loop to iterate over the rows of a CSV-formatted file (i.e., `for $row in $rows { <storm> }`).

Example:

You routinely apply tags to files (`file:bytes` nodes) to annotate things such as whether the file is associated with a particular malware family (`cno.mal.redtree`) or threat group (`cno.threat.viciouswombat`). When you apply any of these tags to a file, you want to automatically apply those same tags to the file's associated hashes (e.g., `hash:md5`, etc.)

You can use a for loop to iterate over the relevant tags on the file and apply("push") the same set of tags to the file's hashes. (**Note:** this code could be executed by a **trigger** (see *Triggers*) that fires when the relevant tag(s) are applied.)

```
<inbound file:bytes node(s)>

for $tag in $node.tags(cno.**) {

    { :md5 -> hash:md5 [ +#$tag ] }
    { :sha1 -> hash:sha1 [ +#$tag ] }
    { :sha256 -> hash:sha256 [ +#$tag ] }
    { :sha512 -> hash:sha512 [ +#$tag ] }
}
```

For each inbound node, the for loop:

- Looks for tags on the node that match the specified pattern (`cno.**`)
- For **each** tag that matches the pattern, execute the Storm code to:
  - Pivot from each of the file's hash properties to the associated hash node.
  - Apply the tag to the node.

Because each "pivot and tag" operation is isolated in a *Subquery*, the original `file:bytes` node remains in our Storm pipeline throughout the set of operations.

Note: A for loop will iterate over "all the things" as defined by the for loop syntax. In the example above, a single inbound node may have multiple tags that match the pattern defined by the for loop. This means that the for loop operations will execute once **per matching tag per node** and yield the inbound node (the `file:bytes` node) to the pipeline for each iteration of the for loop.

In other words, for **each** inbound node:

- the first matching tag causes the for loop to execute;
- the loop operations are performed for that tag (i.e., the tag is applied to the associated hashes);
- the `file:bytes` node is yielded from the for loop;

- if there are additional matching tags to process from the inbound node, **repeat the for loop for each tag.**

Recall that a "single" multi-element tag (such as `cno.mal.redtree`) actually represents three tags (`cno`, `cno.mal`, and `cno.mal.redtree`). If an inbound `file:bytes` node has the tag `#cno.mal.redtree`, the for loop will execute **twice** (for the matching tags `cno.mal` and `cno.mal.redtree`) and yield **two** copies of the `file:bytes` node (one for each match / each iteration of the for loop).

This is by design, and is the way Storm variables (specifically, non-runtime safe variables (*Non-Runtsafe*)) and the Storm execution pipeline (see *Storm Operating Concepts*) are intended to work.

See the *Advanced Storm - Example* below for an illustration of how for loops in particular are impacted by Storm's pipeline behavior.

While Loop

A **while loop** checks inbound nodes against a specified condition and performs the specified Storm operations for as long as the condition is met.

Syntax:

```
while <condition> {

    <storm>
}
```

While loops are more frequently used for developer tasks, such as consuming from Queues; and are less common for day-to-day user use cases.

Try...Catch Statement

A **try...catch statement** allows you to attempt (try) a Storm operation and handle (catch) any errors if they occur. Because Storm's default behavior is to halt execution when an error occurs, try...catch statements allow for more graceful error handling within Storm. "Catching" an error allows the remainder of your Storm to continue executing.

Tip: Storm supports some basic error handling (allowing you to "warn and continue" vs "error and halt") specifically when creating nodes and setting properties or tags through the use of the *Edit "Try" Operator (?=)*.

Syntax:

```
try {

    <storm>

} catch <name> as err {

    <storm>
}
```

If the Storm in the try block runs without error, the catch block (or blocks) are ignored. If an error occurs, execution of the try block halts (any remaining Storm in the try block is ignored) and flow passes to the appropriate catch block to handle the error. Multiple catch blocks can be used to handle different kinds of errors.

Because the catch block handles the error, any additional Storm (i.e., after the catch block) will continue to execute.

In the catch block above, <name> can be the name of a single error type, a set of error types, or the asterisk (*) to represent any error. When using multiple catch blocks, the asterisk can be used in the final block as a default case to catch any error not explicitly handled by a previous catch block.

The catch block can return a status (e.g., `return((1))`) or output a warning message (e.g., using `$lib.warn()` - see *$lib.warn(mesg, **kwargs)*).

Example:

You have an "enrich" macro used to send various kinds of nodes to Storm commands that connect to third-party data sources. There is a particular data source that occasionally returns malformed data, which throws an error and causes the entire macro to halt. You want to isolate the Storm command for that vendor within a try...catch block so the macro will continue to run if an error is encountered.

```
try {

    | enrich.badvendor

} catch * as err {

   $lib.warn("BadVendor blew up again!")
}
```

Advanced Storm - Example

The example below is meant to provide a more concrete illustration of some of Storm's pipeline behavior when combined with certain control flow operations - specifically, with for loops. Control flow operations such as if-else or switch statements allow you to perform more advanced Storm operations, but still typically represent a single "path" through the pipeline for any given node - even though the **specific** path for a given node may vary depending on the if-else or switch conditions.

With for loops, however, we may execute the same Storm multiple times, which may have unexpected results if you don't keep Storm's pipeline concept in mind.

For Loop - No Subquery

Consider the following query:

```
inet:fqdn=vertex.link
$list = ('foo','bar','baz')

for $item in $list {

    $lib.print($item)
}

$lib.print('And we're done!')
```

The query:

- lifts a single FQDN node;
- defines a list containing three elements, `foo`, `bar`, and `baz`;
- uses a `for` loop to iterate over the list, printing each element;

- prints `And we're done!`

When executed, the query generates the following output:

```
storm> inet:fqdn=vertex.link
  $list = ('foo', 'bar', 'baz')

  for $item in $list {

    $lib.print($item)
  }

  $lib.print("And we're done!")


foo
And we're done!
inet:fqdn=vertex.link
        :domain = link
        :host = vertex
        :issuffix = false
        :iszone = true
        :zone = vertex.link
        .created = 2023/07/12 15:14:36.533
bar
And we're done!
inet:fqdn=vertex.link
        :domain = link
        :host = vertex
        :issuffix = false
        :iszone = true
        :zone = vertex.link
        .created = 2023/07/12 15:14:36.533
baz
And we're done!
inet:fqdn=vertex.link
        :domain = link
        :host = vertex
        :issuffix = false
        :iszone = true
        :zone = vertex.link
        .created = 2023/07/12 15:14:36.533
```

What's going on here? Why does `And we're done!` print three times? Why do we apparently have three copies of our FQDN node? The reason has to do with Storm's pipeline behavior, and how our FQDN node travels through the pipeline when the pipeline loops.

Our query starts with a single `inet:fqdn` node in our initial working set. Setting the `$list` variable does not change our working set of nodes.

When we reach the for loop, the loop needs to execute multiple times (three times in this case, once for each item in `$list`). Anything currently in our pipeline (any nodes that are inbound to the for loop, as well as any variables that are currently set) is passed into **each** iteration of the for loop.

In this case, because the for loop is part of our **main** Storm pipeline (it is not isolated in any way, such as by being placed inside a subquery), **each iteration** of the loop outputs our original FQDN node…which then continues its

passage through the remainder of the Storm pipeline, causing the `$lib.print('And we're done!')` statement to print (remember, each node travels through the pipeline one by one). Storm then executes the second iteration of the for loop, and the FQDN that exits from this second iteration continues through the pipeline, and so on.

It may help to think of this process as the for loop effectively "splitting" the main Storm pipeline into multiple pipelines that then each continue to execute in full, one after the other.

Note: Each pipeline still executes **sequentially** - not in parallel. So the first iteration of the for loop (where `$item=foo`) will execute and the remainder of the Storm pipeline will run to completion; followed by the second iteration of the for loop and the remainder of the Storm pipeline, and so on. (This is why one instance of `And we're done!` prints before the messages associated with the second iteration of the loop where `$item=bar`, etc.).

For Loop - With Subquery

In this variation on our original query, we isolate the for loop within a subquery (*Storm Reference - Subqueries*):

```
inet:fqdn=vertex.link
$list = ('foo','bar','baz')

{
    for $item in $list {

        $lib.print($item)
    }
}

$lib.print('And we're done!')
```

The query performs the same actions as described above, but thanks to the subquery, the behavior of this query is different, as we can see from the query's output:

```
storm> inet:fqdn=vertex.link
  $list = ('foo', 'bar', 'baz')

  {
      for $item in $list {
          $lib.print($item)
      }
  }

  $lib.print("And we're done!")


foo
bar
baz
And we're done!
inet:fqdn=vertex.link
        :domain = link
        :host = vertex
        :issuffix = false
        :iszone = true
```

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```
        :zone = vertex.link
        .created = 2023/07/12 15:14:36.533
```

In this case, the query behaves more "as expected" - the strings within the for loop print once for each item / iteration of the loop, `And we're done!` prints once, and a single FQDN node exits our pipeline when our query completes. So what's different?

One of the key features of a subquery is that by default (i.e., unless the `yield` option is used), **the nodes that go into a subquery also come out of a subquery,** regardless of what occurs inside the subquery itself. In other words, **subqueries do not "consume" nodes**.

We still have our single FQDN inbound to the subquery. Inside the subquery, our for loop still executes, effectively "splitting" the Storm pipeline into three pipelines that execute in sequence. But once we complete the for loop and exit the subquery, those pipelines are "discarded". The single FQDN that went into the subquery exits the subquery. We are back to our single node in the main pipeline. That single node causes our print statement to print `And we're done!` only once, and we are left with our single node at the end of the query.

Many of the concepts above are closely related and this outline represents a reasonable effort to introduce concepts in a logical order. However, it is difficult to fully understand the potential of Synapse and hypergraphs without grasping the power of the Storm query language to understand, manipulate, and annotate data. Similarly, it's hard to understand the effectiveness of Storm without knowledge of the underlying data model. **The outline above is our suggested order but readers are encouraged to skip around or revisit earlier sections after digesting later sections to better see how these topics are tied together.**

CHAPTER

FOUR

SYNAPSE ADMIN GUIDE

This guide is designed for use by Synapse Administrators ("global admins"). Synapse Admins are typically Synapse power-users with `admin=true` privileges on the *Cortex* who are responsible for configuration and management of a production instance of Synapse.

The Synapse Admin Guide provides important instructions and background information on topics related to day-to-day Synapse administrative tasks, and focuses on using *Storm* to carry out those tasks.

Synapse provides a number of additional methods that can be used to perform some or all of the tasks described in this guide; however, these methods are **not** covered here. Additional methods include:

- *Storm Libraries* that allow you to work with a broad range of objects in Synapse.
- Synapse tools that can be used from the host CLI (as opposed to the Storm CLI). Tools are available in the synapse.tools package of the *Synapse Python API*. The *Synapse User Guide* includes documentation on some of these *Tools*.
- The *Synapse HTTP/REST API*.

Tip: If you are a commercial Synapse user with the Synapse UI (Optic), see the UI documentation for information on performing Synapse Admin tasks using Optic. Optic simplifies many of Synapse's administrative tasks. However, we encourage you to review the information in this guide for important background and an overview of the relevant topics.

4.1 Enable Synapse Power-Ups

The Vertex Project provides a number of Power-Ups that extend the functionality of Synapse. For more information on configuring your Cortex to use **Rapid Power-Ups,** see the blog post on Synapse Power-Ups.

Note: **Advanced Power-Ups** are deployed via their own Docker containers and are typically configured by a DevOps team.

4.2 Create and Manage Users and Roles

A *User* account is required to authenticate to and access Synapse. Having "a Synapse account" effectively means having an account in the Cortex.

In Synapse, a *Role* can be used to "group" users with similar responsibilities (and related permissions requirements). You can **grant** or **revoke** one or more roles from a user.

You grant (or deny) **permissions** to users or roles by assigning **rules** that specify those permissions (see *Assign and Manage Permissions*).

Synapse includes the following built-in users and roles:

- **Root** user. The **root** account has *Admin* privileges in the Cortex. The **admin** status of the root account cannot be revoked, and the account cannot be locked / disabled.
- **All** role. The **all** role has **read** access to the Cortex (specifically, to any view with `worldreadable=true`, which includes the **default** view). All user accounts are automatically granted the **all** role (are part of the **all** "group"); this role cannot be revoked.

Tip: The set of Storm *auth* commands are collectively used to manage users, roles, and permissions from Storm.

In the commercial Optic UI, users, roles, and permissions can be managed through the **Admin Tool** and through dialogs associated with various objects (such as Views or Stories).

Note: The descriptions and examples below assume that you have deployed Synapse using native Synapse management and authentication of users, roles, and permissions.

The *Synapse Devops Guide* includes information on provisioning **initial** users when Synapse is first deployed (see *Managing Users and Roles*). This guide focuses on ongoing management of users and roles once Synapse admins have access to Storm (i.e., the Storm CLI or Optic UI).

4.2.1 Working with Users

Add a User

The *auth.user.add* command creates a new user. Newly created users do not have any permissions (other than those associated with the built-in **all** role).

Example:

Add the user "Ron" with email address `ronthecat@vertex.link`:

```
storm> auth.user.add ron --email ronthecat@vertex.link
User (ron) added with iden: 72d77fbe2df8bc7e25c0cf1e76d2eb4b
```

Tip: Users are represented by a unique 128-bit identifier (iden). You can modify information about the user account (such as the username or associated email address) without affecting the underlying identifier or any associated roles or permissions.

Display a User

The *auth.user.show* command displays information about a user, including any assigned roles or rules (permissions) and their order.

Example:

Display information for user "Ron":

```
storm> auth.user.show ron
User: ron (72d77fbe2df8bc7e25c0cf1e76d2eb4b)

  Locked: false
  Admin: false
  Email: ronthecat@vertex.link
  Rules:

  Roles:
    d9d720443ca613fcdd56b6b1e5591d11 - all

  Gates:
```

Modify a User

The *auth.user.mod* command modifies a user account. Use the command to:

- Change the username or email address associated with the user.
- Set or reset the user's password.
- Assign (or remove) **admin** status for the user.
- Lock (or unlock) the account.

Examples:

Update the email address for user "Ron":

```
storm> auth.user.mod ron --email ron@vertex.link
User (ron) email address set to ron@vertex.link.
```

Assign **admin** status to the user "ron_admin":

```
storm> auth.user.mod ron_admin --admin $lib.true
User (ron_admin) admin status set to true.
```

Remove **admin** status from user "ron_admin":

```
storm> auth.user.mod ron_admin --admin $lib.false
User (ron_admin) admin status set to false.
```

Lock the user account "ron_admin":

```
storm> auth.user.mod ron_admin --locked $lib.true
User (ron_admin) locked status set to true.
```

Warning: We strongly encourage you to **lock** (disable) accounts when necessary instead of deleting them. Changes to data in the Cortex (such as creating nodes, setting properties, or adding tags) are associated with the user account that made those changes. Deleting an account associated with past changes will prohibit you from identifying the user who made those changes.

If necesssary, user accounts can be deleted using the *$lib.auth.users.del(iden)* library, but there is no equivalent Storm command.

List All Users

The *auth.user.list* command lists all users in the Cortex.

Example:

List all users:

```
storm> auth.user.list
Users:
  ron
  root

Locked Users:
  ron_admin
```

4.2.2 Working with Roles

Add a Role

The *auth.role.add* command creates a new role. Newly created roles do not have any permissions or associated user accounts.

Example:

Add the new role "cattribution analyst":

```
storm> auth.role.add "cattribution analyst"
Role (cattribution analyst) added with iden: 05f3f536b0bb51432c33d4e34247f161
```

Tip: Roles are represented by a unique 128-bit identifier (iden). You can later change information about the role (such as the role name) without affecting the underlying role or any associated permissions or users.

Display a Role

The *auth.role.show* command displays information about a role, including any assigned rules (permissions) and their associated objects.

Example:

Display information for the "all" role:

```
storm> auth.role.show all
Role: all (d9d720443ca613fcdd56b6b1e5591d11)

  Rules:

  Gates:
    729469dd5f908039d9b4ff10483ec35e - (layer)
      [0  ] - layer.read
    1bfaeed8f919a216a6ad7c1f18d56ffe - (view)
      [0  ] - view.read
```

Modify a Role

The *auth.role.mod* command modifies a role. The command can be used to change the name of the role.

Example:

Change the name of the role "cattribution analyst" to "meow-ware analyst":

```
storm> auth.role.mod "cattribution analyst" --name "meow-ware analyst"
Role (cattribution analyst) renamed to meow-ware analyst.
```

List all Roles

The *auth.role.list* command lists all roles in the Cortex.

Example:

List all roles:

```
storm> auth.role.list
Roles:
  a-cat-emic researcher
  all
  cattribution analyst
  meow-ware analyst
```

Delete a Role

The *auth.role.del* command deletes a role.

Example:

Delete the role "meow-ware analyst":

```
storm> auth.role.del "meow-ware analyst"
Role (meow-ware analyst) deleted.
```

Note: Deleting a role has no impact on any users who have been granted the role (other than losing any permissions provided by that role). The user accounts remain intact and the role is simply removed from each user's list of roles.

4.2.3 Grant or Revoke Roles

Granting a role to a user allows the user to inherit the role's permissions. **Revoking** a role removes the associated permissions from the user. It is not possible to grant a role to another role (i.e., roles cannot be nested).

Roles can be granted or revoked using the *auth.user.grant* and *auth.user.revoke* commands.

Examples:

Grant the role "cattribution analyst" to the user "ron":

```
storm> auth.user.grant ron "cattribution analyst"
Granting role cattribution analyst to user ron.
```

Revoke the role "a-cat-emic researcher" from user "ron":

```
storm> auth.user.revoke ron "a-cat-emic researcher"
Revoking role a-cat-emic researcher from user ron.
```

Note: The order in which roles are granted to a user matters; when determining whether a user has permission to perform an action, the permissions for each of the user's roles are checked in sequence.

Each role granted to a user is added to the **end** of the set of roles **unless** a location (index) for the role is specified. To "reorder" roles, you must either:

- revoke the roles and grant them in the desired order;
- use the `--index` option to specify the location to insert the role;
- use stormprims-storm-auth-user-setRoles to replace the user's roles with a new list of roles; or
- use the commercial Synapse UI (Optic) to reorder the roles using drag-and drop.

See *Permissions Background* for additional detail on permissions and *Precedence*.

4.3 Assign and Manage Permissions

Synapse provides a highly flexible system of role-based access control (RBAC). **Rules** are used to assign permissions to users and / or roles, with a defined order of precedence for how permissions are evaluated.

Permissions can be assigned very broadly, such as allowing a user (or role) to create / modify / delete any node. Permissions can also be very fine-grained, restricting users so that they can **only** create specific nodes, set specific properties, create specific edges, or apply specific tags.

4.3.1 Permissions Background

Before describing how to assign and manage permissions in Synapse, it is helpful to define some key components of Synapse and the permissions ecosystem.

Services

Synapse is designed as a modular set of **services.** A service can be thought of as a container used to run an application. **Synapse services** make up the core Synapse architecture, and include the *Cortex* (data store), *Axon* (file storage), and the commercial *Optic* UI. Services handle user authentication and authorization.

From a Synapse Admin perspective, you will primarily be concerned with managing user accounts and permissions to (and within) the Synapse **Cortex.**

Tip: When we talk about "Synapse users" or "permissions to Synapse" we are generally referring to user accounts and roles in a Cortex, and permissions to a Cortex and its associated objects.

Depending on your Synapse deployment, you may need to grant or manage permissions to additional Synapse services. See the sections on *Optic Permissions* and *Power-Up Permissions* for details.

Cortex

The **Cortex** is Synapse's primary data store. Users and roles are created and managed in the Cortex, and most things for which users will need permissions apply to the Cortex and to the views, layers, and data (nodes, tags, etc.) that reside there.

Auth Gate

An **Auth Gate** (or "gate", informally) is an object within a service (such as a Cortex) that may have its own set of permissions. A *View* and a *Layer* are both common examples of Auth Gates.

Auth Gates are represented by a 128-bit identifier (iden) that uniquely identifies the Auth Gate object itself. They also have an associated type to specify the kind of Auth Gate object (e.g., "view"). Some Auth Gates also support the use of "user friendly" names, though this is dependent on the type of Auth Gate and has no impact on the underlying iden or associated permissions.

Scope

Scope refers to the object to which a particular permission applies. For example, permissions granted on an Auth Gate (such as a view) are scoped to (or **local** to) that Auth Gate. Permissions granted at the Cortex level are **global** with respect to the Cortex.

Scope affects the order (precedence) in which permissions are evaluated.

Permission

A **permission** is a string that is used to control access. For example:

`view.add`

Tip: A list of most permissions available in a Cortex can be found under *Cortex Permissions*. You can also display the list in Synapse using the `auth.list.perms` command.

Most permission strings use a dotted (hierarchical) format; specifying a permission higher up in the hierarchy includes all permissions below it. For example, the permission `view` includes all of the following permissions: `view.add`, `view.del`, `view.read`, and `view.set`.

Permissions related to objects such as nodes or tags can optionally extend the permission string to be highly specific, referencing particular forms, properties, tags/tag trees, or light edges. This allows you to set highly granular permissions.

Granular permissions may be useful for organizations with specialized users or teams, where certain individuals are responsible for specific types of analysis (e.g., strategic analysis vs. tactical threat tracking) and should be the only users authorized to create, modify, and tag certain types of data.

Granular permissions can also be used to differentiate between senior and junior roles; for example, only senior analysts may be allowed to apply tags representing certain assessments (such as attribution).

Examples:

Description	Permission
Perform **any** action on **any** kind of node (including deleting nodes and working with properties, tags, edges, and node data)	`node`
Add any kind of node (but not delete nodes, or work with properties, tags, edges, or node data)	`node.add`
Only add `inet:ipv4` nodes (but not set properties, or work with tags or edges)	`node.add.inet:ipv4`
Only add (set) the `:asn` property of `inet:ipv4` nodes (but not create nodes or work with other properties, tags, edges, etc.)	`node.prop.set.inet:ipv4:asn`
Add or remove **any** tag (Note that adding/removing tags may require the ability to create `syn:tag` nodes, unless those nodes already exist.)	`node.tag`
Only add and remove tags in the "mytag" tag tree	`node.tag.add.mytag` `node.tag.del.mytag`
Add or remove **any** edge (Note that adding or removing edges allows creating edges between **any** nodes; there are no model constraints on the kinds of nodes that can be joined. It also allows the creation of new / arbitrarily named edges.)	`node.edge`
Only add edges	`node.edge.add`
Only add `refs` edges	`node.edge.add.refs`

Note: Permissions strings **do not** support wildcards (`*`). For example, you cannot specify `node.tag.*.mytag` to allow users to both add and delete tags in the `mytag` tree.

Rule

A **rule** is used to grant (or prohibit) a specific permission. Rules are evaluated in a defined order of precedence.

When you specify a rule, there is an implicit **allow** directive; a permission string by itself indicates the permission is allowed/true:

```
view.add
```

To use a rule to **deny** a permission, use the "not" or "bang" symbol (`!`) to indicate the permission is denied/false:

```
!node.tag.add.mytag
```

Precedence

Rules in Synapse are evaluated in order of **precedence.** A requested action will be allowed (or denied) based on the **first matching rule** found for the action. If no matching rule is found, the action is **denied.**

Generally speaking, rules are evaluated from "most specific" to "least specific". Rules are evaluated in the following order:

- **User** rules at the **local** (i.e., Auth Gate) level.
- **Role** rules at the **local** level.
- **User** rules at the **global** (i.e., Cortex) level.
- **Role** rules at the **global** level.

Note: Because global rules are evaluated after local rules, permissions granted at the global level can "override" permissions that are not explicitly denied at the local level. For example, a user may fork a view (making them admin of that view) and grant "read" access to a coworker (`view.read`).

If the coworker has "write" permissions (such as `node.tag`) at the **global** level, they will be able to add tags within the forked view (or any view where they have `view.read` permissions).

If the user forking the view also specified `!node` for the view's layer, the coworker would be prevented from adding any tags in the forked view (or making any edits whatsoever).

Roles (granted to a user) and **rules** (assigned to a user or role) are **also ordered:**

- When granting roles to a user, each new role is added to the **end** of the list of roles **unless** a location (index) for the role is specified.
- When assigning rules to a role or user, each new rule is added to the **end** of the list of rules **unless** a location (index) for the rule is specified.

Rules and roles are evaluated in the following order:

- **User rules** are evaluated in order from first to last.
- Each **role** granted to a user is evaluated in order from first to last.
- For each role, the **role's rules** are evaluated in order from first to last.

This means that the same rules, applied and evaluated in a different order, will give different results. As a simple example:

These rules will **allow** the creation of `file:bytes` nodes, but no other nodes:

```
node.add.file:bytes
!node.add
```

The same rules in the opposite order will **disallow** the creation of **any** nodes:

```
!node.add
node.add.file:bytes
```

Admin

Admin status allows a user to **bypass all permissions checks** for the **scope** where the user is admin. For example, a Synapse (Cortex) admin user can bypass all Cortex permissions checks (can "do anything" within the Cortex).

Users are generally **admin** of objects that they create. A user who forks a view is **admin** for the view that they fork, and can bypass all permissions checks ("do anything") within the forked view.

Note: It is not possible to assign **admin** privileges to a role.

Easy Permissions

Easy permissions ("easy perms" for short) is a mechanism that simplifies granting common sets of permissions to users or roles for a particular object. Where easy perms are used, you can specify four levels of access: **deny, read, edit,** and **admin.** These access levels have corresponding integer values:

- Deny = 0
- Read = 1
- Edit = 2
- Admin = 3

Easy perms apply to specific objects. Where easy perms are available, the following conventions apply:

- The user who creates the object has **admin** privileges for that object.
- **Admin** privileges include the ability to grant permissions to others (including the ability to explicitly deny access).
- Admin privileges are required to **delete** the object (i.e., **edit** permissions do not include **delete**).

Tip: $lib.macro.grant library is an example of where easy permissions can be used to assign permissions.

Views and Layers

Data in a Cortex is stored in one or more **layers** (see *Layer*). Layers are composed into **views** (see *View*) containing the data that should be visible to users or roles. (A standard installation of Synapse consists of the default view, which contains one layer.)

Views define the data that a user or role can **see** - they act as a **read** boundary. Granting the `view.read` permission on a view allows users to see (read) data in any of the view's layers; you do not need to explicitly grant "read" access to the individual layers themselves.

The ability to read data in a view is "all or nothing" - you cannot allow users to see some nodes in a view but not others. (Sensitive data should be stored in its own layer, and views containing that layer should be limited to users or roles with a need to access that data.)

Layers define the changes (if any) that a user or role can make to data in Synapse - they act as a **write** boundary. In normal circumstances, only the top layer in a view is writable. The ability to write data **to** a layer is controlled by the various `node.*` permissions, which specify the forms / properties / tags / light edges a user or role can work with (create / modify / delete). Permissions to modify data must be assigned at the appropriate **layer** (or globally, if the permissions apply to all writable layers in the Cortex).

4.3.2 Assign Permissions

You assign (allow or deny) permissions in Synapse by adding rules to (or removing rules from) roles or users. Recall that **order matters** when adding rules (see *Precedence*).

From a Synapse Admin perspective, managing permissions within Synapse commonly involves:

- Assigning rules to users and roles within the Cortex.
- Assigning rules to users and roles for various Auth Gates (such as layers or views) if necessary.
- Assigning rules to users and roles to allow or deny access to additional services, such as various Power-Ups.

Permissions in Synapse are managed using the Storm *auth* commands.

In the commercial Optic UI, permissions can also be managed through the **Admin Tool** and through dialogs associated with various objects (such as Views or Stories).

Tip: If a user attempts an action that they do not have permissions to perform, Synapse will return an `AuthDeny` error that lists the specific permission that is required.

Note: The descriptions and examples below assume that you have deployed Synapse using native Synapse management and authentication of users, roles, and permissions.

Default Permissions

Synapse includes the following default permissions:

- The built-in **root** user has **admin** access (`admin=true`) to the Cortex.
- The built-in **all** role has **read** access (`view.read`) to any view created with `worldreadable=True`. This includes the **default** view.

Any additional permissions must be **explicitly granted** to users or roles. In all but a few edge cases, Synapse assumes an implicit default `deny all` as the final rule evaluated when checking permissions.

Note: There are a few edge cases where a specific permission assumes a **default allow** instead of a **default deny,** but these are uncommon. These cases are highly specific, and usually arise in cases where a **new** permission has been implemented. That is, an action that was not originally subject to a permissions check now has one (usually because of a need to explicitly **deny** that action to particular users or roles).

If a previously unchecked action were added with "default deny", it would potentially break existing Synapse deployments by suddenly blocking an action that had been previously allowed (ungated). In these circumstances the new permission is given a "default allow" that can then be specifically denied if necessary.

Global (Cortex) Permissions

Permissions in Synapse can be assigned at the global (Cortex) level, or to a specific Auth Gate (see *Auth Gate Permissions*). To assign permissions to an Auth Gate, you must specify its identifier (iden) (i.e., using the `--gate` option to the appropriate Storm command) when adding the associated rule to a user or role.

If you do not specify an Auth Gate, the permissions are **global** and apply to any / all instances within the Cortex where a user or role has access. For example, the following Storm command:

```
auth.role.addrule all node
```

. . . grants (allows) the `node` permission to the built-in **all** role. This allows **any** user (because all users are granted the **all** role by default) to perform **any** action on **any** node in **any** layer that is the topmost (writeable) layer in **any** view that the user can see.

Specifying rules at the global (Cortex) level may be sufficient for many basic Synapse deployments.

Note: Recall that **order matters** when adding rules:

- by default, each rule is added to the **end** of the list of rules assigned to a user or role; and
- rules are evaluated in order of precedence.

To reorder rules, you must:

- use the `--index` option with `auth.user.addrule` or `auth.role.addrule` to specify a location to insert a specific rule;
- remove and re-add the rules in the desired order;
- use stormprims-storm-auth-user-setRules or stormprims-storm-auth-role-setRules to replace the rules for a user or role with a new set of rules; or
- use the commercial Synapse UI (Optic) to reorder rules using drag-and-drop.

Assign Permissions

Permissions rules (allow or deny) are assigned using the *auth.user.addrule* and *auth.role.addrule* commands.

Examples:

Prevent the user "ron" from setting tag descriptions (setting the `syn:tag:desc` property):

```
storm> auth.user.addrule ron "!node.prop.set.syn:tag:desc"
Added rule !node.prop.set.syn:tag:desc to user ron.
```

Tip: Deny rules specified with Storm must be enclosed in quotes (single or double) because they begin with a symbol (!).

Allow the role "senior analysts" to add tags in threat attribution (`cno.threat`) tag tree:

```
storm> auth.role.addrule "senior analysts" node.tag.add.cno.threat
Added rule node.tag.add.cno.threat to role senior analysts.
```

Prevent the "all" role from deleting nodes:

```
storm> auth.role.addrule all "!node.del"
Added rule !node.del to role all.
```

Prevent the "all" role from deleting nodes, and insert this as the first rule for the role:

```
storm> auth.role.addrule --index 0 all "!node.del"
Added rule !node.del to role all.
```

Tip: Recall that you can *Display a User* or *Display a Role* with the *auth.user.show* and *auth.role.show* commands.

Revoke Permissions

Permissions rules are revoked using the `auth.user.delrule` and `auth.role.delrule` commands.

Examples:

Revoke the rule that prevents user "ron" from setting tag descriptions:

```
storm> auth.user.delrule ron "!node.prop.set.syn:tag:desc"
Removed rule !node.prop.set.syn:tag:desc from user ron.
```

Revoke the rule that allows "junior analysts" to apply tags in the `cno.threat` tag tree:

```
storm> auth.role.delrule "junior analysts" node.tag.cno.threat
Removed rule node.tag.cno.threat from role junior analysts.
```

Check Permissions

The *auth.user.allowed* command can be used to check whether a user has a particular permission (i.e., is allowed to perform the associated operation) for a specific **scope** (i.e., globally or for an individual Auth Gate). If an appropriate `allow` rule exists, the command will show the source (i.e., the rule, role, and / or associated Auth Gate) where the permission has been assigned.

Tip:

- A user may have permissions locally (e.g., to a specific Auth Gate) that they do not have globally. In other words a **global** check may (correctly) show that a user does **not** have an expected permission globally, but the permission will show as "allowed" when the appropriate Auth Gate is checked.
- When checking whether a user can see (read) data or manipulate (e.g., fork) a view, check the relevant **view.**

- When checking whether a user can modify (write or delete) data, check the relevant **layer.**

Examples:

Check whether user 'ron' is allowed to apply tags in the cno tag tree **globally:**

```
storm> auth.user.allowed ron node.tag.add.cno
allowed: true - Matched role rule (node.tag.add.cno) for role cattribution analyst.
```

Check whether user 'ron' is allowed to apply tags in the cno tag tree in the **current layer:**

```
storm> auth.user.allowed --gate $lib.layer.get().iden ron node.tag.add.cno
allowed: true - Matched role rule (node.tag.add.cno) for role cattribution analyst.
```

Note that the response for each of the commands above is identical, even though the first example performed a global check (no `--gate` option) while the second example checked the current layer (retrieved with `$lib.layer.get()`). The response in the second example shows that Ron can apply tags in the current layer because he has **global** permissions for this action - indicated by the **absence** of an iden in the response. If Ron's permissions were restricted to the queried gate (in this case, the layer), the associated iden would have been included in the command output.

Check whether user 'ron' is allowed to fork the **current view:**

```
storm> auth.user.allowed --gate $lib.view.get().iden ron view.add
allowed: false - No matching rule found.
```

Auth Gate Permissions

To assign permissions for an Auth Gate, you use the same Storm commands used to assign global permissions, but you must specify the Auth Gate's full identifier (iden) (using the `--gate` option) when adding or removing the rule.

Obtain a Gate's Iden

The Storm *view* and *layer* commands can be used to manage views and layers, respectively. In particular, the following commands are useful for displaying all views or layers (including their idens), or displaying a specific view or layer:

- *view.list*
- *view.get*
- *layer.list*
- *layer.get*

Examples:

Display all views:

```
storm> view.list

View: 1bfaeed8f919a216a6ad7c1f18d56ffe (name: default)
  Creator: e8612ee8e55b161e2495ae25602ab0c4
  Layers:
    729469dd5f908039d9b4ff10483ec35e: default readonly: False
```

Display the current layer:

```
storm> layer.get
Layer: 729469dd5f908039d9b4ff10483ec35e (name: default) readonly: False creator:␣
↪e8612ee8e55b161e2495ae25602ab0c4
```

View a Gate's Permissions

The `auth.gate.show` command is used to display permissions information about a particular Auth Gate (e.g., a view or layer). You can provide the specific iden for an Auth Gate, or use the syntax below to retrieve information for the **current** view or layer. (Viewing information for the "current layer" will return information for the top layer of the current view.)

Example:

Display information for the current view:

```
storm> auth.gate.show $lib.view.get().iden
Gate Type: view

Auth Gate Users:
  e8612ee8e55b161e2495ae25602ab0c4 - root
    Admin: true
    Rules:

Auth Gate Roles:
  d9d720443ca613fcdd56b6b1e5591d11 - all
    Rules:
      [0  ] - view.read
```

Display information for the current layer (i.e., the top layer of the current view):

```
storm> auth.gate.show $lib.layer.get().iden
Gate Type: layer

Auth Gate Users:
  e8612ee8e55b161e2495ae25602ab0c4 - root
    Admin: true
    Rules:

Auth Gate Roles:
  d9d720443ca613fcdd56b6b1e5591d11 - all
    Rules:
      [0  ] - layer.read
```

4.3.3 Permissions Best Practices

- Synapse Admins should use a designated admin account for administrative tasks and a separate account for their user tasks.
- Where possible, assign permissions to roles and grant roles to users vs. assigning permissions to users directly.
- Create a general purpose role (such as `users`, or use the built-in `all` role) and assign the basic permissions that **all** Synapse users should have to this role. This includes "things all users should be able to do" (allow rules) as well as "things all users should be **explicitly** prohibited from doing" (deny rules). Create additional roles as needed to allow (or further restrict) specific operations.
- Segregate data with different access requirements into different **layers.** Grant access to data sets by composing those layers into **views** and granting roles access to the appropriate view(s).
- The ability to **delete nodes** in Synapse should be granted to a limited number of trusted individuals. We recommend creating a dedicated role for this purpose.
- If a role will have **limited permissions,** it is generally easier to **explicitly allow** only those actions; everything else will be denied by default.
- If a role or user will have **broad permissions** with some restrictions, it is generally easier to **explicitly deny** the restricted actions first, and then **grant** broad permissions (for example `!node.del` followed by `node`). Because permissions rules are checked in order, Synapse will encounter any deny rules first (i.e., user is unable to delete nodes), blocking the prohibited action while then allowing anything not specifically denied (i.e., user can do anything else to nodes).

4.3.4 Example Permissions

The examples below illustrate a few common use cases for roles and permissions within Synapse. These rule sets are meant as simple illustrations and do not necessarily illustrate fully-defined, production-ready permission sets.

Recall that:

- Views control **read** access to the data store. Users with read access to a view (`view.read`) can read all data in all layers of the view (i.e., no additional layer-specific permissions are required for read access).
- Layers control **write** access to the data store. Use permissions to manage the data that can be written to a given layer (including the ability to merge data into that layer from a forked view).
- A user who can fork a view is **admin** within their forked view.

A list of available Cortex permissions is available under the *Cortex Permissions* section, or can be viewed in Synapse with the `auth.perms.list` command.

Case 1 - Grant common permissions - basic

These basic permissions can be assigned to a role to allow users to perform common operations in Synapse.

Permission	Description
`view.read`	See / read any view
`view.add`	Fork any view they can see
`node`	Create, modify, or delete any type of data (nodes, properties, light edges, tags, and node data) in the top layer of any view they can see

Tips:

- The `all` role has implicit (and non-revocable) "read" access to Synapse's **default** view. This is not the same as global `view.read` access. To allow the `all` role (or any role) to see other views, you must explicitly assign the `view.read` permission (either globally or to individual views).
- Users can only fork (`view.add`) views they can see (`view.read`). If users should be allowed to fork any view where they have read access, the `view.add` permission can be assigned **globally** even if read access is managed on a **per-view** basis.

Case 2 - Grant common permissions - intermediate

These permissions expand on Case 1, but only allow the role to see **specific** views (by granting `view.read` locally to individual views).

Any **global** permissions (e.g., `node.add`) will apply to the top (writeable) layer of **any** view the role can see, unless the permissions are overridden locally.

These permissions also prevent the role from **deleting nodes** globally, while allowing them to delete properties or edges and to remove tags.

Permission	Scope	Description
`view.add`	global	Fork any view they can see (based on `view.read`)
`!node.del`	global	Prevent deletion of any nodes
`node.add`	global	Create nodes in the top layer of any view they can see
`node.prop`	global	Set, modify, or delete node properties in the top layer of any view they can see
`node.edge`	global	Add or remove light edges in the top layer of any view they can see
`node.tag`	global	Add or remove tags from nodes in the top layer of any view they can see
`view.read`	local	See all the data in all the layers of the specific view(s) where the rule is assigned

Case 3 - Create a dedicated role that can delete nodes

Deleting nodes indiscriminately or incorrectly can negatively impact your data store (i.e., leaving "holes" in the graph or destroying data). Synapse requires that users run an explicit command (*delnode*) to delete nodes, so the action is a deliberate choice (vs. an "accidental click").

We strongly recommend that you create a role whose sole permission is the ability to delete nodes, and grant that role to a limited number of users. To do this:

- **Explicitly deny** permission to delete nodes (`!node.del`) at the **global** level to the general purpose role you use to manage permissions for all users (as shown in Case 2 above).
- Create a dedicated role whose only permission will be the ability to delete nodes.
  - We encourage a name that inspires caution, such as `fire ze missiles` or `agents of destruction`, but you can just use `deleters`.
- Assign the `node.del` rule to the role (globally, or for specific layers).

Tips:

- All delete operations (whether deleting nodes, properties, edges, or removing tags) must be performed directly in the layer where the data resides. As admin of any view that they fork, "normal" users can delete data created or modified **within** their forked view.

Case 4 - Place guardrails around writing (creating or merging) data

Permissions can be used to prevent roles from:

- creating various types of data directly in a layer/view; or
- merging various types of data into an underlying view (technically, to the view's top layer).

These types of permissions can help ensure that data in a "production" layer remains as pristine and error-free as possible. For example:

- Help to limit typos that result in "bad" tags or edges.
- Prevent data from a sensitive or restricted layer from being written to a non-restricted layer.

Example use cases:

- Use permissions around light edges to only allow the creation of specific named edges. This can limit typos in edge names and/or prevent users from creating arbitrarily named edges.
- Use permissions around tags or tag trees to only allow applying certain tags (e.g., to enforce your organization's tag conventions). For example, permissions can ensure that users' "scratch" tags (`#thesilence.mywork`) or tags indicating sensitive data (`#tlp.red`) are not added to "production" data.
- Use permissions around individual properties to prohibit setting specific properties in particular layers. For example, taxonomy properties (such as `risk:threat:type`) may be "under development" in an internal analysis view while users test and agree on appropriate categories. You may want to prevent this property from being set (merged) into production data until the taxonomy is finalized.

Tip: The degree to which you enforce data and tag conventions through permissions vs. by consensus (i.e., users agree on "best efforts" to keep the data tidy) will depend on your organization and your use case. Managing permissions adds overhead, but may be worth the effort for data sets that require high fidelity or quality. The overhead may have less benefit for internal data or test data where occasional errors have minimal impact and can be "cleaned up" as needed.

The sample rules below can be applied **globally** (a user with this role can write "approved" data to any writeable layer of any view they can see) or **locally** to specific layers.

The examples below **only** illustrate how certain write actions can be restricted and do not address other permissions that a user/role might need. These permissions could be added to an existing role (such as your general `users` role), or granted via their own role.

Example 1:

If a limited set of actions are allowed, simply specify the changes that the role can make. Anything else is implicitly denied by default.

In this example, a role with the following permissions can:

- **only** add and remove tags in the listed tag trees; and
- **only** create and delete the listed edges.

Permission	Description
node.tag.add.cno	Add / apply tags in the cno tree (e.g., cno, cno.mal, cno.mal.plugx etc.)
node.tag.del.cno	Remove any tags in the cno tree
node.tag.add.rep	Add / apply any tags in the rep tree
node.tag.del.rep	Remove any tags in the rep tree
node.edge.add.refs	Add refs light edges
node.edge.del.refs	Delete refs light edges
node.edge.add.uses	Add uses light edges
node.edge.del.uses	Delete uses light edges
node.edge.add.targets	Add targets light edges
node.edge.del.targets	Delete targets light edges

Example 2:

If specific actions are prohibited, **deny** those changes and then **allow** "everything else".

A role with the following permissions is **prohibited** from:

- Creating risk:threat:type:taxonomy nodes (representing "categories" of threats).
- Setting the :type property for risk:threat nodes (e.g., specifying the taxonomy category for a particular threat).
- Creating tags in the tlp tree.

Note that the permissions as listed only prohibit actions. For a role with these permissions to be able to make other changes (e.g., add other nodes or edges), those permissions need to be granted after these "deny" rules, or as part of another role.

Permission	Description
!node.add. risk:threat:type:taxonomy	Prevent creating these nodes
!node.prop.set.risk:threat:type	Prevent setting this property (i.e., on existing risk:threat nodes)
!node.tag.add.tlp	Prevent applying tags in the tlp tree

Tip: To prevent users or roles from making **any** changes to a particular view (i.e., users cannot merge any data into the view / write any data directly to the view's topmost layer):

- Do not add node permissions to the view's topmost layer (write permissions that are not granted are implicitly denied).
- If a role has been granted node (or similar) permissions **globally,** override this by explicitly denying (!node) the permission on the layer you want to protect.

Case 5 - Senior vs. junior roles

Senior roles (with more permissions) and junior roles (with limited permissions) are used in a variety of situations, such as new trainees vs. experienced users or junior vs. senior analysts.

When using a "fork and merge" workflow, a junior user can "do anything" (as **admin**) in a view that they fork. This allows them to enrich data and annotate their assessments using tags. But permissions can prevent them from merging some (or all) data and tags until a senior user has reviewed the changes. The senior role (with appropriate permissions) can then merge the data on the junior user's behalf.

For example, tags representing key analytical assessments - such as determining if a file or indicator is associated with a malware family, or tags representing threat clustering and attribution - may require careful consideration. The ability to merge these tags may be limited to senior analysts who can verify that the junior analyst has applied them correctly.

These types of permissions are typically **cumulative;** generic users may be prohibited (or simply not allowed) to perform a certain action, with additional permissions granted to increasingly senior or experienced roles. In the example below, all users would have the general `users` role and analysts would be granted **each** additional role as they gained experience.

Example:

Role	Permission(s)	Description

users	`!node.tag.cno`
	`!node.tag.rep`
	`node.tag`
		Prevent applying tags in the `cno` and `rep` trees (representing specific analytical assessements) but apply other tags

novice analyst	`node.tag.add.rep`	Novices can apply tags in the `rep` tree (representing third-party reporting)
junior analyst	`node.tag.add.cno.infra`	Junior analysts can apply tags in the `cno.infra` tree (related to network infrastructure)
senior analyst	`node.tag.add.cno.threat`	Senior analysts can apply tags in the `cno.threat` and `cno.mal` trees (assessments related to threat clusters and malware families)

Note: Because of *Precedence*, as additional roles are granted, they would need to be added (indexed) **before** the `users` role to prevent that role's explicit deny permissions from overriding the newly allowed tag privileges.

Case 6 - Specialized roles

For organizations with diverse analysis teams (e.g., where analysts specialize in particular areas) or organizations where multiple teams or departments use Synapse for different purposes, it may be helpful to create highly specialized roles.

Examples:

- An organization with a dedicated malware analysis team may **only** allow those specialists to apply tags related to malware/code families and malware ecosystems.
- An organization's strategic analysts may be solely responsible for certain objects and related data. For example, a strategic team may be in charge of researching and creating organizations (`ou:org`) and associated industries (`ou:industry`) in order to track victimology. Strategic analysts can ensure that these objects are created according to the team's standards and that organizations are assigned to the appropriate industries.

Malware analyst example:

- We assume the ability to apply the specialized tags listed below is either **not granted** or **explicitly denied** elsewhere/to other roles.
- Malware analysts can also be granted the ability to **remove** the tags listed below with the corresponding `node.tag.del` permissions.

Permission	Description
`node.tag.add.cno.code`	Apply `cno.code` tags (designating specific samples of code families - e.g., `cno.code.plugx`)
`node.tag.add.cno.mal`	Apply `cno.mal` tags (designating components of malware / code family ecosystems, such as related droppers or C2 - e.g., `cno.mal.plugx`)
`node.tag.add.cno.rel`	Apply `cno.rel` tags (designating components that may be observed as part of a malware ecosystem but are not inherently malicious - e.g., `cno.rel.plugx`)

Strategic analyst example:

- We assume the ability to create these nodes / set these properties is either **not granted** or **explicitly denied** elsewhere/to other roles.
- Strategic analysts can optionally be granted the ability to delete relevant nodes/properties with the corresponding `node.del` or `node.prop.del` permissions.
- Depending on how you assign permissions, keep in mind that roles that cannot **create** nodes may still be able to **set or modify properties** on the node as long as the node already exists. This ability can be restricted via additional `node.prop.set` rules if necessary.

Permission	Description
`node.add.ou:org`	Create organization nodes
`node.prop.set.ou:org:industries`	Assign organizations to one or more industries
`node.add.ou:industry`	Create industry nodes

4.3.5 Cortex Permissions

The following is a list of the Cortex permissions that may be granted to a user or role. If a gate other than `cortex` is specified, the permission will be checked against the specific gate instance and if no match is found, it will be checked against the global rules.

```
storm> auth.perms.list
globals
    Used to control all operations for global variables.
    gate: cortex
    default: false

globals.get
    Used to control read access to all global variables.
    gate: cortex
    default: false

globals.get.<name>
    Used to control read access to a specific global variable.
```

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```
    gate: cortex
    default: false

globals.pop
    Used to control delete access to all global variables.
    gate: cortex
    default: false

globals.pop.<name>
    Used to control delete access to a specific global variable.
    gate: cortex
    default: false

globals.set
    Used to control edit access to all global variables.
    gate: cortex
    default: false

globals.set.<name>
    Used to control edit access to a specific global variable.
    gate: cortex
    default: false

node
    Controls all node edits in a layer.
    gate: layer
    default: false

node.add
    Controls adding any form of node in a layer.
    gate: layer
    default: false

node.add.<form>
    Controls adding a specific form of node in a layer.
    gate: layer
    default: false
    example: node.add.inet:ipv4

node.del
    Controls removing any form of node in a layer.
    gate: layer
    default: false

node.del.<form>
    Controls removing a specific form of node in a layer.
    gate: layer
    default: false

node.prop
    Controls editing any prop on any node in the layer.
    gate: layer
```

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```
    default: false

node.prop.del
    Controls removing any prop on any node in a layer.
    gate: layer
    default: false

node.prop.del.<prop>
    Controls removing a specific property from a node in a layer.
    gate: layer
    default: false
    example: node.prop.del.inet:ipv4:asn

node.prop.set
    Controls setting any prop on any node in a layer.
    gate: layer
    default: false

node.prop.set.<prop>
    Controls setting a specific property on a node in a layer.
    gate: layer
    default: false
    example: node.prop.set.inet:ipv4:asn

node.tag
    Controls editing any tag on any node in a layer.
    gate: layer
    default: false

node.tag.add
    Controls adding any tag on any node in a layer.
    gate: layer
    default: false

node.tag.add.<tag...>
    Controls adding a specific tag on any node in a layer.
    gate: layer
    default: false
    example: node.tag.add.cno.mal.redtree

node.tag.del
    Controls removing any tag on any node in a layer.
    gate: layer
    default: false

node.tag.del.<tag...>
    Controls removing a specific tag on any node in a layer.
    gate: layer
    default: false
    example: node.tag.del.cno.mal.redtree

storm.lib.auth.roles.add
```

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```
    Controls the ability to add a role to the system. USE WITH CAUTION!
    gate: cortex
    default: false

storm.lib.auth.roles.del
    Controls the ability to remove a role from the system. USE WITH CAUTION!
    gate: cortex
    default: false

storm.lib.auth.users.add
    Controls the ability to add a user to the system. USE WITH CAUTION!
    gate: cortex
    default: false

storm.lib.auth.users.del
    Controls the ability to remove a user from the system. USE WITH CAUTION!
    gate: cortex
    default: false

storm.lib.axon.del
    Controls the ability to remove a file from the Axon.
    gate: cortex
    default: false

storm.lib.axon.get
    Controls the ability to retrieve a file from the Axon.
    gate: cortex
    default: false

storm.lib.axon.has
    Controls the ability to check if the Axon contains a file.
    gate: cortex
    default: false

storm.lib.axon.wget
    Controls the ability to retrieve a file from URL and store it in the Axon.
    gate: cortex
    default: false

storm.lib.axon.wput
    Controls the ability to push a file from the Axon to a URL.
    gate: cortex
    default: false

storm.lib.telepath.open
    Controls the ability to open an arbitrary telepath URL. USE WITH CAUTION.
    gate: cortex
    default: false

storm.lib.telepath.open.<scheme>
    Controls the ability to open a telepath URL with a specific URI scheme. USE WITH␣
↪CAUTION.
```

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```
    gate: cortex
    default: false

view
    Controls all view permissions.
    gate: cortex
    default: false

view.add
    Controls access to add a new view including forks.
    gate: cortex
    default: false

view.read
    Used to control read access to a view.
    gate: view
    default: false
```

4.3.6 Optic Permissions

Commercial Synapse customers with the Optic UI may need to explicitly grant users or roles permission to some UI tools (such as Spotlight).

- See the Optic Deployment Guide for information on Optic deployment.
- See the Optic DevOps Guide for information on Optic permissions and other features.

Tip: You do not need to explicitly grant permissions to Optic itself. If you are creating and managing Synapse ("Cortex") users and roles via Optic, they have permission to access Optic by default.

4.3.7 Power-Up Permissions

Synapse **Power-Ups** have their own sets of permissions that must be granted to users or roles to allow them to use the Power-Up and any associated Storm commands. Specific permissions are documented in the **Admin Guide** section of the Power-Up documentation for the individual Power-Up.

Tip: While most Vertex-provided Power-Ups are part of the commercial Synapse offering, the following Rapid Power-Ups are also available for use with the community (open source) version of Synapse:

- Synapse-MISP
- Synapse-MITRE-ATT&CK
- Synapse-PSL (FQDN public suffix list)
- Synapse-TOR

4.3.8 Storm Runtime Permissions

When a user runs a Storm query **interactively** (e.g., in the Storm CLI or via the Optic Query Bar), or performs an action in the Optic UI (such as accessing a menu option), the query or action executes **with the permissions of the user,** based on the applicable user and role permissions and the current scope for the query or action.

There are a few cases of Storm runtime execution where different permissions are used that may require additional considerations.

Automation

Synapse includes the ability to automate Storm-based tasks using triggers, cron jobs, and / or macros. These elements are all impacted by permissions in various ways, including:

- who can create or manage automation (e.g., by default any user can create a macro, but explicit permissions are required to create triggers or cron jobs);
- who a given piece of automation runs as (e.g., macros run as the user who executes them, but triggers and cron jobs run as the user who created them).

Refer to the *Storm Reference - Automation* section of the *Synapse User Guide* for a detailed discussion of automation in Synapse (including permissions considerations).

Power-Ups

Power-Ups implement Storm packages and Storm services to provide additional functionality to Synapse. Power-Ups may be provided by The Vertex Project (as free or commercial offerings). Organizations may also develop their own custom Power-Ups.

Power-Ups commonly install Storm commands to allow users to make use of the additional capabilities of the Power-Up. In some cases, Power-Ups may need to access sensitive data (such as API keys or similar credentials) or perform actions (e.g., in adding nodes or applying tags) that some users would not be allowed to perform on their own.

Power-Ups can use privilege separation ("privsep") so that a limited subset of Power-Up capabilities can run with elevated privileges if necessary, with the remainder of the code running as the user who calls the Power-Up.

See the *Rapid Power-Up Development* section of the *Synapse Developer Guide* for additional details.

Note: Synapse Admins are typically only responsible for ensuring that the appropriate users and roles can use or run individual Power-Ups (see *Power-Up Permissions*). While Synapse Admins should be aware of privilege separation within a Power-Up as a best practice, implementation of privilege separation is left to Power-Up developers.

4.4 Add Extended Model Elements

The Synapse data model in a Cortex can be extended with custom forms or properties by using the model extension Storm Library (*$lib.model.ext*). Extended model forms and properties must have names beginning with an underscore (_) to avoid potential naming conflicts with built-in model elements.

4.4.1 Extended Forms

When adding a form, `$lib.model.ext.addForm` takes the following arguments:

formname
Name of the form, must begin with an underscore (_) and contain at least one colon (:).

basetype
The Synapse data model type for the form.

typeopts
A dictionary of type specific options.

typeinfo
A dictionary of info values for the form.

To add a new form named `_foocorp:name`, which contains string values which will be normalized to lowercase, with whitespace stripped from the beginning/end:

```
$typeopts = ({'lower': $lib.true, 'strip': $lib.true})
$typeinfo = ({'doc': 'Foocorp name.'})

$lib.model.ext.addForm(_foocorp:name, str, $typeopts, $typeinfo)
```

If the form is no longer in use and there are no nodes of this form in the Cortex, it can be removed with:

```
$lib.model.ext.delForm(_foocorp:name)
```

4.4.2 Extended Properties

When adding properties, `$lib.model.ext.addFormProp` takes the following arguments:

formname
Name of the form to add the property to, may be a built-in or extended model form.

propname
Relative name of the property, must begin with an underscore (_).

typedef
A tuple of (`type`, `typeopts`) which defines the type for the property

propinfo
A dictionary of info values for the property.

To add a property named `_score` to the `_foocorp:name` form which contains int values between 0 and 100:

```
$typeopts = ({'min': 0, 'max': 100})
$propinfo = ({'doc': 'Score for this name.'})

$lib.model.ext.addFormProp(_foocorp:name, _score, (int, $typeopts), $propinfo)
```

To add a property named `_aliases` to the `_foocorp:name` form which contains a unique array of `ou:name` values:

```
$typeopts = ({'type': 'ou:name', 'uniq': $lib.true})
$propinfo = ({'doc': 'Aliases for this name.'})

$lib.model.ext.addFormProp(_foocorp:name, _aliases, (array, $typeopts), $propinfo)
```

Properties may also be added to existing forms, for example, to add a property named `_classification` to `inet:fqdn` which must contain a string from a predefined set of values:

```
$typeopts = ({'enums': 'unknown,benign,malicious'})
$propinfo = ({'doc': 'Classification for this FQDN.'})

$lib.model.ext.addFormProp(inet:fqdn, _classification, (str, $typeopts), $propinfo)
```

4.4.3 Extended Universal Properties

Similar to `$lib.model.ext.addFormProp`, `$lib.model.ext.addUnivProp` takes the same `propname`, `typedef`, and `propinfo` arguments, but applies to all forms.

4.5 Manage Model Deprecations

As the Synapse Data Model grows and evolves, model elements (types, forms, and properties) may be deprecated and should no longer be used for new data modeling. The Storm `model.deprecated` commands can be used to prepare for the eventual removal of deprecated model elements.

4.5.1 Lock Deprecated Model Elements

The *model.deprecated.lock* command edits the lock status of deprecated model elements. Locked model elements can still be viewed or deleted, but can no longer be added. Attempting to add a locked model element will cause an `IsDeprLocked` error. The *model.deprecated.locks* command can be used to show the current lock status of all deprecated model elements.

Examples:

Lock the `ps:person:img` property:

```
storm> model.deprecated.lock ps:person:img
Locking: ps:person:img
```

Unlock the `ps:person:img` property:

```
storm> model.deprecated.lock --unlock ps:person:img
Unlocking: ps:person:img
```

Lock all deprecated model elements:

```
storm> model.deprecated.lock *
Locking all deprecated model elements.
```

4.5.2 Check for Deprecated Model Elements

The *model.deprecated.check* command checks for lock status and the existence of deprecated model elements in the Cortex. Warnings will be produced for any deprecated model elements which are unlocked or still in use in the Cortex. Once all warnings have been resolved, your Cortex will be ready for future model updates.

4.6 Configure a Mirrored Layer

A Cortex may be configured to mirror a layer from a remote Cortex which will synchronize all edits from the remote layer and use write-back support to facilitate edits originating from the downstream layer. The mirrored layer will be an exact copy of the layer on the remote system including all edit history and will only allow changes which are first sent to the upstream layer.

When configuring a mirrored layer, you may choose to mirror from a remote layer *or* from the top layer of a remote view. If you choose to mirror from the top layer of a remote view, that view will have the opportunity to fire triggers and enforce model constraints on the changes being provided by the mirrored layer.

To specify a remote layer as the upstream, use a Telepath URL which includes the shared object `*/layer/<layeriden>` such as:

```
aha://cortex.loop.vertex.link/*/layer/8ea600d1732f2c4ef593120b3226dea3
```

To specify a remote view, use the shared object `*/view/<viewiden>` such as:

```
aha://cortex.loop.vertex.link/*/view/8ea600d1732f2c4ef593120b3226dea3
```

When you specify a `--mirror` option to the `layer.add` command or within a layer definition provided to the `$lib.layer.add()` Storm API the telepath URL will not be checked. This allows configuration of a remote layer or view which is not yet provisioned or is currently offline.

Note: To allow write access, the telepath URL must allow admin access to the remote Cortex due to being able to fabricate edit origins. The telepath URL may use aliased names or TLS client side certs to prevent credential disclosure.

Once a mirrored layer is configured, it will need to stream down the entire history of events from the upstream layer. During this process, the layer will be readable but writes will hang due to needing to await the write-back to be fully caught up to guarantee that edits are immediately observable like a normal layer. During that process, you may track progress by calling the `getMirrorStatus()` API on the `layer` object within the Storm runtime.

CHAPTER

FIVE

SYNAPSE DEPLOYMENT GUIDE

5.1 Introduction

This step-by-step guide will walk you through a production-ready Synapse deployment. Services will be configured to register with `AHA` for service discovery and to prepare for future devops tasks such as promoting a mirror to leader and provisioning future Synapse Advanced Power-Ups.

This guide will also walk you through deploying all Synapse services using TLS to authenticate both servers and clients using client-certificates to minimize the need for secrets management by eliminating passwords from all telepath URLs.

For the purposes of this guide, we will use `docker-compose` as a light-weight orchestration mechanism. The steps, configurations, and volume mapping guidance given in this guide apply equally to other container orchestration mechanisms such as Kubernetes but for simplicity's sake, this guide will only cover `docker-compose` based deployments.

Note: Due to known networking limitations of docker on Mac we do **not** support or recommend the use of Docker for Mac for testing or deploying production Synapse instances. Containers run within separate `docker-compose` commands will not be able to reliably communicate with each other.

Synapse services **require persistent storage**. Each `docker` container expects persistent storage to be available within the directory `/vertex/storage` which should be a persistent mapped volume. Only one container may run from a given volume at a time.

Note: To allow hosts to be provisioned on one system, this guide instructs you to disable HTTP API listening ports on all services other than the main Cortex. You may remove those configuration options if you are running on separate hosts or select alternate ports which do not conflict.

5.2 Prepare your Hosts

Ensure that you have an updated install of docker and docker-compose.

In order to help you run the Synapse service containers as a non-root user, Synapse service docker containers have been preconfigured with a user named `synuser` with UID `999`. You may replace `999` in the configs below, but keep in mind that doing so will result in the container not having a name for the user. We recommend that you do **not** use the Linux user `nobody` for this purpose.

Default kernel parameters on most Linux distributions are not optimized for database performance. We recommend adding the following lines to `/etc/sysctl.conf` on all systems being used to host Synapse services:

```
vm.swappiness=10
vm.dirty_expire_centisecs=20
vm.dirty_writeback_centisecs=20
```

See *Performance Tuning* for a list of additional tuning options.

We will use the directory `/srv/syn/` on the host systems as the base directory used to deploy the Synapse services. Each service will be deployed in separate `/srv/syn/<svcname>` directories. This directory can be changed to whatever you would like, and the services may be deployed to any host provided that the hosts can directly connect to each other. It is critical to performance that these storage volumes be low-latency. More latent storage mechanisms such as spinning disks, NFS, or EFS should be avoided!

We highly recommend that hosts used to run Synapse services deploy a log aggregation agent to make it easier to view the logs from the various containers in a single place.

When using AHA, you may run any of the **other** services on additional hosts as long as they can connect directly to the AHA service. You may also shutdown a service, move it's volume to a different host, and start it backup without changing anything.

5.3 Decide on a Name

Throughout the examples, we will be using `<yournetwork>` as the AHA network name which is also used as the common-name (CN) for the CA certificate. This should be changed to an appropriate network name used by your synapse deployment such as `syn.acmecorp.com`. We will use `<yournetwork>` in the following configs to specify locations which should be replaced with your selected AHA network name. For a **test** deployment which runs **all** docker containers on one host, you may use `loop.vertex.link`.

Note: It is important that you choose a name and stick with it for a given deployment. Once we begin generating host and service account certificates, changing this name will be difficult.

5.4 Deploy AHA Service

The AHA service is used for service discovery and acts as a CA to issue host/user certificates used to link Synapse services. Other Synapse services will need to be able to resolve the IP address of the AHA service by name, so it is likely that you need to create a DNS A/AAAA record in your existing resolver. When you are using AHA, the only host that needs DNS or other external name resolution is the AHA service.

Note: It is important to ensure that `aha.<yournetwork>` is resolvable via DNS or docker container service name resolution from within the container environment! There are configuration options you may use if this is impossible, but the configuration is far simpler if we can make this assumption.

Create the container directory:

```
mkdir -p /srv/syn/aha/storage
```

Create the `/srv/syn/aha/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  aha:
    user: "999"
    image: vertexproject/synapse-aha:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        - SYN_AHA_HTTPS_PORT=null
        - SYN_AHA_AHA_NAME=aha
        - SYN_AHA_AHA_NETWORK=<yournetwork>
        - SYN_AHA_DMON_LISTEN=ssl://aha.<yournetwork>?ca=<yournetwork>
        - SYN_AHA_PROVISION_LISTEN=ssl://aha.<yournetwork>:27272
```

Note: Don't forget to replace <yournetwork> with your chosen network name!

Change ownership of the storage directory to the user you will use to run the container:

```
chown -R 999 /srv/syn/aha/storage
```

Start the container using `docker-compose`:

```
docker-compose -f /srv/syn/aha/docker-compose.yaml pull
docker-compose -f /srv/syn/aha/docker-compose.yaml up -d
```

To view the container logs at any time you may run the following command on the *host* from the `/srv/syn/aha` directory:

```
docker-compose logs -f
```

You may also execute a shell inside the container using `docker-compose` from the `/srv/syn/aha` directory on the *host*. This will be necessary for some of the additional provisioning steps:

```
docker-compose exec aha /bin/bash
```

5.5 Deploy Axon Service

In the Synapse service architecture, an Axon provides a place to store arbitrary bytes/files as binary blobs and exposes APIs for streaming files in and out regardless of their size. Given sufficient file system size, an Axon can be used to efficiently store and retrieve very large files as well as a high number (easily billions) of files.

Inside the AHA container

Generate a one-time use provisioning URL:

```
python -m synapse.tools.aha.provision.service 00.axon
```

These one-time use URLs are used to connect to the Aha service, retrieve configuration data, and provision SSL certificates for the service. When this is done, the service records that the URL has been used in its persistent storage, and will not attempt to perform the provisioning process again unless the URL changes. If the provisioning URL is

reused, services will encounter **NoSuchName** errors and fail to start up - this indicates a service has attempted to re-use the one-time use URL!

Note: We strongly encourage you to use a numbered hierarchical naming convention for services where the first part of the name is a 0 padded number and the second part is the service type. The above example `00.axon` will allow you to deploy mirror instances in the future, such as `01.axon`, where the AHA name `axon.<yournetwork>` will automatically resolve to which ever one is the current leader.

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container directory:

```
mkdir -p /srv/syn/00.axon/storage
chown -R 999 /srv/syn/00.axon/storage
```

Create the `/srv/syn/00.axon/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  00.axon:
    user: "999"
    image: vertexproject/synapse-axon:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        # disable HTTPS API for now to prevent port collisions
        - SYN_AXON_HTTPS_PORT=null
        - SYN_AXON_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Note: Don't forget to replace your one-time use provisioning URL!

Start the container:

```
docker-compose --file /srv/syn/00.axon/docker-compose.yaml pull
docker-compose --file /srv/syn/00.axon/docker-compose.yaml up -d
```

5.6 Deploy JSONStor Service

Inside the AHA container

Generate a one-time use provisioning URL:

```
python -m synapse.tools.aha.provision.service 00.jsonstor
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container directory:

```
mkdir -p /srv/syn/00.jsonstor/storage
chown -R 999 /srv/syn/00.jsonstor/storage
```

Create the `/srv/syn/00.jsonstor/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  00.jsonstor:
    user: "999"
    image: vertexproject/synapse-jsonstor:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        # disable HTTPS API for now to prevent port collisions
        - SYN_JSONSTOR_HTTPS_PORT=null
        - SYN_JSONSTOR_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=
↪<sha256>
```

Note: Don't forget to replace your one-time use provisioning URL!

Start the container:

```
docker-compose --file /srv/syn/00.jsonstor/docker-compose.yaml pull
docker-compose --file /srv/syn/00.jsonstor/docker-compose.yaml up -d
```

5.7 Deploy Cortex Service

Inside the AHA container

Generate a one-time use provisioning URL:

```
python -m synapse.tools.aha.provision.service 00.cortex
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container directory:

```
mkdir -p /srv/syn/00.cortex/storage
chown -R 999 /srv/syn/00.cortex/storage
```

Create the `/srv/syn/00.cortex/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  00.cortex:
    user: "999"
    image: vertexproject/synapse-cortex:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        - SYN_CORTEX_AXON=aha://axon...
        - SYN_CORTEX_JSONSTOR=aha://jsonstor...
        - SYN_CORTEX_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Note: Don't forget to replace your one-time use provisioning URL!

Note: The values `aha://axon...` and `aha://jsonstor...` can be used as-is without changing them because the AHA network (provided by the provisioning server) is automatically subtituted in any `aha://` scheme URL ending with `...`

Start the container:

```
docker-compose --file /srv/syn/00.cortex/docker-compose.yaml pull
docker-compose --file /srv/syn/00.cortex/docker-compose.yaml up -d
```

Remember, you can view the container logs in real-time using:

```
docker-compose --file /srv/syn/00.cortex/docker-compose.yaml logs -f
```

5.8 Deploy Cortex Mirror (optional)

Inside the AHA container

Generate a one-time use URL for provisioning from *inside the AHA container*:

```
python -m synapse.tools.aha.provision.service 01.cortex --mirror cortex
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container storage directory:

```
mkdir -p /srv/syn/01.cortex/storage
chown -R 999 /srv/syn/01.cortex/storage
```

Create the `/srv/syn/01.cortex/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  01.cortex:
    user: "999"
    image: vertexproject/synapse-cortex:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        # disable HTTPS API for now to prevent port collisions
        - SYN_CORTEX_HTTPS_PORT=null
        - SYN_CORTEX_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Note: Don't forget to replace your one-time use provisioning URL!

Start the container:

```
docker-compose --file /srv/syn/01.cortex/docker-compose.yaml pull
docker-compose --file /srv/syn/01.cortex/docker-compose.yaml up -d
```

Note: If you are deploying a mirror from an existing large Cortex, this startup may take a while to complete initialization.

5.9 Enroll CLI Users

A Synapse user is generally synonymous with a user account on the Cortex. To bootstrap CLI users who will have Cortex access using the Telepath API, we will need to add them to the Cortex and generate user certificates for them. To add a new admin user to the Cortex, run the following command from **inside the Cortex container**:

```
python -m synapse.tools.moduser --add --admin true visi
```

Note: If you are a Synapse Enterprise customer, using the Synapse UI with SSO, the admin may now login to the Synapse UI. You may skip the following steps if the admin will not be using CLI tools to access the Cortex.

Then we will need to generate a one-time use URL they may use to generate a user certificate. Run the following command from **inside the AHA container** to generate a one-time use URL for the user:

```
python -m synapse.tools.aha.provision.user visi
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Then the **user** may run:

```
python -m synapse.tools.aha.enroll ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Once they are enrolled, they will have a user certificate located in `~/.syn/certs/users` and their telepath configuration located in `~/.syn/telepath.yaml` will be updated to reflect the use of the AHA server. From there the user should be able to use standard Synapse CLI tools using the `aha://` URL such as:

```
python -m synapse.tools.storm aha://visi@cortex.<yournetwork>
```

5.10 What's next?

See the *Synapse Admin Guide* for instructions on performing application administrator tasks. See the *Synapse Devops Guide* for instructions on performing various maintenance tasks on your deployment!

CHAPTER

SIX

SYNAPSE DEVOPS GUIDE

6.1 Overview

6.1.1 Docker Images

Each Synapse service is distributed as a `docker` image which contains all the dependencies required to run the service. For the open-source Synapse images, the tag `:v2.x.x` will always be present on the most recent supported release. Image names are specified in each service specific section below.

Synapse services **require persistent storage**. Each `docker` container expects persistent storage to be available within the directory `/vertex/storage` which should be a persistent mapped volume. Only one container may run from a given volume at a time.

6.1.2 cell.yaml

Each Synapse service has one configuration file, `cell.yaml`, which is located in the service storage directory, typically `/vertex/storage/cell.yaml` in the `docker` images. Configuration options are specified in YAML format using the same syntax as their documentation, for example:

```
aha:name: cortex
aha:network: loop.vertex.local
```

6.1.3 Environment Variables

Synapse services may also be configured using environment variables specified in their documentation. The value will be parsed as a YAML value to allow structured data to be specified via environment variables and then subject to normal configuration schema validation.

6.1.4 HTTPS Certificates

Synapse services that expose HTTPS APIs will automatically generate a self-signed certificate and key if they are not found at `sslcert.crt` and `sslkey.pem` in the service storage directory. At any time, you can replace these self-signed files with a certificate and key generated using *easycert* or generated and signed by an external CA.

6.2 Common Devops Tasks

6.2.1 Generating a Backup

Note: If you are a Synapse Enterprise customer you should deploy the Synapse-Backup Advanced Power-Up.

It is strongly recommended that users schedule regular backups of all services deployed within their Synapse ecosystem. Each service must be backed up using either the **live** backup tool `synapse.tools.livebackup` or the offline backup tool `synapse.tools.backup`.

For a production deployment similar to the one described in the *Synapse Deployment Guide* you can easily run the backup tool by executing a shell **inside** the docker container. For example, if we were generating a backup of the Cortex we would:

```
cd /srv/syn/00.cortex
docker-compose exec 00.cortex /bin/bash
```

And from the shell executed within the container:

```
python -m synapse.tools.livebackup
```

This will generate a backup in a time stamp directory similar to:

```
/vertex/storage/backups/20220422094622
```

Once the backup directory is generated you may exit the docker shell and the backup will be accessible from the **host** file system as:

```
/srv/syn/00.cortex/storage/backups/20220422094622
```

At this point it is safe to use standard tools like `mv`, `tar`, and `scp` on the backup folder:

```
mv /srv/syn/00.cortex/storage/backups/20220422094622 /nfs/backups/00.cortex/
```

Note: It is important that you use `synapse.tools.livebackup` to ensure a transactionally consistant backup.

Note: When taking a backup of a service, the backup is written by the service locally to disk. This may take up storage space equal to the current size of the service. If the service does not have the `backup:dir` option configured for a dedicated backup directory (or volume), this backup is made to `/vertex/storage/backups` by default. If the volume backing `/vertex/storage` reaches a maximum capacity, the backup process will fail.

To avoid this from being an issue, when using the default configuration, make sure services do not exceed 50% of their storage utilization. For example, a Cortex that has a size of 32GB of utilized space may take up 32GB during a backup. The volume backing `/vertex/storage` should be at least 64GB in size to avoid issues taking backups.

It is also worth noting that the newly created backup is a defragmented / optimized copy of the databases. We recommend occasionally scheduling a maintenance window to create a "cold backup" using the offline `synapse.tools.backup` command with the service offline and deploy the backup copy when bringing the service back online. Regularly performing this "restore from cold backup" procedure can dramatically improve performance and resource utilization.

6.2.2 Restoring a Backup

In the hopefully unlikely event that you need to restore a **Synapse** service from a backup the process is fairly simple. For a production deployment similar to the one described in *Synapse Deployment Guide* and assuming we moved the backup file as described in *Generating a Backup*:

```
cd /srv/syn/00.cortex
docker-compose down
mv storage storage.broken
cp -R /nfs/backups/00.cortex/20220422094622 storage
docker-compose up -d
```

Then you can tail the logs to ensure the service is fully restored:

```
cd /srv/syn/00.cortex
docker-compose logs -f
```

6.2.3 Promoting a Mirror

Note: To gracefully promote a mirror to being the leader, your deployment must include AHA based service discovery as well as use TLS client-certificates for service authentication.

To gracefully promote a mirror which was deployed in a similar fashion to the one described in *Synapse Deployment Guide* you can use the built-in promote tool `synapse.tools.promote`. Begin by executing a shell within the mirror container:

```
cd /srv/syn/01.cortex
docker-compose exec 01.cortex /bin/bash
```

And from the shell executed within the container:

```
python -m synapse.tools.promote
```

Once completed, the previous leader will now be configured as a follower of the newly promoted leader.

Note: If you are promoting the follower due to a catastrophic failure of the previous leader, you may use the command `synapse.tools.promote --failure` to force promotion despite not being able to carry out a graceful handoff. It is **critical that you not bring the previous leader back online** once this has been done. To regain redundancy, deploy a new mirror using the AHA provisioning process described in the *Synapse Deployment Guide*.

6.2.4 Updating Services

Updating a Synapse service requires pulling the newest docker image and restarting the container. For Synapse services which have mirrors deployed, you must ensure that the mirrors are updated first so that any newly introduced change messages can be consumed. If you are using a mirrors-of-mirrors tree topology, the update should be deployed in a "leafs first" order.

Continuing with our previous example from the *Synapse Deployment Guide* we would update the mirror `01.cortex` first:

```
cd /srv/syn/01.cortex
docker-compose pull
docker-compose down
docker-compose up -d
```

After ensuring that the mirror has come back online and is fully operational, we will update the leader which may include a *Data Migration* while it comes back online:

```
cd /srv/syn/00.cortex
docker-compose pull
docker-compose down
docker-compose up -d
```

Note: Once a Synapse service update has been deployed, you may **NOT** revert to a previous version!

Data Migration

When a Synapse release contains a data migration for a part of the Synapse data model, the Changelog will indicate what component is being migrated and why. This will be made under the `Automated Migrations` header, at the top of the changelog.

Automatic data migrations may cause additional startup times on the first boot of the version. When beginning a data migration, a WARNING level log message will be printed for each stage of the migration:

```
beginning model migration -> (0, 2, 8)
```

Once complete, a WARNING level log message will be issued:

```
...model migrations complete!
```

Note: Please ensure you have a tested backup available before applying these updates.

Model Flag Day

Periodically, a Synapse release will include small, but technically backward incompatible, changes to the data model. All such migrations will include a `Model Flag Day` heading in the Changelog with a detailed description of each change to the data model. Additionally, the release will execute an in-place migration to modify data to confirm with model updates. If necessary, any data that can not be migrated automatically will be saved to a location documented within the detailed description.

When we release a Synapse version containing a `Model Flag Day` update, we will simultaneously release updates to any effected Power-Ups.

Examples of potential `Model Flag Day` changes:

- Removing a previously deprecated property
- Specifying a more specific type for a property to allow pivoting
- Tightening type normalization constraints of a property

It is **highly** recommended that production deployments have a process for testing custom storm code in a staging environment to help identify any tweaks that may be necessary due to the updated data model.

Note: Please ensure you have a tested backup available before applying these updates.

6.2.5 Configure Logging

Synapse services support controlling log verbosity via the `SYN_LOG_LEVEL` environment variable. The following values may be used: `CRITCAL`, `ERROR`, `WARNING`, `INFO`, and `DEBUG`. For example:

```
SYN_LOG_LEVEL=INFO
```

To enable JSON structured logging output suitable for ingest and indexing, specify the following environment variable to the `docker` container:

```
SYN_LOG_STRUCT=true
```

These structured logs are designed to be easy to ingest into third party log collection platforms. They contain the log message, level, time, and metadata about where the log message came from:

```
{
  "message": "log level set to INFO",
  "logger": {
    "name": "synapse.lib.cell",
    "process": "MainProcess",
    "filename": "common.py",
    "func": "setlogging"
  },
  "level": "INFO",
  "time": "2021-06-28 15:47:54,825"
}
```

When exceptions are logged with structured logging, we capture additional information about the exception, including the entire traceback. In the event that the error is a Synapse Err class, we also capture additional metadata which was attached to the error. In the following example, we also have the query text, username and user iden available in the log message pretty-printed log message:

```
{
  "message": "Error during storm execution for { || }",
  "logger": {
    "name": "synapse.lib.view",
    "process": "MainProcess",
    "filename": "view.py",
    "func": "runStorm"
  },
  "level": "ERROR",
  "time": "2021-06-28 15:49:34,401",
  "err": {
    "efile": "coro.py",
    "eline": 233,
    "esrc": "return await asyncio.get_running_loop().run_in_executor(forkpool, _runtodo,␣
↪todo)",
```

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```
    "ename": "forked",
    "at": 1,
    "text": "||",
    "mesg": "No terminal defined for '|' at line 1 col 2.  Expecting one of: #, $, (, *,␣
↪+ or -, -(, -+>, -->, ->, :, <(, <+-, <-, <--, [, break, command name, continue, fini,␣
↪for, function, if, init, property name, return, switch, while, whitespace or comment,␣
↪yield, {",
    "etb": ".... long traceback ...",
    "errname": "BadSyntax"
  },
  "text": "||",
  "username": "root",
  "user": "3189065f95d3ab0a6904e604260c0be2"
}
```


6.2.6 Configure Free Space Requirement

To avoid the risk of data corruption due to lack of disk space, Synapse services periodically check the amount of free space available and will switch to read-only mode if they are below a minimum threshold. This threshold can be controlled via the `limit:disk:free` configuration option, and is set to 5% free space by default.

If the available free space goes below the minimum threshold, the service will continue the free space checks and re-enable writes if the available space returns above the threshold.

6.2.7 Performance Tuning

Performance tuning Synapse services is very similar to performance tuning other database systems like PostgreSQL or MySQL. Recommendations for good performance for other database systems may also apply to Synapse services. Database systems run best when given as much RAM as possible. Under **ideal** circumstances, the amount of RAM exceeds the total database storage size.

Minimizing storage latency is important for a high performance Synapse service. Locating the storage volume backed by a mechanical hard drive is **strongly** discouraged. For the same reason, running Synapse services from an NFS file system (including NFS-based systems like AWS EFS) is **strongly** discouraged.

The default settings of most Linux-based operating systems are not set for ideal performance.

Consider setting the following Linux system variables. These can be set via /etc/sysctl.conf, the sysctl utility, or writing to the /proc/sys file system.

vm.swappiness=10
: Reduce preference for kernel to swap out memory-mapped files.

vm.dirty_expire_centisecs=20
: Define “old” data to be anything changed more than 200 ms ago.

vm.dirty_writeback_centisecs=20
: Accelerate writing “old” data back to disk.

vm.dirty_background_ratio=2
: This is expressed as a percentage of total RAM in the system. After the total amount of dirty memory exceeds this threshold, the kernel will begin writing it to disk in the background. We want this low to maximize storage I/O throughput utilization.

This value is appropriate for systems with 128 GiB RAM. For systems with less RAM, this number should be larger, for systems with more, this number may be smaller.

vm.dirty_ratio=4

This is expressed as a percentage of total RAM in the system. After the total amount of dirty memory exceeds this threshold, all writes will become synchronous, which means the Cortex will "pause" waiting for the write to complete. To avoid large sawtooth-like behavior, this value should be low.

This value is appropriate for systems with 128 GiB RAM. For systems with less RAM, this number should be larger, for systems with more, this number may be smaller.

This setting is particularly important for systems with lots of writing (e.g. making new nodes), lots of RAM, and relatively slow storage.

6.2.8 Managing Users and Roles

Adding Users

Managing users and service accounts in the Synapse ecosystem is most easily accomplished using the `moduser` tool executed from **within** the service `docker` container. In this example we add the user `visi` as an admin user to the Cortex by running the following command from **within the Cortex container**:

```
python -m synapse.tools.moduser --add --admin visi
```

If the deployment is using AHA and TLS client certificates and the user will be connecting via the Telepath API using the *storm* CLI tool, will also need to provision a user TLS certificate for them. This can be done using the `synapse.tools.aha.provision.user` command from **within the AHA container**:

```
python -m synapse.tools.aha.provision.user visi
```

Which will produce output similar to:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Note: The enrollment URL may only be used once. It should be given to the user using a secure messaging system to prevent an attacker from using it before the user.

Once the one-time enrollment URL has been passed along to the user, the **user must run an enrollment command** to configure their environment to use the AHA server and generate a user certificate from the host they will be using to run the Storm CLI:

```
python -m synapse.tools.aha.enroll ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Once they are enrolled, the user can connect using the Telepath URL `aha://cortex.<yournetwork>`:

```
python -m synapse.tools.storm aha://cortex.<yournetwork>
```

6.2.9 Updating to AHA and Telepath TLS

If you have an existing deployment which didn't initially include AHA and Telepath TLS, it can easily be deployed and configured after the fact. However, as services move to TLS it will **break existing telepath URLs** that may be in use, so you should test the deployment before updating your production instance.

To move to AHA, first deploy an AHA service as discussed in the *Synapse Deployment Guide*. For each service, you may then run the `provision` tool as described and add the `aha:provision` configuration option to the `cell.yaml` or use the service specific environment variable to prompt the service to provision itself.

Note: It is recommended that you name your services with leading numbers to prepare for an eventual mirror deployment.

For example, to add an existing Axon to your new AHA server, you would execute the following from **inside the AHA container**:

```
python -m synapse.tools.aha.provision 00.axon
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Then add the following entry to the Axon's `cell.conf`:

```
aha:provision: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Or add the following environment variable to your orchestration:

```
SYN_AXON_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

Then restart the Axon container. As it restarts, the service will generate user and host certificates and update it's `cell.yaml` file to include the necessary AHA configuration options. The `dmon:listen` option will be updated to reflect the use of SSL/TLS and the requirement to use client certificates for authentication. As additional services are provisioned, you may update the URLs they use to connect to the Axon to `aha://axon...`.

6.2.10 Deployment Options

The following are some additional deployment options not covered in the *Synapse Deployment Guide*.

Note: These examples assume the reader has reviewed and understood the Synapse Deployment Guide.

Telepath Listening Port

If you need to deploy a service to have Telepath listen on a specific port, you can use the provision tool to specify the port to bind. This example will show deploying the Axon to a specific Telepath listening port.

Inside the AHA container

Generate a one-time use provisioning URL, with the `--dmon-port` option:

```
python -m synapse.tools.aha.provision.service --dmon-port 30001 01.axon
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container directory:

```
mkdir -p /srv/syn/01.axon/storage
chown -R 999 /srv/syn/01.axon/storage
```

Create the `/srv/syn/01.axon/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  01.axon:
    user: "999"
    image: vertexproject/synapse-axon:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        # disable HTTPS API for now to prevent port collisions
        - SYN_AXON_HTTPS_PORT=null
        - SYN_AXON_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

After starting the service, the Axon will now be configured to bind its Telepath listening port to 30001. This can be seen in the services `cell.yaml` file.

```
---
aha:name: 01.axon
aha:network: <yournetwork>
aha:provision: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
aha:registry:
- ssl://root@aha.<yournetwork>
aha:user: root
dmon:listen: ssl://0.0.0.0:30001?hostname=01.axon.<yournetwork>&ca=
 ↪<yournetwork>
...
```

HTTPS Listening Port

If you need to deploy a service to have HTTPs listen on a specific port, you can use the provision tool to specify the port to bind. This example will show deploying the Cortex to a specific HTTPS listening port.

Inside the AHA container

Generate a one-time use provisioning URL, with the `--https-port` option:

```
python -m synapse.tools.aha.provision.service --https-port 8443 02.cortex
```

You should see output that looks similar to this:

```
one-time use URL: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

On the Host

Create the container directory:

```
mkdir -p /srv/syn/02.cortex/storage
chown -R 999 /srv/syn/02.cortex/storage
```

Create the `/srv/syn/01.axon/docker-compose.yaml` file with contents:

```
version: "3.3"
services:
  02.cortex:
    user: "999"
    image: vertexproject/synapse-axon:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        - SYN_CORTEX_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

After starting the service, the Cortex will now be configured to bind its HTTPS listening port to 8443. This can be seen in the services `cell.yaml` file.

```
---
aha:name: 02.cortex
aha:network: <yournetwork>
aha:provision: ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
aha:registry:
- ssl://root@aha.<yournetwork>
aha:user: root
dmon:listen: ssl://0.0.0.0:0?hostname=02.cortex.<yournetwork>&ca=<yournetwork>
https:port: 8443
...
```

6.2.11 Trimming the Nexus Log

The Nexus log can be trimmed to reduce the storage size of any Synapse Service that has Nexus logging enabled. This is commonly done before taking backups to reduce to their size.

For a Cortex **without** any mirrors, this is best accomplished in Storm via the following query:

```
$lib.cell.trimNexsLog()
```

The Storm API call will rotate the Nexus log and then delete the older entries.

If the Cortex is mirrored, a list of Telepath URLs of all mirrors must be provided. This ensures that all mirrors have rotated their Nexus logs before the cull operation is executed.

Warning: If this list is ommitted, or incorrect, the mirrors may become de-synchronized which will require a re-deployment from a backup of the upstream.

The Telepath URLs can be provided to the Storm API as follows:

```
$mirrors = ("aha://01.cortex...", "aha://02.cortex...")
$lib.cell.trimNexsLog(consumers=$mirrors)
```

6.2.12 Viewing Deprecation Warnings

When functionality in Synapse is deprecated, it is marked with the standard Python warnings mechanism to note that it is deprecated. Deprecated functionality is also noted in service changelogs as well. To view these warnings in your environment, you can set the `PYTHONWARNINGS` environment variable to display them. The following shows this being enabled for a Cortex deployment:

```
version: "3.3"
services:
  00.cortex:
    user: "999"
    image: vertexproject/synapse-cortex:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
    environment:
        - SYN_CORTEX_AXON=aha://axon...
        - SYN_CORTEX_JSONSTOR=aha://jsonstor...
        - PYTHONWARNINGS=default::DeprecationWarning:synapse.common
```

With this set, our deprecation warnings are emitted the first time the deprecated functionality is used. For example, if a remote caller uses the `eval()` API on a Cortex, it would log the following message:

```
/usr/local/lib/python3.8/dist-packages/synapse/common.py:913: DeprecationWarning:
↪"CoreApi.eval" is deprecated in 2.x and will be removed in 3.0.0
  warnings.warn(mesg, DeprecationWarning)
```

This would indicate the use of a deprecated API.

6.2.13 Entrypoint Hooking

Synapse service containers provide two ways that users can modify the container startup process, in order to execute their own scripts or commands.

The first way to modify the startup process is using a script that executes before services start. This can be configured by mapping in a file at `/vertex/boothooks/preboot.sh` and making sure it is marked as an executable. If this file is present, the script will be executed prior to booting the service. If this does not return `0`, the container will fail to start up.

One example for using this hook is to use `certbot` to create HTTPS certificates for a Synapse service. This example assumes the Cortex is running as root, so that certbot can bind port 80 to perform the `http-01` challenge. Non-root deployments may require additional port mapping for a given deployment.

Create a boothooks directory:

```
mkdir -p /srv/syn/00.cortex/bookhooks
```

Copy the following script to `/srv/syn/cortex/bookhooks/preboot.sh` and use `chmod` to mark it as an executable file:

```
#!/bin/bash

# Certbot preboot example
# Author: william.gibb@vertex.link

# This script is an example of using Let's Encrypt certbot tool to generate
# an HTTPS certificate for a Synapse service.
#
# This creates and stores a Python venv in the
# /vertex/storage/preboot/letsencrypt/venv directory, so the certbot
# tool is installed once in a separate python environment, and cached in
# a mapped volume.
#
# Once the venv is setup, certbot is used to create and potentially renew
# an HTTPS certificate. This certificate and private key are then copied to
# the locations in /vertex/storage where Synapse services assume they will
# find the HTTPS keys.
#
# certbot does use a random backoff timer when performing a renewal. There may
# be a random delay when starting a service when the certificate needs to be
# renewed.
#
# Required Environment variables:
#
# CERTBOT_HOSTNAME - the hostname that certbot will generate a certificate for.
# CERTBOT_EMAIL - the email address used with certbot.
#
# Optional Environment variables:
#
# CERTBOT_ARGS - additional args passed to the "certbot certonly" and
#   "certbot renew" commands.
#

# set -x # echo commands
set -e # exit on nonzero

BASEDIR=/vertex/preboot
DSTKEY=/vertex/storage/sslkey.pem
DSTCRT=/vertex/storage/sslcert.pem

if [ -z ${CERTBOT_HOSTNAME} ]; then
    echo "CERTBOT_HOSTNAME env var is unset"
    exit 1
fi

if [ -z ${CERTBOT_EMAIL} ]; then
    echo "CERTBOT_EMAIL env var is unset"
    exit 1
fi
```

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```
LEDIR=$BASEDIR/letsencrypt

CONFDIR=$LEDIR/conf
LOGSDIR=$LEDIR/logs
WORKDIR=$LEDIR/work
VENV=$LEDIR/venv

mkdir -p $LOGSDIR
mkdir -p $CONFDIR
mkdir -p $WORKDIR

CERTBOT_DIR_ARGS=" --work-dir ${WORKDIR} --logs-dir=${LOGSDIR} --config-dir=${CONFDIR} "

KEYFILE="${CONFDIR}/live/${CERTBOT_HOSTNAME}/privkey.pem"
CERTFILE="${CONFDIR}/live/${CERTBOT_HOSTNAME}/fullchain.pem"

# Create a python venv, activate it, and install certbot and supporting tools.
if [ ! -d $VENV ]; then
    echo "Creating venv and installing certbot"
    python3 -m venv --without-pip --copies $VENV

    . $VENV/bin/activate

    python3 -Im ensurepip --default-pip
    python3 -m pip install --no-cache-dir -U pip wheel
    python3 -m pip install --no-cache-dir "certbot==2.0.0"

else

    echo "Activating venv"
    . $VENV/bin/activate

fi

if [ ! -f ${KEYFILE} ]; then

    certbot -n ${CERTBOT_DIR_ARGS} certonly --agree-tos --email ${CERTBOT_EMAIL} --
↪standalone -d ${CERTBOT_HOSTNAME} ${CERTBOT_ARGS:-}

    if [ $? -ne 0 ]; then
        echo "Error running certbot"
        exit 1
    fi

fi

certbot -n ${CERTBOT_DIR_ARGS} renew --standalone ${CERTBOT_ARGS:-}

if [ $? -ne 0 ]; then
    echo "Error checking certificate renewal"
    exit 1
fi
```

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```
echo "Copying certificates"

cp ${KEYFILE} ${DSTKEY}
cp ${CERTFILE} ${DSTCRT}

echo "Done setting up HTTPS certificates"
```

That directory will be mounted at `/vertex/boothooks`. The following docker-compose file shows mounting that directory into the container and setting environment variables for the script to use:

```
version: "3.3"
services:
  00.cortex:
    image: vertexproject/synapse-cortex:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
        - ./storage:/vertex/storage
        - ./boothooks:/vertex/boothooks
    environment:
        SYN_LOG_LEVEL: "DEBUG"
        SYN_CORTEX_STORM_LOG: "true"
        SYN_CORTEX_AHA_PROVISION: "ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
↪"
        CERTBOT_HOSTNAME: "cortex.acme.corp"
        CERTBOT_EMAIL: "user@acme.corp"
```

When started, the container will attempt to run the script before starting the Cortex service.

The second way to modify a container startup process is running a script concurrently to the service. This can be set by mapping in a file at `/vertex/boothooks/concurrent.sh`, also as an executable file. If this file is present, the script is executed as a backgrounded task prior to starting up the Synapse service. This script would be stopped when the container is stopped.

Note: If a volume is mapped into `/vertex/boothooks/` it will not be included in any backups made by a Synapse service using the backup APIs. Making backups of any data persisted in these locations is the responsibility of the operator configuring the container.

6.2.14 Containers with Custom Users

By default, Synapse service containers will work running as `root` (uid 0) and `synuser` (uid 999) without any modification. In order to run a Synapse service container as a different user that is not built into the container by default, the user, group and home directory need to be added to the image. This can be done with a custom Dockerfile to modify a container. For example, the following Dockerfile would add the user `altuser` to the Container with a user id value of 8888:

```
FROM vertexproject/synapse-cortex:v2.x.x
RUN set -ex \
&& groupadd -g 8888 altuser \
```

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```
&& useradd -r --home-dir=/home/altuser -u 8888 -g altuser --shell /bin/bash altuser \
&& mkdir -p /home/altuser \
&& chown 8888:8888 /home/altuser
```

Running this with a `docker build` command can be used to create the image `customcortex:v2.x.x`:

```
$ docker build -f Dockerfile --tag  customcortex:v2.x.x .
Sending build context to Docker daemon  4.608kB
Step 1/2 : FROM vertexproject/synapse-cortex:v2.113.0
---> 8a2dd3465700
Step 2/2 : RUN set -ex && groupadd -g 8888 altuser && useradd -r --home-dir=/home/
↪altuser -u 8888 -g altuser --shell /bin/bash altuser && mkdir -p /home/altuser &&␣
↪chown 8888:8888 /home/altuser
---> Running in 9c7b30365c2d
+ groupadd -g 8888 altuser
+ useradd -r --home-dir=/home/altuser -u 8888 -g altuser --shell /bin/bash altuser
+ mkdir -p /home/altuser
+ chown 8888:8888 /home/altuser
Removing intermediate container 9c7b30365c2d
 ---> fd7173d42923
Successfully built fd7173d42923
Successfully tagged customcortex:v2.x.x
```

That custom user can then be used to run the Cortex:

```
version: "3.3"
services:
  00.cortex:
    user: "8888"
    image: customcortex:v2.x.x
    network_mode: host
    restart: unless-stopped
    volumes:
    - ./storage:/vertex/storage
    environment:
    - SYN_CORTEX_AXON=aha://axon...
    - SYN_CORTEX_JSONSTOR=aha://jsonstor...
    - SYN_CORTEX_AHA_PROVISION=ssl://aha.<yournetwork>:27272/<guid>?certhash=<sha256>
```

The following bash script can be used to help automate this process, by adding the user to an image and appending the custom username to the image tag:

```
#!/bin/bash
# Add a user to a debian based container with an arbitrary uid/gid value.
# default username: altuser
# default uid: 8888

set -e

if [ -z $1 ]
then
    echo "Usage: srcImage name id suffix"
    echo "srcImage required."
```

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```
    exit 1
fi

SRC_IMAGE_NAME=$1
NEW_NAME=${2:-altuser}
NEW_ID=${3:-8888}
SUFFIX=-${4:-$NEW_NAME}

echo "Add user/group ${NEW_NAME} with ${NEW_ID} into ${SRC_IMAGE_NAME}, creating: ${SRC_
↪IMAGE_NAME}${SUFFIX}"

printf "FROM $SRC_IMAGE_NAME \
\nRUN set -ex \\
    && groupadd -g $NEW_ID $NEW_NAME \\
    && useradd -r --home-dir=/home/$NEW_NAME -u $NEW_ID -g $NEW_NAME --shell /bin/bash
↪$NEW_NAME \\
    && mkdir -p /home/$NEW_NAME \\
    && chown $NEW_ID:$NEW_ID /home/$NEW_NAME\n" > ./Dockerfile

docker build -t $SRC_IMAGE_NAME$SUFFIX -f ./Dockerfile .

rm ./Dockerfile

exit 0
```

Saving this to `adduserimage.sh`, it can then be used to quickly modify an image. The following example shows running this to add a user named `foouser` with the uid 1234:

```
$ ./adduserimage.sh vertexproject/synapse-aha:v2.113.0 foouser 1234
Add user/group foouser with 1234 into vertexproject/synapse-aha:v2.113.0, creating:␣
↪vertexproject/synapse-aha:v2.113.0-foouser
Sending build context to Docker daemon  4.608kB
Step 1/2 : FROM vertexproject/synapse-aha:v2.113.0
 ---> 53251b832df0
Step 2/2 : RUN set -ex && groupadd -g 1234 foouser && useradd -r --home-dir=/home/
↪foouser -u 1234 -g foouser --shell /bin/bash foouser && mkdir -p /home/foouser &&␣
↪chown 1234:1234 /home/foouser
 ---> Running in 1c9e793d6761
+ groupadd -g 1234 foouser
+ useradd -r --home-dir=/home/foouser -u 1234 -g foouser --shell /bin/bash foouser
+ mkdir -p /home/foouser
+ chown 1234:1234 /home/foouser
Removing intermediate container 1c9e793d6761
 ---> 21a12f395462
Successfully built 21a12f395462
Successfully tagged vertexproject/synapse-aha:v2.113.0-foouser
```

6.3 Synapse Services

6.3.1 AHA

The AHA service provides service discovery, provisioning, graceful mirror promotion, and certificate authority services to the other Synapse services. For a step-by-step guide to deploying an AHA instance, see the *Synapse Deployment Guide*. We will use <yournetwork> to specify locations where the value should be replaced with your chosen AHA network name.

Docker Image: `vertexproject/synapse-aha:v2.x.x`

Configuration

A typical AHA deployment requires some initial configuration options. At a minimum, you must specify the following:

```
aha:name: aha
aha:network: <yournetwork>
dmon:listen: ssl://aha.<yournetwork>&ca=<yournetwork>
```

To enable provisioning using AHA you must specify an alternate listener such as:

```
provision:listen: tcp://aha.<yournetwork>:27272
```

Note: The network connection from a Synapse service to the AHA service must NOT be passing through a Network Adress Translation (NAT) device.

For the full list supported options, see the *AHA Configuration Options*.

Using Aha with Custom Client Code

Loading the known AHA resolvers for use with custom python clients can be easily accomplished using the `withTeleEnv()` context manager:

```
import sys
import asyncio

import synapse.telepath as s_telepath

async def main(argv):

    # This context manager loads telepath.yaml
    async with s_telepath.withTeleEnv():

        async with await s_telepath.openurl(argv[0]) as proxy:

            # call service provided telepath APIs

            info = await proxy.getCellInfo()
            print(repr(info))

    return 0

sys.exit(asyncio.run(main(sys.argv[1:])))
```

6.3.2 Axon

Note: If you are a Synapse Enterprise customer you should consider deploying the Synapse-S3 Axon.

The Axon service provides binary / blob storage inside of the Synapse ecosystem. Binary objects are indexed based on the SHA-256 hash so that storage of the same set of bytes is not duplicated. The Axon exposes a set of Telepath / HTTP APIs that can be used to upload, download, and check for the existence of a binary blob. For a step-by-step guide to deploying an Axon, see the *Synapse Deployment Guide*.

Docker Image: `vertexproject/synapse-axon:v2.x.x`

Note: For ease of use in simple deployments, the Cortex contains an embedded Axon instance. For production deployments it is **highly** recommended that you install it as a separated service to help distribute load and allow direct access by other Advanced Power-Ups.

Configuration

A typical Axon deployment does not require any additional configuration. For the full list supported options, see the *Axon Configuration Options*.

Permissions

axon
: Controls access to all `axon.*` permissions.

axon.get
: Controls access to retrieve a binary blob from the Axon based on the SHA256 hash.

axon.has
: Controls access to check if bytes are present and return sizes based on the SHA256 hash.

axon.upload
: Controls access to upload a binary blob to the Axon.

For example, to allow the user `visi` to upload, download, and confirm files you would execute the following command from **inside the Axon container**:

```
python -m synapse.tools.moduser --add visi --allow axon
```

6.3.3 JSONStor

The JSONStor is a utility service that provides a mechanism for storing and retrieving arbitrary JSON objects using a hierarchical naming system. It is commonly used to store user preferences, cache API query responses, and hold data that is not part of the *Data Model*. For an example of deploying a JSONStor, see the *Synapse Deployment Guide*.

Docker Image: `vertexproject/synapse-jsonstor:v2.x.x`

Note: For ease of use in simple deployments, the Cortex contains an embedded JSONStor instance. For production deployments it is **highly** recommended that you install it as a separated service to help distribute load and allow direct access by other Advanced Power-Ups.

Configuration

A typical JSONStor deployment does not require any additional configuration. For the full list supported options, see the *JSONStor Configuration Options*.

6.3.4 Cortex

A Cortex is the hypergraph database and main component of the Synapse service architecture. The Cortex is also where the Storm query language runtimes and execute where all automation and enrichment occurs. For a step-by-step guide to deploying a Cortex, see the *Synapse Deployment Guide*.

Docker Image: `vertexproject/synapse-cortex:v2.x.x`

Configuration

Many of the configurations and permissions managed within the Cortex are the responsibility of the global admin rather than the devops team. See the *Synapse Admin Guide* for details on global admin tasks and details.

The Cortex can be configured to log Storm queries executed by users. This is done by setting the `storm:log` and `storm:log:level` configuration options. The `storm:log:level` option may be one of `DEBUG`, `INFO` , `WARNING`, `ERROR`, `CRITICAL` This allows an organization to set what log level their Storm queries are logged at.

When enabled, the log message contains the query text and username:

```
2021-06-28 16:17:55,775 [INFO] Executing storm query {inet:ipv4=1.2.3.4} as [root]␣
↪[cortex.py:_logStormQuery:MainThread:MainProcess]
```

When structured logging is also enabled for a Cortex, the query text, username, and user iden are included as individual fields in the logged message as well:

```
{
  "message": "Executing storm query {inet:ipv4=1.2.3.4} as [root]",
  "logger": {
    "name": "synapse.storm",
    "process": "MainProcess",
    "filename": "cortex.py",
    "func": "_logStormQuery"
  },
  "level": "INFO",
  "time": "2021-06-28 16:18:47,232",
  "text": "inet:ipv4=1.2.3.4",
  "username": "root",
  "user": "3189065f95d3ab0a6904e604260c0be2"
}
```

This logging does interplay with the underlying log configuration (*Configure Logging*). The `storm:log:level` value must be greater than or equal to the `SYN_LOG_LEVEL`, otherwise the Storm log will not be emitted.

For the full list supported options, see the *Cortex Configuration Options*.

6.4 Devops Details

6.4.1 Orchestration

Kubernetes

A popular option for Orchestration is Kubernetes. Kubernetes is an open-source system for automating the deployment, scaling and management of containerized applications. Synapse does work in Kubernetes environments.

Note: If you are using these examples to get started with Synapse on Kubernetes, you may need to adapt them to meet operational needs for your environment.

Example Deployment

The following examples walk through deploying an example Synapse deployment (based on *Synapse Deployment Guide*), but inside of a managed Kubernetes cluster managed by Digital Ocean. This deployment makes a few assumptions:

Synapse Deployment Guide
: This guide assumes a familiarity with the Synapse deployment guide. Concepts covered there are not repeated here.

namespace
: These examples use the Kubernetes `default` namespace.

PersistentVolumeClaim
: These examples use PersistentVolumeClaim (PVC) to create a persistent storage location. All Synapse services assume they have some persistent storage to read and write to. This example uses the `storageClass` of `do-block-storage`. You may need to alter these examples to provide a `storageClass` that is appropriate for your environment.

Aha naming
: In Kubernetes, we rely on the default naming behavior for services to find the Aha service via DNS, so our Aha name and Aha network should match the internal naming for services in the cluster. The `aha:network` value is `<namespace>.<cluster dns root>`. This DNS root value is normally `svc.cluster.local`, so the resulting DNS label for the Aha service is `aha.default.svc.cluster.local`. Similarly, the Aha service is configured to listen on `0.0.0.0`, since we cannot bind the DNS label provided by Kubernetes prior to the Pod running Aha being available.

Aha

The following `aha.yaml` can be used to deploy an Aha service.

```
---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-aha
  labels:
    app.kubernetes.io/name: "aha"
    app.kubernetes.io/instance: "aha"
```

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```
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "aha"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
  storageClassName: do-block-storage
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: aha
  labels:
    app.kubernetes.io/name: "aha"
    app.kubernetes.io/instance: "aha"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "aha"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "aha"
      app.kubernetes.io/instance: "aha"
      app.kubernetes.io/version: "v2.x.x"
      app.kubernetes.io/component: "aha"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "aha"
        app.kubernetes.io/instance: "aha"
        app.kubernetes.io/version: "v2.x.x"
        app.kubernetes.io/component: "aha"
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      securityContext:
        runAsUser: 999
        runAsGroup: 999
        fsGroup: 999
      volumes:
        - name: data
          persistentVolumeClaim:
            claimName: example-aha
```

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```
      containers:
      - name: aha
        image: vertexproject/synapse-aha:v2.x.x
        env:
          - name: SYN_LOG_LEVEL
            value: DEBUG
          - name: SYN_LOG_STRUCT
            value: "false"
          - name: SYN_AHA_AHA_NAME
            value: aha
          - name: SYN_AHA_AHA_NETWORK
            # This is <namespace>.<cluster dns root> - it is used as Certificate␣
↪Authority name
            value: default.svc.cluster.local
          - name: SYN_AHA_DMON_LISTEN
            # This is <aha name>.<namespace>.<cluster dns root> and the CA name from␣
↪above
            value: "ssl://0.0.0.0?hostname=aha.default.svc.cluster.local&ca=default.svc.
↪cluster.local"
          - name: SYN_AHA_PROVISION_LISTEN
            # This is <aha name>.<namespace>.<cluster dns root>
            value: "ssl://0.0.0.0:27272?hostname=aha.default.svc.cluster.local"
          - name: SYN_AHA_HTTPS_PORT
            value: null
        volumeMounts:
          - mountPath: /vertex/storage
            name: data
        imagePullPolicy: Always
        startupProbe:
          failureThreshold: 2147483647
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
        readinessProbe:
          failureThreshold: 2
          initialDelaySeconds: 20
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
      restartPolicy: Always
---
apiVersion: v1
kind: Service
metadata:
  name: aha
  labels:
    app.kubernetes.io/name: "aha"
    app.kubernetes.io/instance: "aha"
```

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```
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "aha"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  type: ClusterIP
  selector:
    app.kubernetes.io/instance: aha
    environment: "dev"
  ports:
    - port: 27492
      protocol: TCP
      name: telepath
    - port: 27272
      protocol: TCP
      name: provisioning
```

This can be deployed via `kubectl apply`. That will create the PVC, deployment, and service.

```
$ kubectl apply -f aha.yaml
persistentvolumeclaim/example-aha created
deployment.apps/aha created
service/aha created
```

You can see the startup logs as well:

```
$ kubectl logs -l app.kubernetes.io/instance=aha
2023-03-08 04:22:02,568 [DEBUG] Set config valu from envar: [SYN_AHA_DMON_LISTEN]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 04:22:02,568 [DEBUG] Set config valu from envar: [SYN_AHA_HTTPS_PORT] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 04:22:02,568 [DEBUG] Set config valu from envar: [SYN_AHA_AHA_NAME] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 04:22:02,569 [DEBUG] Set config valu from envar: [SYN_AHA_AHA_NETWORK]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 04:22:02,651 [INFO] Adding CA certificate for default.svc.cluster.local [aha.
↪py:initServiceRuntime:MainThread:MainProcess]
2023-03-08 04:22:02,651 [INFO] Generating CA certificate for default.svc.cluster.local␣
↪[aha.py:genCaCert:MainThread:MainProcess]
2023-03-08 04:22:06,401 [INFO] Adding server certificate for aha.default.svc.cluster.
↪local [aha.py:initServiceRuntime:MainThread:MainProcess]
2023-03-08 04:22:08,879 [INFO] dmon listening: ssl://0.0.0.0?hostname=aha.default.svc.
↪cluster.local&ca=default.svc.cluster.local [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
2023-03-08 04:22:08,882 [INFO] ...ahacell API (telepath): ssl://0.0.0.0?hostname=aha.
↪default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 04:22:08,882 [INFO] ...ahacell API (https): disabled [cell.
↪py:initFromArgv:MainThread:MainProcess]
```

Axon

The following `axon.yaml` can be used as the basis to deploy an Axon service.

```
---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-axon00
  labels:
    app.kubernetes.io/name: "axon"
    app.kubernetes.io/instance: "axon00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "axon"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
  storageClassName: do-block-storage
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: axon00
  labels:
    app.kubernetes.io/name: "axon"
    app.kubernetes.io/instance: "axon00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "axon"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "axon"
      app.kubernetes.io/instance: "axon00"
      app.kubernetes.io/version: "v2.x.x"
      app.kubernetes.io/component: "axon"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "axon"
        app.kubernetes.io/instance: "axon00"
        app.kubernetes.io/version: "v2.x.x"
        app.kubernetes.io/component: "axon"
```

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```
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      securityContext:
        runAsUser: 999
        runAsGroup: 999
        fsGroup: 999
      volumes:
        - name: data
          persistentVolumeClaim:
            claimName: example-axon00
      containers:
      - name: axon
        image: vertexproject/synapse-axon:v2.x.x
        env:
          - name: SYN_LOG_LEVEL
            value: DEBUG
          - name: SYN_LOG_STRUCT
            value: "false"
          - name: SYN_AXON_AHA_PROVISION
            value: "ssl://aha.default.svc.cluster.local:27272/..."
          - name: SYN_AXON_HTTPS_PORT
            value: null
        volumeMounts:
          - mountPath: /vertex/storage
            name: data
        imagePullPolicy: Always
        startupProbe:
          failureThreshold: 2147483647
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
        readinessProbe:
          failureThreshold: 2
          initialDelaySeconds: 20
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
      restartPolicy: Always
```

Before we deploy that, we need to create the Aha provisioning URL. We can do that via `kubectl exec`. That should look like the following:

```
$ kubectl exec deployment/aha -- python -m synapse.tools.aha.provision.service 00.axon
one-time use URL: ssl://aha.default.svc.cluster.local:27272/
↪39a33f6e3fa2b512552c2c7770e28d30?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f
```

We want to copy that URL into the `SYN_AXON_AHA_PROVISION` environment variable, so that block looks like the

following:

```
- name: SYN_AXON_AHA_PROVISION
  value: "ssl://aha.default.svc.cluster.local:27272/39a33f6e3fa2b512552c2c7770e28d30?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f"
```

This can then be deployed via `kubectl apply`:

```
$ kubectl apply -f axon.yaml
persistentvolumeclaim/example-axon00 unchanged
deployment.apps/axon00 created
```

You can see the Axon logs as well. These show provisioning and listening for traffic:

```
$ kubectl logs -l app.kubernetes.io/instance=axon00
2023-03-08 17:27:44,721 [INFO] log level set to DEBUG [common.
↪py:setlogging:MainThread:MainProcess]
2023-03-08 17:27:44,722 [DEBUG] Set config valu from envar: [SYN_AXON_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:27:44,722 [DEBUG] Set config valu from envar: [SYN_AXON_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:27:44,723 [INFO] Provisioning axon from AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:27:44,833 [DEBUG] Set config valu from envar: [SYN_AXON_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:27:44,833 [DEBUG] Set config valu from envar: [SYN_AXON_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:27:51,649 [INFO] Done provisioning axon AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:27:51,898 [INFO] dmon listening: ssl://0.0.0.0:0?hostname=00.axon.default.
↪svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
2023-03-08 17:27:51,899 [INFO] ...axon API (telepath): ssl://0.0.0.0:0?hostname=00.axon.
↪default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 17:27:51,899 [INFO] ...axon API (https): disabled [cell.
↪py:initFromArgv:MainThread:MainProcess]
```

The hostname `00.axon.default.svc.cluster.local` seen in the logs is **not** a DNS label in Kubernetes. That is an internal label used by the service to resolve SSL certificates that it provisioned with the Aha service, and as the name that it uses to register with the Aha service.

JSONStor

The following `jsonstor.yaml` can be used as the basis to deploy a JSONStor service.

```
---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-jsonstor00
  labels:
    app.kubernetes.io/name: "jsonstor"
```

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```
    app.kubernetes.io/instance: "jsonstor00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "jsonstor"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
  storageClassName: do-block-storage
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: jsonstor00
  labels:
    app.kubernetes.io/name: "jsonstor"
    app.kubernetes.io/instance: "jsonstor00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "jsonstor"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "jsonstor"
      app.kubernetes.io/instance: "jsonstor00"
      app.kubernetes.io/version: "v2.x.x"
      app.kubernetes.io/component: "jsonstor"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "jsonstor"
        app.kubernetes.io/instance: "jsonstor00"
        app.kubernetes.io/version: "v2.x.x"
        app.kubernetes.io/component: "jsonstor"
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      securityContext:
        runAsUser: 999
        runAsGroup: 999
        fsGroup: 999
      volumes:
        - name: data
          persistentVolumeClaim:
```

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```
            claimName: example-jsonstor00
      containers:
      - name: jsonstor
        image: vertexproject/synapse-jsonstor:v2.x.x
        env:
          - name: SYN_LOG_LEVEL
            value: DEBUG
          - name: SYN_LOG_STRUCT
            value: "false"
          - name: SYN_JSONSTOR_AHA_PROVISION
            value: "ssl://aha.default.svc.cluster.local:27272/..."
          - name: SYN_JSONSTOR_HTTPS_PORT
            value: null
        volumeMounts:
          - mountPath: /vertex/storage
            name: data
        imagePullPolicy: Always
        startupProbe:
          failureThreshold: 2147483647
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
        readinessProbe:
          failureThreshold: 2
          initialDelaySeconds: 20
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
      restartPolicy: Always
```

Before we deploy that, we need to create the Aha provisioning URL. We can do that via `kubectl exec`. That should look like the following:

```
$ kubectl exec deployment/aha -- python -m synapse.tools.aha.provision.service 00.
↪jsonstor
one-time use URL: ssl://aha.default.svc.cluster.local:27272/
↪cbe50bb470ba55a5df9287391f843580?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f
```

We want to copy that URL into the `SYN_JSONSTOR_AHA_PROVISION` environment variable, so that block looks like the following:

```
- name: SYN_JSONSTOR_AHA_PROVISION
  value: "ssl://aha.default.svc.cluster.local:27272/cbe50bb470ba55a5df9287391f843580?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f"
```

This can then be deployed via `kubectl apply`:

```
$ kubectl apply -f jsonstor.yaml
persistentvolumeclaim/example-jsonstor00 created
deployment.apps/jsonstor00 created
```

You can see the JSONStor logs as well. These show provisioning and listening for traffic:

```
$ kubectl logs -l app.kubernetes.io/instance=jsonstor00
2023-03-08 17:29:15,137 [INFO] log level set to DEBUG [common.
↪py:setlogging:MainThread:MainProcess]
2023-03-08 17:29:15,137 [DEBUG] Set config valu from envar: [SYN_JSONSTOR_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:15,138 [DEBUG] Set config valu from envar: [SYN_JSONSTOR_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:15,140 [INFO] Provisioning jsonstorcell from AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:29:15,261 [DEBUG] Set config valu from envar: [SYN_JSONSTOR_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:15,261 [DEBUG] Set config valu from envar: [SYN_JSONSTOR_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:19,325 [INFO] Done provisioning jsonstorcell AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:29:19,966 [INFO] dmon listening: ssl://0.0.0.0:0?hostname=00.jsonstor.
↪default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
2023-03-08 17:29:19,966 [INFO] ...jsonstorcell API (telepath): ssl://0.0.0.0:0?
↪hostname=00.jsonstor.default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 17:29:19,966 [INFO] ...jsonstorcell API (https): disabled [cell.
↪py:initFromArgv:MainThread:MainProcess]
```

Cortex

The following `cortex.yaml` can be used as the basis to deploy the Cortex.

```yaml
---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-cortex00
  labels:
    app.kubernetes.io/name: "cortex"
    app.kubernetes.io/instance: "cortex00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "cortex"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
```

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```
  storageClassName: do-block-storage
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: cortex00
  labels:
    app.kubernetes.io/name: "cortex"
    app.kubernetes.io/instance: "cortex00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "cortex"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "cortex"
      app.kubernetes.io/instance: "cortex00"
      app.kubernetes.io/version: "v2.x.x"
      app.kubernetes.io/component: "cortex"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "cortex"
        app.kubernetes.io/instance: "cortex00"
        app.kubernetes.io/version: "v2.x.x"
        app.kubernetes.io/component: "cortex"
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      securityContext:
        runAsUser: 999
        runAsGroup: 999
        fsGroup: 999
      volumes:
        - name: data
          persistentVolumeClaim:
            claimName: example-cortex00
      containers:
      - name: cortex
        image: vertexproject/synapse-cortex:v2.x.x
        env:
          - name: SYN_LOG_LEVEL
            value: DEBUG
          - name: SYN_LOG_STRUCT
            value: "false"
          - name: SYN_CORTEX_AHA_PROVISION
            value: "ssl://aha.default.svc.cluster.local:27272/..."
```

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```
          - name: SYN_CORTEX_HTTPS_PORT
            value: null
          - name: SYN_CORTEX_STORM_LOG
            value: "true"
          - name: SYN_CORTEX_JSONSTOR
            value: "aha://jsonstor..."
          - name: SYN_CORTEX_AXON
            value: "aha://axon..."
        volumeMounts:
          - mountPath: /vertex/storage
            name: data
        imagePullPolicy: Always
        startupProbe:
          failureThreshold: 2147483647
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
        readinessProbe:
          failureThreshold: 2
          initialDelaySeconds: 20
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
      restartPolicy: Always
---
apiVersion: v1
kind: Service
metadata:
  name: cortex
  labels:
    app.kubernetes.io/name: "cortex"
    app.kubernetes.io/instance: "cortex00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "cortex"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  type: ClusterIP
  selector:
    app.kubernetes.io/instance: cortex00
    environment: "dev"
  ports:
    - port: 27492
      protocol: TCP
      name: telepath
```

Before we deploy that, we need to create the Aha provisioning URL. This uses a fixed listening port for the Cortex, so that we can later use port-forwarding to access the Cortex service. We do this via `kubectl exec`. That should look like the following:

```
$ kubectl exec deployment/aha -- python -m synapse.tools.aha.provision.service 00.cortex␣
↪--dmon-port 27492
one-time use URL: ssl://aha.default.svc.cluster.local:27272/
↪c06cd588e469a3b7f8a56d98414acf8a?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f
```

We want to copy that URL into the SYN_CORTEX_AHA_PROVISION environment variable, so that block looks like the following:

```
- name: SYN_CORTEX_AHA_PROVISION
  value: "ssl://aha.default.svc.cluster.local:27272/c06cd588e469a3b7f8a56d98414acf8a?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f"
```

This can then be deployed via `kubectl apply`:

```
$ kubectl apply -f cortex.yaml
persistentvolumeclaim/example-cortex00 created
deployment.apps/cortex00 created
service/cortex created
```

You can see the Cortex logs as well. These show provisioning and listening for traffic, as well as the connection being made to the Axon and JSONStor services:

```
$ kubectl logs -l app.kubernetes.io/instance=cortex00
2023-03-08 17:29:16,892 [INFO] log level set to DEBUG [common.
↪py:setlogging:MainThread:MainProcess]
2023-03-08 17:29:16,893 [DEBUG] Set config valu from envar: [SYN_CORTEX_AXON] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:16,893 [DEBUG] Set config valu from envar: [SYN_CORTEX_JSONSTOR]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:16,894 [DEBUG] Set config valu from envar: [SYN_CORTEX_STORM_LOG]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:16,894 [DEBUG] Set config valu from envar: [SYN_CORTEX_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:16,894 [DEBUG] Set config valu from envar: [SYN_CORTEX_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:16,896 [INFO] Provisioning cortex from AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:29:17,008 [DEBUG] Set config valu from envar: [SYN_CORTEX_AXON] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:17,009 [DEBUG] Set config valu from envar: [SYN_CORTEX_JSONSTOR]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:17,009 [DEBUG] Set config valu from envar: [SYN_CORTEX_STORM_LOG]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:17,010 [DEBUG] Set config valu from envar: [SYN_CORTEX_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:17,010 [DEBUG] Set config valu from envar: [SYN_CORTEX_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:29:20,356 [INFO] Done provisioning cortex AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:29:21,077 [INFO] dmon listening: ssl://0.0.0.0:27492?hostname=00.cortex.
↪default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
```

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```
2023-03-08 17:29:21,078 [INFO] ...cortex API (telepath): ssl://0.0.0.0:27492?hostname=00.
↪cortex.default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 17:29:21,078 [INFO] ...cortex API (https): disabled [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 17:29:21,082 [DEBUG] Connected to remote axon aha://axon... [cortex.
↪py:onlink:MainThread:MainProcess]
2023-03-08 17:29:21,174 [DEBUG] Connected to remote jsonstor aha://jsonstor... [cortex.
↪py:onlink:MainThread:MainProcess]
```

CLI Tooling Example

Synapse services and tooling assumes that IP and Port combinations registered with the AHA service are reachable. This example shows a way to connect to the Cortex from **outside** of the Kubernetes cluster without resolving service information via Aha. Communication between services inside of the cluster does not need to go through these steps. This does assume that your local environment has the Python synapse package available.

First add a user to the Cortex:

```
$ kubectl exec -it deployment/cortex00 -- python -m synapse.tools.moduser --add --admin␣
↪true visi
Adding user: visi
...setting admin: true
```

Then we need to generate a user provisioning URL:

```
$ kubectl exec -it deployment/aha -- python -m synapse.tools.aha.provision.user visi
one-time use URL: ssl://aha.default.svc.cluster.local:27272/
↪5d67f84c279afa240062d2f3b32fdb99?
↪certhash=e32d0e1da01b5eb0cefd4c107ddc8c8221a9a39bce25dea04f469c6474d84a23
```

Port-forward the AHA provisioning service to your local environment:

```
kubectl port-forward service/aha 27272:provisioning
```

Run the enroll tool to create a user certificate pair and have it signed by the Aha service. We replace the service DNS name of `aha.default.svc.cluster.local` with `localhost` in this example.

```
$ python -m synapse.tools.aha.enroll ssl://localhost:27272/
↪5d67f84c279afa240062d2f3b32fdb99?
↪certhash=e32d0e1da01b5eb0cefd4c107ddc8c8221a9a39bce25dea04f469c6474d84a23
Saved CA certificate: /home/visi/.syn/certs/cas/default.svc.cluster.local.crt
Saved user certificate: /home/visi/.syn/certs/users/visi@default.svc.cluster.local.crt
Updating known AHA servers
```

The Aha service port-forward can be disabled, and replaced with a port-forward for the Cortex service:

```
kubectl port-forward service/cortex 27492:telepath
```

Then connect to the Cortex via the Storm CLI, using the URL `ssl://visi@localhost:27492/?hostname=00.cortex.default.svc.cluster.local`.

```
$ python -m synapse.tools.storm "ssl://visi@localhost:27492/?hostname=00.cortex.default.
↪svc.cluster.local"

Welcome to the Storm interpreter!

Local interpreter (non-storm) commands may be executed with a ! prefix:
    Use !quit to exit.
    Use !help to see local interpreter commands.

storm>
```

The Storm CLI tool can then be used to run Storm commands.

Commercial Components

For Synapse-Enterprise users, deploying commercial components can follow a similar pattern. The following is an example of deploying Optic, the Synapse User Interface, as it is a common part of a Synapse deployment. This enables users to interact with Synapse via a web browser, instead of using the CLI tools. This example shows accessing the service via a port-forward. This example does not contain the full configuration settings you will need for a production deployment of Optic, please see *Synapse User Interface* for more information.

Note: Optic is available as a part of the **Synapse Enterprise** commercial offering. This example assumes that the Kubernetes cluster has a valid `imagePullSecret` named `regcred` which can access commercial images.

The following `optic.yaml` can be used as the basis to deploy Optic.

```
---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: example-optic00
  labels:
    app.kubernetes.io/name: "optic"
    app.kubernetes.io/instance: "optic00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "optic"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 10Gi
  # You will need to use an appropriate storageClassName for your cluster.
  storageClassName: do-block-storage
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: optic00
```

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```
  labels:
    app.kubernetes.io/name: "optic"
    app.kubernetes.io/instance: "optic00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "optic"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "optic"
      app.kubernetes.io/instance: "optic00"
      app.kubernetes.io/version: "v2.x.x"
      app.kubernetes.io/component: "optic"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "optic"
        app.kubernetes.io/instance: "optic00"
        app.kubernetes.io/version: "v2.x.x"
        app.kubernetes.io/component: "optic"
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      securityContext:
        runAsUser: 999
        runAsGroup: 999
        fsGroup: 999
      volumes:
        - name: data
          persistentVolumeClaim:
            claimName: example-optic00
      containers:
      - name: optic
        image: vertexproject/optic:v2.x.x
        securityContext:
          readOnlyRootFilesystem: true
        env:
          - name: SYN_LOG_LEVEL
            value: DEBUG
          - name: SYN_LOG_STRUCT
            value: "false"
          - name: SYN_OPTIC_AHA_PROVISION
            value: "ssl://aha.default.svc.cluster.local:27272/..."
          - name: SYN_OPTIC_HTTPS_PORT
            value: "4443"
          - name: SYN_OPTIC_AXON
            value: "aha://axon..."
```

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```
          - name: SYN_OPTIC_CORTEX
            value: "aha://cortex..."
          - name: SYN_OPTIC_JSONSTOR
            value: "aha://jsonstor..."
        volumeMounts:
          - mountPath: /vertex/storage
            name: data
        imagePullPolicy: Always
        startupProbe:
          failureThreshold: 2147483647
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
        readinessProbe:
          failureThreshold: 2
          initialDelaySeconds: 20
          timeoutSeconds: 20
          periodSeconds: 20
          exec:
            command: ['python', '-m', 'synapse.tools.healthcheck', '-c', 'cell:///vertex/
↪storage']
      restartPolicy: Always
      imagePullSecrets:
        - name: "regcred"
---
apiVersion: v1
kind: Service
metadata:
  name: optic
  labels:
    app.kubernetes.io/name: "optic"
    app.kubernetes.io/instance: "optic00"
    app.kubernetes.io/version: "v2.x.x"
    app.kubernetes.io/component: "optic"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  type: ClusterIP
  selector:
    app.kubernetes.io/name: optic
    environment: "dev"
  ports:
    - port: 4443
      protocol: TCP
      name: https
```

Before we deploy that, we need to create the Aha provisioning URL. We do this via `kubectl exec`. That should look like the following:

```
$ kubectl exec deployment/aha -- python -m synapse.tools.aha.provision.service 00.optic
```

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```
one-time use URL: ssl://aha.default.svc.cluster.local:27272/
↪3f692cda9dfb152f74a8a0251165bcc4?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f
```

We want to copy that URL into the SYN_OPTIC_AHA_PROVISION environment variable, so that block looks like the following:

```
- name: SYN_OPTIC_AHA_PROVISION
  value: "ssl://aha.default.svc.cluster.local:27272/3f692cda9dfb152f74a8a0251165bcc4?
↪certhash=09c8329ed29b89b77e0a2fdc23e64aea407ad4d7e71d67d3fea92ddd9466592f"
```

This can then be deployed via kubectl apply:

```
$ kubectl apply -f optic.yaml
persistentvolumeclaim/example-optic00 created
deployment.apps/optic00 created
service/optic created
```

You can see the Optic logs as well. These show provisioning and listening for traffic, as well as the connection being made to the Axon, Cortex, and JSONStor services:

```
$ kubectl logs --tail 30 -l app.kubernetes.io/instance=optic00
2023-03-08 17:32:40,149 [INFO] log level set to DEBUG [common.
↪py:setlogging:MainThread:MainProcess]
2023-03-08 17:32:40,150 [DEBUG] Set config valu from envar: [SYN_OPTIC_CORTEX] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,150 [DEBUG] Set config valu from envar: [SYN_OPTIC_AXON] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,151 [DEBUG] Set config valu from envar: [SYN_OPTIC_JSONSTOR] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,151 [DEBUG] Set config valu from envar: [SYN_OPTIC_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,152 [DEBUG] Set config valu from envar: [SYN_OPTIC_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,153 [INFO] Provisioning optic from AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:32:40,264 [DEBUG] Set config valu from envar: [SYN_OPTIC_CORTEX] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,265 [DEBUG] Set config valu from envar: [SYN_OPTIC_AXON] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,265 [DEBUG] Set config valu from envar: [SYN_OPTIC_JSONSTOR] [config.
↪py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,265 [DEBUG] Set config valu from envar: [SYN_OPTIC_HTTPS_PORT]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:40,266 [DEBUG] Set config valu from envar: [SYN_OPTIC_AHA_PROVISION]␣
↪[config.py:setConfFromEnvs:MainThread:MainProcess]
2023-03-08 17:32:45,181 [INFO] Done provisioning optic AHA service. [cell.py:_
↪bootCellProv:MainThread:MainProcess]
2023-03-08 17:32:45,247 [INFO] optic wwwroot: /usr/local/lib/python3.10/dist-packages/
↪optic/site [app.py:initServiceStorage:MainThread:MainProcess]
2023-03-08 17:32:45,248 [WARNING] Waiting for remote jsonstor... [app.
↪py:initJsonStor:MainThread:MainProcess]
2023-03-08 17:32:45,502 [INFO] Connected to JsonStor at [aha://jsonstor...] [app.
```

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```
↪py:initJsonStor:MainThread:MainProcess]
2023-03-08 17:32:45,504 [INFO] Waiting for connection to Cortex [app.py:_
↪initOpticCortex:MainThread:MainProcess]
2023-03-08 17:32:45,599 [INFO] Connected to Cortex at [aha://cortex...] [app.py:_
↪initOpticCortex:MainThread:MainProcess]
2023-03-08 17:32:45,930 [INFO] Connected to Axon at [aha://axon...] [app.
↪py:onaxonlink:MainThread:MainProcess]
2023-03-08 17:32:45,937 [DEBUG] Email settings/server not configured or invalid. [app.
↪py:initEmailApis:asyncio_0:MainProcess]
2023-03-08 17:32:45,975 [INFO] dmon listening: ssl://0.0.0.0:0?hostname=00.optic.default.
↪svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
2023-03-08 17:32:45,976 [WARNING] NO CERTIFICATE FOUND! generating self-signed␣
↪certificate. [cell.py:addHttpsPort:MainThread:MainProcess]
2023-03-08 17:32:47,773 [INFO] https listening: 4443 [cell.
↪py:initServiceNetwork:MainThread:MainProcess]
2023-03-08 17:32:47,773 [INFO] ...optic API (telepath): ssl://0.0.0.0:0?hostname=00.
↪optic.default.svc.cluster.local&ca=default.svc.cluster.local [cell.
↪py:initFromArgv:MainThread:MainProcess]
2023-03-08 17:32:47,773 [INFO] ...optic API (https): 4443 [cell.
↪py:initFromArgv:MainThread:MainProcess]
```

Once Optic is connected, we will need to set a password for the user we previously created in order to log in. This can be done via `kubectl exec`, setting the password for the user on the Cortex:

```
$ kubectl exec -it deployment/cortex00 -- python -m synapse.tools.moduser --passwd␣
↪secretPassword visi
Modifying user: visi
...setting passwd: secretPassword
```

Enable a port-forward to connect to the Optic service:

```
$ kubectl port-forward service/optic 4443:https
```

You can then use a Chrome browser to navigate to `https://localhost:4443` and you should be prompted with an Optic login screen. You can enter your username and password (`visi` and `secretPassword`) in order to login to Optic.

Practical Considerations

The following items should be considered for Kubernetes deployments intended for production use cases:

Healthchecks
: These examples use large `startupProbe` failure values. Vertex recommends these large values, since service updates may have automatic data migrations which they perform at startup. These will be performed before a service has enabled any listeners which would respond to healthcheck probes. The large value prevents a service from being terminated prior to a long running data migration completing.

Ingress and Load Balancing
: The use of `kubectl port-forward` may not be sustainable in a production environment. It is common to use a form of ingress controller or load balancer for external services to reach services such as the Cortex or Optic applications. It is common for the Optic UI or the Cortex HTTP API to be

exposed to end users since that often has a simpler networking configuration than exposing Telepath services on Aha and the Cortex.

Log aggregation
: Many Kubernetes clusters may perform some sort of log aggregation for the containers running in them. If your log aggregation solution can parse JSON formatted container logs, you can set the `SYN_LOG_STRUCT` environment variable to `"true"` to enable structured log output. See *Configure Logging* for more information about that option.

Node Selectors
: These examples do not use any node selectors to bind pods to specific nodes or node types. Node selectors on the podspec can be used to constrain different services to different types of nodes. For example, they can be used to ensure the Cortex is deployed to a node which has been provisioned as a high memory node for that purpose.

PVC
: The previous examples used relatively small volume claim sizes for demonstration purposes. A `storageClass` which can be dynamically resized will be helpful in the event of needing to grow the storage used by a deployment. This is a common feature for managed Kubernetes instances.

Performance Tuning in Kubernetes

It is common for Kubernetes to be executed in a managed environment, where an operator may not have direct access to the underlying hosts. In that scenario, applying the system configurations detailed in *Performance Tuning* may be difficult. The following example shows a DaemonSet which runs a privileged pod, that ensures that the desired `sysctl` values are set on the host. You may need to modify this to meet any requirements which are specific to your deployment.

The following `sysctl.yaml` can be used as the basis to deploy these modifications.

```
apiVersion: "apps/v1"
kind: "DaemonSet"
metadata:
  name: "setsysctl"
  labels:
    app.kubernetes.io/name: "sysctl"
    app.kubernetes.io/instance: "sysctl"
    app.kubernetes.io/version: "1.36.0-glibc"
    app.kubernetes.io/component: "sysctl"
    app.kubernetes.io/part-of: "synapse"
    environment: "dev"
spec:
  selector:
    matchLabels:
      app.kubernetes.io/name: "sysctl"
      app.kubernetes.io/instance: "sysctl"
      app.kubernetes.io/version: "1.36.0-glibc"
      app.kubernetes.io/component: "sysctl"
      app.kubernetes.io/part-of: "synapse"
      environment: "dev"
  template:
    metadata:
      labels:
        app.kubernetes.io/name: "sysctl"
        app.kubernetes.io/instance: "sysctl"
```

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```
        app.kubernetes.io/version: "1.36.0-glibc"
        app.kubernetes.io/component: "sysctl"
        app.kubernetes.io/part-of: "synapse"
        environment: "dev"
    spec:
      containers:
      - name: "apply-sysctl"
        image: "busybox:1.36.0-glibc"  # Latest glibc based busybox
        securityContext:
          privileged: true
        command:
        - "/bin/sh"
        - "-c"
        - |
          set -o errexit
          set -o xtrace
          while sysctl -w vm.swappiness=10 vm.dirty_expire_centisecs=20 vm.dirty_
↪writeback_centisecs=20 vm.dirty_background_ratio=2 vm.dirty_ratio=4
          do
            sleep 600s
          done
```

This can be deployed via `kubectl apply`. That will create the DaemonSet for you..

```
$ kubectl apply -f sysctl_dset.yaml
daemonset.apps/setsysctl created
```

You can see the sysctl pods by running the following command:

```
$ kubectl get pods -l app.kubernetes.io/component=sysctl -o wide
```

6.4.2 AHA Configuration Options

aha:admin

An AHA client certificate CN to register as a local admin user.

Type
`string`

Environment Variable
`SYN_AHA_AHA_ADMIN`

aha:leader

The AHA service name to claim as the active instance of a storm service.

Type
`string`

Environment Variable
`SYN_AHA_AHA_LEADER`

aha:name

The name of the cell service in the aha service registry.

Type
`string`

Environment Variable
`SYN_AHA_AHA_NAME`

aha:network

The AHA service network. This makes aha:name/aha:leader relative names.

Type
`string`

Environment Variable
`SYN_AHA_AHA_NETWORK`

aha:provision

The telepath URL of the aha provisioning service.

Type
`['string', 'array']`

Environment Variable
`SYN_AHA_AHA_PROVISION`

aha:registry

The telepath URL of the aha service registry.

Type
`['string', 'array']`

Environment Variable
`SYN_AHA_AHA_REGISTRY`

aha:urls

A list of all available AHA server URLs.

Type
`['string', 'array']`

Environment Variable
`SYN_AHA_AHA_URLS`

aha:user

The username of this service when connecting to others.

Type
`string`

Environment Variable
`SYN_AHA_AHA_USER`

auth:anon

Allow anonymous telepath access by mapping to the given user name.

Type
`string`

Environment Variable
`SYN_AHA_AUTH_ANON`

auth:passwd

Set to <passwd> (local only) to bootstrap the root user password.

Type
`string`

Environment Variable
`SYN_AHA_AUTH_PASSWD`

backup:dir

A directory outside the service directory where backups will be saved. Defaults to ./backups in the service storage directory.

Type
`string`

Environment Variable
`SYN_AHA_BACKUP_DIR`

dmon:listen

A config-driven way to specify the telepath bind URL.

Type
`['string', 'null']`

Environment Variable
`SYN_AHA_DMON_LISTEN`

https:headers

Headers to add to all HTTPS server responses.

Type
`object`

Environment Variable
`SYN_AHA_HTTPS_HEADERS`

https:parse:proxy:remoteip

Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine requester IP addresses.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AHA_HTTPS_PARSE_PROXY_REMOTEIP`

https:port

A config-driven way to specify the HTTPS port.

Type
`['integer', 'null']`

Environment Variable
`SYN_AHA_HTTPS_PORT`

limit:disk:free

Minimum disk free space percentage before setting the cell read-only.

Type
`['integer', 'null']`

Default Value
`5`

Environment Variable
`SYN_AHA_LIMIT_DISK_FREE`

mirror

A telepath URL for our upstream mirror (we must be a backup!).

Type
`['string', 'null']`

Environment Variable
`SYN_AHA_MIRROR`

nexslog:en

Record all changes to a stream file on disk. Required for mirroring (on both sides).

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AHA_NEXSLOG_EN`

onboot:optimize

Delay startup to optimize LMDB databases during boot to recover free space and increase performance. This may take a while.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AHA_ONBOOT_OPTIMIZE`

provision:listen

A telepath URL for the AHA provisioning listener.

Type
`['string', 'null']`

Environment Variable
`SYN_AHA_PROVISION_LISTEN`

6.4.3 Axon Configuration Options

aha:admin

An AHA client certificate CN to register as a local admin user.

Type
`string`

Environment Variable
`SYN_AXON_AHA_ADMIN`

aha:leader

The AHA service name to claim as the active instance of a storm service.

Type
`string`

Environment Variable
`SYN_AXON_AHA_LEADER`

aha:name

The name of the cell service in the aha service registry.

Type
`string`

Environment Variable
`SYN_AXON_AHA_NAME`

aha:network

The AHA service network. This makes aha:name/aha:leader relative names.

Type
`string`

Environment Variable
`SYN_AXON_AHA_NETWORK`

aha:provision

The telepath URL of the aha provisioning service.

Type
`['string', 'array']`

Environment Variable
`SYN_AXON_AHA_PROVISION`

aha:registry

The telepath URL of the aha service registry.

Type
`['string', 'array']`

Environment Variable
`SYN_AXON_AHA_REGISTRY`

aha:user

The username of this service when connecting to others.

Type
`string`

Environment Variable
`SYN_AXON_AHA_USER`

auth:anon

Allow anonymous telepath access by mapping to the given user name.

Type
`string`

Environment Variable
`SYN_AXON_AUTH_ANON`

auth:passwd

Set to <passwd> (local only) to bootstrap the root user password.

Type
`string`

Environment Variable
`SYN_AXON_AUTH_PASSWD`

backup:dir

A directory outside the service directory where backups will be saved. Defaults to ./backups in the service storage directory.

Type
`string`

Environment Variable
`SYN_AXON_BACKUP_DIR`

dmon:listen

A config-driven way to specify the telepath bind URL.

Type
`['string', 'null']`

Environment Variable
`SYN_AXON_DMON_LISTEN`

http:proxy

An aiohttp-socks compatible proxy URL to use in the wget API.

Type
`string`

Environment Variable
`SYN_AXON_HTTP_PROXY`

https:headers

Headers to add to all HTTPS server responses.

Type
`object`

Environment Variable
`SYN_AXON_HTTPS_HEADERS`

https:parse:proxy:remoteip

Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine requester IP addresses.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AXON_HTTPS_PARSE_PROXY_REMOTEIP`

https:port

A config-driven way to specify the HTTPS port.

Type
`['integer', 'null']`

Environment Variable
`SYN_AXON_HTTPS_PORT`

limit:disk:free

Minimum disk free space percentage before setting the cell read-only.

Type
`['integer', 'null']`

Default Value
`5`

Environment Variable
`SYN_AXON_LIMIT_DISK_FREE`

max:bytes

The maximum number of bytes that can be stored in the Axon.

Type
`integer`

Environment Variable
`SYN_AXON_MAX_BYTES`

max:count

The maximum number of files that can be stored in the Axon.

Type
`integer`

Environment Variable
`SYN_AXON_MAX_COUNT`

nexslog:en

Record all changes to a stream file on disk. Required for mirroring (on both sides).

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AXON_NEXSLOG_EN`

onboot:optimize

Delay startup to optimize LMDB databases during boot to recover free space and increase performance. This may take a while.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_AXON_ONBOOT_OPTIMIZE`

tls:ca:dir

An optional directory of CAs which are added to the TLS CA chain for wget and wput APIs.

Type
`string`

Environment Variable
`SYN_AXON_TLS_CA_DIR`

6.4.4 JSONStor Configuration Options

aha:admin

An AHA client certificate CN to register as a local admin user.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AHA_ADMIN`

aha:leader

The AHA service name to claim as the active instance of a storm service.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AHA_LEADER`

aha:name

The name of the cell service in the aha service registry.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AHA_NAME`

aha:network

The AHA service network. This makes aha:name/aha:leader relative names.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AHA_NETWORK`

aha:provision

The telepath URL of the aha provisioning service.

Type
`['string', 'array']`

Environment Variable
`SYN_JSONSTOR_AHA_PROVISION`

aha:registry

The telepath URL of the aha service registry.

Type
`['string', 'array']`

Environment Variable
`SYN_JSONSTOR_AHA_REGISTRY`

aha:user

The username of this service when connecting to others.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AHA_USER`

auth:anon

Allow anonymous telepath access by mapping to the given user name.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AUTH_ANON`

auth:passwd

Set to <passwd> (local only) to bootstrap the root user password.

Type
`string`

Environment Variable
`SYN_JSONSTOR_AUTH_PASSWD`

backup:dir

A directory outside the service directory where backups will be saved. Defaults to ./backups in the service storage directory.

Type
`string`

Environment Variable
`SYN_JSONSTOR_BACKUP_DIR`

dmon:listen

A config-driven way to specify the telepath bind URL.

Type
`['string', 'null']`

Environment Variable
`SYN_JSONSTOR_DMON_LISTEN`

https:headers

Headers to add to all HTTPS server responses.

Type
`object`

Environment Variable
`SYN_JSONSTOR_HTTPS_HEADERS`

https:parse:proxy:remoteip

Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine requester IP addresses.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_JSONSTOR_HTTPS_PARSE_PROXY_REMOTEIP`

https:port

A config-driven way to specify the HTTPS port.

Type
`['integer', 'null']`

Environment Variable
`SYN_JSONSTOR_HTTPS_PORT`

limit:disk:free

Minimum disk free space percentage before setting the cell read-only.

Type
`['integer', 'null']`

Default Value
`5`

Environment Variable
`SYN_JSONSTOR_LIMIT_DISK_FREE`

nexslog:en

Record all changes to a stream file on disk. Required for mirroring (on both sides).

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_JSONSTOR_NEXSLOG_EN`

onboot:optimize

Delay startup to optimize LMDB databases during boot to recover free space and increase performance. This may take a while.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_JSONSTOR_ONBOOT_OPTIMIZE`

6.4.5 Cortex Configuration Options

aha:admin

An AHA client certificate CN to register as a local admin user.

Type
`string`

Environment Variable
`SYN_CORTEX_AHA_ADMIN`

aha:leader

The AHA service name to claim as the active instance of a storm service.

Type
`string`

Environment Variable
`SYN_CORTEX_AHA_LEADER`

aha:name

The name of the cell service in the aha service registry.

Type
`string`

Environment Variable
`SYN_CORTEX_AHA_NAME`

aha:network

The AHA service network. This makes aha:name/aha:leader relative names.

Type
`string`

Environment Variable
`SYN_CORTEX_AHA_NETWORK`

aha:provision

The telepath URL of the aha provisioning service.

Type
`['string', 'array']`

Environment Variable
`SYN_CORTEX_AHA_PROVISION`

aha:registry

The telepath URL of the aha service registry.

Type
`['string', 'array']`

Environment Variable
`SYN_CORTEX_AHA_REGISTRY`

aha:user

The username of this service when connecting to others.

Type
`string`

Environment Variable
`SYN_CORTEX_AHA_USER`

auth:anon

Allow anonymous telepath access by mapping to the given user name.

Type
`string`

Environment Variable
`SYN_CORTEX_AUTH_ANON`

auth:passwd

Set to <passwd> (local only) to bootstrap the root user password.

Type
`string`

Environment Variable
`SYN_CORTEX_AUTH_PASSWD`

axon

A telepath URL for a remote axon.

Type
`string`

Environment Variable
`SYN_CORTEX_AXON`

backup:dir

A directory outside the service directory where backups will be saved. Defaults to ./backups in the service storage directory.

Type
`string`

Environment Variable
`SYN_CORTEX_BACKUP_DIR`

cron:enable

Enable cron jobs running.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_CRON_ENABLE`

dmon:listen

A config-driven way to specify the telepath bind URL.

Type
`['string', 'null']`

Environment Variable
`SYN_CORTEX_DMON_LISTEN`

http:proxy

An aiohttp-socks compatible proxy URL to use storm HTTP API.

Type
`string`

Environment Variable
`SYN_CORTEX_HTTP_PROXY`

https:headers

Headers to add to all HTTPS server responses.

Type
`object`

Environment Variable
`SYN_CORTEX_HTTPS_HEADERS`

https:parse:proxy:remoteip

Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine requester IP addresses.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_CORTEX_HTTPS_PARSE_PROXY_REMOTEIP`

https:port

A config-driven way to specify the HTTPS port.

Type
`['integer', 'null']`

Environment Variable
`SYN_CORTEX_HTTPS_PORT`

jsonstor

A telepath URL for a remote jsonstor.

Type
`string`

Environment Variable
`SYN_CORTEX_JSONSTOR`

layer:lmdb:map_async

Set the default lmdb:map_async value in LMDB layers.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_LAYER_LMDB_MAP_ASYNC`

layer:lmdb:max_replay_log

Set the max size of the replay log for all layers.

Type
`integer`

Default Value
`10000`

Environment Variable
`SYN_CORTEX_LAYER_LMDB_MAX_REPLAY_LOG`

layers:lockmemory

Should new layers lock memory for performance by default.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_CORTEX_LAYERS_LOCKMEMORY`

layers:logedits

Whether nodeedits are logged in each layer.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_LAYERS_LOGEDITS`

limit:disk:free

Minimum disk free space percentage before setting the cell read-only.

Type
`['integer', 'null']`

Default Value
`5`

Environment Variable
`SYN_CORTEX_LIMIT_DISK_FREE`

max:nodes

Maximum number of nodes which are allowed to be stored in a Cortex.

Type
`integer`

Environment Variable
`SYN_CORTEX_MAX_NODES`

mirror

A telepath URL for our upstream mirror (we must be a backup!).

Type
`['string', 'null']`

Environment Variable
`SYN_CORTEX_MIRROR`

modules

A list of module classes to load.

Type
`array`

Default Value
`[]`

Environment Variable
`SYN_CORTEX_MODULES`

nexslog:en

Record all changes to a stream file on disk. Required for mirroring (on both sides).

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_NEXSLOG_EN`

onboot:optimize

Delay startup to optimize LMDB databases during boot to recover free space and increase performance. This may take a while.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_CORTEX_ONBOOT_OPTIMIZE`

storm:interface:scrape

Enable Storm scrape interfaces when using $lib.scrape APIs.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_STORM_INTERFACE_SCRAPE`

storm:interface:search

Enable Storm search interfaces for lookup mode.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_STORM_INTERFACE_SEARCH`

storm:log

Log storm queries via system logger.

Type
`boolean`

Default Value
`False`

Environment Variable
`SYN_CORTEX_STORM_LOG`

storm:log:level

Logging log level to emit storm logs at.

Type
`['integer', 'string']`

Default Value
`'INFO'`

Environment Variable
`SYN_CORTEX_STORM_LOG_LEVEL`

tls:ca:dir

An optional directory of CAs which are added to the TLS CA chain for Storm HTTP API calls.

Type
`string`

Environment Variable
`SYN_CORTEX_TLS_CA_DIR`

trigger:enable

Enable triggers running.

Type
`boolean`

Default Value
`True`

Environment Variable
`SYN_CORTEX_TRIGGER_ENABLE`

CHAPTER

SEVEN

SYNAPSE DEVELOPER GUIDE

This Dev Guide is written by and for Synapse developers.

Note: Synapse as a library is under constant development. It is posssible that content here may become out of date. If you encounter issues with documentation in the Developers guides, please reach out to us on our Synapse Slack chat or file an issue in our projects Github page.

The Dev Guide is a living document and will continue to be updated and expanded as appropriate. The current sections are:

7.1 Rapid Power-Up Development

Developing Rapid Power-Ups allows Synapse power users to extend the capabilities of the Storm query language, provides ways to implement use-case specific commands, embed documentation, and even implement customized visual workflows in **Optic**, the commercial Synapse UI.

A Rapid Power-Up consists of a **Storm Package** which is a JSON object which defines everything used to extend the Storm language and provide additional documentation. **Storm Packages** can be loaded directly into your **Cortex**.

In this guide we will discuss the basics of **Storm Package** development and discuss a few best practices you can use to ensure they are secure, powerful, and easy to use.

The example `acme-hello` power-up discussed in this guide is included in the **Synapse** repository within the `examples/power-ups/rapid/acme-hello` folder. You can find that at Acme-Hello Example.

7.1.1 Anatomy of a Storm Package

A **Storm Package** consists of a YAML file which defines the various commands, modules, documentation, and workflows embedded within the package.

Minimal Example

As you can see in the minimal example below, the **Storm Package** is defined by a YAML file that gets processed and loaded into your Cortex.

`acme-hello.yaml`:

```
name: acme-hello
version: 0.0.1

synapse_minversion: [2, 101, 0]

genopts:
    dotstorm: true # Specify that storm command/module files end with ".storm"

author:
  url: https://acme.newp
  name: ACME Explosives and Anvils

desc: Acme-Hello is a minimal example of a Rapid Power-Up.

modules:
  - name: acme.hello
  - name: acme.hello.privsep
    asroot:perms:
        - [ acme, hello, user ]

commands:
  - name: acme.hello.sayhi
    descr: Print the hello message.
```

Note: First, a note on namespacing. To ensure your **Storm Package** is going to play well with other packages, it is important to choose an appropriate namespace for your power-up. In this case, the `acme` part of the name is meant to be replaced with your company name or an abbreviated version of it. The `hello` part is meant to be replaced with an indicator of the type of functionality the **Storm Package** contains.

Namespace now, thank yourself later.

When you define commands and modules, they will be loaded from files using the location of the **Storm Package** YAML file to locate their contents:

```
acme-hello.yaml
storm/

    modules/
        acme.hello.storm
        acme.hello.privsep.storm

    commands/
        acme.hello.sayhi.storm
```

`storm/modules/acme.hello.storm`:

```
function woot(text) {
    $lib.print($text)
    return($lib.null)
}
```

storm/commands/acme.hello.sayhi.storm:

```
$hello = $lib.import(acme.hello)
$hello.woot("hello storm!")
```

Building / Loading

To build and load **Storm Packages**, use the `genpkg` tool included within Synapse. For this example, we will assume you have deployed your Synapse environment according to the Deployment Guide:

```
python -m synapse.tools.genpkg acme-hello.yaml --push aha://cortex...
```

Note: If you added an alternate admin user or used a non-standard naming convention you may need to adjust the `aha://cortex...` telepath URL to connect to your Cortex.

Once your **Storm Package** has loaded successfully, you can use the **Storm** CLI to see it in action:

```
invisigoth@visi01:~$ python -m synapse.tools.storm aha://cortex...

Welcome to the Storm interpreter!

Local interpreter (non-storm) commands may be executed with a ! prefix:
    Use !quit to exit.
    Use !help to see local interpreter commands.

storm> acme.hello.sayhi
hello storm!
complete. 0 nodes in 1 ms (0/sec).
storm>
```

7.1.2 Storm Modules

Deploying **Storm Modules** allows you to author powerful library functions that you can use in automation or **Storm Commands** to facilitate code re-use and enforce privilege separation boundaries.

A **Storm Module** is specified within the `modules:` section of the **Storm Package** YAML file.

```
modules:

  - name: acme.hello
    modconf:
        varname: varvalu
        othervar: [1, 2, 3]
```

The `modconf:` key can be used to specify variables which will be mapped into the module's **Storm** runtime and accessible using the implicit variable `$modconf`:

```
function foo() {
    $lib.print($modconf.varname)
    return((10))
}

function bar() {
    for $i in $modconf.othervar {
        // Do something using $i...
    }
}
```

Privileged Modules

In order to facilitate delegating permission for privileged operations, **Storm** modules may specify permissions which allow the module to be imported with admin privileges. It is a best-practice to declare these permissions within the **Storm** package using the `perms:` key before using them:

```
perms:
  - perm: [ acme, hello, user ]
    gate: cortex
    desc: Allows a user to call privileged APIs from Acme-Hello.

modules:

  - name: acme.hello.privsep
    asroot:perms:
        - [ acme, hello, user ]
```

To minimize risk, you must very carefully consider what functions to implement within a privileged **Storm** module! Privileged modules should contain the absolute minimum required functionality.

An excellent example use case for a privileged **Storm** module exists when you have an API key or password which you would like to use on a user's behalf without disclosing the actual API key. The **Storm** library `$lib.globals.set(<name>, <valu>)` and `$lib.globals.get(<name>)` can be used to access protected global variables which regular users may not access without special permissions. By implementing a privileged **Storm** module which retrieves the API key and uses it on the user's behalf without disclosing it, you may protect the API key from disclosure while also allowing users to use it. For example, `acme.hello.privsep.storm`:

```
function getFooByBar(bar) {

    // Retrieve an API key from protected storage
    $apikey = $lib.globals.get(acme:hello:apikey)

    $headers = ({
        "apikey": $apikey
    })

    $url = $lib.str.format("https://acme.newp/api/v1/foo/{bar}", bar=$bar)

    // Use the API key on the callers behalf
    $resp = $lib.inet.http.get($url, headers=$headers)
    if ($resp.code != 200) {
```

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```
        $lib.warn("/api/v1/foo returned HTTP code: {code}", code=$resp.code)
        return($lib.null)
    }

    // Return the JSON response (but not the API key)
    return($resp.json())
}
```

Notice that the `$apikey` is being retrieved and used to call the HTTP API but is not returned to the caller.

7.1.3 Storm Commands

Adding **Storm Commands** to your Cortex via a **Storm Package** is a great way to extend the functionality of your Cortex in a CLI user-friendly way.

Command Line Options

Every **Storm** command has the `--help` option added automatically. This means that it is always safe to execute any command with `--help` to get a usage statement and enumerate command line arguments. The `desc` field specified in the command is included in the output:

```
storm> acme.hello.sayhi --help

Print the hello message.

Usage: acme.hello.sayhi [options]

Options:

  --help                      : Display the command usage.
complete. 0 nodes in 4 ms (0/sec).
storm>
```

Storm Commands may specify command line arguments using a convention which is similar (although not identical to) Python's `argparse` library.

A more complex command declaration:

```
commands:

  - name: acme.hello.omgopts
    descr: |
        This is a multi-line description containing usage examples.

        // Run the command with some nodes
        inet:fqdn=acme.newp | acme.hello.omgopts vertex.link

        // Run the command with some command line switches
        acme.hello.omgopts --debug --hehe haha vertex.link

    cmdargs:
```

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```
    - - --hehe
      - type: str
        help: The value of the hehe optional input.

    - - --debug
      - type: bool
        default: false
        action: store_true
        help: Enable debug output.

    - - fqdn
      - type: str
        help: A mandatory / positional command line argument.
```

A more complete example of help output:

```
storm> acme.hello.omgopts --help

This is a multi-line description containing usage examples.

// Run the command with some nodes
inet:fqdn=acme.newp | acme.hello.omgopts vertex.link

// Run the command with some command line switches
acme.hello.omgopts --debug --hehe haha vertex.link


Usage: acme.hello.omgopts [options] <fqdn>

Options:

  --help                      : Display the command usage.
  --hehe <hehe>               : The value of the hehe optional input.
  --debug                     : Enable debug output.

Arguments:

  <fqdn>                      : A mandatory / positional command line argument.
complete. 0 nodes in 6 ms (0/sec).
```

Command line options are available within the **Storm** command by accessing the implicit `$cmdopts` variable.

`storm/commands/acme.hello.omgopts.storm`:

```
// An init {} block only runs once even if there are multiple nodes in the pipeline.

init {

    // Set global debug (once) if the user specified --debug
    if $cmdopts.debug { $lib.debug = $lib.true }

    if ($cmdopts.hehe) { $lib.print("User Specified hehe: {hehe}", hehe=$cmdopts.hehe) }
```

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```
    // Normalize the FQDN in case we want to send it to an external system
    ($ok, $fqdn) = $lib.trycast(inet:fqdn, $cmdopts.fqdn)
    if (not $ok) {
        $lib.exit("Invalid FQDN Specified: {fqdn}", fqdn=$cmdopts.fqdn)
    }

    // Maybe call an API here or something...
    $lib.print("FQDN: {fqdn}", fqdn=$fqdn)
}


// You may also act on nodes in the pipeline
$lib.print("GOT NODE: {repr}", repr=$node.repr())

if $lib.debug { $lib.print("debug mode detected!") }

// Any nodes still in the pipeline are sent as output
```

Command Option Conventions

--help This option is reserved and handled automatically to print a command usage statement which also enumerates any positional or optional arguments.

--debug This option is typically used to enable debug output in the **Storm** interpreter by setting the `$lib.debug` variable if it is specified. The `$lib.debug` variable has a recursive effect and will subsequently enable debug output in any command or functions called from the command.

--yield By default, a command is generally expected to yield the nodes that it received as input from the pipeline. In some instances it is useful to instruct the command to yield the nodes it creates. For example, if you specify `inet:fqdn` nodes as input to a DNS resolver command, it may be useful to tell the command to yield the newly created `inet:dns:a` records rather than the input `inet:fqdn` nodes. Commands frequently use the `divert` **Storm** command to implement `--yield` functionality.

--asof <time> To minimize duplicate API calls, many **Storm** packages cache results using the `$lib.jsonstor` API. When caching is in use, the `--asof <time>` option is used to control cache aging. Users may specify `--asof now` to disable caching.

7.1.4 Specifying Documentation

Documentation may be specified in the **Storm Package** file that will embed `markdown` documentation into the package. While there are not currently any CLI tools to view/use this documentation, it is presented in the **Power-Ups** tab in the **Help Tool** within the commercial *Synapse User Interface*.

Markdown documents may be specified for inclusion by adding a `docs:` section to the **Storm Package** YAML file:

```
docs:
    - title: User Guide
      path: docs/userguide.md
```

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```
    - title: Admin Guide
      path: docs/adminguide.md
    - title: Changelog
      path: docs/changelog.md
```

7.1.5 Testing Storm Packages

It is **highly** recommended that any production **Storm Packages** use development "best practices" including version control and unit testing. For the `acme-hello` example, we have included a test that you can use as an example to expand on.

`test_acme_hello.py`:

```
import os

import synapse.tests.utils as s_test

dirname = os.path.abspath(os.path.dirname(__file__))

class AcmeHelloTest(s_test.StormPkgTest):

    assetdir = os.path.join(dirname, 'testassets')
    pkgprotos = (os.path.join(dirname, 'acme-hello.yaml'),)

    async def test_acme_hello(self):

        async with self.getTestCore() as core:

            msgs = await core.stormlist('acme.hello.sayhi')
            self.stormIsInPrint('hello storm!', msgs)
            self.stormHasNoWarnErr(msgs)
```

With the file `test_acme_hello.py` located in the same directory as `acme-hello.yaml` you can use the standard `pytest` invocation to run the test:

```
python -m pytest -svx test_acme_hello.py
```

7.1.6 Advanced Features

Using `divert` to implement `--yield`

The `--yield` option is typically used to allow a **Storm** command which takes nodes as input to optionally output the new nodes it added rather than the nodes it received as input. The `divert` command was added to **Storm** to simplify implementing this convention.

To implement a command with a `--yield` option is typically accomplished via the following pattern:

```
commands:

  - name: acme.hello.mayyield
    descr: |
```

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```
        Take in an FQDN and make DNS A records to demo --yield

        inet:fqdn=vertex.link | acme.hello.mayyield

    cmdargs:

      - - --yield
        - default: false
          action: store_true
          help: Yield the newly created inet:dns:a records rather than the input␣
↪inet:fqdn nodes.
```

Then within `storm/commands/acme.hello.mayyield.storm`:

```
function nodeGenrFunc(fqdn) {
    // Fake a DNS lookup and make a few inet:dns:a records...
    [ inet:dns:a=($fqdn, 1.2.3.4) ]
    [ inet:dns:a=($fqdn, 123.123.123.123) ]
}

divert --yield $cmdopts.yield $nodeGenrFunc($node)
```

When executed, the `acme.hello.mayyield` command will output the nodes received as inputs which is useful for pipelining enrichments. If the user specifies `--yield` the command will output the resulting `inet:dns:a` nodes constructed by the `nodeGenrFunc()` function.

Optic Actions

If you have access to the **Synapse** commercial UI **Optic** you may find it helpful to embed **Optic** actions within your **Storm Package**. These actions will be presented to users in the context-menu when they right-click on nodes within **Optic**.

To define **Optic** actions, you declare them in the **Storm Package** YAML file:

```
optic:
    actions:
      - name: Hello Omgopts
        storm: acme.hello.omgopts --debug
        descr: This description is displayed as the tooltip in the menu
        forms: [ inet:ipv4, inet:fqdn ]
```

By specifying the `forms:` key, you can control which node actions will be presented on different forms. For example, if you are writing a DNS power-up, you may want to limit the specified actions to `inet:ipv4`, `inet:ipv6`, and `inet:fqdn` nodes.

When selected, the query specified in the `storm:` key will be run with the currently selected nodes as input. For example, if you right-click on the node `inet:fqdn=vertex.link` and select `actions -> acme-hello -> Hello Omgopts` it will execute the specified query as though it were run like this:

```
inet:fqdn=vertex.link | acme.hello.omgopts --debug
```

Any printed output, including warnings, will be displayed in the **Optic** `Console Tool`.

7.2 Synapse Architecture

When viewed as a library, not just an application, Synapse is made of up a few core components and concepts.

7.2.1 Library Architecture

The Synapse library is broken out in a hierarchical fashion. The root of the library contains application level code, such as the implementations of the Cortex, Axon, Cryotank, as well as the Telepath client and server components. There are also a set of common helper functions (common.py) and exceptions (exc.py). There are several submodules available as well:

synapse.cmds
Command implementations for the Cmdr CLI tool

synapse.data
Data files stored in the library.

synapse.lib
The lib module contains many of the primitives used by applications in order to implement them.

synapse.lookup
The lookup module contains various lookup definitions.

synapse.models
The models directory contains the core Synapse data model definitions.

synapse.servers
The servers module contains servers use to start and run Synapse applications.

synapse.tests
This is test code. It also contains a useful helper `synapse.tests.utils` which defines our base test class.

synapse.tools
The tools module contains various tools used to interact with the Synapse ecosystem.

synapse.vendor
This contains third-party code and associated LICENSE files. This is for internal library use only; no external API stability is guaranteed for any libraries under this module.

7.2.2 Object hierarchies

There is one base class that many objects inherit from, the `Base` (base.py) class. The `Base` class provides a few useful components (including, but not limited too):

- A way to do asynchronous object construction by override the `__anit__` method. This method is executed inside the python ioloop, allowing the object construction to do async function calls. An implementer still needs to call `await s_base.Base.__anit__(self)` first in order to ensure that the `Base` is setup properly.
- A way to register object teardown methods and perform object teardowns via the `onfini()` and `fini()`. These allow us to keep more granular control over how things are shut down and resources are released, versus relying solely on the garbage collector to handle teardowns properly. Often times, order matters, so we need to be sure that things are torn down cleanly. These routines can be registered during `__anit__`.
- `Base` objects are made via await the call to the `Base.anit()` function. If the `__anit__` function completed then the `anitted` attribute on the object will be True, otherwise it will be False.

- Context manager support. The `Base` object has native async context manager support, and upon exiting the context it will call `fini()` to do teardown. This pattern is convenient since it allows us to freely create `Base` classes without having to remember to always have to tear them down.
- The `Base` contains helpers for implementing an observable design pattern, where functions can be registered as event handlers, and events can be fired on the object at will. This can be very powerful for signaling across disparate components which would be otherwise too heavy to have explicit callbacks for.
- The `Base` contains helpers for executing asyncio coroutines on the ioloop. This is most commonly done via the `schedCoroTask` routine. This will schedule the coroutine to run on the ioloop, register the task with the `Base` and return the asyncio future. During `Base` fini, any coroutines still executing will be cancelled. This makes it very easy to schedule free-running coroutines from any `Base` class.

There are a few very important classes which use the `Base` object:

- The Synapse `Cell`. This is a batteries included primitive for running an application.
- The Telepath `Daemon`. This serves as a RPC server component.
- The Telepath `Proxy`. This serves as a RPC client component.

The `Cell` (cell.py) is a `Base` implementation which has several components available to it:

- It is a `Base`, so it benefits from all the components a `Base` has.
- It contains support for configuration directives at start time, so a cell can have well defined configuration options availble to it.
- It has persistent storage available via two different mechanisms, a LMDB slab for arbitrary data that is local to the cell, and a `Hive` for key-value data storage that can be remotely read and written.
- It handles user authentication and authorization via user data stored in the `Hive`.
- The `Cell` is Telepath aware, and will start his own `Daemon` that allows remote access. By default, the `Cell` has a PF Unix socket available for access, so local telepath access is trivial.
- Since the `Cell` is Telepath aware, there is a base `CellApi` that implements his RPC routines. `Cell` implementers can easily sublcass the `CellApi` class to add additional RPC routines.
- The `Cell` also contains hooks for easily starting a Tornado webserver. This allows us to trivially add web API routes to an object.
- The `Cell` contains a `Boss` which can be used to remotely enumerate and cancel managed coroutines.

Since the cell contains so much core management functionality, adding functionality to the Synapse `Cell` allows **all** applications using a Cell to be immediately extended to take advantage of that functionality without having to re-visit multiple different implementations to update them. For this reason, our core application components (the `Axon`, `Cortex`, and `CryoCell`) all implement the `Cell` class. For example, if we add a new user management capability, that is now available to all those applications, as well as any others `Cell` implementations.

The application level components themselves have servers in the `synapse.servers` module, but there is also a generic server for starting any cell, `synapse.servers.cell`. These servers will create the `Cell`, and also add any additional RPC or HTTP API listening servers as necessary. Those are the preferred ways to run an application implemented via a `Cell`.

7.2.3 Telepath RPC

The Telepath RPC protocol is a lightweight RPC protocol used in Synapse. The server component, the previously mentioned `Daemon`, is used to share objects. An object may or may not be Telepath aware. In the case that it is not aware, all of its methods are exposed via Telepath. Objects which are Telepath aware, such as the `Cell`, implement an API interface that allows much more fine grained control over the the methods which are remotely available.

The base Telepath client is the `Proxy` class, this is used to connect to the Daemon. The `Proxy` intercepts attribute lookups to make and set remote method helpers at runtime, and sends those requests to the Daemon to be serviced. A *very* brief example of this is the following:

```
import synapse.telepath as s_telepath

url = 'tcp://user:secret@1.2.3.4:27492/someObject'

async with await s_telepath.openurl(url) as proxy:

    # Make attribute called "someMethod" on the proxy
    # then send a task to the server called "someMethod"
    # with the argument of somearg=1234
    resp = proxy.someMethod(somearg=1234)
    # The resp is the result of calling the someMethod argument on
    # the object named someObject on the daemon.
    print(resp)
```

A few notes about Telepath:

- Telepath remote call arguments and server responses must be able to be serialized using the msgpack protocol.
- Telepath supports generator protocols; so a server API may be a synchronous or asynchronous generator. From the proxy perspective, these are both considered asynchronous generators.
- The Telepath `Proxy` contains some helpers that allow is to be used from non-async code. These helpers run their API calls through the currently running ioloop, and will cause the client to make an ioloop if one is not currently running.
- Remote calls that raise exceptions on the server will have that exception serialized and sent back to the `Proxy`. The `Proxy` will then raise an exception to the caller.
- Methods calls prefixed with a underscore (`_somePrivatMethod()` for example) will be rejected by the `Daemon`. This does allow us to protect private methods on shared objects.

7.3 Cortex Development Quickstart

This guide is intended for developers looking to integrate Synapse components with other applications by using the Telepath API. Additionally, this guide will introduce developers to writing custom Cortex modules in Python to allow custom data model extensions, storm commands, ingest functions, and change hooks. This guide assumes familiarity with deploying Cortex servers and the Storm query syntax. For help on getting started, see *Getting Started*.

For complete API documentation on all Synapse components see *Synapse Python API*.

7.3.1 Remote Cortex Access

A Cortex, like most synapse components, provides two mechanisms for remote API calls. The HTTP/REST API and the Telepath API. For additional documentation on the Cortex HTTP API, see *Synapse HTTP/REST API*. This guide will cover remote API calls using Telepath.

Telepath is an asynchronous, high-performance, streaming oriented, RPC protocol. It is designed for minimum development effort and maximum performance. Data is serialized using the highly efficient Message_Pack format which is not only more size efficient than JSON, but allows serialization of binary data and supports incremental decoding for use in stream based protocols.

Telepath allows a client to connect to a Python object shared on a remote server and, in most instances, call methods as though the object were local. However, this means all arguments and return values must be serializable using Message Pack.

To connect to a remote object, the caller specifies a URI to connect and construct a Telepath Proxy. In the following examples, we will assume a Cortex was previously setup and configured with the user `visi` and the password `secretsauce` running on port `27492` on the host `1.2.3.4`.

Making a simple call

Once a Telepath proxy is connected, most methods may simply be called as though the object were local. For example, the `getModelDict` method on the `CoreApi` returns a Python dictionary containing the details of the data model in the remote Cortex.

```
import asyncio
import synapse.telepath as s_telepath

async def main():

    async with await s_telepath.openurl('tcp://visi:secretsauce@1.2.3.4:27492/') as core:

        model = await core.getModelDict()

        for form in model.get('forms'):
            dostuff()

if __name__ == '__main__':
    asyncio.run(main())
```

Like many objects in the Synapse ecosystem, a Telepath proxy inherits from `synapse.lib.base.Base`. This requires the `fini` method to be called to release resources and close sockets. In the example above, we use the async context manager implemented by the `Base` class (`async with`) to ensure that the proxy is correctly shutdown. However, Telepath is designed for long-lived Proxy objects to minimize API call delay by using existing sockets and sessions. A typical app will create a telepath proxy during initialization and only create a new one in the event that the remote Telepath server is restarted.

The above example also demonstrates that Telepath is designed for use with Python 3.11 asyncio. However, the Telepath proxy can also be constructed and used transparently from non-async code as seen below.

```
import synapse.telepath as s_telepath

def main():

    core = s_telepath.openurl('tcp://visi:secretsauce@1.2.3.4:27492/')
```

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```
    model = core.getModelDict()

if __name__ == '__main__':
    main()
```

The remainder of the examples in this guide will assume the use of an asyncio loop.

Generators and Yielding

Many of the Telepath APIs published by Synapse services are capable of yielding results as a generator to facilitate incremental reads and time_to_first_byte (TTFB) optimizations. In the remote case, this means the caller may receive and begin processing results before all of the results have been enumerated by the server. Any Python async generator method on a shared object may be iterated by a client with full back_pressure to the server. This means a caller may issue a query which produces a very large result set and consume the results incrementally without concern over client/server memory exhaustion due to buffering. The following example demonstrates using the Cortex `storm` API to retrieve a message stream, which includes nodes in it.

```
import asyncio
import synapse.telepath as s_telepath

async def main():

    async with await s_telepath.openurl('tcp://visi:secretsauce@1.2.3.4:27492/') as core:

        async for mesg in core.storm('inet:ipv4 | limit 10000'):

            # Handle node messages specifically.
            if mesg[0] == 'node':
                node = mesg[1]
                dostuff(node)

            else:
                # Handle non-node messages.
                do_not_node_stuff(mesg)

if __name__ == '__main__':
    asyncio.run(main())
```

The `storm()` API is the preferred API to use for executing Storm queries on a Cortex. It generates a series of messages which the caller needs to consume.

For API documentation on the full Cortex Telepath API, see CoreApi.

7.4 Synapse Docker Builds

This doc details the docker builds and scripts used by Synapse.

7.4.1 Images

There are several images provided by the Synapse repository. These are built from an external image that is periodically updated with core Synapse dependencies.

The images provided include the following:

vertexproject/synapse
: This container just contains Synapse installed into it. It does not start any services.

vertexproject/synapse-aha
: This container starts the Aha service.

vertexproject/synapse-axon
: This container starts the Axon service.

vertexproject/synapse-cortex
: This container starts the Cortex service.

vertexproject/synapse-cryotank
: This container starts the Cryotank service.

vertexproject/synapse-jsonstor
: This container starts the JSONStor service.

vertexproject/synapse-stemcell
: This container launches the Synapse stemcell server.

7.4.2 Building All Images

Images are built using Bash scripts. All of the images can be built directly with a single command:

```
$ ./docker/build_all.sh <optional_image_tag>
```

If the image tag is not provided, it will tag the images with `:dev_build`.

7.4.3 Building a Specific Application Image

A specific application images can be built as well.

```
$ ./docker/build_image.sh <application> <optional_image_tag>

# Example of building a local Cortex image.

$ ./docker/build_image.sh cortex my_test_image
```

If the image tag is not provided, it will tag the image with `:dev_build`.

7.4.4 Building the `vertexproject/synapse` image

The bare image with only Synapse installed on it can be built like the following:

```
$ docker build --pull -t vertexproject/synapse:$TAG -f docker/images/synapse/
↪Dockerfile .

# Example of building directly with the tag mytag

$ docker build --pull -t vertexproject/synapse:mytag -f docker/images/synapse/
↪Dockerfile .
```

7.4.5 Working with Synapse Images

Developers working with Synapse images should consider the following items:

- The Synapse images are not locked to a specific Python version. The underlying Python minor version or base distribution may change. If they do change, that will be noted in the Synapse changelog. If you are building containers off of a floating tag such as `vertexproject/synapse:v2.x.x`, make sure you are reviewing our changelog for items which may affect your use cases. Python patch level updates will not be included in the changelogs.
- The `synapse` package, and supporting packages, are currently installed to the distribution Python environment. The version of `pip` installed in the containers is PEP668 aware. If you are installing your own Python packages to the distribution Python environment with `pip, you will need to add the `--break-system-packages` argument:

```
python -m pip install --break-system-packages yourTargetPackage
```

7.5 Storm Service Development

7.5.1 Anatomy of a Storm Service

A Storm Service (see *Service*) is a standalone application that extends the capabilities of the Cortex. One common use case for creating a service is to add a Storm command that will query third-party data, translate the results into the Synapse datamodel, and then ingest them into the hypergraph.

In order to leverage core functionalities it is recommended that Storm services are created as Cell implementations, and the documentation that follows will assume this. For additional information see *Synapse Architecture*.

A Storm service generally implements the following components:

- A *Package* that contains the new *Storm Service Commands* and optional new *Storm Service Modules*.
- A subclass of `synapse.lib.CellApi` which uses the `synapse.lib.StormSvc` mixin and contains the following information:
  - The service name, version, packages, and events as defined in `synapse.lib.StormSvc`.
  - Custom methods which will be accessible as Telepath API endpoints, and therefore available for use within defined Storm commands.
- A subclass of `synapse.lib.Cell` which includes additional configuration definitions and methods required to implement the service.

When implemented as a Cell, methods can also optionally have custom permissions applied to them. If a specific rule is added it should be namespaced with the service name, e.g. `svcname.rule1`. Alternatively, a method can wrapped with `@s_cell.adminapi()` to only allow admin access.

For additional details see *Minimal Storm Service Example*.

Connecting a service

Before connecting a service to a Cortex it is a best practice to add a new service user, which can be accomplished with `synapse.tools.cellauth`. For example:

```
python -m synapse.tools.cellauth tcp://root:<root_passwd>@<svc_ip>:<svc_port> modify␣
↪svcuser1 --adduser
python -m synapse.tools.cellauth tcp://root:<root_passwd>@<svc_ip>:<svc_port> modify␣
↪svcuser1 --passwd secret
```

If the service requires specific permissions for a new user they can also be added:

```
python -m synapse.tools.cellauth tcp://root:<root_passwd>@<svc_ip>:<svc_port> modify␣
↪svcuser1 --addrule svcname.rule1
```

Permissions to access the service can be granted by adding the `service.get.<svc_iden>` rule to the appropriate users / roles in the Cortex.

A Storm command can be run on the Cortex to add the new service, and the new service will now be present in the service list and Storm `help`.

Services are added to a Cortex with the `service.add` command.

```
storm> service.add mysvc tcp://root:secret@127.0.0.1:42853/
added 37c4d625360f35a4b2e47f0b0dba9d46 (mysvc): tcp://root:secret@127.0.0.1:42853/
complete. 0 nodes in 46 ms (0/sec).
```

Services that have been connected to the Cortex can be listed with the `service.list` command.

```
storm> service.list

Storm service list (iden, ready, name, service name, service version, url):
    37c4d625360f35a4b2e47f0b0dba9d46 false (mysvc) (Unknown @ Unknown): tcp://
↪root:secret@127.0.0.1:42853/

1 services
complete. 0 nodes in 269 ms (0/sec).
```

7.5.2 Storm Service Commands

Implementation

Multiple Storm commands can be added to a Storm service package, with each defining the following attributes:

- `name`: Name of the Storm command to expose in the Cortex.
- `descr`: Description of the command which will be available in `help` displays.
- `cmdargs`: An optional list of arguments for the command.

- `cmdconf`: An optional dictionary of additional configuration variables to provide to the command Storm execution.
- `forms`: List of input and output forms for the command.
- `storm`: The Storm code, as a string, that will be executed when the command is called.

Typically, the Storm code will start by getting a reference to the service via `$svc = $lib.service.get($cmdconf.sviden)` and reading in any defined `cmdargs` that are available in `$cmdopts`. The methods defined in the service's Cell API can then be called by, for example, `$retn = $svc.mysvcmethod($cmdopts.query)`.

Input/Output Conventions

Most commands that enrich or add additional context to nodes should simply yield the nodes they were given as inputs. If they don't know how to enrich or add additional context to a given form, nodes of that form should be yielded rather than producing an error. This allows a series of enrichment commands to be pipelined regardless of the different inputs that a given command knows how to operate on.

Argument Conventions

`--verbose`

In general, Storm commands should operate silently over their input nodes and should especially avoid printing anything "per node". However, when an error occurs, the command may use `$lib.warn()` to print a warning message per-node. Commands should implement a `--verbose` command line option to enable printing "per node" informational output.

`--debug`

For commands where additional messaging would assist in debugging a `--debug` command line option should be implemented. For example, a Storm command that is querying a third-party data source could use `$lib.print()` to print the raw query string and raw response when the `--debug` option is specified.

`--yield`

For commands that create additional nodes, it may be beneficial to add a `--yield` option to allow a query to operate on the newly created nodes. Some guidelines for `--yield` options:

- The command should *not* yield the input node(s) when a `--yield` is specified
- The `--yield` option should *not* be implemented when pivoting from the input node to reach the newly created node is a "refs out" or 1-to-1 direct pivot. For example, there is no need to have a `--yield` option on the `maxmind` command even though it may create an `inet:asn` node for an input `inet:ipv4` node due to the 1-to-1 pivot -> `inet:asn` being possible.
- The `--yield` option should ideally determine a "primary" node form to yield even when the command may create many forms in order to tag them or update .seen times.

7.5.3 Storm Service Modules

Modules can be added to a Storm service package to expose reusable Storm functions. Each module defines a `name`, which is used for importing elsewhere via `$lib.import()`, and a `storm` string. The Storm code in this case contains callable functions with the format:

```
function myfunc(var1, var2) {
    // function Storm code
}
```

7.5.4 Minimal Storm Service Example

A best practice is to separate the Storm and service code into separate files, and nest within a `synmods` directory to avoid Python namespace conflicts:

```
service-example
├── synmods
│   └── example
│       ├── __init__.py
│       ├── service.py
│       ├── storm.py
│       └── version.py
```

The Storm package and the service should also maintain consistent versioning.

For convenience, the example below shows the Storm code included in the `service.py` file.

service.py

```
import sys
import asyncio

import synapse.lib.cell as s_cell
import synapse.lib.stormsvc as s_stormsvc

# The Storm definitions below are included here for convenience
# but are typically contained in a separate storm.py file and imported to service.py.
# Other Storm commands could be created to call the additional Telepath endpoints.
svc_name = 'example'
svc_guid = '0ecc1eb65659a0f07141bc1a360abda3'  # can be generated with synapse.common.
↪guid()
svc_vers = (0, 0, 1)
svc_minvers = (2, 8, 0)

svc_evts = {
    'add': {
        'storm': f'[(meta:source={svc_guid} :name="Example data")]'
    }
}

svc_mod_ingest_storm = '''
function ingest_ips(data, srcguid) {
```

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```
    $results = $lib.set()

    for $ip in $data {
        [ inet:ipv4=$ip ]

        // Lightweight edge back to meta:source
        { [ <(seen)+ { meta:source=$srcguid } ] }

        { +inet:ipv4 $results.add($node) }
    }

    | spin |

    return($results)
}
'''

# The first line of this description will display in the Storm help
svc_cmd_get_desc = '''
Query the Example service.

Examples:

    # Query the service and create an IPv4 node
    inet:fqdn=good.com | example.get

    # Query the service and yield the created inet:ipv4 node
    inet:fqdn=good.com | example.get --yield
'''

svc_cmd_get_forms = {
    'input': [
        'inet:fqdn',
    ],
    'output': [
        'inet:ipv4',
    ],
}

svc_cmd_get_args = (
    ('--yield', {'default': False, 'action': 'store_true',
                 'help': 'Whether to yield the created nodes to the output stream.'}),
    ('--debug', {'default': False, 'action': 'store_true',
                 'help': 'Enable debug output.'}),
)

svc_cmd_get_conf = {
    'srcguid': svc_guid,
}

svc_cmd_get_storm = '''
init {
```

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```
    $svc = $lib.service.get($cmdconf.svciden)
    $ingest = $lib.import(example.ingest)
    $srcguid = $cmdconf.srcguid
    $debug = $cmdopts.debug
    $yield = $cmdopts.yield
}

// $node is a special variable that references the inbound Node object
$form = $node.form()

switch $form {
    "inet:fqdn": {
        $query=$node.repr()
    }
    *: {
        $query=""
        $lib.warn("Example service does not support {form} nodes", form=$form)
    }
}

// Yield behavior to drop the inbound node
if $yield { spin }

// Call the service endpoint and ingest the results
if $query {
    if $debug { $lib.print("example.get query: {query}", query=$query) }

    $retn = $svc.getData($query)

    if $retn.status {
        $results = $ingest.ingest_ips($retn.data, $srcguid)

        if $yield {
            for $result in $results { $lib.print($result) yield $result }
        }
    } else {
        $lib.warn("example.get error: {err}", err=$retn.mesg)
    }
}
'''

svc_cmds = (
    {
        'name': f'{svc_name}.get',
        'descr': svc_cmd_get_desc,
        'cmdargs': svc_cmd_get_args,
        'cmdconf': svc_cmd_get_conf,
        'forms': svc_cmd_get_forms,
        'storm': svc_cmd_get_storm,
    },
)
```

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```
svc_pkgs = (
    {
        'name': svc_name,
        'version': svc_vers,
        'synapse_minversion': svc_minvers,
        'modules': (
            {
                'name': f'{svc_name}.ingest',
                'storm': svc_mod_ingest_storm,
            },
        ),
        'commands': svc_cmds,
    },
)

class ExampleApi(s_cell.CellApi, s_stormsvc.StormSvc):
    '''
    A Telepath API for the Example service.
    '''

    # These defaults must be overridden from the StormSvc mixin
    _storm_svc_name = svc_name
    _storm_svc_vers = svc_vers
    _storm_svc_evts = svc_evts
    _storm_svc_pkgs = svc_pkgs

    async def getData(self, query):
        return await self.cell.getData(query)

    async def getInfo(self):
        await self._reqUserAllowed(('example', 'info'))
        return await self.cell.getInfo()

    @s_cell.adminapi()
    async def getAdminInfo(self):
        return await self.cell.getAdminInfo()

class Example(s_cell.Cell):

    cellapi = ExampleApi

    confdefs = {
        'api_key': {
            'type': 'string',
            'description': 'API key for accessing an external service.',
        },
        'api_url': {
            'type': 'string',
            'description': 'The URL for an external service.',
            'default': 'https://example.com',
        },
    }
```

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```
    async def __anit__(self, dirn, conf):
        await s_cell.Cell.__anit__(self, dirn, conf=conf)
        self.apikey = self.conf.get('api_key')
        self.apiurl = self.conf.get('api_url')

    async def getData(self, query):
        # Best practice is to also return a status and optional message in case of an␣
↪error
        retn = {
            'status': True,
            'data': None,
            'mesg': None,
        }

        # Retrieving and parsing data would go here
        if query == 'good.com':
            data = ['1.2.3.4', '5.6.7.8']
            retn['data'] = data

        else:
            retn['status'] = False
            retn['mesg'] = 'An error occurred during data retrieval.'

        return retn

    async def getInfo(self):
        info = {
            'generic': 'info',
        }

        return info

    async def getAdminInfo(self):
        info = {
            'admin': 'info',
        }

        return info
```

7.6 Storm API Guide

7.6.1 Storm APIs

Storm is available over Telepath and HTTP API interfaces. Both interfaces require a Storm query string, and may take additional `opts` arguments.

Telepath

There are three Storm APIs exposed via Telepath.

storm(text, opts=None)
The Storm API returns a message stream. It can be found here storm.

callStorm(text, opts=None)
The callStorm API returns a message given by the Storm `return( )` syntax. It can be found here callStorm.

count(text, opts=None)
The count API returns a count of the number of nodes which would have been emitted by running a given query. It can be found here *Cortex*.

HTTP API

The HTTP API versions of the Storm APIs can be found here Cortex HTTP API.

/v1/api/storm
This API returns a message stream.

/v1/api/storm/call
This API returns a message given by the Storm `return( )` syntax.

/v1/api/storm/export
This API returns a stream of msgpack encoded data, which can be used as a *.nodes* file for later import.

7.6.2 Message Types

The Telepath `storm()` and HTTP `api/v1/storm` APIs yield messages from the Storm runtime to the caller. These are the messages that may be seen when consuming the message stream.

Each message has the following basic structure:

```
[ "type", { ..type specific info... } ]
```

init

First message sent by a Storm query runtime.

It includes the following keys:

task
The task identifier (which can be used for task cancellation).

tick
The epoch time the query execution started (in milliseconds).

text
The Storm query text.

hash
The md5sum of the Storm query text.

Example:

```
('init',
 {'task': '8c90c67e37a30101a2f6a7dfb2fa0805',
  'text': '.created | limit 3',
  'hash': '2d16e12e80be53e0e79e7c7af9bda12b',
  'tick': 1539221678859})
```

node

This represents a packed node. Each serialized node will have the following structure:

```
[
    [<form>, <valu>],       # The [ typename, typevalue ] definition of the node.
    {
        "iden": <hash>,     # A stable identifier for the node.
        "tags": {},         # The tags on the node.
        "props": {},        # The node's secondary properties.
        "path": {},         # Path related information in the node.
        "tagprops": {},     # The node's tag properties.

        # optional
        "repr": ...         # Presentation values for the type value.
        "reprs": {}         # Presentation values for props which need it.
        "tagpropreprs": {}  # Presentation values for tagprops which need it.

    }
]
```

Example:

This example is very simple - it does not include repr information, or things related to path data:

```
('node',
 (('inet:fqdn', 'icon.torrentart.com'),
  {'iden': 'ae6d871163980f82dc1d3b06e784a80e8085493f68fbf2813c9681cb3e2630a8',
   'props': {'.created': 1526590932444,
             '.seen': (1491771661000, 1538477660797),
             'domain': 'torrentart.com',
             'host': 'icon',
             'issuffix': 0,
             'iszone': 0,
             'zone': 'torrentart.com'},
   'tags': {'aka': (None, None),
            'aka.beep': (None, None),}}))
```

For path and repr information, see the examples in the opts documentation *Storm Opts*.

print

The print event contains a message intended to be displayed to the caller.

It includes the following key:

mesg
: The message to be displayed to the user.

Example:

```
(print, {'mesg': 'I am a message!'})
```

This can be produced by users with the `$lib.print()` Storm API.

warn

The warn event contains data about issues encountered when performing an action.

It includes the following keys:

mesg
: The message to be displayed to the user.

The warn event may contain additional, arbitrary keys in it.

Example:

```
('warn',
 {'mesg': 'Unable to foo the bar.com domain',
  'domain': 'bar.com'})
```

This can be produced by users with the `$lib.warn()` Storm API.

err

The err event is sent if there is a fatal error encountered when executing a Storm query. There will be no further processing; only a `fini` message sent afterwards.

The err event does contain a marshalled exception in it. This contains the exception type as the identifier; and several attributes from the exception.

The following keys are usually present in the marshalled information:

esrc
: Source line that raised the exception.

efile
: File that the exception was raised from.

eline
: Line number from the raising file.

ename
: Name of the function where the exception was from.

mesg
: The `mesg` argument to a SynErr exception, if present; or the `str()` exception.

Additional keys may also be present, depending on the exception that was raised.

Example:

```
('err',
 ('BadTypeValu',
  {'efile': 'inet.py',
   'eline': 294,
   'form': 'inet:fqdn',
   'mesg': 'FQDN failed to match fqdnre [^[\\w._-]+$]',
   'name': 'inet:fqdn',
   'valu': '1234@#'}))
```

fini

The last message sent by a Storm query runtime. This can be used as a key to stop processing messages or finalize any sort of rollup of messages.

It includes the following keys:

tock
: The epoch time the query execution finished (in milliseconds).

took
: The amount of time it took for the query to execute (in milliseconds).

count
: The number of nodes yielded by the runtime.

Example:

```
('fini', {'count': 1, 'tock': 1539221715240, 'took': 36381})
```

Note: If the Storm runtime is cancelled for some reason, there will be no `err` or `fini` messages sent. This is because the task cancellation may tear down the channel and we would have an async task blocking on attempting to send data to a closed channel.

---

node:edits

The `node:edits` message represents changes that are occurring to the underlying graph, as a result of running a Storm query.

It includes the following key:

edits
: A list of changes made to a set of nodes.

Example:

```
# Nodeedits produced by the following query: [(inet:ipv4=1.2.3.4 :asn=1)]

('node:edits',
 {'edits': (('20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f',
             'inet:ipv4',
```

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```
             ((0, (16909060, 4), ()),
              (2, ('.created', 1662578208195, None, 21), ()),
              (2, ('type', 'unicast', None, 1), ()))),)})
('node:edits',
 {'edits': (('20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f',
             'inet:ipv4',
             ((2, ('asn', 1, None, 9), ()),)),
            ('371bfbcd479fec0582d55e8cf1011c91c97f306cf66ceea994ac9c37e475a537',
             'inet:asn',
             ((0, (1, 9), ()),
              (2, ('.created', 1662578208196, None, 21), ())))})
```

node:edits:count

The `node:edits:count` message represents a summary of changes that are occurring to the underlying graph, as a result of running a Storm query. These are produced when the query `opts` set `editformat` to `count`.

It includes the following key:

count
: The number of changes made to the graph as a result of a single `node:edits` event.

Example:

```
# counts produced by the following query: [(inet:ipv4=1.2.3.4 :asn=1)]

('node:edits:count', {'count': 3})
('node:edits:count', {'count': 3})
```

storm:fire

The `storm:fire` message is a arbitrary user created message produced by the `$lib.fire()` Storm API. It includes the following keys:

type
: The type of the event.

data
: User provided data.

Example:

```
# The following query produces an event
$l = ((1), (2), (3)) $lib.fire('demo', key=valu, somelist=$l)

# The event produced.
('storm:fire', {'data': {'key': 'valu', 'somelist': (1, 2, 3)}, 'type': 'demo'})
```

look:miss

The `look:miss` message is sent when the Storm runtime is set to `lookup` mode and the node that was identified by the scrape logic is not present in the current View.

It includes the following key:

ndef
: A tuple of the form and normalized value.

Example:

```
('look:miss', {'ndef': ('inet:fqdn', 'hehe.com')})

# The ipv4 value is presented in system mode.
('look:miss', {'ndef': ('inet:ipv4', 16909060)})
```

csv:row

The `csv:row` message is sent by the Storm runtime by the `$lib.csv.emit()` Storm API.

It includes the following keys:

row
: A list of elements that make up the row.

table
: A optional table name. This may be `None`.

Example:

```
# This query produces the following event: $lib.csv.emit(foo, bar, $lib.time.now())
('csv:row', {'row': ('foo', 'bar', 1662578057658), 'table': None})

# This query produces the following event: $lib.csv.emit(foo, bar, $lib.time.now(),␣
↪table=foo)
('csv:row', {'row': ('foo', 'bar', 1662578059282), 'table': 'foo'})
```

7.6.3 Storm Call APIs

The Telepath `callStorm()` and HTTP API `storm/call` interfaces are designed to return a single message to the caller, as opposed to a stream of messages. This is done using the Storm `return( )` syntax. Common uses for the call interfaces include getting and setting values where the full message stream would not be useful.

Example:

The following example shows retrieving a user definition.

```
# Prox is assumed to be a Telepath proxy to a Cortex.
>>> text = '$user = $lib.auth.users.byname($name) return ( $user )'
>>> opts = {'vars': {'name': 'root'}}
>>> ret = prox.callStorm(text, opts=opts)
>>> pprint(ret)
{'admin': True,
 'archived': False,
 'authgates': {'0b942d5f4309d70e5fa64423714e25aa': {'admin': True},
```

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```
                'cdf6f1727da73dbac95e295e5d258847': {'admin': True}},
 'email': None,
 'iden': '933a320b7ce8134ba5abd93aa487e1b5',
 'locked': False,
 'name': 'root',
 'roles': (),
 'rules': (),
 'type': 'user'}
```

The following shows setting an API key for a Power-Up. There is no `return` statement, so the return value defaults to None.

```
# Prox is assumed to be a Telepath proxy to a Cortex.
>>> text = 'foobar.setup.apikey $apikey'
>>> opts = {'vars': {'apikey': 'secretKey'}}
>>> ret = prox.callStorm(text, opts=opts)
>>> print(ret)
None
```

7.6.4 Storm Opts

All Storm API endpoints take an `opts` argument. This is a dictionary that contains metadata that is used by the Storm runtime for various purposes. Examples are given using Python syntax.

debug

If this is set to True, the Storm runtime will be created with `$lib.debug` set to True.

Example:

```
opts = {'debug': True}
```

editformat

This is a string containing the format that node edits are streamed in. This may be `nodeedits` (the default value), `none`, or `count`. If the value is `none`, then no edit messages will be streamed. If the value is `count`, each `node:edits` message is replaced by a `node:edits:count` message, containing a summary of the number of edits made for a given message.

Examples:

```
# Turn node:edit messages into counts
opts = {'editformat': 'count'}

# Disable node edits
opts = {'editformat': 'none'}
```

idens

This is a list of node iden hashes to use as initial input to the Storm runtime. These nodes are lifted after any `ndefs` options are lifted, but prior to regular lift operations which may start a Storm query.

Example:

```
idens = ('ee6b92c9fd848a2cb00f3a3618148c512b58456b8b51fbed79251811597eeea3',
         'c5a67a095b71771d9663d691f0ab36b53ebdc14fbad18f23f95e923543156bd6',)
opts = {'idens': idens}
```

limit

Limit the total number of nodes that the Storm runtime produces. When this number is reached, the runtime will be stopped.

Example:

```
opts = {'limit': 100}
```

mode

This is the mode that a Storm query is parsed in. This value can be specified to `lookup`, `autoadd`, and `search` modes to get different behaviors.

Example:

```
# Using lookup mode, the query text, before switching to command mode with a |␣
↪character,
# will have its text scrapped for simple values such as FQDNs, IP Addresses,␣
↪and Hashes
# and attempt to lift any matching nodes.
opts = {'mode': 'lookup'}

# Using autoadds mode, the query text is scrapped like in lookup mode; and for␣
↪any
# values which we try to lift that do not produce nodes, those nodes will be␣
↪added
# in the current view.
opts = {'mode': 'autoadd'}

# Using search mode, the query will be run through the Storm search interface.
# This will lift nodes based on searching, which is enabled by the
# Synapse-Search Advanced Power-up.
opts = {'mode': 'search'}
```

ndefs

This is a list of form and value tuples to use as initial input to the Storm runtime. These are expected to be the already normalized, system mode, values for the nodes. These nodes are lifted before any other lift operators are run.

Example:

```
ndefs = (
    ('inet:fqdn', 'com'),
    ('inet:ipv4', 134744072),
)

opts = {'ndefs': ndefs}
```

path

If this is set to True, the `path` key in the packed nodes will contain a `nodes` key, which contains a list of the node iden hashes that were used in pivot operations to get to the node.

Example:

```
opts = {'path': True}

# A Storm node message with a node path added to it, from the query inet:ipv4 ->␣
↪inet:asn.

('node',
 (('inet:asn', 1),
  {'iden': '371bfbcd479fec0582d55e8cf1011c91c97f306cf66ceea994ac9c37e475a537',
   'nodedata': {},
   'path': {'nodes': ('20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f',
                      '371bfbcd479fec0582d55e8cf1011c91c97f306cf66ceea994ac9c37e475a537
↪')},
   'props': {'.created': 1662493825668},
   'tagprops': {},
   'tags': {}}))
```

readonly

Run the Storm query in a readonly mode. This prevents editing the graph data, and only allows a small subset of whitelisted Storm library functions to be used.

Examples:

```
opts = {'readonly': True}
```

repr

If this is set to True, the packed node will have a `repr` and `reprs` key populated, to contain human friendly representations of system mode values.

Example:

```
opts = {'repr': True}

# A Storm node message with reprs added to it.

('node',
 (('inet:ipv4', 134744072),
  {'iden': 'ee6b92c9fd848a2cb00f3a3618148c512b58456b8b51fbed79251811597eeea3',
   'nodedata': {},
   'path': {},
   'props': {'.created': 1662491423034, 'type': 'unicast'},
   'repr': '8.8.8.8',
   'reprs': {'.created': '2022/09/06 19:10:23.034'},
   'tagpropreprs': {},
   'tagprops': {},
   'tags': {}}))
```

scrub

This is a set of rules that can be provided to the Storm runtime which dictate which data should be included or excluded from nodes that are returned in the message stream. Currently the only rule type supported is `include` for `tags`.

Example:

```
# Only include tags which start with cno and rep.foo
scrub = {'include': {'tags': ['cno', 'rep.foo',]}}
opts = {'scrub': scrub}

# Do not include any tags in the output
scrub = {'include': {'tags': []}}
opts = {'scrub': scrub}
```

show

A list of message types to include in the output message stream. The `init`, `fini`, and `err` message types cannot be filtered with this option.

Example:

```
# Only node and warning messages.
opts = {'show': ['node', 'warning']}

# Only include required messages.
opts = {'show': []}
```

task

A user provided guid that is used as the task identifier for the Storm runtime. This allows a user to have a predictable identifier that they can use for task cancellation.

The Storm runtime will raise a `BadArg` value if the `task` iden is associated with a currently running task.

Example:

```
# Generate a guid on the client side and provide it to the Cortex
import synapse.common as s_commmon
task_iden = s_common.guid()
opts = {'task': task_iden}
```

user

The User iden to run the Storm query as. This allows a user with the permission `impersonate` to run a Storm query as another user.

Example:

```
opts = {'user': 6e9c8de2f1aa39fee11c19d0974e0917}
```

vars

A dictionary of key - value pairs that are mapped into the Storm runtime as variables. Some uses of this include providing data to the runtime that is used with an ingest script, or to provide secrets to the Storm runtime so that they will not be logged.

Example:

```
# A secret key - A good example of this is configuring a Rapid Power-Up.
vars = {'secretkey': 'c8de2fe11c19d0974e091aa39fe176e9'}
opts = {'vars': vars}

# Some example data that could be used in a Storm ingest script.
records = (
    ('foobar.com', '8.8.8.8', '20210810'),
    ('bazplace.net', '1.2.3.4', '20210810'),
)
vars = {'records': records}
opts = {'vars': vars}
```

view

The View iden in which to run the Storm query in. If not specified, the query will run in the user's default view.

Example:

```
opts = {'view': 31ded629eea3c7221be0a61695862952}
```

CHAPTER

EIGHT

SYNAPSE GLOSSARY

This Glossary provides a quick reference for common terms related to Synapse technical and analytical concepts.

8.1 A

8.1.1 Addition, Automatic

See *Autoadd*.

8.1.2 Addition, Dependent

See *Depadd*.

8.1.3 Advanced Power-Up

See *Power-Up, Advanced*.

8.1.4 Admin Tool

See *Tool, Admin*.

8.1.5 Analytical Model

See *Model, Analytical*.

8.1.6 Auth Gate

An auth gate (short for "authorization gate", informally a "gate") is an object within a *Service* that may have its own set of permissions.

Both a *Layer* and a *View* are common examples of auth gates.

8.1.7 Autoadd

Short for "automatic addition". Within Synapse, a feature of node creation where any secondary properties that are derived from a node's primary property are automatically set when the node is created. Because these secondary properties are based on the node's primary property (which cannot be changed once set), the secondary properties are read-only.

For example, creating the node `inet:email=alice@mail.somecompany.org` will result in the autoadd of the secondary properties `inet:email:user=alice` and `inet:email:domain=mail.somecompany.org`.

See also the related concept *Depadd*.

8.1.8 Axon

The Axon is a *Synapse Service* that provides binary / blob ("file") storage within the Synapse ecosystem. An Axon indexes binaries based on their SHA-256 hash for deduplication. The default Axon implemenation stores the blobs in an LMDB *Slab*.

8.2 B

8.2.1 Base Tag

See *Tag, Base*.

8.2.2 Binary Unique Identifier

See *BUID*.

8.2.3 BUID

Short for Binary Unique Identifier. Within Synapse, a BUID is the globally unique (within a *Cortex*) SHA-256 digest of a node's msgpack-encoded *Ndef*.

8.3 C

8.3.1 Cell

The Cell is a basic building block of a *Synapse Service*, including the *Cortex*. See *Synapse Architecture* for additional detail.

8.3.2 Column, Embed

In *Optic*, a column in Tabular display mode that displays a **property value from an adjacent or nearby node**.

8.3.3 Column, Property

In *Optic*, a column in Tabular display mode that displays a **property value** from the specified form.

8.3.4 Column, Tag

In *Optic*, a column in Tabular display mode that displays the **timestamps** associated with the specified tag. (Technically, Optic displays two columns - one for each of the min / max timestamps, if present).

8.3.5 Column, Tag Glob

In *Optic*, a column in Tabular display mode that displays any **tags** that match the specified tag or tag glob pattern.

8.3.6 Comparator

Short for *Comparison Operator*.

8.3.7 Comparison Operator

A symbol or set of symbols used in the Storm language to evaluate *Node* property values against one or more specified values. Comparison operators can be grouped into standard and extended operators.

8.3.8 Comparison Operator, Standard

The set of common operator symbols used to evaluate (compare) values in Storm. Standard comparison operators include equal to (=), greater than (>), less than (<), greater than or equal to (>=), and less than or equal to (<=).

8.3.9 Comparison Operator, Extended

The set of Storm-specific operator symbols or expressions used to evaluate (compare) values in Storm based on custom or Storm-specific criteria. Extended comparison operators include regular expression (~=), time/interval (`@=`), set membership (`*in=`), tag (`#`), and so on.

8.3.10 Composite Form

See *Form, Composite*.

8.3.11 Console Tool

See *Tool, Console*.

8.3.12 Constant

In Storm, a constant is a value that cannot be altered during normal execution, i.e., the value is constant.

Contrast with *Variable*. See also *Runtsafe* and *Non-Runtsafe*.

8.3.13 Constructor

Within Synapse, a constructor is code that defines how a *Property* value of a given *Type* can be constructed to ensure that the value is well-formed for its type. Also known as a *Ctor* for short. Constructors support *Type Normalization* and *Type Enforcement*.

8.3.14 Cortex

A Cortex is a *Synapse Service* that implements Synapse's primary data store (as an individual *Hypergraph*). Cortex features include scalability, key/value-based node properties, and a *Data Model* which facilitates normalization.

8.3.15 Cron

Within Synapse, cron jobs are used to create scheduled tasks, similar to the Linux/Unix "cron" utility. The task to be executed by the cron job is specified using the *Storm* query language.

See the Storm command reference for the *cron* command and the *Storm Reference - Automation* document for additional detail.

8.3.16 Ctor

Pronounced "see-tore". Short for *Constructor*.

8.4 D

8.4.1 Daemon

Similar to a traditional Linux or Unix daemon, a Synapse daemon ("dmon") is a long-running or recurring query or process that runs continuously in the background. A dmon is typically implemented by a Storm *Service* and may be used for tasks such as processing elements from a *Queue*. A dmon allows for non-blocking background processing of non-critical tasks. Dmons are persistent and will restart if they exit.

8.4.2 Data Model

See *Model, Data*.

8.4.3 Data Model Explorer

In *Optic*, the Data Model Explorer (found in the *Help Tool*) documents and cross-references the current forms and lightweight edges in the Synapse *Data Model*.

8.4.4 Deconflictable

Within Synapse, a term typically used with respect to *Node* creation. A node is deconflictable if, upon node creation, Synapse can determine whether the node already exists within a Cortex (i.e., the node creation attempt is deconflicted against existing nodes). For example, on attempting to create the node `inet:fqdn=woot.com` Synapse can deconflict the node by checking whether a node of the same form with the same primary property already exists.

Most primary properties are sufficiently unique to be readily deconflictable. GUID forms (see *Form, GUID*) require additional considerations for deconfliction. See the *guid* section of the *Storm Reference - Type-Specific Storm Behavior* document for additional detail.

8.4.5 Depadd

Short for "dependent addition". Within Synapse, when a node's secondary property is set, if that secondary property is of a type that is also a form, Synapse will automatically create the node with the corresponding primary property value if it does not already exist. (You can look at this as the secondary property value being "dependent on" the existence of the node with the corresponding primary property value.)

For example, creating the node `inet:email=alice@mail.somecompany.org` will set (via *Autoadd*) the secondary property `inet:email:domain=mail.somecompany.org`. Synapse will automatically create the node `inet:fqdn=mail.somecompany.org` as a dependent addition if it does not exist.

(Note that limited recursion will occur between dependent additions (depadds) and automatic additions (autoadds). When `inet:fqdn=mail.somecompany.org` is created via depadd, Synapse will set (via autoadd) `inet:fqdn:domain=somecompany.org`, which will result in the creation (via depadd) of the node `inet:fqdn=somecompany.org` if it does not exist, etc.)

See also the related concept *Autoadd*.

8.4.6 Derived Property

See *Property, Derived*.

8.4.7 Directed Edge

See *Edge, Directed*.

8.4.8 Directed Graph

See *Graph, Directed*.

8.4.9 Display Mode

In *Optic*, a means of visualizing data using the *Research Tool*. Optic supports four display modes, namely:

- **Tabular mode,** which displays data and tags in tables (rows of results with configurable columns).
- **Force Graph mode,** which projects data into a directed graph-like view of nodes and their interconnections.
- **Statistics (stats) mode,** which automatically summarizes data using histogram (bar) and sunburst charts.
- **Geospatial mode,** which can be used to plot geolocation data on a map projection.

8.4.10 Dmon

Short for *Daemon*.

8.5 E

8.5.1 Easy Permissions

In Synapse, easy permissions ("easy perms" for short) are a simplified means to grant common sets of permissions for a particular object to users or roles. Easy perms specify four levels of access, each with a corresponding integer value:

- Deny = 0
- Read = 1
- Edit = 2
- Admin = 3

As an example, the *$lib.macro.grant(name, scope, iden, level)* Storm library can be used to assign easy perms to a *Macro*. Contrast with *Permission*.

8.5.2 Edge

In a traditional *Graph*, an edge is used to connect exactly two nodes (vertexes). Compare with *Hyperedge*.

8.5.3 Edge, Directed

In a *Directed Graph*, a directed edge is used to connect exactly two nodes (vertexes) in a one-way (directional) relationship. Compare with *Hyperedge*.

8.5.4 Edge, Lightweight (Light)

In Synapse, a lightweight (light) edge is a mechanism that links two arbitrary forms via a user-defined verb that describes the linking relationship. Light edges are not forms and so do not support secondary properties or tags. They are meant to simplify performance, representation of data, and Synapse hypergraph navigation for many use cases. Contrast with *Form, Edge*.

8.5.5 Embed Column

See *Column, Embed*.

8.5.6 Entity Resolution

Entity resolution is the process of determining whether different records or sets of data refer to the same real-world entity.

A number of data model elements in Synapse are designed to support entity resolution. For example:

- A `ps:contact` node can capture "a set of observed contact data" for a person (`ps:person`) or organization (`ou:org`). You can link sets of contact data that you assess represent "the same" entity via their `ps:contact:person` or `ps:contact:org` properties.
- A `risk:threat` node can capture "a set of reported data about a threat". If you assess that multiple sources are reporting on "the same" threat, you can link them to an authoritative threat organization via their `risk:threat:org` property.
- An `ou:industryname` node can capture a term used to refer to a commercial industry. You can link variations of a name (e.g., "finance", "financial", "financial services", "banking and finance") to a single `ou:industry` via the `ou:industry:name` and `ou:industry:names` properties.

8.5.7 Extended Comparison Operator

See *Comparison Operator, Extended*.

8.5.8 Extended Form

See *Form, Extended*.

8.5.9 Extended Property

See *Property, Extended*.

8.6 F

8.6.1 Feed

A feed is an ingest API consisting of a set of ingest formats (e.g., file formats, record formats) used to parse records directly into nodes. Feeds are typically used for bulk node creation, such as ingesting data from an external source or system.

8.6.2 Filter

Within Synapse, one of the primary methods for interacting with data in a *Cortex*. A filter operation downselects a subset of nodes from a set of results. Compare with *Lift*, *Pivot*, and *Traverse*.

See *Storm Reference - Filtering* for additional detail.

8.6.3 Filter, Subquery

Within Synapse, a subquery filter is a filter that consists of a *Storm* expression.

See *Subquery Filters* for additional detail.

8.6.4 Fork

Within Synapse, **fork** may refer to the process of forking a *View*, or to the forked view itself.

When you fork a view, you create a new, empty, writable *Layer* on top of the fork's original view. The writable layer from the original view becomes read-only with respect to the fork. Any changes made within a forked view are made within the new writable layer. These changes can optionally be merged back into the original view (in whole or in part), or discarded. (Note that any view-specific automation, such as triggers, dmons, or cron jobs, are **not** copied to the forked view. However, depending on the automation, it may be activated if / when data is merged down into the original view.

8.6.5 Form

A form is the definition of an object in the Synapse data model. A form acts as a "template" that specifies how to create an object (*Node*) within a Cortex. A form consists of (at minimum) a *Primary Property* and its associated *Type*. Depending on the form, it may also have various secondary properties with associated types.

See the *Form* section in the *Data Model - Terminology* document for additional detail.

8.6.6 Form, Composite

A category of form whose primary property is an ordered set of two or more comma-separated typed values. Examples include DNS A records (`inet:dns:a`) and web-based accounts (`inet:web:acct`).

See also *Form, Edge*.

8.6.7 Form, Edge

A specialized **composite form** (*Form, Composite*) whose primary property consists of two *Ndef* values. Edge forms can be used to link two arbitrary forms via a generic relationship where additional information needs to be captured about that relationship (i.e., via secondary properties and/or tags). Contrast with *Edge, Lightweight (Light)*.

8.6.8 Form, Extended

A custom form added outside of the base Synapse *Data Model* to represent specialized data. Extended forms can be added with the *$lib.model.ext* libraries. **Note** that whenever possible, it is preferable to expand the base Synapse data model to account for novel use cases instead of creating specialized extended forms.

8.6.9 Form, GUID

In the Synpase *Data Model*, a specialized case of a *Simple Form* whose primary property is a *GUID*. The GUID can be either arbitrary or constructed from a specified set of values. GUID forms have additional considerations as to whether or not they are *Deconflictable* in Synapse. Examples of GUID forms include file execution data (e.g., `inet:file:exec:read`) or articles (`media:news`).

8.6.10 Form, Simple

In the Synapse *Data Model*, a category of form whose primary property is a single typed value. Examples include domains (`inet:fqdn`) or hashes (e.g., `hash:md5`).

8.6.11 Fused Knowledge

See *Knowledge, Fused*.

8.7 G

8.7.1 Gate

See *Auth Gate*.

8.7.2 Global Default Workspace

See *Workspace, Global Default*.

8.7.3 Globally Unique Identifier

See *GUID*.

8.7.4 Graph

A graph is a mathematical structure used to model pairwise relations between objects. Graphs consist of vertices (or nodes) that represent objects and edges that connect exactly two vertices in some type of relationship. Nodes and edges in a graph are typically represented by dots or circles connected by lines.

See *Background - Graphs and Hypergraphs* for additional detail on graphs and hypergraphs.

8.7.5 Graph, Directed

A directed graph is a *Graph* where the edges representing relationships between nodes have a "direction". Given node X and node Y connected by edge E, the relationship is valid for X -> E -> Y but not Y -> E -> X. For example, the relationship "Fred owns bank account #01234567" is valid, but "bank account #01234567 owns Fred" is not. Nodes and edges in a directed graph are typically represented by dots or circles connected by arrows.

See *Background - Graphs and Hypergraphs* for additional detail on graphs and hypergraphs.

8.7.6 GUID

Short for Globally Unique Identifier. Within Synapse, a GUID is a *Type* specified as a 128-bit value that is unique within a given *Cortex*. GUIDs are used as primary properties for forms that cannot be uniquely represented by a specific value or set of values.

8.7.7 GUID Form

See *Form, GUID*.

8.8 H

8.8.1 Help Tool

See *Tool, Help*.

8.8.2 Hive

The Hive is a key/value storage mechanism which is used to persist various data structures required for operating a Synapse *Cell*.

8.8.3 Hyperedge

A hyperedge is an edge within a *Hypergraph* that can join any number of nodes (vs. a *Graph* or *Directed Graph* where an edge joins exactly two nodes). A hyperedge joining an arbitrary number of nodes can be difficult to visualize in flat, two-dimensional space; for this reason hyperedges are often represented as a line or "boundary" encircling a set of nodes, thus "joining" those nodes into a related group.

See *Background - Graphs and Hypergraphs* for additional detail on graphs and hypergraphs.

8.8.4 Hypergraph

A hypergraph is a generalization of a *Graph* in which an edge can join any number of nodes. If a *Directed Graph* where edges join exactly two nodes is two-dimensional, then a hypergraph where a *Hyperedge* can join any number (n-number) of nodes is n-dimensional.

See *Background - Graphs and Hypergraphs* for additional detail on graphs and hypergraphs.

8.9 I

8.9.1 Iden

Short for *Identifier*. Within Synapse, the hexadecimal representation of a unique identifier (e.g., for a node, a task, a trigger, etc.) The term "identifier" / "iden" is used regardless of how the specific identifier is generated.

8.9.2 Identifier

See *Iden*.

8.9.3 Ingest Tool

See *Tool, Ingest*.

8.9.4 Instance Knowledge

See *Knowledge, Instance*.

8.10 K

8.10.1 Knowledge, Fused

If a form within the Synapse data model has a "range" of time elements (i.e., an interval such as "first seen"/"last seen"), the form typically represents **fused knowledge** – a period of time during which an object, relationship, or event was known to exist. Forms representing fused knowledge can be thought of as combining *n* number of instance knowledge observations. `inet:dns:query`, `inet:dns:a`, and `inet:whois:email` forms are examples of fused knowledge.

See *Instance Knowledge vs. Fused Knowledge* for a more detailed discussion.

8.10.2 Knowledge, Instance

If a form within the Synapse data model has a specific time element (i.e., a single date/time value), the form typically represents **instance knowledge** – a single instance or occurrence of an object, relationship, or event. `inet:dns:request` and `inet:whois:rec` forms are examples of instance knowledge.

See *Instance Knowledge vs. Fused Knowledge* for a more detailed discussion.

8.11 L

8.11.1 Layer

Within Synapse, a layer is the substrate that contains node data and where permissions enforcement occurs. Viewed another way, a layer is a storage and write permission boundary.

By default, a *Cortex* has a single layer and a single *View*, meaning that by default all nodes are stored in one layer and all changes are written to that layer. However, multiple layers can be created for various purposes such as:

- separating data from different data sources (e.g., a read-only layer consisting of third-party data and associated tags can be created underneath a "working" layer, so that the third-party data is visible but cannot be modified);
- providing users with a personal "scratch space" where they can make changes in their layer without affecting the underlying main Cortex layer; or
- segregating data sets that should be visible/accessible to some users but not others.

Layers are closely related to views (see *View*). The order in which layers are instantiated within a view matters; in a multi-layer view, typically only the topmost layer is writeable by that view's users, with subsequent (lower) layers read-only. Explicit actions can push upper-layer writes downward (merge) into lower layers.

8.11.2 Leaf Tag

See *Tag, Leaf*.

8.11.3 Lift

Within Synapse, one of the primary methods for interacting with data in a *Cortex*. A lift is a read operation that selects a set of nodes from the Cortex. Compare with *Pivot*, *Filter*, and *Traverse*.

See *Storm Reference - Lifting* for additional detail.

8.11.4 Lightweight (Light) Edge

See *Edge, Lightweight (Light)*.

8.12 M

8.12.1 Macro

A macro is a stored Storm query. Macros support the full range of Storm syntax and features.

See the Storm command reference for the *macro* command and the *Storm Reference - Automation* for additional detail.

8.12.2 Merge

Within Synapse, merge refers to the process of copying changes made within a forked (see *Fork*) *View* into the original view.

8.12.3 Model

Within Synapse, a system or systems used to represent data and/or assertions in a structured manner. A well-designed model allows efficient and meaningful exploration of the data to identify both known and potentially arbitrary or discoverable relationships.

8.12.4 Model, Analytical

Within Synapse, the set of tags (*Tag*) representing analytical assessments or assertions that can be applied to objects in a *Cortex*.

8.12.5 Model, Data

Within Synapse, the set of forms (*Form*) that define the objects that can be represented in a *Cortex*.

8.13 N

8.13.1 Ndef

Pronounced "en-deff". Short for **node definition.** A node's *Form* and associated value (i.e., <*form*> = <*valu*>) represented as comma-separated elements enclosed in parentheses: `(<form>,<valu>)`.

8.13.2 Node

A node is a unique object within a *Cortex*. Where a *Form* is a template that defines the charateristics of a given object, a node is a specific instance of that type of object. For example, `inet:fqdn` is a form; `inet:fqdn=woot.com` is a node.

See *Node* in the *Data Model - Terminology* document for additional detail.

8.13.3 Node Action

In *Optic*, a saved, named Storm query or command (action) that can be executed via a right-click context menu option for specified forms (nodes).

8.13.4 Node Data

Node data is a named set of structured metadata that may optionally be stored on a node in Synapse. Node data may be used for a variety of purposes. For example, a *Power-Up* may use node data to cache results returned by a third-party API along with the timestamp when the data was retrieved. If the same API is queried again for the same node within a specific time period, the Power-Up can use the cached node data instead of re-querying the API (helping to prevent using up any API query limits by re-querying the same data).

Node data can be accessed using the node:data type.

8.13.5 Node Definition

See *Ndef*.

8.13.6 Node, Runt

Short for "runtime node". A runt node is a node that does not persist within a Cortex but is created at runtime when a Cortex is initiated. Runt nodes are commonly used to represent metadata associated with Synapse, such as data model elements like forms (`syn:form`) and properties (`syn:prop`) or automation elements like triggers (`syn:trigger`) or cron jobs (`syn:cron`).

8.13.7 Node, Storage

A storage node ("sode") is a collection of data for a given node (i.e., the node's primary property, secondary / universal properties, tags, etc.) that is present in a specific *Layer*.

8.13.8 Non-Runtime Safe

See *Non-Runtsafe*.

8.13.9 Non-Runtsafe

Short for "non-runtime safe". Non-runtsafe refers to the use of variables within Storm. A variable that is **non-runtsafe** has a value that may change based on the specific node passing through the Storm pipeline. A variable whose value is set to a node property, such as `$fqdn = :fqdn` is an example of a non-runtsafe variable (i.e., the value of the secondary property `:fqdn` may be different for different nodes, so the value of the variable will be different based on the specific node being operated on).

Contrast with *Runtsafe*.

8.14 O

8.14.1 Optic

The Synapse user interface (UI), available as part of the commercial Synapse offering.

8.15 P

8.15.1 Package

A package is a set of commands and library code used to implement a *Storm Service*. When a new Storm service is loaded into a Cortex, the Cortex verifies that the service is legitimate and then requests the service's packages in order to load any extended Storm commands associated with the service and any library code used to implement the service.

8.15.2 Permission

Within Synapse, a permission is a string (such as `node.add`) used to control access. A permission is assigned (granted or revoked) using a *Rule*.

Access to some objects in Synapse may be controlled by *Easy Permissions*.

8.15.3 Pivot

Within Synapse, one of the primary methods for interacting with data in a *Cortex*. A pivot moves from a set of nodes with one or more properties with specified value(s) to a set of nodes with a property having the same value(s). Compare with *Lift*, *Filter*, and *Traverse*.

See *Storm Reference - Pivoting* for additional detail.

8.15.4 Power-Up

Power-Ups provide specific add-on capabilities to Synapse. For example, Power-Ups may provide connectivity to external databases or third-party data sources, or enable functionality such as the ability to manage YARA rules, scans, and matches.

The term Power-Up is most commonly used to refer to Vertex-developed packages and services that are available as part of the commercial Synapse offering (only a few Power-Ups are available with open-source Synapse). However, many organizations write their own custom packages and services that may also be referred to as Power-Ups.

Vertex distinguishes between an *Advanced Power-Up* and a *Rapid Power-Up*.

8.15.5 Power-Up, Advanced

Advanced Power-Ups are implemented as Storm services (see *Service, Storm*). Vertex-developed Advanced Power-Ups are implemented as Docker containers and may require DevOps support and additional resources to deploy.

8.15.6 Power-Up, Rapid

Rapid Power-Ups are implemented as Storm packages (see *Package*). Rapid Power-Ups are written entirely in Storm and can be loaded directly into a *Cortex*.

8.15.7 Power-Ups Tool

See *Tool, Power-Ups*.

8.15.8 Primary Property

See *Property, Primary*.

8.15.9 Property

Within Synapse, properties are individual elements that define a *Form* or (along with their specific values) that comprise a *Node*. Every property in Synapse must have a defined *Type*.

See the *Property* section in the *Data Model - Terminology* document for additional detail.

8.15.10 Property Column

See *Column, Property*.

8.15.11 Property, Derived

Within Synapse, a derived property is a secondary property that can be extracted (derived) from a node's primary property. For example, the domain `inet:fqdn=www.google.com` can be used to derive `inet:fqdn:domain=google.com` and `inet:fqdn:host=www`; the DNS A record `inet:dns:a=(woot.com, 1.2.3.4)` can be used to derive `inet:dns:a:fqdn=woot.com` and `inet:dns:a:ipv4=1.2.3.4`.

Synapse will automatically set (*Autoadd*) any secondary properties that can be derived from a node's primary property. Because derived properties are based on primary property values, derived secondary properties are always read-only (i.e., cannot be modified once set).

8.15.12 Property, Extended

Within Synapse, an extended property is a custom property added to an existing form to capture specialized data. For example, extended properties may be added to the data model by a *Power-Up* in order to record vendor-specific data (such as a "risk" score).

Extended properties can be added with the *$lib.model.ext* libraries. **Note** that we strongly recommend that any extended properties be added within a custom namespace; specifically, that property names begin with an underscore and include a vendor or source name (if appropriate) as the first namespace element.

An example of an extended property is the `:_virustotal:reputation` score added to some forms to account for VirusTotal-specific data returned by that Power-Up (e.g., `inet:fqdn:_virustotal:reputation`).

8.15.13 Property, Primary

Within Synapse, a primary property is the property that defines a given *Form* in the data model. The primary property of a form must be defined such that the value of that property is unique across all possible instances of that form. Primary properties are always read-only (i.e., cannot be modified once set).

8.15.14 Property, Relative

Within Synapse, a relative property is a *Secondary Property* referenced using only the portion of the property's namespace that is relative to the form's *Primary Property*. For example, `inet:dns:a:fqdn` is the full name of the "domain" secondary property of a DNS A record form (`inet:dns:a`). `:fqdn` is the relative property / relative property name for that same property.

8.15.15 Property, Secondary

Within Synapse, secondary properties are optional properties that provide additional detail about a *Form*. Within the data model, secondary properties may be defined with optional constraints, such as:

- Whether the property is read-only once set.
- Any normalization (outside of type-specific normalization) that should occur for the property (such as converting a string to all lowercase).

8.15.16 Property, Universal

Within Synapse, a universal property is a *Secondary Property* that is applicable to all forms and may optionally be set for any form where the property is applicable. For example, `.created` is a universal property whose value is the date/time when the associated node was created in a Cortex.

8.16 Q

8.16.1 Queue

Within Synapse, a queue is a basic first-in, first-out (FIFO) data structure used to store and serve objects in a classic pub/sub (publish/subscribe) manner. Any primitive (such as a node iden) can be placed into a queue and then consumed from it. Queues can be used (for example) to support out-of-band processing by allowing non-critical tasks to be executed in the background. Queues are persistent; i.e., if a Cortex is restarted, the queue and any objects in the queue are retained.

8.17 R

8.17.1 Rapid Power-Up

See *Power-Up, Rapid*.

8.17.2 Relative Property

See *Property, Relative*.

8.17.3 Repr

Short for "representation". The repr of a *Property* defines how the property should be displayed in cases where the display format differs from the storage format. For example, date/time values in Synapse are stored in epoch milliseconds but are displayed in human-friendly "yyyy/mm/dd hh:mm:ss.mmm" format.

8.17.4 Research Tool

See *Tool, Research*.

8.17.5 Role

In Synapse, a role is used to group users with similar authorization needs. You can assign a set of rules (see *Rule*) to a role, and grant the role to users who need to perform those actions.

8.17.6 Root Tag

See *Tag, Root*.

8.17.7 Rule

Within Synapse, a rule is a structure used to assign (grant or prohibit) a specific *Permission* (e.g., `node.tag` or `!view.del`). A rule is assigned to a *User* or a *Role*.

8.17.8 Runt Node

See *Node, Runt*.

8.17.9 Runtime Safe

See *Runtsafe*.

8.17.10 Runtsafe

Short for "runtime safe". Runtsafe refers to the use of variables within Storm. A variable that is **runtsafe** has a value that will not change based on the specific node passing through the Storm pipeline. A variable whose value is explcitly set, such as `$fqdn = woot.com` is an example of a runtsafe varaible.

Contrast with *Non-Runtsafe*.

8.18 S

8.18.1 Secondary Property

See *Property, Secondary*.

8.18.2 Service

Synapse is designed as a modular set of services. Broadly speaking, a service can be thought of as a container used to run an application. We may informally differentiate between a *Synapse Service* and a *Storm Service*.

8.18.3 Service, Storm

A Storm service is a registerable remote component that can provide packages (*Package*) and additional APIs to Storm and Storm commands. A service resides on a *Telepath* API endpoint outside of the *Cortex*.

When the Cortex is connected to a service, the Cortex queries the endpoint to determine if the service is legitimate and, if so, loads the associated package to implement the service.

An advantage of Storm services (over, say, additional Python modules) is that services can be restarted to reload their service definitions and packages while a Cortex is still running – thus allowing a service to be updated without having to restart the entire Cortex.

8.18.4 Service, Synapse

Synapse services make up the core Synapse architecture and include the *Cortex* (data store), *Axon* (file storage), and the commercial *Optic* UI. Synapse services are built on the *Cell* object.

8.18.5 Simple Form

See *Form, Simple*.

8.18.6 Slab

A Slab is a core Synapse component which is used for persisting data on disk into a LMDB backed database. The Slab interface offers an asyncio friendly interface to LMDB objects, while allowing users to largely avoid having to handle native transactions themselves.

8.18.7 Splice

A splice is an atomic change made to data within a Cortex, such as node creation or deletion, adding or removing a tag, or setting, modifying, or removing a property. All changes within a Cortex may be retrieved as individual splices within the Cortex's splice log.

8.18.8 Spotlight Tool

See *Tool, Spotlight*.

8.18.9 Standard Comparison Operator

See *Comparison Operator, Standard*.

8.18.10 Storage Node

See *Node, Storage*.

8.18.11 Stories Tool

See *Tool, Stories*.

8.18.12 Storm

Storm is the custom query language analysts use to interact with data in Synapse.

Storm can also be used as a programming language by advanced users and developers, though this level of expertise is not required for normal use. Many of Synapse's **Power-Ups** (see *Power-Up*) are written in Storm.

See *Storm Reference - Introduction* for additional detail.

8.18.13 Storm Editor

Also "Storm Editor Tool". See *Tool, Storm Editor*.

8.18.14 Storm Service

See *Service, Storm*.

8.18.15 Subquery

Within Synapse, a subquery is a *Storm* query that is executed inside of another Storm query.

See *Storm Reference - Subqueries* for additional detail.

8.18.16 Subquery Filter

See *Filter, Subquery*.

8.18.17 Synapse Service

See *Service, Synapse*.

8.19 T

8.19.1 Tag

Within Synapse, a tag is a label applied to a node that provides additional context about the node. Tags typically represent assessments or judgements about the data represented by the node.

See the *Tag* section in the *Data Model - Terminology* document for additional detail.

8.19.2 Tag, Base

Within Synapse, the lowest (rightmost) tag element in a tag hierarchy. For example, for the tag `#foo.bar.baz`, `baz` is the base tag.

8.19.3 Tag, Leaf

The full tag path / longest tag in a given tag hierarchy. For example, for the tag `#foo.bar.baz`, `foo.bar.baz` is the leaf tag.

8.19.4 Tag, Root

Within Synapse, the highest (leftmost) tag element in a tag hierarchy. For example, for the tag `#foo.bar.baz`, `foo` is the root tag.

8.19.5 Tag Column

See *Column, Tag*.

8.19.6 Tag Explorer

In *Optic*, the Tag Explorer (found in the *Help Tool*) provides an expandable, tree-based listing of all tags in your Synapse *Cortex*, along with their definitions (if present).

8.19.7 Tag Glob Column

See *Column, Tag Glob*.

8.19.8 Telepath

Telepath is a lightweight remote procedure call (RPC) protocol used in Synapse. See *Telepath RPC* in the *Synapse Architecture* guide for additional detail.

8.19.9 Tool, Admin

In *Optic*, the Admin Tool provides a unified interface to perform basic management of users, roles, and permissions; views and layers; and triggers and cron jobs.

8.19.10 Tool, Console

In *Optic*, the Console Tool provides a CLI-like interface to Synapse. It can be used to run Storm queries in a manner similar to the Storm CLI (in the community version of Synapse). In Optic the Console Tool is more commonly used to display status, error, warning, and debug messages, or to view help for built-in Storm commands (see *Storm Reference - Storm Commands*) and / or Storm commands installed by Power-Ups.

8.19.11 Tool, Help

In *Optic*, the central repository for Synapse documentation and assistance. The Help Tool includes the *Data Model Explorer*, *Tag Explorer*, documentation for any installed Power-Ups (see *Power-Up*), links to the public Synapse, Storm, and Optic documents, and version / changelog information.

8.19.12 Tool, Ingest

In *Optic*, the primary tool used to load structured data in CSV, JSON, or JSONL format into Synapse using Storm. The Ingest Tool can also be used to prototype and test more formal ingest code.

8.19.13 Tool, Power-Ups

In *Optic*, the tool used to view, install, update, and remove Power-Ups (see *Power-Up*).

8.19.14 Tool, Research

In *Optic*, the primary tool used to ingest, enrich, explore, visualize, and annotate Synapse data.

8.19.15 Tool, Spotlight

Also known as simply "Spotlight". In *Optic*, a tool used to load and display PDF or HTML content, create an associated `media:news` node, and easily extract and link relevant indicators or other nodes.

8.19.16 Tool, Stories

Also known as simply "Stories". In *Optic*, a tool used to create, collaborate on, review, and publish finished reports. Stories allows you to integrate data directly from the *Research Tool* into your report ("Story").

8.19.17 Tool, Storm Editor

Also known as simply "Storm Editor". In *Optic*, a tool used to compose, test, and store Storm queries (including macros - see *Macro*). Storm Editor includes a number of integrated development environment (IDE) features, including syntax highlighting, auto-indenting, and auto-completion (via `ctrl-space`) for the names of forms, properties, tags, and libraries.

8.19.18 Tool, Workflows

In *Optic*, the tool used to access and work with Workflows (see *Workflow*).

8.19.19 Tool, Workspaces

In *Optic*, the tool used to configure and manage a user's Workspaces (see *Workspace*).

8.19.20 Traverse

Within Synapse, one of the primary methods for interacting with data in a *Cortex*. Traversal refers to navigating the data by crossing ("walking") a lighweight (light) edge (*Edge, Lightweight (Light)*) betweeen nodes. Compare with *Lift*, *Pivot*, and *Filter*.

See *Traverse (Walk) Light Edges* for additional detail.

8.19.21 Trigger

Within Synapse, a trigger is a Storm query that is executed automatically upon the occurrence of a specified event within a Cortex (such as adding a node or applying a tag). "Trigger" refers collectively to the event and the query fired ("triggered") by the event.

See the Storm command reference for the *trigger* command and the *Storm Reference - Automation* for additional detail.

8.19.22 Type

Within Synapse, a type is the definition of a data element within the data model. A type describes what the element is and enforces how it should look, including how it should be normalized.

See the *Type* section in the *Data Model - Terminology* document for additional detail.

8.19.23 Type, Base

Within Synapse, base types include standard types such as integers and strings, as well as common types defined within or specific to Synapse, including globally unique identifiers (`guid`), date/time values (`time`), time intervals (`ival`), and tags (`syn:tag`). Many forms within the Synapse data model are built upon (extensions of) a subset of common types.

8.19.24 Type, Model-Specific

Within Synapse, knowledge-domain-specific forms may themselves be specialized types. For example, an IPv4 address (`inet:ipv4`) is its own specialized type. While an IPv4 address is ultimately stored as an integer, the type has additional constraints, e.g., IPv4 values must fall within the allowable IPv4 address space.

8.19.25 Type Awareness

Type awareness is the feature of the *Storm* query language that facilitates and simplifies navigation through the *Hypergraph* when pivoting across nodes. Storm leverages knowledge of the Synapse *Data Model* (specifically knowledge of the type of each node property) to allow pivoting between primary and secondary properties of the same type across different nodes without the need to explicitly specify the properties involved in the pivot.

8.19.26 Type Enforcement

Within Synapse, the process by which property values are required to conform to value and format constraints defined for that *Type* within the data model before they can be set. Type enforcement helps to limit bad data being entered in to a Cortex by ensuring values entered make sense for the specified data type (e.g., that an IP address cannot be set as the value of a property defined as a domain (`inet:fqdn`) type, and that the integer value of the IP falls within the allowable set of values for IP address space).

8.19.27 Type Normalization

Within Synapse, the process by which properties of a particular type are standardized and formatted in order to ensure consistency in the data model. Normalization may include processes such as converting user-friendly input into a different format for storage (e.g., converting an IP address entered in dotted-decimal notation to an integer), converting certain string-based values to all lowercase, and so on.

8.20 U

8.20.1 Universal Property

See *Property, Universal*.

8.20.2 User

In Synapse, a user is represented by an account in the Cortex. An account is required to authenticate (log in) to the Cortex and is used for authorization (permissions) to access services and perform operations.

8.21 V

8.21.1 Variable

In Storm, a variable is an identifier with a value that can be defined and/or changed during normal execution, i.e., the value is variable.

Contrast with *Constant*. See also *Runtsafe* and *Non-Runtsafe*.

See *Storm Reference - Advanced - Variables* for a more detailed discussion of variables.

8.21.2 View

Within Synapse, a view is a ordered set of layers (see *Layer*) and associated permissions that are used to synthesize nodes from the *Cortex*, determining both the nodes that are visible to users via that view and where (i.e., in what layer) any changes made by a view's users are recorded. A default Cortex consists of a single layer and a single view, meaning that by default all nodes are stored in one layer, all changes are written to that layer, and all users have the same visibility (view) into Synapse's data.

In multi-layer systems, a view consists of the set of layers that should be visible to users of that view, and the order in which the layers should be instantiated for that view. Order matters because typically only the topmost layer is writeable by that view's users, with subsequent (lower) layers read-only. Explicit actions can push upper-layer writes downward (merge) into lower layers.

8.22 W

8.22.1 Workflow

In *Optic*, a Workflow is a customized set of UI elements that provides an intuitive way to perform particular tasks. Workflows may be installed by Synapse Power-Ups (see *Power-Up*) and give users a more tailored means (compared to the *Research Tool* or Storm query bar) to work with Power-Up Storm commands or associated analysis tasks.

8.22.2 Workflows Tool

See *Tool, Workflows*.

8.22.3 Workspace

In *Optic*, a Workspace is a customizable user environment. Users may configure one or more Workspaces; different Workspaces may be designed to support different analysis tasks.

8.22.4 Workspace, Global Default

In *Optic*, a Workspace that has been pre-configured with various custom settings and distributed for use. A Global Default Workspace can be used to share a set of baseline Workspace customizations with a particular group or team.

8.22.5 Workspaces Tool

See *Tool, Workspaces*.

CHAPTER

NINE

SYNAPSE CONTRIBUTORS GUIDE

This Contributors Guide is written for people who will be working on the Synapse code base, contributing to it via code patches, or maintaining written documentation.

The Contributors Guide is a living document and will continue to be updated and expanded. The current sections are:

9.1 Contributing to Synapse

- *Project Style Guide*.
- *Git Hook & Syntax Checking*.
- *Contribution Process*.

9.1.1 Project Style Guide

The following items should be considered when contributing to Synapse:

- The project is not currently strictly PEP8 compliant. Compliant sections include the following:
  - Whitespace in Expressions and Statements.
  - Programming Recommendations regarding singleton comparison (use 'is' instead of equality operators).
- Please keep line lengths under 120 characters.
- Use single quotes for string constants (including docstrings) unless double quotes are required.

```
# Do this
foo = '1234'
# NOT this
foo = "1234"
```

- Use a single line break between top level functions and class definitions, and class methods. This helps conserve vertical space.
  - Do this

```
import foo
import duck

def bar():
    return True
```

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```
def baz():
    return False

class Obj(object):

    def __init__(self, a):
        self.a = a

    def gimmeA(self):
        return self.a
```

  * NOT this

```
import foo
import duck


def bar():
    return True


def baz():
    return False


class Obj(object):

    def __init__(self, a):
        self.a = a


    def gimmeA(self):
        return self.a
```

- Use Google style Python docstrings. This format is very readable and will allow type hinting for IDE users. See the following notes below about our slight twist on this convention.
  - Use ‘’’ quotes instead of “”” for starting/stoping doc strings.
  - Google Style typically has the summary line after the opening ‘’’ marker. Place this summary value on the new line following the opening ‘’’ marker.
  - More information about Google Style docstrings (and examples) can be found at the examples here.
  - We use Napoleon for parsing these doc strings. More info here.
  - Synapse as a project is not written using the Napoleon format currently but all new modules should adhere to that format.
  - Synapse acceptable example:

```
def fooTheBar(param1, param2, **kwargs):
    '''
    Summary line goes first.

```

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```
    Longer description lives here. It can be a bunch of stuff across
    multiple blocks if necessary.

    Example:
        Examples should be given using either the ``Example`` section.
        Sections support any reStructuredText formatting, including
        literal blocks::

            woah = fooTheBar('a', 'b', duck='quacker')

    Section breaks are created by resuming unindented text. Section breaks
    are also implicitly created anytime a new section starts.

    `PEP 484`_ type annotations are supported. If attribute, parameter, and
    return types are annotated according to `PEP 484`_, they do not need to be
    included in the docstring:

    Args:
        param1 (int): The first parameter.
        param2 (str): The second parameter.

    Keyword Arguments:
        duck (str): Optional keyword args which come in via **kwargs call␣
↪conventions,
                    which modify function behavior, should be documented under␣
↪the
                    Keyword Args section.

    Returns:
        bool: The return value. True for success, False otherwise.

              The ``Returns`` section supports any reStructuredText formatting,
              including literal blocks::

                  {
                      'param1': param1,
                      'param2': param2
                  }

    Raises:
        AttributeError: The ``Raises`` section is a list of all exceptions
            that are relevant to the interface.
        ValueError: If `param2` is equal to `param1`.


    .. _PEP 484:
        https://www.python.org/dev/peps/pep-0484/

    """
    # Do stuff the with args...
```

- Imports should first be sorted in order of shortest to longest import, then by alphabetical order (when lengths match). Imports should be ordered starting from the Python standard library first, then any third party packages,

then any Synapse specific imports. The following example shows the recommended styling for imports:

```
# Stdlib
import logging
import collections
# Third Party Code
import barlib.duck as b_duck
import foolib.thing as f_thing
# Synapse Code
import synapse.common as s_common
import synapse.cortex as s_cortex
import synapse.lib.config as s_config
```

- Previously we used * imports in the Synapse codebase (especially around synapse.exc and synapse.common). If common functions or exceptions are needed, import synapse.common as noted above, and both the common functions and the entirety of synapse.exc exceptions will be available. This provides a consistent manner for referencing common functions and Synapse specific exception classes. New code should generally not use * imports. Here is an example:

```
# Do this
import synapse.common as s_common
tick = s_common.now()
if tick < 1000000000:
   raise s_common.HitMaxTime(mesg='We have gone too far!')

# NOT this
from synapse.common import *
tick = now()
if tick < 1000000000:
   raise HitMaxTime(mesg='We have gone too far!')
```

- Function names should follow the mixedCase format for anything which is exposed as a externally facing API on a object or module.

```
# Do this
fooTheBar()
# NOT this
foo_the_bar()
```

- Private methods should be marked as such with a proceeding underscore.

```
# Do this
_internalThing()
# NOT this
privateInternalThingDontUseMe()
```

  - The corollary to this is that any function which is not private may be called arbitrarily at any time, so avoid public API functions which are tightly bound to instance state. For example, if a processing routine is broken into smaller subroutines for readability or testability, these routines are likely private and should not be exposed to outside callers.

- Function calls with mandatory arguments should be called with positional arguments. Do not use keyword arguments unless necessary.

```
def foo(a, b, duck=None):
   print(a, b, duck)

# Do this
foo('a', 'b', duck='quacker')
# Not this
foo(a='a', b='b', duck='quacker')
```

- Avoid the use of @property decorators. They do not reliably work over the telepath RMI.
- Logging should be setup on a per-module basis, with loggers created using calls to logging.getLogger(__name__). This allows for module level control of loggers as neccesary.
  - Logger calls should use logging string interpolation, instead of using % or .format() methods. See Python Logging module docs for reference.
  - Example:

```
# Get the module level logger
logger = logging.getLogger(__name__)
# Do this - it only forms the final string if the message is
# actually going to be logged
logger.info('I am a message from %s about %s', 'bob', 'a duck')
# NOT this - it performs the string format() call regardless of
# whether or not the message is going to be logged.
logger.info('I am a message from {} about {}'.format('bob', 'a duck'))
```

- Convenience methods are available for unit tests, primarily through the SynTest class. This is a subclass of unittest.TestCase and provides many short aliases for the assert* functions that TestCase provides.
  - Ensure you are closing resources which may be open with test cases. Many Synapse objects may be used as content managers which make this easy for test authors.
- Avoid the use of the built-in `re` module. Instead use the third-party `regex` module. `regex` is preferred due to known bugs with unicode in the `re` module. Additionally, `regex` does provide some performance benefits over `re`, especially when using pre-compiled regular expression statements.
- Whenever possible, regular expressions should be pre-compiled. String matches/comparisons should be performed against the pre-compiled regex instance.

```
# Do this
fqdnre = regex.compile(r'^[\w._-]+$', regex.U)

def checkValue(valu):
    if not fqdnre.match(valu):
        self._raiseBadValu(valu)

# NOT this
def checkValue(valu):
    if not regex.match(r'^[\w._-]+$', valu, regex.U)
        self._raiseBadValu(valu)
```

- Return values should be preferred over raising exceptions. Functions/methods that return a value should return None (or a default value) in the case of an error. The logic behind this is that it is much easier, cleaner, faster to check a return value than to handle an exception.

  Raising exceptions is reserved for "exceptional circumstances" and should not be used for normal program flow.

```
# Do this
def getWidgetById(self, wid):
    widget_hash = self._index.get(wid)
    if widget_hash is None:
        return None

    widget = self._widgets.get(widget_hash)
    return widget

# NOT this
def getWidgetById(self, wid):
    widget_hash = self._index.get(wid)
    if widget_hash is None:
        raise NotFoundError

    widget = self._widgets.get(widget_hash)
    if widget is None:
        raise NotFoundError

    return widget
```

Contributions to Synapse which do not follow the project style guidelines may not be accepted.

9.1.2 Git Hook & Syntax Checking

A set of helper scripts are available for doing python syntax checking. Basic syntax checking can be run with the `pycodestyle` tool; while a a git pre-commit hook; and a script to run autopep8 on staged git files also exist to make life easier.

The pre-commit hook does syntax checking on .py files which contain invalid syntax. The hook will **ALSO** run nbstripout on .ipynb files to remove output data from cells. This results in cleaner diffs for .ipynb files over time.

1. An example of running the generic syntax check script is seen below:

```
~/git/synapse$ python -m pycodestyle
./synapse/tests/test_lib_types.py:397: [E226] missing whitespace around arithmetic␣
↪operator
./synapse/tests/test_lib_types.py:398: [E226] missing whitespace around arithmetic␣
↪operator
```

2. Installing the git hook is easy:

```
cp scripts/githooks/pre-commit .git/hooks/pre-commit
chmod +x .git/hooks/pre-commit
```

3. After installing the hook, attempting a commit with a syntax error will fail

```
~/git/synapse$ git commit -m "Demo commit"
PEP8 style violations have been detected.  Please fix them
or force the commit with "git commit --no-verify".

./synapse/tests/test_lib_types.py:397: [E226] missing whitespace around arithmetic␣
↪operator
```

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```
./synapse/tests/test_lib_types.py:398: [E226] missing whitespace around arithmetic␣
↪operator
```

4. This may be automatically fixed for you using the `pep8_staged_files.py` script. Note that **most**, but not **all** syntax errors may be fixed with the helper script.

```
# Run the pep8_staged_files.py script
~/git/synapse$ ./scripts/pep8_staged_files.py
# Check the diff
~/git/synapse$ git diff synapse/tests/test_lib_types.py
diff --git a/synapse/tests/test_lib_types.py b/synapse/tests/test_lib_types.py
index 0e3a7498..b81575ef 100644
--- a/synapse/tests/test_lib_types.py
+++ b/synapse/tests/test_lib_types.py
 class TypesTest(s_t_utils.SynTest):

     def test_type(self):
@@ -397,8 +395,8 @@ class TypesTest(s_t_utils.SynTest):
             self.eq({node.ndef[1] for node in nodes}, {'m'})
             nodes = await alist(core.eval('testcomp +testcomp*range=((1024,␣
↪grinch), (4096, zemeanone))'))
             self.eq({node.ndef[1] for node in nodes}, {(2048, 'horton'), (4096,
↪'whoville')})
-            guid0 = 'B'*32
-            guid1 = 'D'*32
+            guid0 = 'B' * 32
+            guid1 = 'D' * 32
             nodes = await alist(core.eval(f'testguid +testguid*range=({guid0},
↪{guid1})'))
             self.eq({node.ndef[1] for node in nodes}, {'c' * 32})
             nodes = await alist(core.eval('testint | noderefs |␣
↪+testcomp*range=((1000, grinch), (4000, whoville))'))

# Add the file and commit
~/git/synapse$ git add synapse/tests/test_lib_types.py
~/git/synapse$ git commit -m "Demo commit"
[some-branch f254f5bf] Demo commit
 1 file changed, 3 insertions(+), 2 deletions(-)
```

9.1.3 Contribution Process

The Vertex Project welcomes contributions to the Synapse Hypergraph framework in order to continue its growth!

In order to contribute to the project, do the following:

1. Fork the Synapse repository from the Vertex Project. Make a new branch in git with a descriptive name for your change. For example:

```
git checkout -b foohuman_new_widget
```

2. Make your changes. Changes should include the following information:

   - Clear documentation for new features or changed behavior

- Unit tests for new features or changed behaviors
- If possible, unit tests should also show minimal use examples of new features.

3. Ensure that both your tests and existing Synapse tests successfully run. You can do that manually via the python unittest module, or you can set up CircleCI to run tests for your fork (this is a exercise for the reader). The following examples shows manual test runs:

```
pytest -v
pytest -v synapse/tests/your_test_file.py
```

If test coverage is desired, you can use the provided testrunner.sh shell script to run a test. This script will generate HTML coverage reports and attempt to open those reports using xdg-open. This requires the pytest, pytest-cov, pytest-xdist packages to be installed.

```
./scripts/testrunner.sh
./scripts/testrunner.sh synapse/tests/your_test_file.py
./scripts/testrunner.sh synapse/tests/your_test_file.py::YourTestClass
./scripts/testrunner.sh synapse/tests/your_test_file.py::YourTestClass::test_
↪function
```

4. Rebase your feature branch on top of the latest master branch of the Vertex Project Synapse repository. This may require you to add the Vertex Project repository to your git remotes. The following example of rebasing can be followed:

```
# Add the Vertex project repository as a remote named "upstream".
git remote add upstream https://github.com/vertexproject/synapse.git
# Grab data from the upstream repository
git fetch --all
# Change to your local git master branch
git checkout master
# Merge changes from upstream/master to your local master
git merge upstream/master
# Move back to your feature branch
git checkout foohuman_new_feature
# Rebase your feature branch ontop of master.
# This may require resolving merge conflicts.
git rebase master
# Push your branch up to to your fork - this may require a --force
# flag if you had previously pushed the branch prior to the rebase.
git push
```

5. Ensure your tests still pass with the rebased feature branch.
6. If your changes require extensive documentation, please very your API documentation builds properly and any additional user or devops docs are created as needed. See *Synapse Doc Mastering* for documentation mastering notes.
7. Create the Pull Request in Github, from your fork's feature branch to the master branch of the Vertex Project Synapse repository. Include a description and a reference to any open issues related to the PR.

9.2 Synapse Doc Mastering

Documentation for creation and generation of documentation for Synapse.

9.2.1 Generating Docs Locally

API documentation is automatically generated from docstrings, and additional docs may also be added to Synapse as well for more detailed discussions of Synapse subsystems. This is currently done via readthedocs.

In order to do local doc generation you can do the following steps:

1. Install the following packages (preferably in a virtualenv):

```
# cd to your synapse checkout
cd synapse
# Install additional packages - this assumes the environment already has
# any additional packages required for executing synapse code in it.
python -m pip install -U -r requirements_doc.txt
# Alternativly, you can install synapse directly in develop mode with pip
# python -m pip install .[docs]

# Install pandoc package, required for building HTML.
# This may require sudo access depending on your environment.
apt install pandoc
```

2. Build the docs using sphinx. A makefile is provided which makes this easy.

```
# Go to your synapse repo
cd synapse
# Go to the docs folder
cd docs
# Use the make command to build the HTML docs
make html
```

3. Now you can open the HTML docs for browsing them.

```
xdg-open _build/html/index.html
```

4. To rebuild documentation from scratch you can delete the _build directory and the `api` directories. Deleting the `api` directory will cause the automatic Synapse API documentation to be rebuilt.

```
# Delete the _build directory
make clean
# Remove all old files and remove the autodocs directory
rm -rf synapse/autodocs
```

9.2.2 Mastering Docs

Synapse documents are mastered using either raw ReStructuredText (.rst) files or as Jupyter Notebooks (.ipynb). Notebooks should be used for documenting anything which may include Storm or code examples, so that the examples can be written in a manner that can be asserted, so the documentation can be tested in the CI pipeline. Notebooks are also executed during sphinx document build steps, so any output is current as of document build time. Text in Notebooks should be mastered as RST using raw NbConvert cells.

In general, docs for Synapse fall into two categories: User guides and devops guides. User guides should be mastered in `./docs/synapse/userguides` and devops guides should be mastered in `./docs/synapse/devops`. Additional top level sections may be added over time.

In order to master Notebooks, you will need to setup the hide_code extension for Jupyter. That is used to selectively hide code and output blocks as needed. For example, this allows use to hide the code used to run a Storm command and show the output.

The following steps are a high level overview of the process to setup Jupyter and add or edit notebooks for documentation purposes.

- Setup the hide_code extension:

```
# Then install & enable the Jupyter hide-code extension
# This only has to be run once.
jupyter nbextension install --py --user hide_code
jupyter nbextension enable --py --user hide_code
jupyter serverextension enable --py --user hide_code
```

- Launch Jupyter to run a local notebook server:

```
# Go to your synapse repo
cd synapse
# Launch the notebook server
jupyter notebook
```

- Navigate to the docs directory in Jupyter. Create a new notebook or open an existing notebook as needed. This will likely be located under the `docs/synapse/userguides` or `docs/synapse/devops` directories.
- For Storm CLI integration, you can add the following code block into the first code cell in order to get some Synapse Jupyter helpers:

```
import os, sys
try:
    from synapse.lib.jupyter import *
except ImportError as e:
    # Insert the root path of the repository to sys.path.
    # This assumes the notebook is located three directories away
    # From the root synapse directory. It may need to be varied
    synroot = os.path.abspath('../../../')
    sys.path.insert(0, synroot)
    from synapse.lib.jupyter import *
```

- You can use helpers to execute storm commands in the following fashion to get a CoreCmdr object, execute a storm query printing the CLI ouput to screen, while asserting the number of nodes returned, and then closing the object.

```
# Get a CoreCmdr object
corecmdr = await getTempCoreCmdr()
# Execute the query and get the packed nodes.
podes = await corecmdr.eval('[inet:ipv4=1.2.3.4]',
                            num=1, cmdr=True)
```

```
cli> storm [inet:ipv4=1.2.3.4]
Executing query at 2023/07/12 15:13:45.126
...
inet:ipv4=1.2.3.4
        .created = 2023/07/12 15:13:47.120
        :type = unicast
complete. 1 nodes in 1995 ms (0/sec).
```

- We have a helper function available from the `synapse.lib.jupyter` imported earlier called `getDocData(fn)`. It will look for a given filename in the `docs/docdata` directory; and get its data. If the file ends with `.json`, `.jsonl`, `.yaml`, or `.mpk` we will return the decoded data, otherwise we will return the raw bytes. This uses a function called `getDocPath(fn)` which will find and return a file under the `docs\docdata` directory.

  There is an example below showing the use of this to load a json file located at `docs/docdata/mastering_example_ingest.json`, and adding the data to the Cortex via the `addFeedData()` function.

```
fn = 'mastering_example_ingest.json'
data = getDocData(fn)
await corecmdr.addFeedData('syn.nodes', data)
podes = await corecmdr.eval('#example', num=2, cmdr=True)
```

```
cli> storm #example
Executing query at 2023/07/12 15:13:47.173
inet:ipv4=0.0.0.1
        .created = 2023/07/12 15:13:47.153
        :type = private
        #example
inet:fqdn=woot.com
        .created = 2023/07/12 15:13:47.154
        :domain = com
        :host = woot
        :issuffix = false
        :iszone = true
        :zone = woot.com
        #example
complete. 2 nodes in 17 ms (117/sec).
```

- Since the Code cells are persistent, you can reuse the objects from earlier cells until a resource has been closed (`.fini()`'d). The following example shows using the `corecmdr` object from the above code section to lift a node and print it to the screen.

```
from pprint import pprint # We want to make our nodes pretty
podes = await(corecmdr.eval('inet:ipv4'))
for pode in podes:
    pprint(pode)
```

```
(('inet:ipv4', 1),
 {'iden': '2f70f448adcc6e9b9846aecfd034efc4f9d583e614f1b3489d1cf1d32fb64667',
  'nodedata': {},
  'path': {},
  'props': {'.created': 1689174827153, 'type': 'private'},
  'tagprops': {},
  'tags': {'example': (None, None)}})
(('inet:ipv4', 16909060),
 {'iden': '20153b758f9d5eaaa38e4f4a65c36da797c3e59e549620fa7c4895e1a920991f',
  'nodedata': {},
  'path': {},
  'props': {'.created': 1689174827120, 'type': 'unicast'},
  'tagprops': {},
  'tags': {}})
```

- We can also execute a line of text in the CLI directly with the `runCmdLine()` function. For example, we can use this to execute the `help` command and see all available commands to the raw CLI object. This will always print the CLI output to the Jupyter cell output.

```
# Run the help command.
text = 'help'
await corecmdr.runCmdLine(text)
```

```
cli> help
at      - Adds a non-recurring cron job.
cron    - Manages cron jobs in a cortex.
help    - List commands and display help output.
hive    - Manipulates values in a cell's Hive.
kill    - Kill a running task/query within the cortex.
locs    - List the current locals for a given CLI object.
log     - Add a storm log to the local command session.
ps      - List running tasks in the cortex.
quit    - Quit the current command line interpreter.
storm   - Execute a storm query.
trigger - Manipulate triggers in a cortex.
```

- In the above example, there is some Python syntax highlighting occuring. This may not be desired. In order to disable that, add the following to the first line of the RST body of a document:

  ```
  .. highlight::  none
  ```

  This will disable all code highlighting in a given document, until another `highlight` directive is encountered.

- The following code and output will have their highlighting disabled, via the use of a pair of `highlight` directives before and after the code cell. The first directive disabled highlighting, and the subsequent directive re-enabled it for python3 highlighting.

  Read the Sphinx Literal documentation for additional information about highlighting controls.

```
# Run the help command again.
text = 'help'
await corecmdr.runCmdLine(text)
```

```
cli> help
at      - Adds a non-recurring cron job.
```

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```
cron    - Manages cron jobs in a cortex.
help    - List commands and display help output.
hive    - Manipulates values in a cell's Hive.
kill    - Kill a running task/query within the cortex.
locs    - List the current locals for a given CLI object.
log     - Add a storm log to the local command session.
ps      - List running tasks in the cortex.
quit    - Quit the current command line interpreter.
storm   - Execute a storm query.
trigger - Manipulate triggers in a cortex.
```

- When we are done with the CoreCmdr object, we should `fini()` is to remove any resources it may have created. This is done below.

```
# Close the object.
_ = await corecmdr.fini()
```

- You can enable the hide_code options by selecting the "View -> Cell Toolbar -> Hide code" option. This will allow you to optionally hide code or output blocks.
- After adding text and code to a notebook, ensure that it runs properly and any produces the expected outputs. You can then mark any code cells for hiding as necessary; then save your notebook. You can then follow the earlier instructions for how to build and view the docs locally.
- Once new documents are made, they will needto be added to the appropriate toctree directive. There are three index documents:
  - index.rst - This controls top-level documentation ordering. It generally should not need to be edited unless adding a new top level document or adding an additional section to the second level Synapse directory.
  - synapse/userguide.rst - This controls the TOC ordering for user guides.
  - synapse/devops.rst - The controls the TOC ordering for devops guides.
- Add notebooks to the repository using `git add ..path/to/notebook.ipynb`. You can then commit the notebook using `git commit`. If you have the git pre-commit hook from `scripts/githooks/pre-commit`, this will strip any output from the notebook upon commit time. This will result in cleaner `git diff` views over time. See *Git Hook & Syntax Checking*

9.2.3 Under the hood

Docs are built from Notebooks using a custom `conf.py` file which executes the notebooks, converting them to RST and using a custom template which looks for flags set by the `hide_code` extension in order to hide the blocks as needed.

9.3 Synapse Release Process

This doc details the release process we use for Synapse.

9.3.1 Github Milestone Management

The current milestone and the next milestone should be created in github. For example, if the current release is v0.2.1, we should have a v0.2.2 and v0.2.3 milestones created. When PRs are created or issues are addressed (via PR), they should be added to the milestone. This allows us to easily pull stories and PRs for release note generation.

9.3.2 Release Notes Format

Release notes should be compiled from the issues and PRs assigned to the milestone being released. These can all be obtained via a issue search in github. For example, if we're releasing v0.2.2, we can pull all the stories via the following query in github:

```
milestone:v0.2.2
```

Release notes should break things out by the following categories:

1. New Features in Synapse & Enhancements to existing features
2. Bugfixes
3. Major documentation updates

Short text form is fine for describing these.

9.3.3 Cutting the Release

This includes three parts:

1. Preparing the release notes/changelog information.
2. Tagging the release and pushing to github.
3. Close out the milestone in Github.

Preparing The Release Notes

Changelog notes are kept in the `CHANGELOG.rst` file. This allows us to keep a copy of the release notes in the repository, as well as having them automatically built into our documentation. This file needs to be updated prior to the release tagging. The formatting for adding the content to the file is the following:

```
<git tag> - YYYY-MM-DD
======================

Features and Enhancements
-------------------------

- Add new features (`#XXX <https://github.com/vertexproject/synapse/pull/XXX>`_)

Bugfixes
--------

- Fix old bugs (`#XXX <https://github.com/vertexproject/synapse/pull/XXX>`_)

Improved Documentation
----------------------
```

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```
- Write awesome docs (`#XXX <https://github.com/vertexproject/synapse/pull/XXX>`_)
```

This also allows for machine parseable notes so that `pyup.io` can show our changelogs.

It is recommended that as new PRs are made, the PR includes an update to the `CHANGELOG.rst` file so that during a release, notes don't have to be updated. If that has been done; a simple double check of the issues in the Github milestone should show anything missing.

When prepping the release, it is okay to add a blank template with the tag set to the next patch value and TBD date, so that PRs have a place to put their changelogs as they come in.

Tagging the Release

Version tagging in Synapse is managed by bumpversion. This handles updating the .py files containing the version number in them, as well as creating git tags and commit messages. There should not be a need to manually edit version numbers or do git commits.

bumpversion is a python application, and can be installed via pip:

```
python -m pip install bumpversion
```

Warning: Do *not* use `bump2version`, the API compatible fork of bumpversion. It changed how tags are made which are incompatible with our current CircleCI based workflows.

Bumpversion is designed for projects which do semantic versioning. This can be done via the following (assuming the vertexproject/synapse remote is called 'upstream'):

```
# Ensure we're on master with the latest version
git checkout master && git fetch --all && git merge upstream/master
# Do a dry-run to ensure that we're updating things properly
bumpversion --dry-run --verbose patch
# Bump the patch version
bumpversion --verbose patch
# Ensure that no erroneous changes were introduced by bumvpersion
git show HEAD
# Push the new commit and tag up to github
git push upstream
# Push the new tag up explicitly. Do not use --tags
git push upstream <the new tag>
```

Next, go to github at https://github.com/vertexproject/synapse/tags and edit the release notes for the tag that was pushed up. Add a link to the release notes from the readthedocs changelog page for the current release.

Closing Milestone in Github

Close out the milestone associated with the just released version at the milestones page so no new issues are added to it.

Publishing on Pypi

Publishing packages to PyPI is done via CircleCi configuration.

Updating Docker images

Publishing docker images to DockerHub is done via CircleCi configuration.

CHAPTER

TEN

SYNAPSE PYTHON API

10.1 synapse package

The synapse intelligence analysis framework.

10.1.1 Subpackages

synapse.cmds package

Submodules

synapse.cmds.boss module

class synapse.cmds.boss.**KillCmd**(*cli*, ***opts*)

Bases: *Cmd*

Kill a running task/query within the cortex.

Syntax:
kill <iden>

Users may specify a partial iden GUID in order to kill exactly one matching process based on the partial guid.

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.cmds.boss.**PsCmd**(*cli*, ***opts*)

Bases: *Cmd*

List running tasks in the cortex.

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

synapse.cmds.cortex module

class synapse.cmds.cortex.**Log**(*cli*, ***opts*)

Bases: *Cmd*

Add a storm log to the local command session.

Notes

By default, the log file contains all messages received from the execution of a Storm query by the current CLI. By default, these messages are saved to a file located in ~/.syn/stormlogs/storm_(date).(format).

Examples

Enable logging all messages to mpk files (default) log –on

Disable logging and close the current file log –off

Enable logging, but only log edits. Log them as jsonl instead of mpk. log –on –edits-only –format jsonl

Enable logging, but log to a custom path: log –on –path /my/aweome/log/directory/storm20010203.mpk

Log only the node messages which come back from a storm cmd execution. log –on –nodes-only –path /my/awesome/log/directory/stormnodes20010203.mpk

closeLogFd()

encodeMsg(*mesg*)

Get byts for a message

onStormMesg(*mesg*)

openLogFd(*opts*)

queueLoop()

async **runCmdOpts**(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

save(*mesg*)

splicetypes = ('tag:add', 'tag:del', 'node:add', 'node:del', 'prop:set', 'prop:del', 'tag:prop:set', 'tag:prop:del')

class synapse.cmds.cortex.**StormCmd**(*cli*, ***opts*)

Bases: *Cmd*

Execute a storm query.

Syntax:
storm <query>

Parameters
query – The storm query

Optional Arguments:

–hide-tags: Do not print tags. –hide-props: Do not print secondary properties. –hide-unknown: Do not print messages which do not have known handlers. –show-nodeedits: Show full nodeedits (otherwise printed as a single . per edit). –editformat <format>: What format of edits the server shall emit.

Options are

- nodeedits (default),
- splices (similar to < 2.0.0),
- count (just counts of nodeedits), or
- none (no such messages emitted).

–show-prov: Show provenance messages. –raw: Print the nodes in their raw format. This overrides –hide-tags and –hide-props. –debug: Display cmd debug information along with nodes in raw format. This overrides other display arguments. –path: Get path information about returned nodes. –show <names>: Limit storm events (server-side) to the comma-separated list. –file <path>: Run the storm query specified in the given file path. –optsfile <path>: Run the query with the given options from a JSON/YAML file.

Examples

storm inet:ipv4=1.2.3.4 storm –debug inet:ipv4=1.2.3.4

editformat_enums = ('nodeedits', 'splices', 'count', 'none')

printf(*mesg*, *addnl=True*, *color=None*)

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters

opts (*dict*) – Options dictionary.

synapse.cmds.cron module

class synapse.cmds.cron.**At**(*cli*, ***opts*)

Bases: *Cmd*

Adds a non-recurring cron job.

It will execute a Storm query at one or more specified times.

List/details/deleting cron jobs created with 'at' use the same commands as other cron jobs: cron list/stat/del respectively.

Syntax:

at (time|+time delta)+ {query}

Notes

This command accepts one or more time specifications followed by exactly one storm query in curly braces. Each time specification may be in synapse time delta format (e.g + 1 day) or synapse time format (e.g. 20501217030432101). Seconds will be ignored, as cron jobs' granularity is limited to minutes.

All times are interpreted as UTC.

The other option for time specification is a relative time from now. This consists of a plus sign, a positive integer, then one of 'minutes, hours, days'.

Note that the record for a cron job is stored until explicitly deleted via "cron del".

Examples

Run a storm query in 5 minutes at +5 minutes {[inet:ipv4=1]}

Run a storm query tomorrow and in a week at +1 day +7 days {[inet:ipv4=1]}

Run a query at the end of the year Zulu at 20181231Z2359 {[inet:ipv4=1]}

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.cmds.cron.**Cron**(*cli*, ***opts*)

Bases: *Cmd*

Manages cron jobs in a cortex.

Cron jobs are rules persistently stored in a cortex such that storm queries automatically run on a time schedule.

Cron jobs may be be recurring or one-time. Use the 'at' command to add one-time jobs.

A subcommand is required. Use 'cron -h' for more detailed help.

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

synapse.cmds.hive module

class synapse.cmds.hive.**HiveCmd**(*cli*, ***opts*)

Bases: *Cmd*

Manipulates values in a cell's Hive.

A Hive is a hierarchy persistent storage mechanism typically used for configuration data.

static parsepath(*path*)

Turn a slash-delimited path into a list that hive takes

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

synapse.cmds.trigger module

class synapse.cmds.trigger.**Trigger**(*cli*, ***opts*)

Bases: *Cmd*

Manipulate triggers in a cortex.

Triggers are rules persistently stored in a cortex such that storm queries automatically run when a particular event happens.

A subcommand is required. Use *trigger -h* for more detailed help.

async **runCmdOpts**(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

synapse.data package

synapse.data.**get**(*name*, *defval=None*)

Return an object from the embedded synapse data folder.

Example

for tld in synapse.data.get('iana.tlds'):
dostuff(tld)

NOTE: Files are named synapse/data/<name>.mpk

synapse.data.**path**(**names*)

synapse.lib package

Subpackages

synapse.lib.crypto package

Submodules

synapse.lib.crypto.coin module

synapse.lib.crypto.coin.**bch_check**(*match: Match*)

synapse.lib.crypto.coin.**btc_base58_check**(*match: Match*)

synapse.lib.crypto.coin.**btc_bech32_check**(*match: Match*)

synapse.lib.crypto.coin.**cardano_byron_check**(*match: Match*)

synapse.lib.crypto.coin.**cardano_shelly_check**(*match: Match*)

synapse.lib.crypto.coin.**eth_check**(*match: Match*)

synapse.lib.crypto.coin.**ether_eip55**(*body: str*)

synapse.lib.crypto.coin.**logger = <Logger synapse.lib.crypto.coin (WARNING)>**

synapse.lib.crypto.coin contains functions for verifying whether or not a given regex match containing a valu is valid for a given type of coin.

these functions are intended to be used with synapse.lib.scrape.

synapse.lib.crypto.coin.**substrate_check**(*match: Match*)

synapse.lib.crypto.coin.**xrp_check**(*match: Match*)

synapse.lib.crypto.ecc module

class synapse.lib.crypto.ecc.**PriKey**(*priv*)

Bases: object

A helper class for using ECC private keys.

dump()

Get the private key bytes in DER/PKCS8 format.

Returns
The DER/PKCS8 encoded private key.

Return type
bytes

exchange(*pubkey*)

Perform a ECDH key exchange with a public key.

Parameters
pubkey (PubKey) – A PubKey to perform the ECDH with.

Returns
The ECDH bytes. This is deterministic for a given pubkey and private key.

Return type
bytes

static generate()

Generate a new ECC PriKey instance.

Returns
A new PriKey instance.

Return type
PriKey

iden()

Return a SHA256 hash for the public key (to be used as a GUID).

Returns
The SHA256 hash of the public key bytes.

Return type
str

static load(*byts*)

Create a PriKey instance from DER/PKCS8 encoded bytes.

Parameters
byts (*bytes*) – Bytes to load

Returns
A new PubKey instance.

Return type
PriKey

public()

Get the PubKey which corresponds to the ECC PriKey.

Returns
A new PubKey object whose key corresponds to the private key.

Return type
PubKey

sign(*byts*)

Compute the ECC signature for the given bytestream.

Parameters
byts (*bytes*) – The bytes to sign.

Returns
The RSA Signature bytes.

Return type
bytes

class synapse.lib.crypto.ecc.**PubKey**(*publ*)

Bases: object

A helper class for using ECC public keys.

dump()

Get the public key bytes in DER/SubjectPublicKeyInfo format.

Returns
The DER/SubjectPublicKeyInfo encoded public key.

Return type
bytes

iden()

Return a SHA256 hash for the public key (to be used as a GUID).

Returns
The SHA256 hash of the public key bytes.

Return type
str

static load(*byts*)

Create a PubKey instance from DER/PKCS8 encoded bytes.

Parameters
byts (*bytes*) – Bytes to load

Returns
A new PubKey instance.

Return type
PubKey

verify(*byts*, *sign*)

Verify the signature for the given bytes using the ECC public key.

Parameters

- **byts** (*bytes*) – The data bytes.
- **sign** (*bytes*) – The signature bytes.

Returns
True if the data was verified, False otherwise.

Return type
bool

synapse.lib.crypto.ecc.**doECDHE**(*statprv_u*, *statpub_v*, *ephmprv_u*, *ephmpub_v*, *length=64*, *salt=None*, *info=None*)

Perform one side of an Ecliptic Curve Diffie Hellman Ephemeral key exchange.

Parameters

- **statprv_u** (PriKey) – Static Private Key for U
- **(PubKey** (*statpub_v*) – Static Public Key for V
- **ephmprv_u** (PriKey) – Ephemeral Private Key for U
- **ephmpub_v** (PubKey) – Ephemeral Public Key for V
- **length** (*int*) – Number of bytes to return
- **salt** (*bytes*) – Salt to use when computing the key.
- **info** (*bytes*) – Additional information to use when computing the key.

Notes

This makes no assumption about the reuse of the Ephemeral keys passed to the function. It is the caller's responsibility to destroy the keys after they are used for doing key generation. This implementation is the dhHybrid1 scheme described in NIST 800-56A Revision 2.

Returns
The derived key.

Return type
bytes

synapse.lib.crypto.passwd module

async synapse.lib.crypto.passwd.**checkShadowV2**(*passwd: AnyStr*, *shadow: Dict*) → bool

Check a password against a shadow dictionary.

Parameters

- **passwd** (*str*) – Password to check.
- **shadow** (*dict*) – Data to check the password against.

Returns

True if the password is valid, false otherwise.

Return type

bool

async synapse.lib.crypto.passwd.**getPbkdf2**(*passwd: AnyStr*) → Dict

async synapse.lib.crypto.passwd.**getShadowV2**(*passwd: AnyStr*) → Dict

Get the shadow dictionary for a given password.

Parameters

- **passwd** (*str*) – Password to hash.
- **ptyp** (*str*) – The password hash type.

Returns

A dictionary containing shadowed password information.

Return type

dict

async synapse.lib.crypto.passwd.**verifyPbkdf2**(*passwd: AnyStr*, *shadow: Dict*) → bool

synapse.lib.crypto.rsa module

class synapse.lib.crypto.rsa.**PriKey**(*priv*)

Bases: object

A helper class for using RSA private keys.

Signing methods use RSA-PSS and MFG1 with sha256 hashing.

iden()

Return a SHA256 hash for the public key (to be used as a GUID).

Returns

The SHA256 hash of the public key bytes.

Return type

str

public()

Get the PubKey which corresponds to the RSA PriKey.

Returns

A new PubKey object whose key corresponds to the private key.

Return type

PubKey

sign(*byts*)

Compute the RSA signature for the given bytestream.

Parameters
byts (*bytes*) – The bytes to sign.

Returns
The RSA Signature bytes.

Return type
bytes

signitem(*item*)

Compute the RSA signature for the given python primitive.

Parameters
item – The item to sign. This will be flattened and msgpacked prior to signing.

Returns
The RSA Signature bytes.

Return type
bytes

class synapse.lib.crypto.rsa.**PubKey**(*publ*)

Bases: object

A helper class for using RSA public keys.

dump()

Get the public key bytes in DER/SubjectPublicKeyInfo format.

Returns
The DER/SubjectPublicKeyInfo encoded public key.

Return type
bytes

iden()

Return a SHA256 hash for the public key (to be used as a GUID).

Returns
The SHA256 hash of the public key bytes.

Return type
str

static load(*byts*)

Create a PubKey instance from DER/PKCS8 encoded bytes.

Parameters
byts (*bytes*) – Bytes to load

Returns
A new PubKey instance.

Return type
PubKey

verify(*byts*, *sign*)

Verify the signature for the given bytes using the RSA public key.

Parameters

- **byts** (*bytes*) – The data bytes.
- **sign** (*bytes*) – The signature bytes.

Returns
True if the data was verified, False otherwise.

Return type
bool

`verifyitem`(*item*, *sign*)

Verify the signature for the given item with the RSA public key.

Parameters

- **item** – The Python primitive to verify.
- **sign** (*bytes*) – The signature bytes.

Returns
True if the data was verified, False otherwise.

Return type
bool

synapse.lib.crypto.tinfoil module

`class synapse.lib.crypto.tinfoil.CryptSeq`(*rx_key*, *tx_key*, *initial_rx_seq=0*, *initial_tx_seq=0*)

Bases: `object`

Applies and verifies sequence numbers of encrypted messages coming and going

Parameters

- **rx_key** (*bytes*) – TX key (used with TinFoilHat).
- **tx_key** (*bytes*) – RX key (used with TinFoilHat).
- **initial_rx_seq** (*int*) – Starting rx sequence number.
- **initial_tx_seq** (*int*) – Starting tx sequence number.

`decrypt`(*ciphertext*)

Decrypt a message, validating its sequence number is as we expect.

Parameters
ciphertext (*bytes*) – The message to decrypt and verify.

Returns
A mesg.

Return type
mesg

Raises
s_exc.CryptoErr – If the message decryption fails or the sequence number was unexpected.

`encrypt`(*mesg*)

Wrap a message with a sequence number and encrypt it.

Parameters
mesg – The mesg to encrypt.

Returns
The encrypted message.

Return type
bytes

class synapse.lib.crypto.tinfoil.**TinFoilHat**(*ekey*)

Bases: object

The TinFoilHat class implements a GCM-AES encryption/decryption class.

Parameters

- **ekey** (*bytes*) – A 32 byte key used for doing encryption & decryption. It
- **manner.** (*is assumed the caller has generated the key in a safe*) –

dec(*byts*)

Decode an envelope dict and decrypt the given bytes.

Parameters
byts (*bytes*) – Bytes to decrypt.

Returns
Decrypted message.

Return type
bytes

enc(*byts*, *asscd=None*)

Encrypt the given bytes and return an envelope dict in msgpack form.

Parameters

- **byts** (*bytes*) – The message to be encrypted.
- **asscd** (*bytes*) – Extra data that needs to be authenticated (but not encrypted).

Returns
The encrypted message. This is a msgpacked dictionary containing the IV, ciphertext, and associated data.

Return type
bytes

synapse.lib.crypto.tinfoil.**newkey**()

Generate a new, random 32 byte key.

Returns
32 random bytes

Return type
bytes

synapse.lib.platforms package

Home for platform specific code such as thishost info.

all platform modules *must* be importable from any platform.

(guard any platform specific code with appropriate conditionals)

Submodules

synapse.lib.platforms.common module

synapse.lib.platforms.common.**daemonize**()
For unix platforms, form a new process group using fork().

synapse.lib.platforms.common.**getLibC**()
Return a ctypes reference to libc

synapse.lib.platforms.common.**getVolInfo**(**paths*)
Retrieve volume usage info for the given path.

synapse.lib.platforms.common.**inet_ntop**(*afam*, *byts*)

synapse.lib.platforms.common.**inet_pton**(*afam*, *text*)

synapse.lib.platforms.common.**initHostInfo**()

synapse.lib.platforms.common.**setProcName**(*name*)
Set the process title/name for process listing.

synapse.lib.platforms.darwin module

synapse.lib.platforms.darwin.**initHostInfo**()

synapse.lib.platforms.freebsd module

synapse.lib.platforms.freebsd.**initHostInfo**()

synapse.lib.platforms.linux module

synapse.lib.platforms.linux.**getAvailableMemory**()
Returns the available memory of the system

synapse.lib.platforms.linux.**getCurrentLockedMemory**()
Return the amount of memory this process has locked

synapse.lib.platforms.linux.**getFileMappedRegion**(*filename*)
Return a tuple of address and length of a particular file memory mapped into this process

synapse.lib.platforms.linux.**getMaxLockedMemory**()
Returns the maximum amount of memory this process can lock

synapse.lib.platforms.linux.**getTotalMemory**()

Get the total amount of memory in the system.

Notes

This attempts to get information from cgroup data before falling back to /proc/meminfo data.

Returns
The number of bytes of memory available in the system.

Return type
int

synapse.lib.platforms.linux.**initHostInfo**()

synapse.lib.platforms.linux.**maximizeMaxLockedMemory**()

Remove any discretionary (i.e. soft) limits

synapse.lib.platforms.linux.**mlock**(*address*, *length*)

Lock a chunk of memory to prevent it from being swapped out, raising an OSError on error

synapse.lib.platforms.linux.**mmap**(*address*, *length*, *prot*, *flags*, *fd*, *offset*)

A simple mmap context manager that releases the GIL while mapping and unmapping. It raises an OSError on error

synapse.lib.platforms.linux.**munlock**(*address*, *length*)

Unlock a chunk of memory, raising an OSError on error

synapse.lib.platforms.windows module

synapse.lib.platforms.windows.**daemonize**()

synapse.lib.platforms.windows.**getLibC**()

Override to account for python on windows not being able to find libc sometimes…

synapse.lib.platforms.windows.**initHostInfo**()

class synapse.lib.platforms.windows.**sockaddr**

Bases: Structure

ipv4

Structure/Union member

ipv6

Structure/Union member

sa_family

Structure/Union member

synapse.lib.stormlib package

Submodules

synapse.lib.stormlib.auth module

synapse.lib.stormlib.backup module

class synapse.lib.stormlib.backup.**BackupLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with the backup APIs in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.basex module

class synapse.lib.stormlib.basex.**BaseXLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for encoding and decoding strings using an arbitrary charset.

async decode(*text*, *charset*)

async encode(*byts*, *charset*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.cell module

class synapse.lib.stormlib.cell.**CellLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.cell.**getMaxHotFixes**()

synapse.lib.stormlib.compression module

class synapse.lib.stormlib.compression.**Bzip2Lib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for bzip2 compression.

async en(*valu*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async un(*valu*)

class synapse.lib.stormlib.compression.**GzipLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for gzip compression.

async en(*valu*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async un(*valu*)

class synapse.lib.stormlib.compression.**ZlibLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for zlib compression.

async en(*valu*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async un(*valu*)

synapse.lib.stormlib.easyperm module

class synapse.lib.stormlib.easyperm.**LibEasyPerm**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with easy perm dictionaries.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.ethereum module

class synapse.lib.stormlib.ethereum.**EthereumLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for Ethereum.

async eip55(*addr*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.gen module

class synapse.lib.stormlib.gen.**LibGen**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for secondary property based deconfliction.

synapse.lib.stormlib.graph module

class synapse.lib.stormlib.graph.**GraphLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with graph projections in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.hashes module

class synapse.lib.stormlib.hashes.**LibHashes**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for hashing bytes

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.hashes.**LibHmac**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for computing RFC2104 HMAC values.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.hex module

class synapse.lib.stormlib.hex.**HexLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements helpers for hexadecimal encoded strings.

async decode(*valu*)

async encode(*valu*)

async fromint(*valu*, *length*, *signed=False*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async signext(*valu*, *length*)

async toint(*valu*, *signed=False*)

async trimext(*valu*)

synapse.lib.stormlib.imap module

class synapse.lib.stormlib.imap.**ImapLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library to connect to an IMAP server.

async connect(*host*, *port=993*, *timeout=30*, *ssl=True*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.imap.**ImapServer**(*runt*, *imap_cli*, *path=None*)

Bases: *StormType*

An IMAP server for retrieving email messages.

async delete(*uid_set*)

async fetch(*uid*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async list(*reference_name='"'*, *pattern='*'*)

async login(*user*, *passwd*)

async markSeen(*uid_set*)

async search(**args*)

async select(*mailbox='INBOX'*)

async synapse.lib.stormlib.imap.**run_imap_coro**(*coro*)

Raises or returns data.

synapse.lib.stormlib.infosec module

synapse.lib.stormlib.infosec.**CVSS2_calc**(*vdict*)

synapse.lib.stormlib.infosec.**CVSS2_round**(*x*)

synapse.lib.stormlib.infosec.**CVSS3_0_calc**(*vdict*)

synapse.lib.stormlib.infosec.**CVSS3_0_round**(*x*)

Round up to the nearest one decimal place. From the JS reference implementation: https://www.first.org/cvss/calculator/cvsscalc30.js

synapse.lib.stormlib.infosec.**CVSS3_1_calc**(*vdict*)

synapse.lib.stormlib.infosec.**CVSS3_1_round**(*x*)

Round up to the nearest one decimal place. From the JS reference implementation: https://www.first.org/cvss/calculator/cvsscalc31.js

synapse.lib.stormlib.infosec.**CVSS_get_coefficients**(*vdict*, *vers*)

class synapse.lib.stormlib.infosec.**CvssLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements CVSS score calculations.

async calculate(*node*, *save=True*, *vers='3.1'*)

async calculateFromProps(*props*, *vers='3.1'*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async saveVectToNode(*node*, *text*)

async vectToProps(*text*)

async vectToScore(*vect*, *vers=None*)

synapse.lib.stormlib.infosec.**roundup**(*x*)

synapse.lib.stormlib.ipv6 module

class synapse.lib.stormlib.ipv6.**LibIpv6**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for providing ipv6 helpers.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.iters module

class synapse.lib.stormlib.iters.**LibIters**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for providing iterator helpers.

async enum(*genr*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.json module

class synapse.lib.stormlib.json.**JsonLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Json data.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.json.**JsonSchema**(*runt*, *schema*, *use_default=True*)

Bases: *StormType*

A JsonSchema validation object for use in validating data structures in Storm.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async stormrepr()

synapse.lib.stormlib.json.**compileJsSchema**(*schema*, *use_default=True*)

synapse.lib.stormlib.json.**runJsSchema**(*schema*, *item*, *use_default=True*)

synapse.lib.stormlib.log module

class synapse.lib.stormlib.log.**LoggerLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library which implements server side logging. These messages are logged to the `synapse.storm.log` logger.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.macro module

class synapse.lib.stormlib.macro.**LibMacro**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with the Storm Macros in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.macro.**MacroExecCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute a named macro.

Example

inet:ipv4#cno.threat.t80 | macro.exec enrich_foo

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'macro.exec'

synapse.lib.stormlib.math module

class synapse.lib.stormlib.math.**MathLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for performing math operations.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.mime module

class synapse.lib.stormlib.mime.**LibMimeHtml**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for manipulating HTML text.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async totext(*html*)

synapse.lib.stormlib.mime.**htmlToText**(*html*)

synapse.lib.stormlib.model module

class synapse.lib.stormlib.model.**LibModel**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with the Data Model in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.model.**LibModelDeprecated**(*runt*, *name=()*)

Bases: *Lib*

A storm library for interacting with the model deprecation mechanism.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.model.**LibModelEdge**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with light edges and manipulating their key-value attributes.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

hivepath = ('cortex', 'model', 'edges')

validedgekeys = ('doc',)

class synapse.lib.stormlib.model.**LibModelTags**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with tag specifications in the Cortex Data Model.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.model.**ModelForm**(*form*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Form.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

value()

class synapse.lib.stormlib.model.**ModelProp**(*prop*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Property.

value()

class synapse.lib.stormlib.model.**ModelTagProp**(*tagprop*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Tag Property.

value()

class synapse.lib.stormlib.model.**ModelType**(*valu*, *path=None*)

Bases: *Prim*

A Storm types wrapper around a lib.types.Type

value()

synapse.lib.stormlib.modelext module

class synapse.lib.stormlib.modelext.**LibModelExt**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for manipulating extended model elements.

async addForm(*formname*, *basetype*, *typeopts*, *typeinfo*)

async addFormProp(*formname*, *propname*, *typedef*, *propinfo*)

async addTagProp(*propname*, *typedef*, *propinfo*)

async addUnivProp(*propname*, *typedef*, *propinfo*)

async delForm(*formname*)

async delFormProp(*formname*, *propname*)

async delTagProp(*propname*)

async delUnivProp(*propname*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.notifications module

class synapse.lib.stormlib.notifications.**NotifyLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for a user interacting with their notifications.

async get(*indx*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async list(*size=None*)

synapse.lib.stormlib.oauth module

class synapse.lib.stormlib.oauth.**OAuthV1Client**(*runt*, *ckey*, *csecret*, *atoken*, *asecret*, *sigtype*, *path=None*)

Bases: *StormType*

A client for doing OAuth V1 Authentication from Storm.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.oauth.**OAuthV1Lib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library to handle OAuth v1 authentication.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormlib.oauth.**OAuthV2Lib**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for managing OAuth V2 clients.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.project module

class synapse.lib.stormlib.project.**LibProjects**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Projects in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

class synapse.lib.stormlib.project.**Project**(*runt*, *node*, *path=None*)

Bases: *Prim*

Implements the Storm API for Project objects, which are used for managing a scrum style project in the Cortex

confirm(*perm*)

async nodes()

value()

class synapse.lib.stormlib.project.**ProjectEpic**(*proj*, *node*)

Bases: *Prim*

Implements the Storm API for a ProjectEpic

async nodes()

async value()

class synapse.lib.stormlib.project.**ProjectEpics**(*proj*)

Bases: *Prim*

Implements the Storm API for ProjectEpics objects, which are collections of ProjectEpic objects associated with a particular Project

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

class synapse.lib.stormlib.project.**ProjectSprint**(*proj*, *node*)

Bases: *Prim*

Implements the Storm API for a ProjectSprint

async nodes()

async value()

class synapse.lib.stormlib.project.ProjectSprints(*proj*)

Bases: *Prim*

Implements the Storm API for ProjectSprints objects, which are collections of sprints associated with a single project

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

class synapse.lib.stormlib.project.ProjectTicket(*proj*, *node*)

Bases: *Prim*

Implements the Storm API for a ProjectTicket.

async nodes()

async value()

class synapse.lib.stormlib.project.ProjectTicketComment(*ticket*, *node*)

Bases: *Prim*

Implements the Storm API for a ProjectTicketComment

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async nodes()

async value()

class synapse.lib.stormlib.project.ProjectTicketComments(*ticket*)

Bases: *Prim*

Implements the Storm API for ProjectTicketComments objects, which are collections of comments associated with a ticket.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

class synapse.lib.stormlib.project.ProjectTickets(*proj*)

Bases: *Prim*

Implements the Storm API for ProjectTickets objects, which are collections of tickets associated with a project

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

synapse.lib.stormlib.random module

class synapse.lib.stormlib.random.LibRandom(*runt*, *name=()*)

Bases: *Lib*

A Storm library for generating random values.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.scrape module

class synapse.lib.stormlib.scrape.LibScrape(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for providing helpers for scraping nodes from text.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.smtp module

class synapse.lib.stormlib.smtp.**SmtpLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for sending email messages via SMTP.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async message()

class synapse.lib.stormlib.smtp.**SmtpMessage**(*runt*)

Bases: *StormType*

An SMTP message to compose and send.

async send(*host*, *port=25*, *user=None*, *passwd=None*, *usetls=False*, *starttls=False*, *timeout=60*)

synapse.lib.stormlib.stix module

class synapse.lib.stormlib.stix.**LibStix**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Stix Version 2.1 CS02.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async liftBundle(*bundle*)

async validateBundle(*bundle*)

class synapse.lib.stormlib.stix.**LibStixExport**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for exporting to STIX version 2.1 CS02.

async bundle(*config=None*)

async config()

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

timestamp(*tick*)

class synapse.lib.stormlib.stix.**LibStixImport**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for importing Stix Version 2.1 data.

async config()

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async ingest(*bundle*, *config=None*)

class synapse.lib.stormlib.stix.**StixBundle**(*libstix*, *runt*, *config*, *path=None*)

Bases: *Prim*

Implements the Storm API for creating and packing a STIX bundle for v2.1

async add(*node*, *stixtype=None*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

pack()

size()

async value()

synapse.lib.stormlib.stix.**uuid4**(*valu=None*)

synapse.lib.stormlib.stix.**uuid5**(*valu=None*)

synapse.lib.stormlib.stix.**validateStix**(*bundle*, *version='2.1'*)

synapse.lib.stormlib.storm module

class synapse.lib.stormlib.storm.**LibStorm**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for evaluating dynamic storm expressions.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.stormlib.version module

class synapse.lib.stormlib.version.**VersionLib**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with version information.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async matches(*vertup*, *reqstr*)

synapse.lib.stormlib.xml module

class synapse.lib.stormlib.xml.**LibXml**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for parsing XML.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async parse(*valu*)

class synapse.lib.stormlib.xml.**XmlElement**(*runt*, *elem*)

Bases: *Prim*

A Storm object for dealing with elements in an XML tree.

async **find**(*name*, *nested=True*)

async **get**(*name*)

async **iter**()

synapse.lib.stormlib.yaml module

class synapse.lib.stormlib.yaml.**LibYaml**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for saving/loading YAML data.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async **load**(*valu*)

async **save**(*valu*, *sort_keys=True*)

Submodules

synapse.lib.agenda module

class synapse.lib.agenda.**Agenda**

Bases: *Base*

Organize and execute all the scheduled storm queries in a cortex.

async **add**(*cdef*)

Persistently adds an appointment

Parameters
cdef (*dict*) – Dictionary containing the Cron definition.

Notes

The cron definition may contain the following keys:

creator (str)
Iden of the creating user.

iden (str)
Iden of the appointment.

storm (str)
The Storm query to run.

reqs (Union[None, Dict[TimeUnit, Union[int, Tuple[int]], List[...])
One or more dicts of the fixed aspects of the appointment. dict value may be a single or multiple. May be an empty dict or None.

incunit (Union[None, TimeUnit])
The unit that changes for recurring, or None for non-recurring. It is an error for this value to match a key in reqdict.

incvals (Union[None, int, Iterable[int])
Count of units of incunit or explicit day of week or day of month. Not allowed for incunit == None, required for others (1 would be a typical value)

If the values for req and incvals are both lists, all combinations of all values (the product) are used.

Returns
Packed appointment definition

`async delete`(*iden*)

Delete an appointment

`async disable`(*iden*)

`async enable`(*iden*)

`async get`(*iden*)

`list`()

`async mod`(*iden*, *query*)

Change the query of an appointment

`async move`(*croniden*, *viewiden*)

Move a cronjob from one view to another

`async start`()

Enable cron jobs to start running, start the scheduler loop

Go through all the appointments, making sure the query is valid, and remove the ones that aren't. (We can't evaluate queries until enabled because not all the modules are loaded yet.)

`async stop`()

Cancel the scheduler loop, and set self.enabled to False.

`class` synapse.lib.agenda.**ApptRec**(*reqdict*, *incunit=None*, *incval=1*)

Bases: `object`

Represents a single element of a single combination of an appointment

`nexttime`(*lastts*)

Returns next timestamp that meets requirements, incrementing by (self.incunit * incval) if not increasing, or 0.0 if there are no future matches

`pack`()

Make ApptRec json/msgpack-friendly

`classmethod unpack`(*val*)

Convert from json/msgpack-friendly

`class` synapse.lib.agenda.**TimeUnit**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Bases: `IntEnum`

Unit of time that recurring and required parts of appointments are made of

DAY = 5

DAYOFMONTH = 3

DAYOFWEEK = 4

HOUR = 6

MINUTE = 7

MONTH = 2

NOW = 8

YEAR = 1

classmethod fromString(*s*)

synapse.lib.aha module

class synapse.lib.aha.**AhaApi**

Bases: *CellApi*

async addAhaSvc(*name*, *info*, *network=None*)

Register a service with the AHA discovery server.

NOTE: In order for the service to remain marked "up" a caller
must maintain the telepath link.

addAhaSvcProv(*name*, *provinfo=None*)

Provision the given relative service name within the configured network name.

addAhaUserEnroll(*name*, *userinfo=None*, *again=False*)

Create and return a one-time user enroll key.

async delAhaSvc(*name*, *network=None*)

Remove an AHA service entry.

delAhaSvcProv(*iden*)

Remove a previously added provisioning entry by iden.

delAhaUserEnroll(*iden*)

Remove a previously added enrollment entry by iden.

async genCaCert(*network*)

async getAhaSvc(*name*, *filters=None*)

Return an AHA service description dictionary for a service name.

async getAhaSvcMirrors(*name*)

Return list of AHA svcinfo dictionaries for mirrors of a service.

async getAhaSvcs(*network=None*)

Yield AHA svcinfo dictionaries.

Parameters
network (*str*) – Optionally specify a network to filter on.

async **getAhaUrls**()

async **getCaCert**(*network*)

async **modAhaSvcInfo**(*name*, *svcinfo*)

async **signHostCsr**(*csrtext*, *signas=None*, *sans=None*)

async **signUserCsr**(*csrtext*, *signas=None*)

class synapse.lib.aha.**AhaCell**

Bases: *Cell*

async **addAhaSvc**(*name*, *info*, *network=None*)

async **addAhaSvcProv**(*name*, *provinfo=None*)

async **addAhaUserEnroll**(*name*, *userinfo=None*, *again=False*)

cellapi

alias of *AhaApi*

```
confbase = {'_log_conf': {'description': 'Opaque structure used for logging by
spawned processes.', 'hideconf': True, 'type': 'object'}, 'aha:admin':
{'description': 'An AHA client certificate CN to register as a local admin user.',
'type': 'string'}, 'aha:leader': {'description': 'The AHA service name to claim
as the active instance of a storm service.', 'type': 'string'}, 'aha:name':
{'description': 'The name of the cell service in the aha service registry.',
'type': 'string'}, 'aha:network': {'description': 'The AHA service network. This
makes aha:name/aha:leader relative names.', 'type': 'string'}, 'aha:provision':
{'description': 'The telepath URL of the aha provisioning service.', 'items':
{'type': 'string'}, 'type': ['string', 'array']}, 'aha:registry': {'description':
'The telepath URL of the aha service registry.', 'items': {'type': 'string'},
'type': ['string', 'array']}, 'aha:svcinfo': {'description': 'An AHA svcinfo
object. If set, this overrides self discovered Aha service information.',
'hidecmdl': True, 'hidedocs': True, 'properties': {'urlinfo': {'properties':
{'host': {'type': 'string'}, 'port': {'type': 'integer'}, 'schema': {'type':
'string'}}, 'required': ('host', 'port', 'scheme'), 'type': 'object'}},
'required': ('urlinfo',), 'type': 'object'}, 'aha:user': {'description': 'The
username of this service when connecting to others.', 'type': 'string'},
'auth:anon': {'description': 'Allow anonymous telepath access by mapping to the
given user name.', 'type': 'string'}, 'auth:conf': {'description': 'Extended
configuration to be used by an alternate auth constructor.', 'hideconf': True,
'type': 'object'}, 'auth:ctor': {'description': 'Allow the construction of the
cell auth object to be hooked at runtime.', 'hideconf': True, 'type': 'string'},
'auth:passwd': {'description': 'Set to <passwd> (local only) to bootstrap the root
user password.', 'type': 'string'}, 'backup:dir': {'description': 'A directory
outside the service directory where backups will be saved. Defaults to ./backups in
the service storage directory.', 'type': 'string'}, 'cell:ctor': {'description':
'An optional python path to the Cell class. Used by stemcell.', 'hideconf': True,
'type': 'string'}, 'cell:guid': {'description': 'An optional hard-coded GUID to
store as the permanent GUID for the service.', 'hideconf': True, 'type':
'string'}, 'dmon:listen': {'description': 'A config-driven way to specify the
telepath bind URL.', 'type': ['string', 'null']}, 'https:headers': {'description':
'Headers to add to all HTTPS server responses.', 'hidecmdl': True, 'type':
'object'}, 'https:parse:proxy:remoteip': {'default': False, 'description':
'Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine
requester IP addresses.', 'type': 'boolean'}, 'https:port': {'description': 'A
config-driven way to specify the HTTPS port.', 'type': ['integer', 'null']},
'inaugural': {'description': 'Data used to drive configuration of the service upon
first startup.', 'hidedocs': True, 'properties': {'roles': {'items':
{'additionalProperties': False, 'properties': {'name': {'pattern':
'^(?!all$).+$', 'type': 'string'}, 'rules': {'items': {'items': [{'type':
'boolean'}, {'type': 'array', 'items': {'type': 'string'}}], 'maxItems': 2,
'minItems': 2, 'type': 'array'}, 'type': 'array'}}, 'required': ['name'],
'type': 'object'}, 'type': 'array'}, 'users': {'items': {'additionalProperties':
False, 'properties': {'admin': {'default': False, 'type': 'boolean'}, 'email':
{'type': 'string'}, 'name': {'pattern': '^(?!root$).+$', 'type': 'string'},
'roles': {'items': {'type': 'string'}, 'type': 'array'}, 'rules': {'items':
{'items': [{'type': 'boolean'}, {'type': 'array', 'items': {'type':
'string'}}], 'maxItems': 2, 'minItems': 2, 'type': 'array'}, 'type': 'array'}},
'required': ['name'], 'type': 'object'}, 'type': 'array'}}, 'type': 'object'},
'limit:disk:free': {'default': 5, 'description': 'Minimum disk free space
percentage before setting the cell read-only.', 'maximum': 100, 'minimum': 0,
'type': ['integer', 'null']}, 'mirror': {'description': 'A telepath URL for our
upstream mirror (we must be a backup!).', 'hidecmdl': False, 'hidedocs': False,
'type': ['string', 'null']}, 'nexslog:async': {'default': False, 'description':
'(Experimental) Map the nexus log LMDB instance with map_async=True.', 'hidecmdl':
True, 'hidedocs': True, 'type': 'boolean'}, 'nexslog:en': {'default': False,
'description': 'Record all changes to a stream file on disk. Required for mirroring
(on both sides).', 'type': 'boolean'}, 'onboot:optimize': {'default': False,
'description': 'Delay startup to optimize LMDB databases during boot to recover
```

confdefs = {'aha:urls': {'description': 'A list of all available AHA server URLs.', 'items': {'type': 'string'}, 'type': ['string', 'array']}, 'provision:listen': {'description': 'A telepath URL for the AHA provisioning listener.', 'type': ['string', 'null']}}

async **delAhaSvc**(*name*, *network=None*)

async **delAhaSvcProv**(*iden*)

async **delAhaUserEnroll**(*iden*)

async **genCaCert**(*network*)

async **getAhaSvc**(*name*, *filters=None*)

async **getAhaSvcMirrors**(*iden*, *network=None*)

async **getAhaSvcProv**(*iden*)

async **getAhaSvcs**(*network=None*)

async **getAhaUserEnroll**(*iden*)

async **getCaCert**(*network*)

classmethod **getEnvPrefix**()

Get a list of envar prefixes for config resolution.

async **initServiceNetwork**()

async **initServiceRuntime**()

async **initServiceStorage**()

async **modAhaSvcInfo**(*name*, *svcinfo*)

async **saveCaCert**(*name*, *cakey*, *cacert*)

async **saveHostCert**(*name*, *hostkey*, *hostcert*)

async **saveUserCert**(*name*, *userkey*, *usercert*)

async **setAhaSvcDown**(*name*, *linkiden*, *network=None*)

async **signHostCsr**(*csrtext*, *signas=None*, *sans=None*)

async **signUserCsr**(*csrtext*, *signas=None*)

class synapse.lib.aha.**AhaProvisionServiceV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async **post**()

class synapse.lib.aha.**EnrollApi**(*aha*, *userinfo*)

Bases: object

async **getCaCert**()

async **getUserInfo**()

async **signUserCsr**(*byts*)

class synapse.lib.aha.**ProvApi**(*aha*, *provinfo*)

Bases: object

async **getCaCert**()

async **getProvInfo**()

async **signHostCsr**(*byts*)

async **signUserCsr**(*byts*)

class synapse.lib.aha.**ProvDmon**

Bases: *Daemon*

synapse.lib.ast module

class synapse.lib.ast.**AbsProp**(*astinfo*, *valu*, *kids=()*)

Bases: *Const*

class synapse.lib.ast.**AbsPropCond**(*astinfo*, *kids=()*)

Bases: *Cond*

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**AndCond**(*astinfo*, *kids=()*)

Bases: *Cond*

<cond> and <cond>

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

async **getLiftHints**(*runt*, *path*)

class synapse.lib.ast.**ArgvQuery**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

isRuntSafe(*runt*)

runtopaque = True

validate(*runt*)

class synapse.lib.ast.**ArrayCond**(*astinfo*, *kids=()*)

Bases: *Cond*

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**AstNode**(*astinfo*, *kids=()*)

Bases: object

Base class for all nodes in the Storm abstract syntax tree.

addExcInfo(*exc*)

addKid(*astn*)

format(*depth=0*)

getAstText()

getPosInfo()

getRuntVars(*runt*)

hasAstClass(*clss*)

hasVarName(*name*)

init(*core*)

isRuntSafe(*runt*)

isRuntSafeAtom(*runt*)

iterright()

Yield "rightward" siblings until None.

optimize()

prepare()

repr()

reqRuntSafe(*runt*, *mesg*)

runtopaque = False

sibling(*offs=1*)

Return sibling node by relative offset from self.

validate(*runt*)

class synapse.lib.ast.**Bool**(*astinfo*, *valu*, *kids=()*)

Bases: *Const*

class synapse.lib.ast.**BreakOper**(*astinfo*, *kids=()*)

Bases: *AstNode*

async run(*runt*, *genr*)

class synapse.lib.ast.**CallArgs**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.**CallKwarg**(*astinfo*, *kids=()*)

Bases: *CallArgs*

class synapse.lib.ast.**CallKwargs**(*astinfo*, *kids=()*)

Bases: *CallArgs*

class synapse.lib.ast.**CaseEntry**(*astinfo*, *kids=()*)

Bases: *AstNode*

class synapse.lib.ast.**CatchBlock**(*astinfo*, *kids=()*)

Bases: *AstNode*

async catches(*name*, *runt*, *path=None*)

errvar()

getRuntVars(*runt*)

async run(*runt*, *genr*)

class synapse.lib.ast.**CmdOper**(*astinfo*, *kids=()*)

Bases: *Oper*

async run(*runt*, *genr*)

class synapse.lib.ast.**Cmpr**(*astinfo*, *valu*, *kids=()*)

Bases: *Const*

class synapse.lib.ast.**Cond**(*astinfo*, *kids=()*)

Bases: *Value*

A condition that is evaluated to filter nodes.

class synapse.lib.ast.**Const**(*astinfo*, *valu*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

isRuntSafe(*runt*)

repr()

value()

class synapse.lib.ast.**ContinueOper**(*astinfo*, *kids=()*)

Bases: *AstNode*

async run(*runt*, *genr*)

class synapse.lib.ast.**DollarExpr**(*astinfo*, *kids=()*)

Bases: *Value*

Top level node for $(...) expressions

async compute(*runt*, *path*)

class synapse.lib.ast.**Edit**(*astinfo*, *kids=()*)

Bases: *Oper*

class synapse.lib.ast.**EditEdgeAdd**(*astinfo*, *kids=()*, *n2=False*)

Bases: *Edit*

async run(*runt*, *genr*)

class synapse.lib.ast.**EditEdgeDel**(*astinfo*, *kids=()*, *n2=False*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditNodeAdd**(*astinfo*, *kids=()*)

Bases: *Edit*

async **addFromPath**(*form*, *runt*, *path*)

Add a node using the context from path.

NOTE: CALLER MUST CHECK PERMS

prepare()

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditParens**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditPropDel**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditPropSet**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditTagAdd**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditTagDel**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditTagPropDel**(*astinfo*, *kids=()*)

Bases: *Edit*

[-#foo.bar:baz]

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditTagPropSet**(*astinfo*, *kids=()*)

Bases: *Edit*

[#foo.bar:baz=10]

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EditUnivDel**(*astinfo*, *kids=()*)

Bases: *Edit*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**EmbedQuery**(*astinfo*, *valu*, *kids=()*)

Bases: *Const*

async compute(*runt*, *path*)

getRuntVars(*runt*)

hasVarName(*name*)

runtopaque = True

validate(*runt*)

class synapse.lib.ast.**Emit**(*astinfo*, *kids=()*)

Bases: *Oper*

async run(*runt*, *genr*)

class synapse.lib.ast.**ExprAndNode**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.**ExprDict**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

prepare()

class synapse.lib.ast.**ExprList**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

prepare()

class synapse.lib.ast.**ExprNode**(*astinfo*, *kids=()*)

Bases: *Value*

A binary (i.e. two argument) expression node

async compute(*runt*, *path*)

prepare()

class synapse.lib.ast.**ExprOrNode**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.**FiltByArray**(*astinfo*, *kids=()*)

Bases: *FiltOper*

+:foo*[^=visi]

class synapse.lib.ast.**FiltOper**(*astinfo*, *kids=()*)

Bases: *Oper*

async getLiftHints(*runt*, *path*)

async run(*runt*, *genr*)

class synapse.lib.ast.**FiniBlock**(*astinfo*, *kids=()*)

Bases: *AstNode*

An AST node that runs only once after all nodes have been consumed.

Example

Using a fini block:

```
fini {
   // stuff here runs *once* after the last node yield (even if there are no nodes)
}
```

Notes

A fini block must be runtsafe.

async run(*runt*, *genr*)

class synapse.lib.ast.**ForLoop**(*astinfo*, *kids=()*)

Bases: *Oper*

getRuntVars(*runt*)

async run(*runt*, *genr*)

class synapse.lib.ast.**FormName**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.**FormPivot**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

-> foo:bar

async run(*runt*, *genr*)

class synapse.lib.ast.**FormTagProp**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.**FormatString**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

prepare()

class synapse.lib.ast.**FuncArgs**(*astinfo*, *kids=()*)

Bases: *AstNode*

Represents the function arguments in a function definition

async compute(*runt*, *path*)

class synapse.lib.ast.FuncCall(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

class synapse.lib.ast.Function(*astinfo*, *kids=()*)

Bases: *AstNode*

(name, args, body)

// use args/kwargs syntax function bar(x, v=$(30)) { }

we auto-detect the behavior of the target function

return a value function bar(x, y) { return ($(x + y)) }

a function that produces nodes function bar(x, y) { [baz:faz=(x, y)] }

$foo = $bar(10, v=20)

async callfunc(*runt*, *argdefs*, *args*, *kwargs*)

Execute a function call using the given runtime.

This function may return a value / generator / async generator

getRuntVars(*runt*)

isRuntSafe(*runt*)

prepare()

async run(*runt*, *genr*)

runtopaque = True

validate(*runt*)

class synapse.lib.ast.HasAbsPropCond(*astinfo*, *kids=()*)

Bases: *Cond*

async getCondEval(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.HasRelPropCond(*astinfo*, *kids=()*)

Bases: *Cond*

async getCondEval(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

async getLiftHints(*runt*, *path*)

async hasProp(*node*, *runt*, *name*)

class synapse.lib.ast.HasTagPropCond(*astinfo*, *kids=()*)

Bases: *Cond*

async getCondEval(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**IfClause**(*astinfo*, *kids=()*)

Bases: *AstNode*

class synapse.lib.ast.**IfStmt**(*astinfo*, *kids=()*)

Bases: *Oper*

prepare()

async run(*runt*, *genr*)

class synapse.lib.ast.**InitBlock**(*astinfo*, *kids=()*)

Bases: *AstNode*

An AST node that runs only once before yielding nodes.

Example

Using a init block:

```
init {
    // stuff here runs *once* before the first node yield (even if there are no␣
↪nodes)
}
```

async run(*runt*, *genr*)

class synapse.lib.ast.**LiftByArray**(*astinfo*, *kids=()*)

Bases: *LiftOper*

:prop*[range=(200, 400)]

async lift(*runt*, *path*)

class synapse.lib.ast.**LiftFormTag**(*astinfo*, *kids=()*)

Bases: *LiftOper*

async lift(*runt*, *path*)

class synapse.lib.ast.**LiftFormTagProp**(*astinfo*, *kids=()*)

Bases: *LiftOper*

hehe:haha#foo.bar:baz [= x]

async lift(*runt*, *path*)

class synapse.lib.ast.**LiftOper**(*astinfo*, *kids=()*)

Bases: *Oper*

async lift(*runt*, *path*)

async run(*runt*, *genr*)

class synapse.lib.ast.**LiftProp**(*astinfo*, *kids=()*)

Bases: *LiftOper*

async **getRightHints**(*runt*, *path*)

async **lift**(*runt*, *path*)

class synapse.lib.ast.**LiftPropBy**(*astinfo*, *kids=()*)

Bases: *LiftOper*

async **lift**(*runt*, *path*)

class synapse.lib.ast.**LiftTag**(*astinfo*, *kids=()*)

Bases: *LiftOper*

async **lift**(*runt*, *path*)

class synapse.lib.ast.**LiftTagProp**(*astinfo*, *kids=()*)

Bases: *LiftOper*

#foo.bar:baz [= x]

async **lift**(*runt*, *path*)

class synapse.lib.ast.**LiftTagTag**(*astinfo*, *kids=()*)

Bases: *LiftOper*

##foo.bar

async **lift**(*runt*, *path*)

class synapse.lib.ast.**List**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

repr()

class synapse.lib.ast.**LookList**(*astinfo*, *kids=()*)

Bases: *AstNode*

class synapse.lib.ast.**Lookup**(*astinfo*, *kids*, *autoadd=False*)

Bases: *Query*

When storm input mode is "lookup"

async **run**(*runt*, *genr*)

class synapse.lib.ast.**N1Walk**(*astinfo*, *kids=()*)

Bases: *Oper*

async **run**(*runt*, *genr*)

async **walkNodeEdges**(*runt*, *node*, *verb=None*)

class synapse.lib.ast.**N1WalkNPivo**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOut*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**N2Walk**(*astinfo*, *kids=()*)

Bases: *N1Walk*

async **walkNodeEdges**(*runt*, *node*, *verb=None*)

class synapse.lib.ast.**N2WalkNPivo**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotIn*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**NotCond**(*astinfo*, *kids=()*)

Bases: *Cond*

not <cond>

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**Oper**(*astinfo*, *kids=()*)

Bases: *AstNode*

class synapse.lib.ast.**OrCond**(*astinfo*, *kids=()*)

Bases: *Cond*

<cond> or <cond>

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**PivotIn**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

<- *

async **getPivsIn**(*runt*, *node*, *path*)

async **run**(*runt*, *genr*)

class synapse.lib.ast.**PivotInFrom**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

<- foo:edge

async **run**(*runt*, *genr*)

class synapse.lib.ast.**PivotOper**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *Oper*

repr()

class synapse.lib.ast.**PivotOut**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

-> *

async **getPivsOut**(*runt*, *node*, *path*)

async **run**(*runt*, *genr*)

class synapse.lib.ast.**PivotToTags**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

-> # pivot to all leaf tag nodes -> #* pivot to all tag nodes -> #cno.* pivot to all tag nodes which match cno.* -> #foo.bar pivot to the tag node foo.bar if present

async run(*runt*, *genr*)

class synapse.lib.ast.**PropName**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

prepare()

class synapse.lib.ast.**PropPivot**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

:foo -> bar:foo

async run(*runt*, *genr*)

class synapse.lib.ast.**PropPivotOut**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

:prop -> *

async run(*runt*, *genr*)

class synapse.lib.ast.**PropValue**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

async getPropAndValu(*runt*, *path*)

isRuntSafe(*runt*)

isRuntSafeAtom(*runt*)

prepare()

class synapse.lib.ast.**Query**(*astinfo*, *kids=()*)

Bases: *AstNode*

async iterNodePaths(*runt*, *genr=None*)

async run(*runt*, *genr*)

class synapse.lib.ast.**RawPivot**(*astinfo*, *kids=()*, *isjoin=False*)

Bases: *PivotOper*

-> { <varsfrompath> }

async run(*runt*, *genr*)

class synapse.lib.ast.**RelProp**(*astinfo*, *kids=()*)

Bases: *PropName*

class synapse.lib.ast.**RelPropCond**(*astinfo*, *kids=()*)

Bases: *Cond*

(:foo:bar or .univ) <cmpr> <value>

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

async **getLiftHints**(*runt*, *path*)

class synapse.lib.ast.**RelPropValue**(*astinfo*, *kids=()*)

Bases: *PropValue*

class synapse.lib.ast.**Return**(*astinfo*, *kids=()*)

Bases: *Oper*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**Search**(*astinfo*, *kids=()*)

Bases: *Query*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**SetItemOper**(*astinfo*, *kids=()*)

Bases: *Oper*

$foo.bar = baz $foo."bar baz" = faz $foo.$bar = baz

async **run**(*runt*, *genr*)

class synapse.lib.ast.**SetVarOper**(*astinfo*, *kids=()*)

Bases: *Oper*

getRuntVars(*runt*)

async **run**(*runt*, *genr*)

class synapse.lib.ast.**Stop**(*astinfo*, *kids=()*)

Bases: *Oper*

async **run**(*runt*, *genr*)

class synapse.lib.ast.**SubGraph**(*rules*)

Bases: object

An Oper like object which generates a subgraph.

Notes

The rules format for the subgraph is shaped like the following:

```
rules = {

    'degrees': 1,

    'edges': True,
    'filterinput': True,
```

(continues on next page)

(continued from previous page)

```
    'yieldfiltered': False,

    'filters': [
        '-(#foo or #bar)',
        '-(foo:bar or baz:faz)',
    ],

    'pivots': [
        '-> * | limit 100',
        '<- * | limit 100',
    ]

    'forms': {

        'inet:fqdn':{
            'filters': [],
            'pivots': [],
        }

        '*': {
            'filters': [],
            'pivots': [],
        },
    },
}
```

Nodes which were original seeds have path.meta('graph:seed').

All nodes have path.meta('edges') which is a list of (iden, info) tuples.

async omit(*runt*, *node*)

async pivots(*runt*, *node*, *path*)

async run(*runt*, *genr*)

class synapse.lib.ast.**SubQuery**(*astinfo*, *kids=()*)

Bases: *Oper*

async compute(*runt*, *path*)

Use subquery as a value. It is error if the subquery used in this way doesn't yield exactly one node or has a return statement.

Its value is the primary property of the node yielded, or the returned value.

async compute_array(*runt*, *path*)

Use subquery as an array.

async inline(*runt*, *genr*)

Operate subquery as if it were inlined

async run(*runt*, *genr*)

class synapse.lib.ast.**SubqCond**(*astinfo*, *kids=()*)

Bases: *Cond*

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**SwitchCase**(*astinfo*, *kids=()*)

Bases: *Oper*

prepare()

async **run**(*runt*, *genr*)

class synapse.lib.ast.**TagCond**(*astinfo*, *kids=()*)

Bases: *Cond*

#foo.bar

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

async **getLiftHints**(*runt*, *path*)

class synapse.lib.ast.**TagMatch**(*astinfo*, *kids=()*)

Bases: *TagName*

Like TagName, but can have asterisks

async **compute**(*runt*, *path*)

hasglob()

class synapse.lib.ast.**TagName**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

async **computeTagArray**(*runt*, *path*, *excignore=()*)

prepare()

class synapse.lib.ast.**TagProp**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

class synapse.lib.ast.**TagPropCond**(*astinfo*, *kids=()*)

Bases: *Cond*

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**TagPropValue**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

class synapse.lib.ast.**TagValuCond**(*astinfo*, *kids=()*)

Bases: *Cond*

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

class synapse.lib.ast.**TagValue**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

isRuntSafe(*runt*)

isRuntSafeAtom(*runt*)

class synapse.lib.ast.**TryCatch**(*astinfo*, *kids=()*)

Bases: *AstNode*

async **getCatchBlock**(*name*, *runt*, *path=None*)

async **getErrValu**(*e*)

async **run**(*runt*, *genr*)

class synapse.lib.ast.**UnaryExprNode**(*astinfo*, *kids=()*)

Bases: *Value*

A unary (i.e. single-argument) expression node

async **compute**(*runt*, *path*)

prepare()

class synapse.lib.ast.**UnivProp**(*astinfo*, *kids=()*)

Bases: *RelProp*

async **compute**(*runt*, *path*)

class synapse.lib.ast.**UnivPropValue**(*astinfo*, *kids=()*)

Bases: *PropValue*

class synapse.lib.ast.**Value**(*astinfo*, *kids=()*)

Bases: *AstNode*

The base class for all values and value expressions.

async **compute**(*runt*, *path*)

async **getCondEval**(*runt*)

Return a function that may be used to evaluate the boolean truth of the value expression using a runtime and optional node path.

async **getLiftHints**(*runt*, *path*)

isRuntSafe(*runt*)

class synapse.lib.ast.**VarDeref**(*astinfo*, *kids=()*)

Bases: *Value*

async **compute**(*runt*, *path*)

class synapse.lib.ast.**VarEvalOper**(*astinfo*, *kids=()*)

Bases: *Oper*

Facilitate a stand-alone operator that evaluates a var. $foo.bar("baz")

async run(*runt*, *genr*)

class synapse.lib.ast.**VarList**(*astinfo*, *valu*, *kids=()*)

Bases: *Const*

class synapse.lib.ast.**VarListSetOper**(*astinfo*, *kids=()*)

Bases: *Oper*

getRuntVars(*runt*)

async run(*runt*, *genr*)

class synapse.lib.ast.**VarValue**(*astinfo*, *kids=()*)

Bases: *Value*

async compute(*runt*, *path*)

hasVarName(*name*)

isRuntSafe(*runt*)

isRuntSafeAtom(*runt*)

prepare()

validate(*runt*)

class synapse.lib.ast.**WhileLoop**(*astinfo*, *kids=()*)

Bases: *Oper*

async run(*runt*, *genr*)

class synapse.lib.ast.**YieldValu**(*astinfo*, *kids=()*)

Bases: *Oper*

async run(*runt*, *genr*)

async yieldFromValu(*runt*, *valu*)

async synapse.lib.ast.**expr_add**(*x*, *y*)

async synapse.lib.ast.**expr_div**(*x*, *y*)

async synapse.lib.ast.**expr_eq**(*x*, *y*)

async synapse.lib.ast.**expr_ge**(*x*, *y*)

async synapse.lib.ast.**expr_gt**(*x*, *y*)

async synapse.lib.ast.**expr_le**(*x*, *y*)

async synapse.lib.ast.**expr_lt**(*x*, *y*)

async synapse.lib.ast.**expr_mod**(*x*, *y*)

async synapse.lib.ast.**expr_mul**(*x*, *y*)

async synapse.lib.ast.**expr_ne**(*x*, *y*)

async synapse.lib.ast.**expr_neg**(*x*)

async synapse.lib.ast.**expr_not**(*x*)

async synapse.lib.ast.**expr_pow**(*x*, *y*)

async synapse.lib.ast.**expr_prefix**(*x*, *y*)

async synapse.lib.ast.**expr_re**(*x*, *y*)

async synapse.lib.ast.**expr_sub**(*x*, *y*)

synapse.lib.ast.**parseNumber**(*x*)

async synapse.lib.ast.**pullone**(*genr*)

synapse.lib.autodoc module

class synapse.lib.autodoc.**RstHelp**

Bases: object

addHead(*name*, *lvl=0*, *link=None*)

addLines(**lines*)

getRstText()

synapse.lib.autodoc.**docStormTypes**(*page*, *docinfo*, *linkprefix*, *islib=False*, *lvl=1*, *known_types=None*, *types_prefix=None*, *types_suffix=None*)

Process a list of StormTypes doc information to add them to a a RstHelp object.

Notes

This will create internal hyperlink link targets for each header item. The link prefix string must be given with the `linkprefix` argument.

Parameters

- **page** (RstHelp) – The RST page to add .
- **docinfo** (*dict*) – A Stormtypes Doc.
- **linkprefix** (*str*) – The RST link prefix string to use.
- **islib** (*bool*) – Treat the data as a library. This will preface the header and attribute values with $ and use full paths for attributes.
- **lvl** (*int*) – The base header level to use when adding headers to the page.

Returns

None

synapse.lib.autodoc.**genCallsig**(*rtype*)

synapse.lib.autodoc.**getArgLines**(*rtype*)

synapse.lib.autodoc.**getLink**(*sname*, *linkprefix*, *ref=False*, *suffix=None*)

synapse.lib.autodoc.**getReturnLines**(*rtype*, *known_types=None*, *types_prefix=None*, *suffix=None*, *isstor=False*)

synapse.lib.autodoc.**getRtypeStr**(*rtype*, *known_types*, *types_prefix*, *suffix*)

synapse.lib.autodoc.**ljuster**(*ilines*)

Helper to lstrip lines of whitespace an appropriate amount.

synapse.lib.autodoc.**prepareRstLines**(*doc*)

Prepare a desc string for RST lines.

synapse.lib.autodoc.**scrubLines**(*lines*)

Remove any empty lines until we encounter non-empty linee

synapse.lib.base module

class synapse.lib.base.**Base**

Bases: object

Base class for Synapse objects.

Acts as an observable, enables async init and fini.

Example

class Foo(Base):

async def __anit__(self, x, y):

await Base.__anit__(self)

await stuff(x, y)

foo = await Foo.anit(10)

Note: One should not create instances directly via its initializer, i.e. Base(). One shall always use the class method anit.

---

async addSignalHandlers()

Register SIGTERM/SIGINT signal handlers with the ioloop to fini this object.

async classmethod anit(**args*, ***kwargs*)

async dist(*mesg*)

Distribute an existing event tuple.

Parameters

mesg (*(str,dict)*) – An event tuple.

Example

await base.dist(('foo',{'bar':'baz'}))

async enter_context(*item*)

Modeled on Python's contextlib.ExitStack.enter_context. Enters a new context manager and adds its __exit__() and __aexit__ method to its onfini handlers.

Returns
The result of item's own __aenter__ or __enter__() method.

async fini()

Shut down the object and notify any onfini() coroutines.

Returns
Remaining ref count

async fire(*evtname*, ***info*)

Fire the given event name on the Base. Returns a list of the return values of each callback.

Example

for ret in d.fire('woot',foo='asdf'):
print('got: %r' % (ret,))

incref()

Increment the reference count for this base. This API may be optionally used to control fini().

link(*func*)

Add a callback function to receive *all* events.

Example

base1 = Base() base2 = Base()

base1.link(base2.dist)

all events on base1 are also propagated on base2

async main()

Helper function to setup signal handlers for this base as the main object. (use base.waitfini() to block)

Note: This API may only be used when the ioloop is *also* the main thread.

---

off(*evnt*, *func*)

Remove a previously registered event handler function.

Example

base.off('foo', onFooFunc)

on(*evnt*, *func*, *base=None*)

Add an base function callback for a specific event with optional filtering. If the function returns a coroutine, it will be awaited.

Parameters

- **evnt** (*str*) – An event name
- **func** (*function*) – A callback function to receive event tufo

Examples

Add a callback function and fire it:

async def baz(event):
x = event[1].get('x') y = event[1].get('y') return x + y

d.on('foo', baz)

this fire triggers baz… await d.fire('foo', x=10, y=20)

Return type
None

onWith(*evnt*, *func*)

A context manager which can be used to add a callback and remove it when using a `with` statement.

Parameters

- **evnt** (*str*) – An event name
- **func** (*function*) – A callback function to receive event tufo

onfini(*func*)

Add a function/coroutine/Base to be called on fini().

async postAnit()

Method called after self.__anit__() has completed, but before anit() returns the object to the caller.

schedCallSafe(*func*, **args*, ***kwargs*)

Schedule a function to run as soon as possible on the same event loop that this Base is running on.

This function does *not* pend on the function completion.

Parameters

- **func** –
- ***args** –
- ****kwargs** –

Notes

This method may be called from outside of the event loop on a different thread. This function will break any task scoping done with synapse.lib.scope.

Returns
A Future representing the eventual function execution.

Return type
concurrent.futures.Future

`schedCoro`(*coro*)

Schedules a free-running coroutine to run on this base's event loop. Kills the coroutine if Base is fini'd. It does not pend on coroutine completion.

Parameters
coro – The coroutine to schedule.

Notes

This function is *not* threadsafe and must be run on the Base's event loop. Tasks created by this function do inherit the synapse.lib.scope Scope from the current task.

Returns
An asyncio.Task object.

Return type
asyncio.Task

`schedCoroSafe`(*coro*)

Schedules a coroutine to run as soon as possible on the same event loop that this Base is running on.

This function does *not* pend on coroutine completion.

Notes

This method may be run outside the event loop on a different thread. This function will break any task scoping done with synapse.lib.scope.

Returns
A Future representing the eventual coroutine execution.

Return type
concurrent.futures.Future

`schedCoroSafePend`(*coro*)

Schedules a coroutine to run as soon as possible on the same event loop that this Base is running on

---

Note: This method may *not* be run inside an event loop

`unlink`(*func*)

Remove a callback function previously added with link()

Example

base.unlink(callback)

waiter(*count*, **names*)

Construct and return a new Waiter for events on this base.

Example

wait up to 3 seconds for 10 foo:bar events...

waiter = base.waiter(10,'foo:bar')

.. fire task that will cause foo:bar events

events = await waiter.wait(timeout=3)

if events == None:
    # handle the timeout case...

for event in events:
    # parse the events if you need...

Note: Use this with caution. It's easy to accidentally construct race conditions with this mechanism ;)

async waitfini(*timeout=None*)

Wait for the base to fini()

Returns
None if timed out, True if fini happened

Example

base.waitfini(timeout=30)

class synapse.lib.base.**BaseRef**

Bases: *Base*

An object for managing multiple Base instances by name.

async gen(*name*)

Atomically get/gen a Base and incref. (requires ctor during BaseRef init)

Parameters
name (*str*) – The name/iden of the Base instance.

get(*name*)

Retrieve a Base instance by name.

Parameters
name (*str*) – The name/iden of the Base

Returns
The Base instance (or None)

Return type
(*Base*)

items()

pop(*name*)

Remove and return a Base from the BaseRef.

Parameters
name (*str*) – The name/iden of the Base instance

Returns
The named base (or None)

Return type
(*Base*)

put(*name*, *base*)

Add a Base (or sub-class) to the BaseRef by name.

Parameters

- **name** (*str*) – The name/iden of the Base
- **base** (Base) – The Base instance

Returns
(None)

vals()

class synapse.lib.base.**Waiter**(*base*, *count*, **names*)

Bases: object

A helper to wait for a given number of events on a Base.

fini()

async wait(*timeout=None*)

Wait for the required number of events and return them or None on timeout.

Example

evnts = waiter.wait(timeout=30)

if evnts == None:
handleTimedOut() return

for evnt in evnts:
doStuff(evnt)

async synapse.lib.base.**main**(*coro*)

async synapse.lib.base.**schedGenr**(*genr*, *maxsize=100*)

Schedule a generator to run on a separate task and yield results to this task (pipelined generator).

synapse.lib.boss module

class synapse.lib.boss.**Boss**

Bases: *Base*

An object to track "promoted" async tasks.

async execute(*coro*, *name*, *user*, *info=None*, *iden=None*)

Create a synapse task from the given coroutine.

get(*iden*)

async promote(*name*, *user*, *info=None*, *taskiden=None*)

Promote the currently running task.

Parameters

- **name** (*str*) – The name of the task.
- **user** – The User who owns the task.
- **taskiden** – An optional GUID for the task.
- **info** – An optional information dictionary containing information about the task.

Returns
The Synapse Task object.

Return type
s_task.Task

ps()

synapse.lib.cache module

A few speed optimized (lockless) cache helpers. Use carefully.

class synapse.lib.cache.**FixedCache**(*callback*, *size=10000*)

Bases: object

async aget(*key*)

clear()

get(*key*)

pop(*key*)

put(*key*, *val*)

class synapse.lib.cache.**LruDict**(*size=10000*)

Bases: MutableMapping

Maintains the last n accessed keys

get(*key*, *default=None*)

Note: we override default impl from parent to avoid costly KeyError

items() → a set-like object providing a view on D's items

values() → an object providing a view on D's values

class synapse.lib.cache.**TagGlobs**

Bases: object

An object that manages multiple tag globs and values for caching.

add(*name*, *valu*, *base=None*)

get(*name*)

rem(*name*, *valu*)

synapse.lib.cache.**getTagGlobRegx**(*name*)

synapse.lib.cache.**memoize**(*size=16384*)

synapse.lib.cache.**memoizemethod**(*size=16384*)

A version of memoize that doesn't cause GC cycles when applied to a method.

synapse.lib.cache.**regexizeTagGlob**(*tag*)

Returns
a regular expression string with ** and * interpreted as tag globs

Precondition:
tag is a valid tagmatch

Notes

A single asterisk will replace exactly one dot-delimited component of a tag A double asterisk will replace one or more of any character.

The returned string does not contain a starting '^' or trailing '$'.

synapse.lib.cell module

class synapse.lib.cell.**Cell**

Bases: *Pusher*, *Aware*

A Cell() implements a synapse micro-service.

A Cell has 5 phases of startup:

1. Universal cell data structures
2. Service specific storage/data (pre-nexs)
3. Nexus subsystem initialization
4. Service specific startup (with nexus)
5. Networking and mirror services

BACKUP_SPAWN_TIMEOUT = 60.0

COMMIT = ''

FREE_SPACE_CHECK_FREQ = 60.0

VERSION = (2, 141, 0)

VERSTRING = '2.141.0'

addActiveCoro(*func*, *iden=None*, *base=None*)

Add a function callback to be run as a coroutine when the Cell is active.

Parameters

- **func** (*coroutine function*) – The function run as a coroutine.
- **iden** (*str*) – The iden to use for the coroutine.
- **base** (*Optional[Base]*) – if present, this active coro will be fini'd when the base is fini'd

Returns

A GUID string that identifies the coroutine for delActiveCoro()

Return type

str

Note: This will re-fire the coroutine if it exits and the Cell is still active.

addHealthFunc(*func*)

Register a callback function to get a HealthCheck object.

addHttpApi(*path*, *ctor*, *info*)

async addHttpSess(*iden*, *info*)

async addHttpsPort(*port*, *host='0.0.0.0'*, *sslctx=None*)

async addRole(*name*)

async addRoleRule(*iden*, *rule*, *indx=None*, *gateiden=None*)

async addUser(*name*, *passwd=None*, *email=None*, *iden=None*)

async addUserRole(*useriden*, *roleiden*, *indx=None*)

async addUserRule(*iden*, *rule*, *indx=None*, *gateiden=None*)

async behold()

beholder()

cellapi

alias of *CellApi*

checkFreeSpace()

```
confbase = {'_log_conf': {'description': 'Opaque structure used for logging by
spawned processes.', 'hideconf': True, 'type': 'object'}, 'aha:admin':
{'description': 'An AHA client certificate CN to register as a local admin user.',
'type': 'string'}, 'aha:leader': {'description': 'The AHA service name to claim
as the active instance of a storm service.', 'type': 'string'}, 'aha:name':
{'description': 'The name of the cell service in the aha service registry.',
'type': 'string'}, 'aha:network': {'description': 'The AHA service network. This
makes aha:name/aha:leader relative names.', 'type': 'string'}, 'aha:provision':
{'description': 'The telepath URL of the aha provisioning service.', 'items':
{'type': 'string'}, 'type': ['string', 'array']}, 'aha:registry': {'description':
'The telepath URL of the aha service registry.', 'items': {'type': 'string'},
'type': ['string', 'array']}, 'aha:svcinfo': {'description': 'An AHA svcinfo
object. If set, this overrides self discovered Aha service information.',
'hidecmdl': True, 'hidedocs': True, 'properties': {'urlinfo': {'properties':
{'host': {'type': 'string'}, 'port': {'type': 'integer'}, 'schema': {'type':
'string'}}, 'required': ('host', 'port', 'scheme'), 'type': 'object'}},
'required': ('urlinfo',), 'type': 'object'}, 'aha:user': {'description': 'The
username of this service when connecting to others.', 'type': 'string'},
'auth:anon': {'description': 'Allow anonymous telepath access by mapping to the
given user name.', 'type': 'string'}, 'auth:conf': {'description': 'Extended
configuration to be used by an alternate auth constructor.', 'hideconf': True,
'type': 'object'}, 'auth:ctor': {'description': 'Allow the construction of the
cell auth object to be hooked at runtime.', 'hideconf': True, 'type': 'string'},
'auth:passwd': {'description': 'Set to <passwd> (local only) to bootstrap the root
user password.', 'type': 'string'}, 'backup:dir': {'description': 'A directory
outside the service directory where backups will be saved. Defaults to ./backups in
the service storage directory.', 'type': 'string'}, 'cell:ctor': {'description':
'An optional python path to the Cell class. Used by stemcell.', 'hideconf': True,
'type': 'string'}, 'cell:guid': {'description': 'An optional hard-coded GUID to
store as the permanent GUID for the service.', 'hideconf': True, 'type':
'string'}, 'dmon:listen': {'description': 'A config-driven way to specify the
telepath bind URL.', 'type': ['string', 'null']}, 'https:headers': {'description':
'Headers to add to all HTTPS server responses.', 'hidecmdl': True, 'type':
'object'}, 'https:parse:proxy:remoteip': {'default': False, 'description':
'Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine
requester IP addresses.', 'type': 'boolean'}, 'https:port': {'description': 'A
config-driven way to specify the HTTPS port.', 'type': ['integer', 'null']},
'inaugural': {'description': 'Data used to drive configuration of the service upon
first startup.', 'hidedocs': True, 'properties': {'roles': {'items':
{'additionalProperties': False, 'properties': {'name': {'pattern':
'^(?!all$).+$', 'type': 'string'}, 'rules': {'items': {'items': [{'type':
'boolean'}, {'type': 'array', 'items': {'type': 'string'}}], 'maxItems': 2,
'minItems': 2, 'type': 'array'}, 'type': 'array'}}, 'required': ['name'],
'type': 'object'}, 'type': 'array'}, 'users': {'items': {'additionalProperties':
False, 'properties': {'admin': {'default': False, 'type': 'boolean'}, 'email':
{'type': 'string'}, 'name': {'pattern': '^(?!root$).+$', 'type': 'string'},
'roles': {'items': {'type': 'string'}, 'type': 'array'}, 'rules': {'items':
{'items': [{'type': 'boolean'}, {'type': 'array', 'items': {'type':
'string'}}], 'maxItems': 2, 'minItems': 2, 'type': 'array'}, 'type': 'array'}},
'required': ['name'], 'type': 'object'}, 'type': 'array'}}, 'type': 'object'},
'limit:disk:free': {'default': 5, 'description': 'Minimum disk free space
percentage before setting the cell read-only.', 'maximum': 100, 'minimum': 0,
'type': ['integer', 'null']}, 'mirror': {'description': 'A telepath URL for our
upstream mirror (we must be a backup!).', 'hidecmdl': True, 'hidedocs': True,
'type': ['string', 'null']}, 'nexslog:async': {'default': False, 'description':
'(Experimental) Map the nexus log LMDB instance with map_async=True.', 'hidecmdl':
True, 'hidedocs': True, 'type': 'boolean'}, 'nexslog:en': {'default': False,
'description': 'Record all changes to a stream file on disk. Required for mirroring
(on both sides).', 'type': 'boolean'}, 'onboot:optimize': {'default': False,
'description': 'Delay startup to optimize LMDB databases during boot to recover
```

confdefs = {}

async cullNexsLog(*offs*)

async delActiveCoro(*iden*)

Remove an Active coroutine previously added with addActiveCoro().

Parameters

iden (*str*) – The iden returned by addActiveCoro()

async delBackup(*name*)

async delHttpSess(*iden*)

async delRole(*iden*)

async delRoleRule(*iden*, *rule*, *gateiden=None*)

async delUser(*iden*)

async delUserRole(*useriden*, *roleiden*)

async delUserRule(*iden*, *rule*, *gateiden=None*)

async dyncall(*iden*, *todo*, *gatekeys=()*)

async dyniter(*iden*, *todo*, *gatekeys=()*)

async classmethod execmain(*argv*, *outp=None*)

The main entry point for running the Cell as an application.

Parameters

- **argv** (*list*) – A list of command line arguments to launch the Cell with.
- **outp** (*s_ouput.OutPut*) – Optional, an output object. No longer used in the default implementation.

Notes

This coroutine waits until the Cell is fini'd or a SIGINT/SIGTERM signal is sent to the process.

Returns

None.

async feedBeholder(*name*, *info*, *gates=None*, *perms=None*)

Feed a named event onto the `cell:beholder` message bus that will sent to any listeners.

Parameters

- **info** (*dict*) – An information dictionary to be sent to any consumers.
- **gates** (*list*) – List of gate idens, whose details will be added to the outbound message(s).
- **perms** (*list*) – List of permission names, whose details will be added to the outbound message(s).

Returns

None

async fini()

Fini override that ensures locking teardown order.

async genHttpSess(*iden*)

async genUserOnepass(*iden*, *duration=600000*)

async getAhaInfo()

classmethod getArgParser(*conf=None*)

Get an argparse.ArgumentParser for the Cell.

Parameters

conf (*s_config.Config*) – Optional, a Config object which

Notes

Boot time configuration data is placed in the argument group called config. This adds default dirn, --telepath, --https and --name arguements to the argparser instance. Configuration values which have the hideconf or hidecmdl value set to True are not added to the argparser instance.

Returns

A ArgumentParser for the Cell.

Return type

argparse.ArgumentParser

async getAuthGate(*iden*)

async getAuthGates()

async getAuthRoles()

async getAuthUsers(*archived=False*)

async getBackupInfo()

Gets information about recent backup activity

async getBackups()

async getCellApi(*link*, *user*, *path*)

Get an instance of the telepath Client object for a given user, link and path.

Parameters

- **link** (*s_link.Link*) – The link object.
- **user** (*s_hive.HiveUser*) – The heavy user object.
- **path** (*str*) – The path requested.

Notes

This defaults to the self.cellapi class. Implementors may override the default class attribute for cellapi to share a different interface.

Returns
The shared object for this cell.

Return type
object

getCellIden()

async getCellInfo()

Return metadata specific for the Cell.

Notes

By default, this function returns information about the base Cell implementation, which reflects the base information in the Synapse Cell.

It is expected that implementers override the following Class attributes in order to provide meaningful version information:

`COMMIT` - A Git Commit `VERSION` - A Version tuple. `VERSTRING` - A Version string.

Returns
A Dictionary of metadata.

Return type
Dict

getCellNexsRoot()

async getCellRunId()

classmethod getCellType()

async getConfOpt(*name*)

async getDmonSessions()

classmethod getEnvPrefix()

Get a list of envar prefixes for config resolution.

async getHealthCheck()

async getHiveKey(*path*)

Get the value of a key in the cell default hive

async getHiveKeys(*path*)

Return a list of (name, value) tuples for nodes under the path.

async getHttpSessDict(*iden*)

getLocalProxy(*share='*'*, *user='root'*)

getLocalUrl(*share='*'*, *user='root'*)

async getLogExtra(**kwargs)

Get an extra dictionary for structured logging which can be used as a extra argument for loggers.

Parameters
****kwargs** – Additional key/value items to add to the log.

Returns
A dictionary

Return type
Dict

async getMirrorUrls()

async getNexsIndx()

async getNexusChanges(*offs*, *tellready=False*)

async getPermDef(*perm*)

async getPermDefs()

async getRoleDef(*iden*)

async getRoleDefByName(*name*)

async getRoleDefs()

getSpooledSet()

async getSystemInfo()

Get info about the system in which the cell is running

Returns

- volsize - Volume where cell is running total space
- volfree - Volume where cell is running free space
- backupvolsize - Backup directory volume total space
- backupvolfree - Backup directory volume free space
- cellstarttime - Cell start time in epoch milliseconds
- celluptime - Cell uptime in milliseconds
- cellrealdisk - Cell's use of disk, equivalent to du
- cellapprdisk - Cell's apparent use of disk, equivalent to ls -l
- osversion - OS version/architecture
- pyversion - Python version
- totalmem - Total memory in the system
- availmem - Available memory in the system
- cpucount - Number of CPUs on system

Return type
A dictionary with the following keys. All size values are in bytes

async getTeleApi(*link*, *mesg*, *path*)

Return a shared object for this link. :param link: A network link. :type link: synapse.lib.link.Link :param mesg: The tele:syn handshake message. :type mesg: (str,dict)

getTempDir()

async getUserDef(*iden*, *packroles=True*)

async getUserDefByName(*name*)

async getUserDefs()

getUserName(*iden*, *defv='<unknown>'*)

Translate the user iden to a user name.

async getUserProfInfo(*iden*, *name*)

async getUserProfile(*iden*)

async getUserVarValu(*iden*, *name*)

async handoff(*turl*, *timeout=30*)

Hand off leadership to a mirror in a transactional fashion.

classmethod initCellConf(*conf=None*)

Create a Config object for the Cell.

Parameters

conf (*s_config.Config*) – An optional config structure. This has _opts_data taken from it.

Notes

The Config object has a `envar_prefix` set according to the results of `cls.getEnvPrefix()`.

Returns

A Config helper object.

Return type

s_config.Config

async classmethod initFromArgv(*argv*, *outp=None*)

Cell launcher which does automatic argument parsing, environment variable resolution and Cell creation.

Parameters

- **argv** (*list*) – A list of command line arguments to launch the Cell with.
- **outp** (*s_ouput.OutPut*) – Optional, an output object. No longer used in the default implementation.

Notes

This does the following items:

- Create a Config object from the Cell class.
- Creates an Argument Parser from the Cell class and Config object.
- Parses the provided arguments.
- Loads configuration data from the parsed options and environment variables.
- Sets logging for the process.
- Creates the Cell from the Cell Ctor.
- Adds a Telepath listener, HTTPs port listeners and Telepath share names.
- Returns the Cell.

Returns
This returns an instance of the Cell.

Return type
Cell

async initNexusSubsystem()

async initServiceActive()

async initServiceNetwork()

async initServicePassive()

async initServiceRuntime()

async initServiceStorage()

initSslCtx(*certpath*, *keypath*)

async isCellActive()

async isRoleAllowed(*iden*, *perm*, *gateiden=None*)

async isUserAllowed(*iden*, *perm*, *gateiden=None*)

async iterBackupArchive(*name*, *user*)

async iterNewBackupArchive(*user*, *name=None*, *remove=False*)

async iterUserVars(*iden*)

async kill(*user*, *iden*)

async listHiveKey(*path=None*)

async loadHiveTree(*tree*, *path=()*, *trim=False*)
Note: this is for expert emergency use only.

modCellConf(*conf*)
Modify the Cell's ondisk configuration overrides file and runtime configuration.

Parameters
conf (*dict*) – A dictionary of items to set.

Notes

This does require the data being set to be schema valid.

Returns
None.

popCellConf(*name*)

Remove a key from the Cell's ondisk configuration overrides file and runtime configuration.

Parameters
name (*str*) – Name of the value to remove.

Notes

This does **not** modify the cell.yaml file. This does re-validate the configuration after removing the value, so if the value removed had a default populated by schema, that default would be reset.

Returns
None

async popHiveKey(*path*)

Remove and return the value of a key in the cell default hive.

Note: this is for expert emergency use only.

async popUserProfInfo(*iden*, *name*, *default=None*)

async popUserVarValu(*iden*, *name*, *default=None*)

async promote(*graceful=False*)

Transform this cell from a passive follower to an active cell that writes changes locally.

async ps(*user*)

async readyToMirror()

async reqGateKeys(*gatekeys*)

async rotateNexsLog()

async runBackup(*name=None*, *wait=True*)

async saveHiveTree(*path=()*)

async setCellActive(*active*)

async setHiveKey(*path*, *valu*)

Set or change the value of a key in the cell default hive

async setHttpSessInfo(*iden*, *name*, *valu*)

async setNexsIndx(*indx*)

async setRoleName(*iden*, *name*)

async setRoleRules(*iden*, *rules*, *gateiden=None*)

async setUserAdmin(*iden*, *admin*, *gateiden=None*)

async **setUserArchived**(*iden*, *archived*)

async **setUserEmail**(*useriden*, *email*)

async **setUserLocked**(*iden*, *locked*)

async **setUserName**(*useriden*, *name*)

async **setUserPasswd**(*iden*, *passwd*)

async **setUserProfInfo**(*iden*, *name*, *valu*)

async **setUserRoles**(*useriden*, *roleidens*)

async **setUserRules**(*iden*, *rules*, *gateiden=None*)

async **setUserVarValu**(*iden*, *name*, *valu*)

async **sync**()

no-op mutable for testing purposes. If I am follower, when this returns, I have received and applied all the writes that occurred on the leader before this call.

async **trimNexsLog**(*consumers=None*, *timeout=30*)

async **tryUserPasswd**(*name*, *passwd*)

async **waitNexsOffs**(*offs*, *timeout=None*)

class synapse.lib.cell.**CellApi**

Bases: *Base*

addAuthRole(*name*)

addAuthRule(*name*, *rule*, *indx=None*, *gateiden=None*)

This API is deprecated.

addRole(*name*)

addRoleRule(*iden*, *rule*, *indx=None*, *gateiden=None*)

addUser(*name*, *passwd=None*, *email=None*, *iden=None*)

addUserRole(*useriden*, *roleiden*, *indx=None*)

addUserRule(*iden*, *rule*, *indx=None*, *gateiden=None*)

async **allowed**(*perm*, *default=None*)

Check if the user has the requested permission.

Parameters

- **perm** – permission path components to check
- **default** – Value returned if no value stored

Examples

Form a path and check the permission from a remote proxy:

```
perm = ('node', 'add', 'inet:ipv4')
allowed = await prox.allowed(perm)
if allowed:
    dostuff()
```

Returns
True if the user has permission, False if explicitly denied, None if no entry

Return type
Optional[bool]

behold()

Yield Cell system messages

cullNexsLog(*offs*)

Remove Nexus log entries up to (and including) the given offset.

Note: If there are consumers of this cell's nexus log they must be caught up to at least the offs argument before culling.

Only rotated logs where the last index is less than the provided offset will be removed from disk.

Parameters
offs (*int*) – The offset to remove entries up to.

Returns
Whether the cull was executed

Return type
bool

delAuthRole(*name*)

delAuthRule(*name*, *rule*, *gateiden=None*)

This API is deprecated.

delAuthUser(*name*)

delBackup(*name*)

Delete a backup by name.

Parameters
name (*str*) – The name of the backup to delete.

delRole(*iden*)

delRoleRule(*iden*, *rule*, *gateiden=None*)

delUser(*iden*)

delUserRole(*useriden*, *roleiden*)

delUserRule(*iden*, *rule*, *gateiden=None*)

dyncall(*iden*, *todo*, *gatekeys=()*)

dyniter(*iden*, *todo*, *gatekeys=()*)

genUserOnepass(*iden*, *duration=60000*)

getAuthGate(*iden*)

getAuthGates()

getAuthInfo(*name*)

This API is deprecated.

getAuthRoles()

getAuthUsers(*archived=False*)

Parameters

archived (*bool*) – If true, list all users, else list non-archived users

getBackupInfo()

Get information about recent backup activity.

Returns

- currduration - If backup currently running, time in ms since backup started, otherwise None
- laststart - Last time (in epoch milliseconds) a backup started
- lastend - Last time (in epoch milliseconds) a backup ended
- lastduration - How long last backup took in ms
- lastsize - Disk usage of last backup completed
- lastupload - Time a backup was last completed being uploaded via iter(New)BackupArchive
- lastexception - Tuple of exception information if last backup failed, otherwise None

Return type

(dict) It has the following keys

Note: these statistics are not persistent, i.e. they are not preserved between cell restarts.

getBackups()

Retrieve a list of backups.

Returns

A list of backup names.

Return type

list[str]

getCellIden()

async getCellInfo()

async getCellRunId()

getCellType()

getCellUser()

getDiagInfo()

getDmonSessions()

getGcInfo()

For diagnostic purposes only!

NOTE: This API is *not* supported and can be removed at any time!

async getHealthCheck()

getHiveKey(*path*)

getHiveKeys(*path*)

getMirrorUrls()

getNexsIndx()

getNexusChanges(*offs*, *tellready=False*)

async getPermDef(*perm*)

Return a specific permission definition.

async getPermDefs()

Return a non-comprehensive list of perm definitions.

getRoleDef(*iden*)

getRoleDefByName(*name*)

getRoleDefs()

async getRoleInfo(*name*)

getSystemInfo()

Get info about the system in which the cell is running

Returns

- volsize - Volume where cell is running total space
- volfree - Volume where cell is running free space
- backupvolsize - Backup directory volume total space
- backupvolfree - Backup directory volume free space
- celluptime - Cell uptime in milliseconds
- cellrealdisk - Cell's use of disk, equivalent to du
- cellapprdisk - Cell's apparent use of disk, equivalent to ls -l
- osversion - OS version/architecture
- pyversion - Python version
- totalmem - Total memory in the system
- availmem - Available memory in the system

Return type
A dictionary with the following keys. All size values are in bytes

getUserDef(*iden*, *packroles=True*)

getUserDefByName(*name*)

getUserDefs()

async getUserInfo(*name*)

getUserProfInfo(*iden*, *name*)

getUserProfile(*iden*)

handoff(*turl*, *timeout=30*)

async initCellApi()

async isCellActive()
Returns True if the cell is an active/leader cell.

isRoleAllowed(*iden*, *perm*, *gateiden=None*)

isUserAllowed(*iden*, *perm*, *gateiden=None*)

issue(*nexsiden: str*, *event: str*, *args*, *kwargs*, *meta=None*)

iterBackupArchive(*name*)
Retrieve a backup by name as a compressed stream of bytes.

Note: Compression and streaming will occur from a separate process.

Parameters
name (*str*) – The name of the backup to retrieve.

iterNewBackupArchive(*name=None*, *remove=False*)
Run a new backup and return it as a compressed stream of bytes.

Note: Compression and streaming will occur from a separate process.

Parameters

- **name** (*str*) – The name of the backup to retrieve.
- **remove** (*bool*) – Delete the backup after streaming.

async kill(*iden*)

listHiveKey(*path=None*)

popHiveKey(*path*)

popUserProfInfo(*iden*, *name*, *default=None*)

promote(*graceful=False*)

async ps()

readyToMirror()

rotateNexsLog()

Rotate the Nexus log at the current offset.

Returns
The starting index of the active Nexus log

Return type
int

runBackup(*name=None*, *wait=True*)

Run a new backup.

Parameters

- **name** (*str*) – The optional name of the backup.
- **wait** (*bool*) – On True, wait for backup to complete before returning.

Returns
The name of the newly created backup.

Return type
str

runGcCollect(*generation=2*)

For diagnostic purposes only!

NOTE: This API is *not* supported and can be removed at any time!

saveHiveTree(*path=()*)

setAuthAdmin(*name*, *isadmin*)

This API is deprecated.

setCellUser(*iden*)

Switch to another user (admin only).

This API allows remote admin/service accounts to impersonate a user. Used mostly by services that manage their own authentication/sessions.

setHiveKey(*path*, *valu*)

setRoleRules(*iden*, *rules*, *gateiden=None*)

setUserAdmin(*iden*, *admin*, *gateiden=None*)

setUserArchived(*useriden*, *archived*)

setUserEmail(*useriden*, *email*)

setUserLocked(*useriden*, *locked*)

async setUserPasswd(*iden*, *passwd*)

setUserProfInfo(*iden*, *name*, *valu*)

setUserRoles(*useriden*, *roleidens*)

setUserRules(*iden*, *rules*, *gateiden=None*)

trimNexsLog(*consumers=None*, *timeout=60*)

Rotate and cull the Nexus log (and those of any consumers) at the current offset.

Note: If the consumers argument is provided they will first be checked if online before rotating and raise otherwise. After rotation, all consumers must catch-up to the offset to cull at before executing the cull, and will raise otherwise.

Parameters

- **consumers** (*list or None*) – Optional list of telepath URLs for downstream Nexus log consumers.
- **timeout** (*int*) – Time in seconds to wait for downstream consumers to be caught up.

Returns
The offset that the Nexus log was culled up to and including.

Return type
int

tryUserPasswd(*name*, *passwd*)

waitNexsOffs(*offs*, *timeout=None*)

Wait for the Nexus log to write an offset.

Parameters

- **offs** (*int*) – The offset to wait for.
- **timeout** (*int or None*) – An optional timeout in seconds.

Returns
True if the offset was written, False if it timed out.

Return type
bool

synapse.lib.cell.**SLAB_MAP_SIZE = 134217728**

Base classes for the synapse "cell" microservice architecture.

synapse.lib.cell.**adminapi**(*log=False*)

Decorator for CellApi (and subclasses) for requiring a method to be called only by an admin user.

Parameters
log (*bool*) – If set to True, log the user, function and arguments.

synapse.lib.certdir module

class synapse.lib.certdir.**CRL**(*certdir*, *name*)

Bases: object

revoke(*cert*)

Revoke a certificate with the CRL.

Parameters
cert (*cryto.X509*) – The certificate to revoke.

Returns
None

class synapse.lib.certdir.**CertDir**(*path=None*)

Bases: object

Certificate loading/generation/signing utilities.

Features:

- Locates and load certificates, keys, and certificate signing requests (CSRs).
- Generates keypairs for users, hosts, and certificate authorities (CAs), supports both signed and self-signed.
- Generates certificate signing requests (CSRs) for users, hosts, and certificate authorities (CAs).
- Signs certificate signing requests (CSRs).
- Generates PKCS#12 archives for use in browser.

Parameters
path (*str*) – Optional path which can override the default path directory.

Notes

- All certificates will be loaded from and written to ~/.syn/certs by default. Set the environment variable SYN_CERT_DIR to override.
- All certificate generation methods create 4096 bit RSA keypairs.
- All certificate signing methods use sha256 as the signature algorithm.
- CertDir does not currently support signing CA CSRs.

addCertPath(**path*)

delCertPath(**path*)

genCaCert(*name*, *signas=None*, *outp=None*, *save=True*)

Generates a CA keypair.

Parameters

- **name** (*str*) – The name of the CA keypair.
- **signas** (*str*) – The CA keypair to sign the new CA with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

Make a CA named “myca”:

mycakey, mycacert = cdir.genCaCert(‘myca’)

Returns
Tuple containing the private key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

genCaCrl(*name*)

Get the CRL for a given CA.

Parameters
name (*str*) – The CA name.

Returns
The CRL object.

Return type
CRL

genClientCert(*name*, *outp=None*)

Generates a user PKCS #12 archive. Please note that the resulting file will contain private key material.

Parameters

- **name** (*str*) – The name of the user keypair.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

Make the PKC12 object for user "myuser":

myuserpkcs12 = cdir.genClientCert('myuser')

Returns
The PKCS #12 archive.

Return type
OpenSSL.crypto.PKCS12

genCodeCert(*name*, *signas=None*, *outp=None*, *save=True*)

Generates a code signing keypair.

Parameters

- **name** (*str*) – The name of the code signing cert.
- **signas** (*str*) – The CA keypair to sign the new code keypair with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

Generate a code signing cert for the name "The Vertex Project":

myuserkey, myusercert = cdir.genCodeCert('The Vertex Project')

Returns
Tuple containing the key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

genCrlPath(*name*)

genHostCert(*name*, *signas=None*, *outp=None*, *csr=None*, *sans=None*, *save=True*)

Generates a host keypair.

Parameters

- **name** (*str*) – The name of the host keypair.
- **signas** (*str*) – The CA keypair to sign the new host keypair with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.
- **csr** (*OpenSSL.crypto.PKey*) – The CSR public key when generating the keypair from a CSR.
- **sans** (*list*) – List of subject alternative names.

Examples

Make a host keypair named "myhost":

myhostkey, myhostcert = cdir.genHostCert('myhost')

Returns
Tuple containing the private key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

genHostCsr(*name*, *outp=None*)

Generates a host certificate signing request.

Parameters

- **name** (*str*) – The name of the host CSR.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

Generate a CSR for the host key named "myhost":

cdir.genHostCsr('myhost')

Returns
The bytes of the CSR.

Return type
bytes

genUserCert(*name*, *signas=None*, *outp=None*, *csr=None*, *save=True*)

Generates a user keypair.

Parameters

- **name** (*str*) – The name of the user keypair.
- **signas** (*str*) – The CA keypair to sign the new user keypair with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

- **csr** (*OpenSSL.crypto.PKey*) – The CSR public key when generating the keypair from a CSR.

Examples

Generate a user cert for the user "myuser":

myuserkey, myusercert = cdir.genUserCert('myuser')

Returns
Tuple containing the key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

genUserCsr(*name*, *outp=None*)

Generates a user certificate signing request.

Parameters

- **name** (*str*) – The name of the user CSR.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

Generate a CSR for the user "myuser":

cdir.genUserCsr('myuser')

Returns
The bytes of the CSR.

Return type
bytes

getCaCert(*name*)

Loads the X509 object for a given CA.

Parameters
name (*str*) – The name of the CA keypair.

Examples

Get the certificate for the CA "myca"

mycacert = cdir.getCaCert('myca')

Returns
The certificate, if exists.

Return type
OpenSSL.crypto.X509

getCaCertBytes(*name*)

getCaCertPath(*name*)

Gets the path to a CA certificate.

Parameters
name (*str*) – The name of the CA keypair.

Examples

Get the path to the CA certificate for the CA "myca":

mypath = cdir.getCACertPath('myca')

Returns
The path if exists.

Return type
str

getCaCerts()

Return a list of CA certs from the CertDir.

Returns
List of CA certificates.

Return type
[OpenSSL.crypto.X509]

getCaKey(*name*)

Loads the PKey object for a given CA keypair.

Parameters
name (*str*) – The name of the CA keypair.

Examples

Get the private key for the CA "myca":

mycakey = cdir.getCaKey('myca')

Returns
The private key, if exists.

Return type
OpenSSL.crypto.PKey

getCaKeyPath(*name*)

Gets the path to a CA key.

Parameters
name (*str*) – The name of the CA keypair.

Examples

Get the path to the private key for the CA "myca":

mypath = cdir.getCAKeyPath('myca')

Returns
The path if exists.

Return type
str

`getClientCert`(*name*)

Loads the PKCS12 archive object for a given user keypair.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the PKCS12 object for the user "myuser":

mypkcs12 = cdir.getClientCert('myuser')

Notes

The PKCS12 archive will contain private key material if it was created with CertDir or the easycert tool

Returns
The PKCS12 archive, if exists.

Return type
OpenSSL.crypto.PKCS12

`getClientCertPath`(*name*)

Gets the path to a client certificate.

Parameters
name (*str*) – The name of the client keypair.

Examples

Get the path to the client certificate for "myuser":

mypath = cdir.getClientCertPath('myuser')

Returns
The path if exists.

Return type
str

`getClientSSLContext`(*certname=None*)

Returns an ssl.SSLContext appropriate for initiating a TLS session

Parameters
certname – If specified, use the user certificate with the matching name to authenticate to the remote service.

Returns
A SSLContext object.

Return type
ssl.SSLContext

getCodeCert(*name*)

getCodeCertPath(*name*)

getCodeKey(*name*)

getCodeKeyPath(*name*)

getCrlPath(*name*)

getHostCaPath(*name*)
Gets the path to the CA certificate that issued a given host keypair.

Parameters
name (*str*) – The name of the host keypair.

Examples

Get the path to the CA cert which issue the cert for "myhost":

mypath = cdir.getHostCaPath('myhost')

Returns
The path if exists.

Return type
str

getHostCert(*name*)
Loads the X509 object for a given host keypair.

Parameters
name (*str*) – The name of the host keypair.

Examples

Get the certificate object for the host "myhost":

myhostcert = cdir.getHostCert('myhost')

Returns
The certificate, if exists.

Return type
OpenSSL.crypto.X509

getHostCertHash(*name*)

getHostCertPath(*name*)

Gets the path to a host certificate.

Parameters
name (*str*) – The name of the host keypair.

Examples

Get the path to the host certificate for the host "myhost":

mypath = cdir.getHostCertPath('myhost')

Returns
The path if exists.

Return type
str

getHostKey(*name*)

Loads the PKey object for a given host keypair.

Parameters
name (*str*) – The name of the host keypair.

Examples

Get the private key object for the host "myhost":

myhostkey = cdir.getHostKey('myhost')

Returns
The private key, if exists.

Return type
OpenSSL.crypto.PKey

getHostKeyPath(*name*)

Gets the path to a host key.

Parameters
name (*str*) – The name of the host keypair.

Examples

Get the path to the host key for the host "myhost":

mypath = cdir.getHostKeyPath('myhost')

Returns
The path if exists.

Return type
str

getServerSSLContext(*hostname=None*, *caname=None*)

Returns an ssl.SSLContext appropriate to listen on a socket

Parameters

- **hostname** – If None, the value from socket.gethostname is used to find the key in the servers directory. This name should match the not-suffixed part of two files ending in .key and .crt in the hosts subdirectory.
- **caname** – If not None, the given name is used to locate a CA certificate used to validate client SSL certs.

Returns
A SSLContext object.

Return type
ssl.SSLContext

getUserCaPath(*name*)

Gets the path to the CA certificate that issued a given user keypair.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the path to the CA cert which issue the cert for "myuser":

mypath = cdir.getUserCaPath('myuser')

Returns
The path if exists.

Return type
str

getUserCert(*name*)

Loads the X509 object for a given user keypair.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the certificate object for the user "myuser":

myusercert = cdir.getUserCert('myuser')

Returns
The certificate, if exists.

Return type
OpenSSL.crypto.X509

getUserCertPath(*name*)

Gets the path to a user certificate.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the path for the user cert for "myuser":

mypath = cdir.getUserCertPath('myuser')

Returns
The path if exists.

Return type
str

getUserForHost(*user*, *host*)

Gets the name of the first existing user cert for a given user and host.

Parameters

- **user** (*str*) – The name of the user.
- **host** (*str*) – The name of the host.

Examples

Get the name for the "myuser" user cert at "cool.vertex.link":

usercertname = cdir.getUserForHost('myuser', 'cool.vertex.link')

Returns
The cert name, if exists.

Return type
str

getUserKey(*name*)

Loads the PKey object for a given user keypair.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the key object for the user key for "myuser":

myuserkey = cdir.getUserKey('myuser')

Returns
The private key, if exists.

Return type
OpenSSL.crypto.PKey

getUserKeyPath(*name*)

Gets the path to a user key.

Parameters
name (*str*) – The name of the user keypair.

Examples

Get the path to the user key for "myuser":

mypath = cdir.getUserKeyPath('myuser')

Returns
The path if exists.

Return type
str

importFile(*path*, *mode*, *outp=None*)

Imports certs and keys into the Synapse cert directory

Parameters

- **path** (*str*) – The path of the file to be imported.
- **mode** (*str*) – The certdir subdirectory to import the file into.

Examples

Import CA certifciate 'mycoolca.crt' to the 'cas' directory.

certdir.importFile('mycoolca.crt', 'cas')

Notes

importFile does not perform any validation on the files it imports.

Returns
None

isCaCert(*name*)

Checks if a CA certificate exists.

Parameters
name (*str*) – The name of the CA keypair.

Examples

Check if the CA certificate for "myca" exists:

exists = cdir.isCaCert('myca')

Returns
True if the certificate is present, False otherwise.

Return type
bool

`isClientCert`(*name*)

Checks if a user client certificate (PKCS12) exists.

Parameters
name (*str*) – The name of the user keypair.

Examples

Check if the client certificate "myuser" exists:

exists = cdir.isClientCert('myuser')

Returns
True if the certificate is present, False otherwise.

Return type
bool

`isHostCert`(*name*)

Checks if a host certificate exists.

Parameters
name (*str*) – The name of the host keypair.

Examples

Check if the host cert "myhost" exists:

exists = cdir.isUserCert('myhost')

Returns
True if the certificate is present, False otherwise.

Return type
bool

`isUserCert`(*name*)

Checks if a user certificate exists.

Parameters
name (*str*) – The name of the user keypair.

Examples

Check if the user cert "myuser" exists:

exists = cdir.isUserCert('myuser')

Returns
True if the certificate is present, False otherwise.

Return type
bool

`loadCertByts`(*byts*)

Load a X509 certificate from its PEM encoded bytes.

Parameters
byts (*bytes*) – The PEM encoded bytes of the certificate.

Returns
The X509 certificate.

Return type
OpenSSL.crypto.X509

Raises
BadCertBytes – If the certificate bytes are invalid.

`saveCaCertByts`(*byts*)

`saveCertPem`(*cert*, *path*)

Save a certificate in PEM format to a file outside the certdir.

`saveHostCertByts`(*byts*)

`savePkeyPem`(*pkey*, *path*)

Save a private key in PEM format to a file outside the certdir.

`saveUserCertByts`(*byts*)

`selfSignCert`(*cert*, *pkey*)

Self-sign a certificate.

Parameters

- **cert** (*OpenSSL.crypto.X509*) – The certificate to sign.
- **pkey** (*OpenSSL.crypto.PKey*) – The PKey with which to sign the certificate.

Examples

Sign a given certificate with a given private key:

cdir.selfSignCert(mycert, myotherprivatekey)

Returns
None

signCertAs(*cert*, *signas*)

Signs a certificate with a CA keypair.

Parameters

- **cert** (*OpenSSL.crypto.X509*) – The certificate to sign.
- **signas** (*str*) – The CA keypair name to sign the new keypair with.

Examples

Sign a certificate with the CA "myca":

cdir.signCertAs(mycert, 'myca')

Returns
None

signHostCsr(*xcsr*, *signas*, *outp=None*, *sans=None*, *save=True*)

Signs a host CSR with a CA keypair.

Parameters

- **xcsr** (*OpenSSL.crypto.X509Req*) – The certificate signing request.
- **signas** (*str*) – The CA keypair name to sign the CSR with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.
- **sans** (*list*) – List of subject alternative names.

Examples

Sign a host key with the CA "myca":

cdir.signHostCsr(mycsr, 'myca')

Returns
Tuple containing the public key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

signUserCsr(*xcsr*, *signas*, *outp=None*, *save=True*)

Signs a user CSR with a CA keypair.

Parameters

- **xcsr** (*OpenSSL.crypto.X509Req*) – The certificate signing request.
- **signas** (*str*) – The CA keypair name to sign the CSR with.
- **outp** (*synapse.lib.output.Output*) – The output buffer.

Examples

cdir.signUserCsr(mycsr, 'myca')

Returns
Tuple containing the public key and certificate objects.

Return type
((OpenSSL.crypto.PKey, OpenSSL.crypto.X509))

valCodeCert(*byts*)

Verify a code cert is valid according to certdir's available CAs and CRLs.

Parameters
byts (*bytes*) – The certificate bytes.

Returns
The certificate.

Return type
OpenSSL.crypto.X509

valUserCert(*byts*, *cacerts=None*)

Validate the PEM encoded x509 user certificate bytes and return it.

Parameters

- **byts** (*bytes*) – The bytes for the User Certificate.
- **cacerts** (*tuple*) – A tuple of OpenSSL.crypto.X509 CA Certificates.

Raises
BadCertVerify – If the certificate is not valid.

Returns
The certificate, if it is valid.

Return type
OpenSSL.crypto.X509

synapse.lib.certdir.**addCertPath**(*path*)

synapse.lib.certdir.**delCertPath**(*path*)

synapse.lib.certdir.**getCertDir**() → *CertDir*

Get the singleton CertDir instance.

Returns
A certdir object.

Return type
CertDir

synapse.lib.certdir.**getCertDirn**() → str

Get the expanded default path used by the singleton CertDir instance.

Returns
The path string.

Return type
str

synapse.lib.certdir.**getServerSSLContext**() → SSLContext

Get a server SSLContext object.

This object has a minimum TLS version of 1.2, a subset of ciphers in use, and disabled client renegotiation.

This object has no certificates loaded in it.

Returns
The context object.

Return type
ssl.SSLContext

synapse.lib.certdir.**iterFqdnUp**(*fqdn*)

synapse.lib.chop module

synapse.lib.chop.**TagMatchRe = regex.Regex('([\\w*]+\\.)*[\\w*]+', flags=regex.V0)**

Shared primitive routines for chopping up strings and values.

synapse.lib.chop.**cvss2_normalize**(*vect*)

Helper function to normalize CVSS2 vectors

synapse.lib.chop.**cvss3x_normalize**(*vect*)

Helper function to normalize CVSS3.X vectors

synapse.lib.chop.**cvss_normalize**(*vdict*, *vers*)

Normalize CVSS vectors

synapse.lib.chop.**cvss_validate**(*vect*, *vers*)

Validate (as best as possible) the CVSS vector string. Look for issues such as:

- No duplicated metrics
- Invalid metrics
- Invalid metric values
- Missing mandatory metrics

Returns a dictionary with the parsed metric:value pairs.

synapse.lib.chop.**digits**(*text*)

synapse.lib.chop.**hexstr**(*text*)

Ensure a string is valid hex.

Parameters
text (*str*) – String to normalize.

Examples

Norm a few strings:

hexstr('0xff00') hexstr('ff00')

Notes

Will accept strings prefixed by '0x' or '0X' and remove them.

Returns
Normalized hex string.

Return type
str

synapse.lib.chop.**intstr**(*text*)

synapse.lib.chop.**onespace**(*text*)

synapse.lib.chop.**printables**(*text*)

synapse.lib.chop.**replaceUnicodeDashes**(*valu*)

Replace unicode dashes in a string with regular dashes.

Parameters
valu (*str*) – A string.

Returns
A new string with replaced dashes.

Return type
str

synapse.lib.chop.**stormstring**(*s*)

Make a string storm safe by escaping backslashes and double quotes.

Parameters
s (*str*) – String to make storm safe.

Notes

This does not encapsulate a string in double quotes.

Returns
A string which can be embedded directly into a storm query.

Return type
str

synapse.lib.chop.**tag**(*text*)

synapse.lib.chop.**tagpath**(*text*)

synapse.lib.chop.**tags**(*norm*)

Divide a normalized tag string into hierarchical layers.

synapse.lib.chop.**validateTagMatch**(*tag*)

Raises an exception if tag is not a valid tagmatch (i.e. a tag that might have globs)

synapse.lib.cli module

class synapse.lib.cli.**Cli**

Bases: *Base*

A modular / event-driven CLI base object.

addCmdClass(*ctor*, ***opts*)

Add a Cmd subclass to this cli.

async addSignalHandlers()

Register SIGINT signal handler with the ioloop to cancel the currently running cmdloop task.

get(*name*, *defval=None*)

getCmdByName(*name*)

Return a Cmd instance by name.

getCmdNames()

Return a list of all the known command names for the CLI.

getCmdPrompt()

Get the command prompt.

Returns
Configured command prompt

Return type
str

histfile = 'cmdr_history'

initCmdClasses()

printf(*mesg*, *addnl=True*, *color=None*)

async prompt(*text=None*)

Prompt for user input from stdin.

async runCmdLine(*line*)

Run a single command line.

Parameters
line (*str*) – Line to execute.

Examples

Execute the 'woot' command with the 'help' switch:

await cli.runCmdLine('woot –help')

Returns
Arbitrary data from the cmd class.

Return type
object

async runCmdLoop()

Run commands from a user in an interactive fashion until fini() or EOFError is raised.

set(*name*, *valu*)

class synapse.lib.cli.Cmd(*cli*, ***opts*)

Bases: object

Base class for modular commands in the synapse CLI.

getCmdBrief()

Return the single-line description for this command.

getCmdDoc()

Return the help/doc output for this command.

getCmdItem()

Get a reference to the object we are commanding.

getCmdName()

getCmdOpts(*text*)

Use the _cmd_syntax def to split/parse/normalize the cmd line.

Parameters
text (*str*) – Command to process.

Notes

This is implemented independent of argparse (et al) due to the need for syntax aware argument splitting. Also, allows different split per command type

Returns
An opts dictionary.

Return type
dict

printf(*mesg*, *addnl=True*, *color=None*)

async runCmdLine(*line*)

Run a line of command input for this command.

Parameters
line (*str*) – Line to execute

Examples

Run the foo command with some arguments:

await foo.runCmdLine('foo –opt baz woot.com')

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.lib.cli.**CmdHelp**(*cli*, ***opts*)

Bases: *Cmd*

List commands and display help output.

Example

help foocmd

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.lib.cli.**CmdLocals**(*cli*, ***opts*)

Bases: *Cmd*

List the current locals for a given CLI object.

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.lib.cli.**CmdQuit**(*cli*, ***opts*)

Bases: *Cmd*

Quit the current command line interpreter.

Example

quit

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

synapse.lib.cmd module

class synapse.lib.cmd.**Parser**(*prog=None*, *outp=<synapse.lib.output.OutPut object>*, ***kwargs*)

Bases: ArgumentParser

exit(*status=0*, *message=None*)

Argparse expects exit() to be a terminal function and not return. As such, this function must raise an exception instead.

synapse.lib.cmdr module

async synapse.lib.cmdr.**getItemCmdr**(*cell*, *outp=None*, *color=False*, ***opts*)

Construct and return a cmdr for the given remote cell.

Parameters

- **cell** – Cell proxy being commanded.
- **outp** – Output helper object.
- **color** (*bool*) – If true, enable colorized output.
- ****opts** – Additional options pushed into the Cmdr locs.

Examples

Get the cmdr for a proxy:

```
cmdr = await getItemCmdr(foo)
```

Returns
A Cli instance with Cmds loaeded into it.

Return type
s_cli.Cli

async synapse.lib.cmdr.**runItemCmdr**(*item*, *outp=None*, *color=False*, ***opts*)

Create a cmdr for the given item and run the cmd loop.

Parameters

- **item** – Cell proxy being commanded.
- **outp** – Output helper object.
- **color** (*bool*) – If true, enable colorized output.
- ****opts** – Additional options pushed into the Cmdr locs.

Notes

This function does not return while the command loop is run.

Examples

Run the Cmdr for a proxy:

```
await runItemCmdr(foo)
```

Returns
This function returns None.

Return type
None

synapse.lib.config module

class synapse.lib.config.**Config**(*schema*, *conf=None*, *envar_prefixes=None*)

Bases: MutableMapping

Synapse configuration helper based on JSON Schema.

Parameters

- **schema** (*dict*) – The JSON Schema (draft v7) which to validate configuration data against.
- **conf** (*dict*) – Optional, a set of configuration data to preload.
- **envar_prefixes** (*list*) – Optional, a list of prefix strings used when collecting configuration data from environment variables.

Notes

This class implements the collections.abc.MutableMapping class, so it may be used where a dictionary would otherwise be used.

The default values provided in the schema must be able to be recreated from the repr() of their Python value.

Default values are not loaded into the configuration data until the `reqConfValid()` method is called.

asDict()

Get a copy of configuration data.

Returns
A copy of the configuration data.

Return type
dict

getArgParseArgs()

getCmdlineMapping()

classmethod **getConfFromCell**(*cell*, *conf=None*, *envar_prefixes=None*)

Get a Config object from a Cell directly (either the ctor or the instance thereof).

Returns
A Config object.

Return type
Config

getEnvarMapping(*prefix=None*)

Get a mapping of config values to envars.

Configuration values which have the `hideconf` value set to True are not resolved from environment variables.

reqConfValid()

Validate that the loaded configuration data is valid according to the schema.

Notes

The validation set does set any default values which are not currently set for configuration options.

Returns
This returns nothing.

Return type
None

`reqConfValu`(*key*)

Get a configuration value. If that value is not present in the schema or is not set, then raise an exception.

Parameters
key (*str*) – The key to require.

Returns
The requested value.

`reqKeyValid`(*key*, *value*)

Test if a key is valid for the provided schema it is associated with.

Parameters

- **key** (*str*) – Key to check.
- **value** – Value to check.

Raises

- *BadArg* – If the key has no associated schema.
- *BadConfValu* – If the data is not schema valid.

Returns
None when valid.

`setConfFromEnvs`()

Set configuration options from environment variables.

Notes

Environment variables are resolved from configuration options after doing the following transform:

- Replace `:` characters with `_`.
- Add a config provided prefix, if set.
- Uppercase the string.
- Resolve the environment variable
- If the environment variable is set, set the config value to the results of `yaml.yaml_safeload()` on the value.

Configuration values which have the `hideconf` value set to True are not resolved from environment variables.

Examples

For the configuration value `auth:passwd`, the environment variable is resolved as `AUTH_PASSWD`. With the prefix `cortex`, the the environment variable is resolved as `CORTEX_AUTH_PASSWD`.

Returns
Returns a dictionary of values which were set from enviroment variables.

Return type
dict

setConfFromFile(*path*, *force=False*)

Set the opts for a conf object from YAML file path.

Parameters

- **path** (*str*) – Path to the yaml load. If it exists, it must represent a dictionary.
- **force** (*bool*) – Force the update instead of using setdefault() behavior.

Returns
None

setConfFromOpts(*opts=None*)

Set the opts for a conf object from a namespace object.

Parameters

- **opts** (*argparse.Namespace*) – A Namespace object made from parsing args with an ArgumentParser
- **getArgumentParser.** (*made with*) –

Returns
Returns None.

Return type
None

synapse.lib.config.**getJsSchema**(*confbase*, *confdefs*)

Generate a Synapse JSON Schema for a Cell using a pair of confbase and confdef values.

Parameters

- **confbase** (*dict*) – A JSON Schema dictionary of properties for the object. This content has precedence over the confdefs argument.
- **confdefs** (*dict*) – A JSON Schema dictionary of properties for the object.

Notes

This generated a JSON Schema draft 7 schema for a single object, which does not allow for additional properties to be set on it. The data in confdefs is implementer controlled and is welcome to specify

Returns
A complete JSON schema.

Return type
dict

synapse.lib.config.**getJsValidator**(*schema*, *use_default=True*)

Get a fastjsonschema callable.

Parameters

- **schema** (*dict*) – A JSON Schema object.
- **use_default** (*bool*) – Whether to insert "default" key arguments into the validated data structure.

Returns
A callable function that can be used to validate data against the json schema.

Return type
callable

synapse.lib.config.**make_envar_name**(*key*, *prefix=None*)

Convert a colon delimited string into an uppercase, underscore delimited string.

Parameters

- **key** (*str*) – Config key to convert.
- **prefix** (*str*) – Optional string prefix to prepend the the config key.

Returns
The string to lookup against a envar.

Return type
str

synapse.lib.const module

synapse.lib.coro module

Async/Coroutine related utilities.

class synapse.lib.coro.**Event**

Bases: Event

async timewait(*timeout=None*)

class synapse.lib.coro.**GenrHelp**(*genr*)

Bases: object

async list()

async spin()

async synapse.lib.coro.**agen**(*item*)

Wrap an async_generator *or* generator in an async_generator.

Notes

Do not use this for a synchronous generator which would cause non-blocking IO; otherwise that IO will block the ioloop.

async synapse.lib.coro.**event_wait**(*event: Event*, *timeout=None*)

Wait on an an asyncio event with an optional timeout

Returns
true if the event got set, False if timed out

synapse.lib.coro.**executor**(*func*, **args*, ***kwargs*)

Execute a non-coroutine function in the ioloop executor pool.

Parameters

- **func** – Function to execute.
- ***args** – Args for the function.
- ****kwargs** – Kwargs for the function.

Examples

Execute a blocking API call in the executor pool:

```
import requests

def block(url, params=None):
    return requests.get(url, params=params).json()

fut = s_coro.executor(block, 'http://some.tld/thign')
resp = await fut
```

Returns
An asyncio future.

Return type
asyncio.Future

async synapse.lib.coro.**forked**(*func*, **args*, ***kwargs*)

Execute a target function in the shared forked process pool and fallback to running in a spawned process if the pool is unavailable.

Parameters

- **func** – The target function.
- ***args** – Function positional arguments.
- ****kwargs** – Function keyword arguments.

Returns
The target function return.

synapse.lib.coro.**genrhelp**(*f*)

synapse.lib.coro.**iscoro**(*item*)

async synapse.lib.coro.**ornot**(*func*, **args*, ***kwargs*)

Calls func and awaits it if a returns a coroutine.

Note: This is useful for implementing a function that might take a telepath proxy object or a local object, and you must call a non-async method on that object.

This is also useful when calling a callback that might either be a coroutine function or a regular function.

Usage:

ok = await s_coro.ornot(maybeproxy.allowed, 'path')

synapse.lib.coro.**set_pool_logging**(*logger_*, *logconf*)

async synapse.lib.coro.**spawn**(*todo*, *timeout=None*, *ctx=None*, *log_conf=None*)

Run a todo (func, args, kwargs) tuple in a multiprocessing subprocess.

Parameters

- **todo** (*tuple*) – A tuple of function, `*args`, and `**kwargs`.
- **timeout** (*int*) – The timeout to wait for the todo function to finish.
- **ctx** (*multiprocess.Context*) – A optional multiprocessing context object.
- **log_conf** (*dict*) – An optional logging configuration for the spawned process.

Notes

The contents of the todo tuple must be able to be pickled for execution. This means that locally bound functions are not eligible targets for spawn.

Returns

The return value of executing the todo function.

async synapse.lib.coro.**waittask**(*task*, *timeout=None*)

Await a task without cancelling it when you time out.

Returns

True if the task completed before the timeout.

Return type

boolean

synapse.lib.datfile module

Utilities for handling data files embedded within python packages.

synapse.lib.datfile.**openDatFile**(*datpath*)

Open a file-like object using a pkg relative path.

Example

fd = openDatFile('foopkg.barpkg/wootwoot.bin')

synapse.lib.dyndeps module

synapse.lib.dyndeps.**getDynLocal**(*name*)

Dynamically import a python module and return a local.

Example

cls = getDynLocal('foopkg.barmod.BlahClass') blah = cls()

synapse.lib.dyndeps.**getDynMeth**(*name*)

Retrieve and return an unbound method by python path.

synapse.lib.dyndeps.**getDynMod**(*name*)

Dynamically import a python module and return a ref (or None).

Example

mod = getDynMod('foo.bar')

synapse.lib.dyndeps.**runDynTask**(*task*)

Run a dynamic task and return the result.

Example

foo = runDynTask(('baz.faz.Foo', (), {}))

synapse.lib.dyndeps.**tryDynFunc**(*name*, **args*, ***kwargs*)

Dynamically import a module and call a function or raise an exception.

synapse.lib.dyndeps.**tryDynLocal**(*name*)

Dynamically import a module and return a module local or raise an exception.

synapse.lib.dyndeps.**tryDynMod**(*name*)

Dynamically import a python module or exception.

synapse.lib.encoding module

synapse.lib.encoding.**addFormat**(*name*, *fn*, *opts*)

Add an additional ingest file format

synapse.lib.encoding.**decode**(*name*, *byts*, ***opts*)

Decode the given byts with the named decoder. If name is a comma separated list of decoders, loop through and do them all.

Example

byts = s_encoding.decode('base64',byts)

Note: Decoder names may also be prefixed with +
to *encode* for that name/layer.

synapse.lib.encoding.**encode**(*name*, *item*, ***opts*)

synapse.lib.encoding.**iterdata**(*fd*, *close_fd=True*, ***opts*)

Iterate through the data provided by a file like object.

Optional parameters may be used to control how the data is deserialized.

Examples

The following example show use of the iterdata function.:

```
with open('foo.csv','rb') as fd:
    for row in iterdata(fd, format='csv', encoding='utf8'):
        dostuff(row)
```

Parameters

- **fd** (*file*) – File like object to iterate over.
- **close_fd** (*bool*) – Default behavior is to close the fd object. If this is not true, the fd will not be closed.
- ****opts** (*dict*) – Ingest open directive. Causes the data in the fd to be parsed according to the 'format' key and any additional arguments.

Yields
An item to process. The type of the item is dependent on the format parameters.

synapse.lib.gis module

synapse.lib.gis.**bbox**(*lat*, *lon*, *dist*)

Calculate a min/max bounding box for the circle defined by lalo/dist.

Parameters

- **lat** (*float*) – The latitude in degrees
- **lon** (*float*) – The longitude in degrees
- **dist** (*int*) – A distance in geo:dist base units (mm)

Returns
(latmin, latmax, lonmin, lonmax)

Return type
(float,float,float,float)

synapse.lib.gis.**dms2dec**(*degs*, *mins*, *secs*)

Convert degrees, minutes, seconds lat/long form to degrees float.

Parameters

- **degs** (*int*) – Degrees
- **mins** (*int*) – Minutes
- **secs** (*int*) – Seconds

Returns
Degrees

Return type
(float)

synapse.lib.gis.**haversine**(*px*, *py*, *r=6371008800.0*)

Calculate the haversine distance between two points defined by (lat,lon) tuples.

Parameters

- **px** (*(float,float)*) – lat/long position 1
- **py** (*(float,float)*) – lat/long position 2
- **r** (*float*) – Radius of sphere

Returns
Distance in mm.

Return type
(int)

synapse.lib.gis.**latlong**(*text*)

Chop a latlong string and return (float,float). Does not perform validation on the coordinates.

Parameters
text (*str*) – A longitude,latitude string.

Returns
A longitude, latitude float tuple.

Return type
(float,float)

synapse.lib.gis.**near**(*point*, *dist*, *points*)

Determine if the given point is within dist of any of points.

Parameters

- **point** (*(float,float)*) – A latitude, longitude float tuple.
- **dist** (*int*) – A distance in mm (base units)
- **points** (*list*) – A list of latitude, longitude float tuples to compare against.

synapse.lib.grammar module

synapse.lib.grammar.**chop_float**(*text*, *off*)

synapse.lib.grammar.**isBasePropNoPivprop**(*name*)

synapse.lib.grammar.**isCmdName**(*name*)

synapse.lib.grammar.**isFormName**(*name*)

synapse.lib.grammar.**isPropName**(*name*)

synapse.lib.grammar.**isUnivName**(*name*)

synapse.lib.grammar.**meh**(*txt*, *off*, *cset*)

synapse.lib.grammar.**nom**(*txt*, *off*, *cset*, *trim=True*)

Consume chars in set from the string and return (subtxt,offset).

Example

text = "foo(bar)" chars = set('abcdefghijklmnopqrstuvwxyz')

name,off = nom(text,0,chars)

Note:

This really shouldn't be used for new code

synapse.lib.grammar.**parse_float**(*text*, *off*)

synapse.lib.hashitem module

synapse.lib.hashitem.**hashitem**(*item*)

Generate a uniq hash for the JSON compatible primitive data structure.

synapse.lib.hashitem.**normdict**(*item*)

synapse.lib.hashitem.**normitem**(*item*)

synapse.lib.hashitem.**normiter**(*item*)

synapse.lib.hashset module

class synapse.lib.hashset.**HashSet**

Bases: `object`

digests()

Get a list of (name, bytes) tuples for the hashes in the hashset.

eatfd(*fd*)

Consume all the bytes from a file like object.

Example

hset = HashSet() hset.eatfd(fd)

guid()

Use elements from this hash set to create a unique (re)identifier.

update(*byts*)

Update all the hashes in the set with the given bytes.

synapse.lib.health module

class synapse.lib.health.**HealthCheck**(*iden*)

Bases: object

getStatus()

pack()

setStatus(*valu*)

update(*name*, *status*, *mesg=''*, *data=None*)

Append a new component to the Healcheck object.

Parameters

- **name** (*str*) – Name of the reported component.
- **status** (*str*) – nomdinal/degraded/failed status code.
- **mesg** (*str*) – Optional message about the component status.
- **data** (*dict*) – Optional arbitrary dictionary of additional metadata about the component.

Returns
None

synapse.lib.hive module

class synapse.lib.hive.**Hive**

Bases: *Pusher*, *Aware*

An optionally persistent atomically accessed tree which implements primitives for use in making distributed/clustered services.

async add(*full*, *valu*)

Atomically increments a node's value.

async dict(*full*, *nexs=False*)

Open a HiveDict at the given full path.

Parameters
full (*tuple*) – A full path tuple.

Returns
A HiveDict for the full path.

Return type
HiveDict

dir(*full*)

List subnodes of the given Hive path.

Parameters
full (*tuple*) – A full path tuple.

Notes

This returns None if there is not a node at the path.

Returns
A list of tuples. Each tuple contains the name, node value, and the number of children nodes.

Return type
list

async exists(*full*)

Returns whether the Hive path has already been created.

async get(*full*, *defv=None*)

Get the value of a node at a given path.

Parameters
full (*tuple*) – A full path tuple.

Returns
Arbitrary node value.

async getHiveAuth()

Retrieve a HiveAuth for hive standalone or non-cell uses.

Note: This is for the hive's own auth, or for non-cell auth. It isn't the same auth as for a cell

async getTeleApi(*link*, *mesg*, *path*)

Return a shared object for this link. :param link: A network link. :type link: synapse.lib.link.Link :param mesg: The tele:syn handshake message. :type mesg: (str,dict)

async loadHiveTree(*tree*, *path=()*, *trim=False*)

async open(*full*)

Open and return a hive Node().

Parameters
full (*tuple*) – A full path tuple.

Returns
A Hive node.

Return type
Node

async pop(*full*, *nexs=False*)

Remove and return the value for the given node.

async rename(*oldpath*, *newpath*)

Moves a node at oldpath and all its descendant nodes to newpath. newpath must not exist

async saveHiveTree(*path=()*)

async set(*full*, *valu*, *nexs=False*)

A set operation at the hive level (full path).

async storNodeDele(*path*)

async **storNodeValu**(*full*, *valu*)

class synapse.lib.hive.**HiveApi**

Bases: *Base*

async **addAndSync**(*path*, *valu*, *iden*)

async **edits**()

async **get**(*full*)

async **loadHiveTree**(*tree*, *path=()*, *trim=False*)

async **popAndSync**(*path*, *iden*, *nexs=False*)

async **saveHiveTree**(*path=()*)

async **setAndSync**(*path*, *valu*, *iden*, *nexs=False*)

async **treeAndSync**(*path*, *iden*)

class synapse.lib.hive.**HiveDict**

Bases: *Base*

get(*name*, *default=None*)

items()

pack()

async **pop**(*name*, *default=None*)

async **set**(*name*, *valu*, *nexs=None*)

setdefault(*name*, *valu*)

values()

class synapse.lib.hive.**Node**

Bases: *Base*

A single node within the Hive tree.

async **add**(*valu*)

Increments existing node valu

async **dict**(*nexs=False*)

Get a HiveDict for this Node.

Returns

A HiveDict for this Node.

Return type

HiveDict

dir()

get(*name*)

name()

async open(*path*)

Open a child Node of the this Node.

Parameters
path (*tuple*) – A child path of the current node.

Returns
A Node at the child path.

Return type
Node

parent()

async pop(*path=()*)

async set(*valu*)

class synapse.lib.hive.SlabHive

Bases: *Hive*

async storNodeDele(*full*)

async storNodeValu(*full*, *valu*)

class synapse.lib.hive.TeleHive

Bases: *Hive*

A Hive that acts as a consistent read cache for a telepath proxy Hive

async add(*path*, *valu*)

Atomically increments a node's value.

async get(*path*)

Get the value of a node at a given path.

Parameters
full (*tuple*) – A full path tuple.

Returns
Arbitrary node value.

async open(*path*)

Open and return a hive Node().

Parameters
full (*tuple*) – A full path tuple.

Returns
A Hive node.

Return type
Node

async pop(*path*, *nexs=False*)

Remove and return the value for the given node.

async set(*path*, *valu*, *nexs=False*)

A set operation at the hive level (full path).

synapse.lib.hive.iterpath(*path*)

async synapse.lib.hive.**opendir**(*dirn*, *conf=None*)

async synapse.lib.hive.**openurl**(*url*, ***opts*)

synapse.lib.hiveauth module

class synapse.lib.hiveauth.**Auth**

Bases: *Pusher*

Auth is a user authentication and authorization stored in a Hive. Users correspond to separate logins with different passwords and potentially different privileges.

Users are assigned "rules". These rules are evaluated in order until a rule matches. Each rule is a tuple of boolean, and a rule path (a sequence of strings). Rules that are prefixes of a privilege match, i.e. a rule ('foo',) will match ('foo', 'bar').

Roles are just collections of rules. When a user is "granted" a role those rules are assigned to that user. Unlike in an RBAC system, users don't explicitly assume a role; they are merely a convenience mechanism to easily assign the same rules to multiple users.

Authgates are objects that manage their own authorization. Each AuthGate has roles and users subkeys which contain rules specific to that user or role for that AuthGate. The roles and users of an AuthGate, called GateRole and GateUser respectively, contain the iden of a role or user defined prior and rules specific to that role or user; they do not duplicate the metadata of the role or user.

Node layout:

```
Auth root (passed into constructor)
├ roles
│   ├ <role iden 1>
│   ├ ...
│   └ last role
├ users
│   ├ <user iden 1>
│   ├ ...
│   └ last user
└ authgates
    ├ <iden 1>
    │   ├ roles
    │   │   ├ <role iden 1>
    │   │   ├ ...
    │   │   └ last role
    │   └ users
    │       ├ <user iden 1>
    │       ├ ...
    │       └ last user
    ├ <iden 2>
    │   ├ ...
    └ ... last authgate
```

async addAuthGate(*iden*, *authgatetype*)

Retrieve AuthGate by iden. Create if not present.

Note: Not change distributed

Returns
(HiveAuthGate)

async addRole(*name*, *iden=None*)

async addUser(*name*, *passwd=None*, *email=None*, *iden=None*)

Add a User to the Hive.

Parameters

- **name** (*str*) – The name of the User.
- **passwd** (*str*) – A optional password for the user.
- **email** (*str*) – A optional email for the user.
- **iden** (*str*) – A optional iden to use as the user iden.

Returns
A Hive User.

Return type
HiveUser

async delAuthGate(*iden*)

Delete AuthGate by iden.

Note: Not change distributed

async delRole(*iden*)

async delUser(*iden*)

async feedBeholder(*evnt*, *info*, *gateiden=None*, *logged=True*)

getAuthGate(*iden*)

getAuthGates()

async getRoleByName(*name*)

async getUserByName(*name*)

Get a user by their username.

Parameters
name (*str*) – Name of the user to get.

Returns
A Hive User. May return None if there is no user by the requested name.

Return type
HiveUser

async getUserIdenByName(*name*)

reqAuthGate(*iden*)

async reqRole(*iden*)

async reqRoleByName(*name*)

async **reqUser**(*iden*)

async **reqUserByName**(*name*)

async **reqUserByNameOrIden**(*name*)

role(*iden*)

roles()

async **setRoleInfo**(*iden*, *name*, *valu*, *gateiden=None*, *logged=True*, *mesg=None*)

async **setRoleName**(*iden*, *name*)

async **setUserInfo**(*iden*, *name*, *valu*, *gateiden=None*, *logged=True*, *mesg=None*)

async **setUserName**(*iden*, *name*)

user(*iden*)

users()

class synapse.lib.hiveauth.**AuthGate**

Bases: *Base*

The storage object for object specific rules for users/roles.

async **delete**()

async **genRoleInfo**(*iden*)

async **genUserInfo**(*iden*)

pack()

class synapse.lib.hiveauth.**HiveRole**

Bases: *HiveRuler*

A role within the Hive authorization subsystem.

A role in HiveAuth exists to bundle rules together so that the same set of rules can be applied to multiple users.

allowed(*perm*, *default=None*, *gateiden=None*)

clearAuthCache()

async **genGateInfo**(*gateiden*)

pack()

async **setName**(*name*)

class synapse.lib.hiveauth.**HiveRuler**

Bases: *Base*

A HiveNode that holds a list of rules. This includes HiveUsers, HiveRoles, and the AuthGate variants of those

async **addRule**(*rule*, *indx=None*, *gateiden=None*, *nexs=True*)

async **delRule**(*rule*, *gateiden=None*)

getRules(*gateiden=None*)

async **setRules**(*rules*, *gateiden=None*, *nexs=True*, *mesg=None*)

class synapse.lib.hiveauth.**HiveUser**

Bases: *HiveRuler*

A user (could be human or computer) of the system within HiveAuth.

Cortex-wide rules are stored here. AuthGate-specific rules for this user are stored in an GateUser.

async **allow**(*perm*)

allowed(*perm*, *default=None*, *gateiden=None*)

clearAuthCache()

confirm(*perm*, *default=None*, *gateiden=None*)

async **genGateInfo**(*gateiden*)

getAllowedReason(*perm*, *gateiden=None*, *default=False*)

A non-optimized diagnostic routine which will return a tuple of (allowed, reason). This is implemented separately for perf.

NOTE: This must remain in sync with any changes to _allowed()!

getRoles()

async **grant**(*roleiden*, *indx=None*)

hasRole(*iden*)

isAdmin(*gateiden=None*)

isLocked()

pack(*packroles=False*)

raisePermDeny(*perm*, *gateiden=None*)

async **revoke**(*iden*, *nexs=True*)

async **setAdmin**(*admin*, *gateiden=None*, *logged=True*)

async **setArchived**(*archived*)

async **setLocked**(*locked*, *logged=True*)

async **setName**(*name*)

async **setPasswd**(*passwd*, *nexs=True*)

async **setRoles**(*roleidens*)

Replace all the roles for a given user with a new list of roles.

Parameters

roleidens (*list*) – A list of roleidens.

Notes

The roleiden for the "all" role must be present in the new list of roles. This replaces all existing roles that the user has with the new roles.

Returns
None

async tryPasswd(*passwd*, *nexs=True*)

synapse.lib.hiveauth.**getShadow**(*passwd*)

This API is deprecated.

synapse.lib.hiveauth.**textFromRule**(*rule*)

synapse.lib.httpapi module

class synapse.lib.httpapi.**ActiveV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

class synapse.lib.httpapi.**AuthAddRoleV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**AuthAddUserV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**AuthDelRoleV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**AuthGrantV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

/api/v1/auth/grant?user=iden&role=iden

async get()

async post()

class synapse.lib.httpapi.**AuthRevokeV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

/api/v1/auth/grant?user=iden&role=iden

async get()

async post()

class synapse.lib.httpapi.AuthRoleV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get(*iden*)

async post(*iden*)

class synapse.lib.httpapi.AuthRolesV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

class synapse.lib.httpapi.AuthUserPasswdV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post(*iden*)

class synapse.lib.httpapi.AuthUserV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get(*iden*)

async post(*iden*)

class synapse.lib.httpapi.AuthUsersV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

class synapse.lib.httpapi.BeholdSockV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *WebSocket*

async onInitMessage(*byts*)

async on_message(*byts*)

Handle incoming messages on the WebSocket

This method must be overridden.

Changed in version 4.5: `on_message` can be a coroutine.

class synapse.lib.httpapi.CoreInfoV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

/api/v1/core/info

async get()

class synapse.lib.httpapi.**FeedV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

/api/v1/feed

Examples

Example data:

```
{
    'name': 'syn.nodes',
    'view': null,
    'items': [...],
}
```

async post()

class synapse.lib.httpapi.**Handler**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *HandlerBase*, RequestHandler

on_connection_close()

Called in async handlers if the client closed the connection.

Override this to clean up resources associated with long-lived connections. Note that this method is called only if the connection was closed during asynchronous processing; if you need to do cleanup after every request override *on_finish* instead.

Proxies may keep a connection open for a time (perhaps indefinitely) after the client has gone away, so this method may not be called promptly after the end user closes their connection.

prepare()

Called at the beginning of a request before *get*/*post*/etc.

Override this method to perform common initialization regardless of the request method.

Asynchronous support: Use `async def` or decorate this method with .*gen.coroutine* to make it asynchronous. If this method returns an `Awaitable` execution will not proceed until the `Awaitable` is done.

New in version 3.1: Asynchronous support.

class synapse.lib.httpapi.**HandlerBase**

Bases: `object`

async allowed(*perm*, *gateiden=None*)

Check if the authenticated user has the given permission.

Parameters

- **perm** (*tuple*) – The permission tuple to check.
- **gateiden** (*str*) – The gateiden to check the permission against.

Notes

This API sets up HTTP response values if it returns False.

Returns
True if the user has the requested permission.

Return type
bool

`async authenticated()`
Check if the request has an authenticated user or not.

Returns
True if the request has an authenticated user, false otherwise.

Return type
bool

`check_origin(origin)`

`getAuthCell()`
Return a reference to the cell used for auth operations.

`getCustomHeaders()`

`getJsonBody(validator=None)`

`async getUseridenBody(validator=None)`
Helper function to confirm that there is an auth user and a valid JSON body in the request.

Parameters
validator – Validator function run on the deserialized JSON body.

Returns
The user definition and body of the request as deserialized JSON, or a tuple of s_common.novalu objects if there was no user or json body.

Return type
(str, object)

`async handleBasicAuth()`
Handle basic authentication in the handler.

Notes

Implementors may override this to disable or implement their own basic auth schemes. This is expected to set web_useriden and web_username upon successful authentication.

Returns
The user iden of the logged in user.

Return type
str

`initialize(cell)`

`isOrigHost(origin)`

async isUserAdmin()

Check if the current authenticated user is an admin or not.

Returns
True if the user is an admin, false otherwise.

Return type
bool

loadJsonMesg(*byts*, *validator=None*)

options()

async reqAuthAdmin()

Require the current authenticated user to be an admin.

Notes

If this returns False, an error message has already been sent and no additional processing for the request should be done.

Returns
True if the user is an admin, false otherwise.

Return type
bool

async reqAuthUser()

sendAuthRequired()

sendRestErr(*code*, *mesg*)

sendRestExc(*e*)

sendRestRetn(*valu*)

async sess(*gen=True*)

Get the heavy Session object for the request.

Parameters
gen (*bool*) – If set to True, generate a new session if there is no sess cookie.

Notes

This stores the identifier in the `sess` cookie for with a 14 day expiration, stored in the Cell. Valid requests with that `sess` cookie will resolve to the same Session object.

Returns
A heavy session object. If the sess cookie is invalid or gen is false, this returns None.

Return type
Sess

set_default_headers()

async useriden()

Get the user iden of the current session user.

Note: This function will pull the iden from the current session, or attempt to resolve the useriden with basic authentication.

Returns
The iden of the current session user.

Return type
str

class synapse.lib.httpapi.**HealthCheckV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

class synapse.lib.httpapi.**LoginV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**ModelNormV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

async post()

class synapse.lib.httpapi.**ModelV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async get()

class synapse.lib.httpapi.**OnePassIssueV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

/api/v1/auth/onepass/issue

async post()

class synapse.lib.httpapi.**ReqValidStormV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *StormHandler*

async get()

async post()

class synapse.lib.httpapi.**RobotHandler**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *HandlerBase*, RequestHandler

async get()

class synapse.lib.httpapi.Sess

Bases: Base

addWebSock(*sock*)

delWebSock(*sock*)

async login(*user*)

async logout()

async set(*name*, *valu*)

class synapse.lib.httpapi.StormCallV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: StormHandler

async get()

async post()

class synapse.lib.httpapi.StormExportV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: StormHandler

async get()

async post()

class synapse.lib.httpapi.StormHandler(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: Handler

getCore()

class synapse.lib.httpapi.StormNodesV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: StormHandler

async get()

async post()

class synapse.lib.httpapi.StormV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: StormHandler

async get()

async post()

class synapse.lib.httpapi.StormVarsGetV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: Handler

async get()

class synapse.lib.httpapi.**StormVarsPopV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**StormVarsSetV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

async post()

class synapse.lib.httpapi.**StreamHandler**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

Subclass for Tornado streaming uploads.

Notes

- Async method prepare() is called after headers are read but before body processing.
- Sync method on_finish() can be used to cleanup after a request.
- Sync method on_connection_close() can be used to cleanup after a client disconnect.
- Async methods post(), put(), etc are called after the streaming has completed.

async data_received(*chunk*)

Implement this method to handle streamed request data.

Requires the *.stream_request_body* decorator.

May be a coroutine for flow control.

class synapse.lib.httpapi.**WatchSockV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *WebSocket*

A web-socket based API endpoint for distributing cortex tag events.

Deprecated.

async onWatchMesg(*byts*)

async on_message(*byts*)

Handle incoming messages on the WebSocket

This method must be overridden.

Changed in version 4.5: `on_message` can be a coroutine.

class synapse.lib.httpapi.**WebSocket**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *HandlerBase*, `WebSocketHandler`

async xmit(*name*, ***info*)

synapse.lib.ingest module

synapse.lib.interval module

A few utilities for dealing with intervals.

synapse.lib.interval.**fold**(**vals*)

Initialize a new (min,max) tuple interval from values.

Parameters
***vals** (*[int,...]*) – A list of values (or Nones)

Returns
A (min,max) interval tuple or None

Return type
((int,int))

synapse.lib.interval.**overlap**(*ival0*, *ival1*)

Determine if two interval tuples have overlap.

Parameters

- **ival0** (*(int,int)*) – An interval tuple
- **ival1** (*(int,int)*) –

Returns
True if the intervals overlap, otherwise False

Return type
(bool)

synapse.lib.interval.**parsetime**(*text*)

Parse an interval time string and return a (min,max) tuple.

Parameters
text (*str*) – A time interval string

Returns
A epoch millis epoch time string

Return type
((int,int))

synapse.lib.jsonstor module

class synapse.lib.jsonstor.**JsonStor**

Bases: *Base*

A filesystem like storage mechanism that allows hirarchical lookup of reference counted "objects" that have individually editable properties.

#TODO json validation by path glob matches? (persists?) #TODO GUID ACCESS with index generation by type #TODO registered types jsonschema with optional write-back validation

async cmpDelPathObjProp(*path*, *prop*, *valu*)

async copyPathObj(*oldp*, *newp*)

async copyPathObjs(*paths*)

async delPathObj(*path*)

Remove a path and decref the object it references.

async delPathObjProp(*path*, *prop*)

async getPathList(*path*)

async getPathObj(*path*)

async getPathObjProp(*path*, *prop*)

async getPathObjs(*path*)

async hasPathObj(*path*)

async popPathObjProp(*path*, *prop*, *defv=None*)

async setPathLink(*srcpath*, *dstpath*)

Add a link from the given srcpath to the dstpath. NOTE: This causes the item at dstpath to be incref'd

async setPathObj(*path*, *item*)

Set (and/or reinitialize) the object at the given path.

NOTE: This will break any links by creating a new object.

async setPathObjProp(*path*, *prop*, *valu*)

class synapse.lib.jsonstor.JsonStorApi

Bases: *CellApi*

async addQueue(*name*, *info*)

addUserNotif(*useriden*, *mesgtype*, *mesgdata=None*)

async cmpDelPathObjProp(*path*, *name*, *valu*)

async copyPathObj(*oldp*, *newp*)

async copyPathObjs(*paths*)

async cullQueue(*name*, *offs*)

async delPathObj(*path*)

async delPathObjProp(*path*, *name*)

async delQueue(*name*)

delUserNotif(*indx*)

async getPathList(*path*)

async getPathObj(*path*)

async getPathObjProp(*path*, *prop*)

async getPathObjs(*path*)

getUserNotif(*indx*)

async **getsQueue**(*name*, *offs*, *size=None*, *cull=True*, *wait=True*)

async **hasPathObj**(*path*)

iterUserNotifs(*useriden*, *size=None*)

async **popPathObjProp**(*path*, *prop*)

async **putsQueue**(*name*, *items*)

async **setPathLink**(*srcpath*, *dstpath*)

async **setPathObj**(*path*, *item*)

async **setPathObjProp**(*path*, *prop*, *valu*)

watchAllUserNotifs(*offs=None*)

class synapse.lib.jsonstor.**JsonStorCell**

Bases: *Cell*

async **addQueue**(*name*, *info*)

async **addUserNotif**(*useriden*, *mesgtype*, *mesgdata=None*)

cellapi

alias of *JsonStorApi*

async **cmpDelPathObjProp**(*path*, *name*, *valu*)

async **copyPathObj**(*oldp*, *newp*)

async **copyPathObjs**(*paths*)

async **cullQueue**(*name*, *offs*)

async **delPathObj**(*path*)

async **delPathObjProp**(*path*, *name*)

async **delQueue**(*name*)

async **delUserNotif**(*indx*)

classmethod **getEnvPrefix**()

Get a list of envar prefixes for config resolution.

async **getPathList**(*path*)

async **getPathObj**(*path*)

async **getPathObjProp**(*path*, *prop*)

async **getPathObjs**(*path*)

async **getUserNotif**(*indx*)

async **getsQueue**(*name*, *offs*, *size=None*, *cull=True*, *wait=True*)

async **hasPathObj**(*path*)

async **initServiceStorage**()

async **iterUserNotifs**(*useriden*, *size=None*)

async **popPathObjProp**(*path*, *prop*)

async **putsQueue**(*name*, *items*)

async **setPathLink**(*srcpath*, *dstpath*)

async **setPathObj**(*path*, *item*)

async **setPathObjProp**(*path*, *prop*, *valu*)

async **watchAllUserNotifs**(*offs=None*)

synapse.lib.jupyter module

class synapse.lib.jupyter.**CmdrCore**

Bases: *Base*

A helper for jupyter/cmdr CLI interaction

async **addFeedData**(*name*, *items*, *, *viewiden=None*)

Add feed data to the cortex.

async **eval**(*text*, *opts=None*, *num=None*, *cmdr=False*)

A helper for executing a storm command and getting a list of packed nodes.

Parameters

- **text** (*str*) – Storm command to execute.
- **opts** (*dict*) – Opt to pass to the cortex during execution.
- **num** (*int*) – Number of nodes to expect in the output query. Checks that with an assert statement.
- **cmdr** (*bool*) – If True, executes the line via the Cmdr CLI and will send output to outp.

Notes

The opts dictionary will not be used if cmdr=True.

Returns
A list of packed nodes.

Return type
list

async **runCmdLine**(*text*)

Run a line of text directly via cmdr.

async **storm**(*text*, *opts=None*, *num=None*, *cmdr=False*, *suppress_logging=False*)

A helper for executing a storm command and getting a list of storm messages.

Parameters

- **text** (*str*) – Storm command to execute.

- **opts** (*dict*) – Opt to pass to the cortex during execution.
- **num** (*int*) – Number of nodes to expect in the output query. Checks that with an assert statement.
- **cmdr** (*bool*) – If True, executes the line via the Cmdr CLI and will send output to outp.
- **suppress_logging** (*bool*) – If True, suppresses some logging related to Storm runtime exceptions.

Notes

The opts dictionary will not be used if cmdr=True.

Returns
A list of storm messages.

Return type
list

suppress_logging(*suppress*)

Context manager to suppress specific loggers.

class synapse.lib.jupyter.**StormCore**

Bases: *Base*

A helper for jupyter/storm CLI interaction

async runCmdLine(*text*, *opts=None*)

Run a line of text directly via storm cli.

async storm(*text*, *opts=None*, *num=None*, *cli=False*, *suppress_logging=False*)

A helper for executing a storm command and getting a list of storm messages.

Parameters

- **text** (*str*) – Storm command to execute.
- **opts** (*dict*) – Opt to pass to the cortex during execution.
- **num** (*int*) – Number of nodes to expect in the output query. Checks that with an assert statement.
- **cli** (*bool*) – If True, executes the line via the Storm CLI and will send output to outp.
- **suppress_logging** (*bool*) – If True, suppresses some logging related to Storm runtime exceptions.

Notes

The opts dictionary will not be used if cmdr=True.

Returns
A list of storm messages.

Return type
list

suppress_logging(*suppress*)

Context manager to suppress specific loggers.

synapse.lib.jupyter.**genTempCoreProxy**(*mods=None*)

Get a temporary cortex proxy.

synapse.lib.jupyter.**genTempStormsvcProxy**(*cmdrcore*, *svcname*, *svcctor*, *conf=None*)

synapse.lib.jupyter.**getDocData**(*fp*, *root=None*)

Parameters

- **fp** (*str*) – Name of the file to retrieve the data of.
- **root** (*str*) – Optional root path to look for a docdata directory in.

Notes

Will detect json/jsonl/yaml/mpk extensions and automatically decode that data if found; otherwise it returns bytes.

Defaults to looking for the `docdata` directory in the current working directory. This behavior works fine for notebooks nested in the docs directory of synapse; but this root directory that is looked for may be overridden by providing an alternative root.

Returns
May be deserialized data or bytes.

Return type
data

Raises
ValueError if the file does not exist or directory traversal attempted..
–

synapse.lib.jupyter.**getDocPath**(*fn*, *root=None*)

Helper for getting a documentation data file paths.

Parameters

- **fn** (*str*) – Name of the file to retrieve the full path for.
- **root** (*str*) – Optional root path to look for a docdata in.

Notes

Defaults to looking for the `docdata` directory in the current working directory. This behavior works fine for notebooks nested in the docs directory of synapse; but this root directory that is looked for may be overridden by providing an alternative root.

Returns
A file path.

Return type
str

Raises
ValueError if the file does not exist or directory traversal attempted..
–

async synapse.lib.jupyter.**getItemCmdr**(*prox*, *outp=None*, *locs=None*)

Get a Cmdr instance with prepopulated locs

async synapse.lib.jupyter.**getItemStorm**(*prox*, *outp=None*)

Get a Storm CLI instance with prepopulated locs

async synapse.lib.jupyter.**getTempCoreCmdr**(*mods=None*, *outp=None*)

Get a CmdrCore instance which is backed by a temporary Cortex.

Parameters

- **mods** (*list*) – A list of additional CoreModules to load in the Cortex.
- **outp** – A output helper. Will be used for the Cmdr instance.

Notes

The CmdrCore returned by this should be fini()'d to tear down the temporary Cortex.

Returns
A CmdrCore instance.

Return type
CmdrCore

async synapse.lib.jupyter.**getTempCoreCmdrStormsvc**(*svcname*, *svcctor*, *svcconf=None*, *outp=None*)

Get a proxy to a Storm service and a CmdrCore instance backed by a temporary Cortex with the service added.

Parameters

- **svcname** (*str*) – Storm service name
- **svcctor** – Storm service constructor (e.g. Example.anit)
- **svcconf** – Optional conf for the Storm service
- **outp** – A output helper for the Cmdr instance

Notes

Both the CmdrCore and Storm service proxy should be fini()'d for proper teardown

Returns
A CmdrCore instance and proxy to the Storm service

Return type
(*CmdrCore*, *Proxy*)

async synapse.lib.jupyter.**getTempCoreProx**(*mods=None*)

Get a Telepath Proxt to a Cortex instance which is backed by a temporary Cortex.

Parameters
mods (*list*) – A list of additional CoreModules to load in the Cortex.

Notes

The Proxy returned by this should be fini()'d to tear down the temporary Cortex.

Returns
s_telepath.Proxy

async synapse.lib.jupyter.**getTempCoreStorm**(*mods=None*, *outp=None*)

Get a StormCore instance which is backed by a temporary Cortex.

Parameters

- **mods** (*list*) – A list of additional CoreModules to load in the Cortex.
- **outp** – A output helper. Will be used for the Cmdr instance.

Notes

The StormCore returned by this should be fini()'d to tear down the temporary Cortex.

Returns
A StormCore instance.

Return type
StormCore

async synapse.lib.jupyter.**getTempCoreStormStormsvc**(*svcname*, *svcctor*, *svcconf=None*, *outp=None*)

Get a proxy to a Storm service and a StormCore instance backed by a temporary Cortex with the service added.

Parameters

- **svcname** (*str*) – Storm service name
- **svcctor** – Storm service constructor (e.g. Example.anit)
- **svcconf** – Optional conf for the Storm service
- **outp** – A output helper for the Cmdr instance

Notes

Both the StormCore and Storm service proxy should be fini()'d for proper teardown

Returns
A StormCore instance and proxy to the Storm service

Return type
(*StormCore*, *Proxy*)

synapse.lib.jupyter.**suppress_logging**(*suppress*)

Context manager to suppress specific loggers.

synapse.lib.layer module

The Layer 2.0 archtecture introduces several optimized node/message serialization formats used by the layers to optimize returning primitives and facilitate efficient node construction:

Note: This interface is subject to change between minor revisions.

Storage Types (<stortype>)

In Layers 2.0, each node property from the model has an associated "storage type". Each storage type determines how the data is indexed and represented within the Layer. This formalizes the separation of "data model" from "storage model". Each data model type has a "stortype" property which coresponds to one of the STOR_TYPE_XXX values. The knowledge of the mapping of data model types to storage types is the responsibility of the data model, making the Layer implementation fully decoupled from the data model.

Node Edits / Edits

A node edit consists of a (<buid>, <form>, [edits]) tuple. An edit is Tuple of (<type>, <info>, List[NodeEdits]) where the first element is an int that matches to an EDIT_* constant below, the info is a tuple that varies depending on the first element, and the third element is a list of dependent NodeEdits that will only be applied if the edit actually makes a change.

Storage Node (<sode>)

A storage node is a layer/storage optimized node representation which is similar to a "packed node". A storage node *may* be partial (as it is produced by a given layer) and are joined by the view/snap into "full" storage nodes which are used to construct Node() instances.

Sode format:

```
(<buid>, {

    'ndef': (<formname>, <formvalu>),

    'props': {
        <propname>: <propvalu>,
    }

    'tags': {
        <tagname>: <tagvalu>,
    }

    'tagprops: {
        <tagname>: {
            <propname>: <propvalu>,
        },
    }

    # changes that were *just* made.
    'edits': [
        <edit>
    ]

}),
```

class synapse.lib.layer.**IndxBy**(*layr*, *abrv*, *db*)

Bases: object

IndxBy sub-classes encapsulate access methods and encoding details for various types of properties within the layer to be lifted/compared by storage types.

buidsByDups(*indx*)

buidsByPref(*indx=b''*)

buidsByRange(*minindx*, *maxindx*)

buidsByRangeBack(*minindx*, *maxindx*)

getNodeValu(*buid*)

hasIndxBuid(*indx*, *buid*)

keyBuidsByDups(*indx*)

keyBuidsByPref(*indx=b''*)

keyBuidsByRange(*minindx*, *maxindx*)

keyBuidsByRangeBack(*minindx*, *maxindx*)

Yields backwards from maxindx to minindx

scanByDups(*indx*)

scanByPref(*indx=b''*)

scanByRange(*minindx*, *maxindx*)

class synapse.lib.layer.**IndxByForm**(*layr*, *form*)

Bases: *IndxBy*

getNodeValu(*buid*)

class synapse.lib.layer.**IndxByProp**(*layr*, *form*, *prop*)

Bases: *IndxBy*

getNodeValu(*buid*)

class synapse.lib.layer.**IndxByPropArray**(*layr*, *form*, *prop*)

Bases: *IndxBy*

getNodeValu(*buid*)

class synapse.lib.layer.**IndxByTag**(*layr*, *form*, *tag*)

Bases: *IndxBy*

getNodeValuForm(*buid*)

class synapse.lib.layer.**IndxByTagProp**(*layr*, *form*, *tag*, *prop*)

Bases: *IndxBy*

getNodeValu(*buid*)

class synapse.lib.layer.**Layer**

Bases: *Pusher*

The base class for a cortex layer.

async clone(*newdirn*)

Copy the contents of this layer to a new layer

async delete()

Delete the underlying storage

getAbrvProp(*abrv*)

async getEdgeVerbs()

async getEdges(*verb=None*)

async getEditIndx()

Returns what will be the *next* (i.e. 1 past the last) nodeedit log index.

async getEditOffs()

Return the offset of the last *recorded* log entry. Returns -1 if nodeedit log is disabled or empty.

async getEditSize()

async getFormCounts()

getFormProps()

getIdenFutu(*iden=None*)

async getLayerSize()

Get the total storage size for the layer.

async getMirrorStatus()

async getModelVers()

async getNodeData(*buid*, *name*)

Return a single element of a buid's node data

getNodeEditWindow()

async getNodeForm(*buid*)

async getNodeTag(*buid*, *tag*)

async getNodeValu(*buid*, *prop=None*)

Retrieve either the form valu or a prop valu for the given node by buid.

getPropAbrv(*form*, *prop*)

async getPropCount(*formname*, *propname=None*, *maxsize=None*)

Return the number of property rows in the layer for the given form/prop.

getStorIndx(*stortype*, *valu*)

async getStorNode(*buid*)

async getStorNodes()

Yield (buid, sode) tuples for all the nodes with props/tags/tagprops stored in this layer.

async getTagCount(*tagname*, *formname=None*)

Return the number of tag rows in the layer for the given tag/form.

getTagPropAbrv(**args*)

getTagProps()

async getUnivPropCount(*propname*, *maxsize=None*)

Return the number of universal property rows in the layer for the given prop.

async hasNodeData(*buid*, *name*)

async hasNodeEdge(*buid1*, *verb*, *buid2*)

async hasTagProp(*name*)

async initLayerActive()

async initLayerPassive()

async initUpstreamSync(*url*)

async iterFormRows(*form*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes of a single form, optionally (re)starting at startvalu.

Parameters

- **form** (*str*) – A form name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns

AsyncIterator[Tuple(buid, valu)]

async iterLayerNodeEdits()

Scan the full layer and yield artificial sets of nodeedits.

async iterNodeData(*buid*)

Return a generator of all a buid's node data

async iterNodeDataKeys(*buid*)

Return a generator of all a buid's node data keys

async iterNodeEdgesN1(*buid*, *verb=None*)

async iterNodeEdgesN2(*buid*, *verb=None*)

async iterNodeEditLog(*offs=0*)

Iterate the node edit log and yield (offs, edits, meta) tuples.

async iterNodeEditLogBack(*offs=0*)

Iterate the node edit log and yield (offs, edits, meta) tuples in reverse.

async iterPropRows(*form*, *prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular secondary property, optionally (re)starting at startvalu.

Parameters

- **form** (*str*) – A form name.
- **prop** (*str*) – A universal property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns

AsyncIterator[Tuple(buid, valu)]

async iterTagPropRows(*tag*, *prop*, *form=None*, *stortype=None*, *startvalu=None*)

Yields (buid, valu) that match a tag:prop, optionally (re)starting at startvalu.

Parameters

- **tag** (*str*) – tag name
- **prop** (*str*) – prop name
- **form** (*Optional[str]*) – optional form name
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns

AsyncIterator[Tuple(buid, valu)]

async iterTagRows(*tag*, *form=None*, *starttupl=None*)

Yields (buid, (valu, form)) values that match a tag and optional form, optionally (re)starting at starttupl.

Parameters

- **tag** (*str*) – the tag to match
- **form** (*Optional[str]*) – if present, only yields buids of nodes that match the form.
- **starttupl** (*Optional[Tuple[buid, form]]*) – if present, (re)starts the stream of values there.

Returns

AsyncIterator[Tuple(buid, (valu, form))]

Note: This yields (buid, (tagvalu, form)) instead of just buid, valu in order to allow resuming an interrupted call by feeding the last value retrieved into starttupl

---

async iterUnivRows(*prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular universal property, optionally (re)starting at startvalu.

Parameters

- **prop** (*str*) – A universal property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop

- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterWipeNodeEdits()

async liftByDataName(*name*)

async liftByFormValu(*form*, *cmprvals*)

async liftByProp(*form*, *prop*)

async liftByPropArray(*form*, *prop*, *cmprvals*)

async liftByPropValu(*form*, *prop*, *cmprvals*)

async liftByTag(*tag*, *form=None*)

async liftByTagProp(*form*, *tag*, *prop*)

async liftByTagPropValu(*form*, *tag*, *prop*, *cmprvals*)
Note: form may be None

async liftByTagValu(*tag*, *cmpr*, *valu*, *form=None*)

async liftTagProp(*name*)

async makeSplices(*offs*, *nodeedits*, *meta*, *reverse=False*)
Flatten a set of nodeedits into splices.

mayDelBuid(*buid*, *sode*)

nodeeditctor
alias of *SlabSeqn*

async pack()

async saveNodeEdits(*edits*, *meta*)
Save node edits to the layer and return a tuple of (nexsoffs, changes).

Note: nexsoffs will be None if there are no changes.

async setLayerInfo(*name*, *valu*)
Set a mutable layer property.

async setModelVers(*vers*)

setPropAbrv(*form*, *prop*)

setSodeDirty(*buid*, *sode*, *form*)

setTagPropAbrv(**args*)

async splices(*offs=None*, *size=None*)
This API is deprecated.

Yield (offs, splice) tuples from the nodeedit log starting from the given offset.

Nodeedits will be flattened into splices before being yielded.

async splicesBack(*offs=None*, *size=None*)

async stat()

async storNodeEdits(*nodeedits*, *meta*)

async storNodeEditsNoLift(*nodeedits*, *meta*)

Execute a series of node edit operations.

Does not return the updated nodes.

async syncIndexEvents(*offs*, *matchdef*, *wait=True*)

Yield (offs, (buid, form, ETYPE, VALS, META)) tuples from the nodeedit log starting from the given offset. Only edits that match the filter in matchdef will be yielded.

Notes

ETYPE is an constant EDIT_* above. VALS is a tuple whose format depends on ETYPE, outlined in the comment next to the constant. META is a dict that may contain keys 'user' and 'time' to represent the iden of the user that initiated the change, and the time that it took place, respectively.

Additionally, every 1000 entries, an entry (offs, (None, None, EDIT_PROGRESS, (), ())) message is emitted.

The matchdef dict may contain the following keys: forms, props, tags, tagprops. The value must be a sequence of strings. Each key/val combination is treated as an "or", so each key and value yields more events. forms: EDIT_NODE_ADD and EDIT_NODE_DEL events. Matches events for nodes with forms in the value list. props: EDIT_PROP_SET and EDIT_PROP_DEL events. Values must be in form:prop or .universal form tags: EDIT_TAG_SET and EDIT_TAG_DEL events. Values must be the raw tag with no #. tagprops: EDIT_TAGPROP_SET and EDIT_TAGPROP_DEL events. Values must be just the prop or tag:prop.

Will not yield any values if this layer was not created with logedits enabled

Parameters

- **offs** (*int*) – starting nexus/editlog offset
- **matchdef** (*Dict[str, Sequence[str]]*) – a dict describing which events are yielded
- **wait** (*bool*) – whether to pend and stream value until this layer is fini'd

async syncNodeEdits(*offs*, *wait=True*)

Identical to syncNodeEdits2, but doesn't yield meta

async syncNodeEdits2(*offs*, *wait=True*)

Once caught up with storage, yield them in realtime.

Returns

Tuple of offset(int), nodeedits, meta(dict)

async truncate()

Nuke all the contents in the layer, leaving an empty layer NOTE: This internal API is deprecated but is kept for Nexus event backward compatibility

async verify(*config=None*)

async verifyAllBuids(*scanconf=None*)

async **verifyAllProps**(*scanconf=None*)

async **verifyAllTagProps**(*scanconf=None*)

async **verifyAllTags**(*scanconf=None*)

async **verifyBuidTag**(*buid*, *formname*, *tagname*, *tagvalu*)

async **verifyByBuid**(*buid*, *sode*)

async **verifyByProp**(*form*, *prop*, *autofix=None*)

async **verifyByPropArray**(*form*, *prop*, *autofix=None*)

async **verifyByTag**(*tag*, *autofix=None*)

async **verifyByTagProp**(*form*, *tag*, *prop*, *autofix=None*)

async **waitEditOffs**(*offs*, *timeout=None*)

Wait for the node edit log to write an entry at/past the given offset.

async **waitForHot**()

Wait for the layer's slab to be prefaulted and locked into memory if lockmemory is true, otherwise return.

async **waitUpstreamOffs**(*iden*, *offs*)

class synapse.lib.layer.**LayerApi**

Bases: *CellApi*

async **getEditIndx**()

Returns what will be the *next* nodeedit log index.

async **getEditSize**()

Return the total number of (edits, meta) pairs in the layer changelog.

async **getIden**()

async **iterLayerNodeEdits**()

Scan the full layer and yield artificial nodeedit sets.

saveNodeEdits(*edits*, *meta*)

Save node edits to the layer and return a tuple of (nexsoffs, changes).

Note: nexsoffs will be None if there are no changes.

async **splices**(*offs=None*, *size=None*)

This API is deprecated.

Yield (offs, splice) tuples from the nodeedit log starting from the given offset.

Nodeedits will be flattened into splices before being yielded.

async **storNodeEdits**(*nodeedits*, *meta=None*)

async **storNodeEditsNoLift**(*nodeedits*, *meta=None*)

async **syncNodeEdits**(*offs*, *wait=True*)

Yield (offs, nodeedits) tuples from the nodeedit log starting from the given offset.

Once caught up with storage, yield them in realtime.

async **syncNodeEdits2**(*offs*, *wait=True*)

class synapse.lib.layer.**StorType**(*layr*, *stortype*)

Bases: object

decodeIndx(*valu*)

indx(*valu*)

async **indxBy**(*liftby*, *cmpr*, *valu*)

async **indxByForm**(*form*, *cmpr*, *valu*)

async **indxByProp**(*form*, *prop*, *cmpr*, *valu*)

async **indxByPropArray**(*form*, *prop*, *cmpr*, *valu*)

async **indxByTagProp**(*form*, *tag*, *prop*, *cmpr*, *valu*)

async **verifyBuidProp**(*buid*, *form*, *prop*, *valu*)

class synapse.lib.layer.**StorTypeFloat**(*layr*, *stortype*, *size=8*)

Bases: *StorType*

FloatPackNegMax = b'\x80\x00\x00\x00\x00\x00\x00\x00'

FloatPackNegMin = b'\xff\xf0\x00\x00\x00\x00\x00\x00'

FloatPackPosMax = b'\x7f\xf0\x00\x00\x00\x00\x00\x00'

FloatPackPosMin = b'\x00\x00\x00\x00\x00\x00\x00\x00'

FloatPacker = <_struct.Struct object>

decodeIndx(*bytz*)

fpack()

S.pack(v1, v2, ...) -> bytes

Return a bytes object containing values v1, v2, ... packed according to the format string S.format. See help(struct) for more on format strings.

indx(*valu*)

class synapse.lib.layer.**StorTypeFqdn**(*layr*)

Bases: *StorTypeUtf8*

decodeIndx(*bytz*)

indx(*norm*)

class synapse.lib.layer.**StorTypeGuid**(*layr*)

Bases: *StorType*

decodeIndx(*bytz*)

indx(*valu*)

class synapse.lib.layer.**StorTypeHier**(*layr*, *stortype*, *sepr='.'*)

Bases: *StorType*

decodeIndx(*bytz*)

getHierIndx(*valu*)

indx(*valu*)

class synapse.lib.layer.**StorTypeHugeNum**(*layr*, *stortype*)

Bases: *StorType*

decodeIndx(*bytz*)

getHugeIndx(*norm*)

indx(*norm*)

class synapse.lib.layer.**StorTypeInt**(*layr*, *stortype*, *size*, *signed*)

Bases: *StorType*

decodeIndx(*bytz*)

getIntIndx(*valu*)

indx(*valu*)

class synapse.lib.layer.**StorTypeIpv6**(*layr*)

Bases: *StorType*

decodeIndx(*bytz*)

getIPv6Indx(*valu*)

indx(*valu*)

class synapse.lib.layer.**StorTypeIval**(*layr*)

Bases: *StorType*

decodeIndx(*bytz*)

indx(*valu*)

class synapse.lib.layer.**StorTypeLatLon**(*layr*)

Bases: *StorType*

decodeIndx(*bytz*)

indx(*valu*)

class synapse.lib.layer.**StorTypeLoc**(*layr*)

Bases: *StorTypeHier*

class synapse.lib.layer.**StorTypeMsgp**(*layr*)

Bases: *StorType*

indx(*valu*)

class synapse.lib.layer.**StorTypeTag**(*layr*)

Bases: *StorTypeHier*

static getTagFilt(*cmpr*, *valu*)

class synapse.lib.layer.**StorTypeTime**(*layr*)

Bases: *StorTypeInt*

class synapse.lib.layer.**StorTypeUtf8**(*layr*)

Bases: *StorType*

decodeIndx(*bytz*)

indx(*valu*)

synapse.lib.layer.**getFlatEdits**(*nodeedits*)

synapse.lib.layer.**getNodeEditPerms**(*nodeedits*)

Yields (offs, perm) tuples that can be used in user.allowed()

synapse.lib.link module

class synapse.lib.link.**Link**

Bases: *Base*

A Link() is created to wrap a socket reader/writer.

feed(*byts*)

Used by Plex() to unpack bytes.

get(*name*, *defval=None*)

Get a property from the Link info.

getAddrInfo()

Get a summary of address information related to the link.

async getSpawnInfo()

getTlsPeerCn()

async recv(*size*)

async recvsize(*size*)

async rx()

async send(*byts*)

set(*name*, *valu*)

Set a property in the Link info.

async tx(*mesg*)

Async transmit routine which will wait for writer drain().

txfini()

async synapse.lib.link.**connect**(*host*, *port*, *ssl=None*, *hostname=None*, *linkinfo=None*)

Async connect and return a Link().

async synapse.lib.link.**fromspawn**(*spawninfo*)

async synapse.lib.link.**linkfile**(*mode='wb'*)

Connect a socketpair to a file-object and return (link, file).

async synapse.lib.link.**linksock**(*forceclose=False*)

Connect a Link, socket pair.

async synapse.lib.link.**listen**(*host*, *port*, *onlink*, *ssl=None*)

Listen on the given host/port and fire onlink(Link).

Returns a server object that contains the listening sockets

async synapse.lib.link.**unixconnect**(*path*)

Connect to a PF_UNIX server listening on the given path.

async synapse.lib.link.**unixlisten**(*path*, *onlink*)

Start an PF_UNIX server listening on the given path.

synapse.lib.lmdbslab module

class synapse.lib.lmdbslab.**GuidStor**(*slab*, *name*)

Bases: object

async del_(*iden*)

async dict(*iden*)

gen(*iden*)

set(*iden*, *name*, *valu*)

class synapse.lib.lmdbslab.**Hist**(*slab*, *name*)

Bases: object

A class for storing items in a slab by time.

Each added item is inserted into the specified db within the slab using the current epoch-millis time stamp as the key.

add(*item*, *tick=None*)

carve(*tick*, *tock=None*)

class synapse.lib.lmdbslab.**HotCount**

Bases: *HotKeyVal*

Like HotKeyVal, but optimized for integer/count vals

static DecFunc(*b*)

Decode a signed 64-bit int from 8 byte big-endian

static EncFunc(*i*)

Encode a signed 64-bit int into 8 byte big-endian bytes

get(*name: str*, *defv=0*)

inc(*name: str*, *valu=1*)

set(*name: str*, *valu*)

class synapse.lib.lmdbslab.**HotKeyVal**

Bases: *Base*

A hot-loop capable keyval that only syncs on commit.

static DecFunc(*byts*, *use_list=False*)

Use msgpack to de-serialize a python object.

Parameters
byts (*bytes*) – The bytes to de-serialize

Notes

String objects are decoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow decoding bad input strings.

Returns
The de-serialized object

Return type
obj

static EncFunc(*item*)

Use msgpack to serialize a compatible python object.

Parameters
item (*obj*) – The object to serialize

Notes

String objects are encoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow encoding bad input strings.

Returns
The serialized bytes in msgpack format.

Return type
bytes

delete(*name: str*)

get(*name: str*, *defv=None*)

pack()

set(*name: str*, *valu*)

sync()

class synapse.lib.lmdbslab.**LmdbBackup**

Bases: *Base*

async saveto(*dstdir*)

class synapse.lib.lmdbslab.**MultiQueue**

Bases: *Base*

Allows creation/consumption of multiple durable queues in a slab.

async **add**(*name*, *info*)

async **cull**(*name*, *offs*)

Remove up-to (and including) the queue entry at offs.

async **dele**(*name*, *minoffs*, *maxoffs*)

Remove queue entries from minoffs, up-to (and including) the queue entry at maxoffs.

exists(*name*)

async **get**(*name*, *offs*, *wait=False*, *cull=True*)

Return (nextoffs, item) tuple or (-1, None) for the given offset.

async **gets**(*name*, *offs*, *size=None*, *cull=False*, *wait=False*)

Yield (offs, item) tuples from the message queue.

list()

offset(*name*)

async **pop**(*name*, *offs*)

Pop a single entry from the named queue by offset.

async **put**(*name*, *item*, *reqid=None*)

async **puts**(*name*, *items*, *reqid=None*)

async **rem**(*name*)

async **sets**(*name*, *offs*, *items*)

Overwrite queue entries with the values in items, starting at offs.

size(*name*)

status(*name*)

class synapse.lib.lmdbslab.**Scan**(*slab*, *db*)

Bases: object

A state-object used by Slab. Not to be instantiated directly.

Parameters

- **slab** (Slab) – which slab the scan is over
- **db** (*str*) – name of open database on the slab

bump()

first()

isatitem()

Returns if the cursor is at the value in atitem

iterfunc()

iternext()

resume()

set_key(*lkey*)

set_range(*lkey*, *valu=None*)

class synapse.lib.lmdbslab.**ScanBack**(*slab*, *db*)

Bases: *Scan*

A state-object used by Slab. Not to be instantiated directly.

Scans backwards.

first()

iterfunc()

resume()

set_key(*lkey*)

set_range(*lkey*)

class synapse.lib.lmdbslab.**ScanKeys**(*slab*, *db*)

Bases: *Scan*

An iterator over the keys of the database. If the database is dupsort, a key with multiple values with be yielded once for each value.

isatitem()

Returns if the cursor is at the value in atitem

iterfunc()

iternext()

resume()

class synapse.lib.lmdbslab.**Slab**

Bases: *Base*

A "monolithic" LMDB instance for use in a asyncio loop thread.

COMMIT_PERIOD = 0.2

DEFAULT_GROWSIZE = None

DEFAULT_MAPSIZE = 1073741824

WARN_COMMIT_TIME_MS = 1000

addResizeCallback(*callback*)

allslabs = {}

copydb(*sourcedbname*, *destslab*, *destdbname=None*, *progresscb=None*)

Copy an entire database in this slab to a new database in potentially another slab.

Parameters

- **sourcedbname** (*str*) – name of the db in the source environment
- **destslab** (*LmdbSlab*) – which slab to copy rows to
- **destdbname** (*str*) – the name of the database to copy rows to in destslab

- **progresscb** (*Callable[int]*) – if not None, this function will be periodically called with the number of rows completed

Returns
the number of rows copied

Return type
(int)

Note: If any rows already exist in the target database, this method returns an error. This means that one cannot use destdbname=None unless there are no explicit databases in the destination slab.

---

async copyslab(*dstpath*, *compact=True*)

async countByPref(*byts*, *db=None*, *maxsize=None*)

Return the number of rows in the given db with the matching prefix bytes.

dbexists(*name*)

The DB exists already if there's a key in the default DB with the name of the database

delete(*lkey*, *val=None*, *db=None*)

dropdb(*name*)

Deletes an **entire database** (i.e. a table), losing all data.

async fini()

Shut down the object and notify any onfini() coroutines.

Returns
Remaining ref count

firstkey(*db=None*)

Return the first key or None from the given db.

forcecommit()

Note: This method may raise a MapFullError

---

get(*lkey*, *db=None*)

async getHotCount(*name*)

async getMultiQueue(*name*, *nexsroot=None*)

getNameAbrv(*name*)

getSeqn(*name*)

async classmethod getSlabStats()

classmethod getSlabsInDir(*dirn*)

Returns all open slabs under a directory

has(*lkey*, *db=None*)

hasdup(*lkey*, *lval*, *db=None*)

async classmethod initSyncLoop(*inst*)

initdb(*name*, *dupsort=False*, *integerkey=False*, *dupfixed=False*)

last(*db=None*)

Return the last key/value pair from the given db.

lastkey(*db=None*)

Return the last key or None from the given db.

pop(*lkey*, *db=None*)

prefexists(*byts*, *db=None*)

Returns True if a prefix exists in the db.

put(*lkey*, *lval*, *dupdata=False*, *overwrite=True*, *append=False*, *db=None*)

putmulti(*kvpairs*, *dupdata=False*, *append=False*, *db=None*)

Returns

Tuple of number of items consumed, number of items added

rangeexists(*lmin*, *lmax=None*, *db=None*)

Returns True if at least one key exists in the range.

replace(*lkey*, *lval*, *db=None*)

Like put, but returns the previous value if existed

scanByDups(*lkey*, *db=None*)

scanByDupsBack(*lkey*, *db=None*)

scanByFull(*db=None*)

scanByFullBack(*db=None*)

scanByPref(*byts*, *startkey=None*, *startvalu=None*, *db=None*)

Parameters

- **byts** (*bytes*) – prefix to match on
- **startkey** (*Optional[bytes]*) – if present, will start scanning at key=byts+startkey
- **startvalu** (*Optional[bytes]*) – if present, will start scanning at (key+startkey, startvalu)

Notes

startvalu only makes sense if byts+startkey matches an entire key. startvalu is only value for dupsort=True dbs

scanByPrefBack(*byts*, *db=None*)

scanByRange(*lmin*, *lmax=None*, *db=None*)

scanByRangeBack(*lmax*, *lmin=None*, *db=None*)

scanKeys(*db=None*)

scanKeysByPref(*byts*, *db=None*)

stat(*db=None*)

statinfo()

async sync()

async classmethod syncLoopOnce()

async classmethod syncLoopTask()

syncevnt = None

synctask = None

async trash()

Deletes underlying storage

class synapse.lib.lmdbslab.**SlabAbrv**(*slab*, *name*)

Bases: object

A utility for translating arbitrary bytes into fixed with id bytes

abrvToByts(*abrv*)

abrvToName(*byts*)

bytsToAbrv(*byts*)

keys()

nameToAbrv(*name*)

names()

setBytsToAbrv(*byts*)

class synapse.lib.lmdbslab.**SlabDict**(*slab*, *db=None*, *pref=b''*)

Bases: object

A dictionary-like object which stores its props in a slab via a prefix.

It is assumed that only one SlabDict with a given prefix exists at any given time, but it is up to the caller to cache them.

get(*name*, *defval=None*)

Get a name from the SlabDict.

Parameters

- **name** (*str*) – The key name.
- **defval** (*obj*) – The default value to return.

Returns

The return value, or None.

Return type

(obj)

inc(*name*, *valu=1*)

items()

Return a tuple of (prop, valu) tuples from the SlabDict.

Returns
Tuple of (name, valu) tuples.

Return type
(((str, object), ...))

keys()

pop(*name*, *defval=None*)

Pop a name from the SlabDict.

Parameters

- **name** (*str*) – The name to remove.
- **defval** (*obj*) – The default value to return if the name is not present.

Returns
The object stored in the SlabDict, or defval if the object was not present.

Return type
object

set(*name*, *valu*)

Set a name in the SlabDict.

Parameters

- **name** (*str*) – The key name.
- **valu** (*obj*) – A msgpack compatible value.

Returns
None

synapse.lib.modelrev module

class synapse.lib.modelrev.**ModelRev**(*core*)

Bases: object

async revCoreLayers()

async revModel20210126(*layers*)

async revModel20210312(*layers*)

async revModel20210528(*layers*)

async revModel20210801(*layers*)

async revModel20211112(*layers*)

async revModel20220307(*layers*)

async revModel20220315(*layers*)

async revModel20220509(*layers*)

async **revModel20220706**(*layers*)

async **revModel20220803**(*layers*)

async **revModel20220901**(*layers*)

async **revModel20221025**(*layers*)

async **revModel20221123**(*layers*)

async **revModel20221212**(*layers*)

async **revModel20221220**(*layers*)

async **revModel20230209**(*layers*)

async **revModel_0_2_18**(*layers*)

async **revModel_0_2_19**(*layers*)

async **revModel_0_2_20**(*layers*)

async **revModel_0_2_21**(*layers*)

async **runStorm**(*text*, *opts=None*)

Run storm code in a schedcoro and log the output messages.

Parameters

- **text** (*str*) – Storm query to execute.
- **opts** – Storm opts.

Returns
None

synapse.lib.module module

class synapse.lib.module.**CoreModule**(*core*, *conf=None*)

Bases: object

confdefs = ()

getConfPath()

Get the path to the module specific config file (conf.yaml).

Notes

This creates the parent directory for the conf.yaml file if it does not exist. This API exists to allow a implementor to get the conf path during initCoreModule and drop a example config if needed. One use case of that is for missing configuration values, an example config can be written to the file and a exception raised.

Returns
Path to where the conf file is located at.

Return type
str

`getModDir()`

Get the path to the module specific directory.

Notes

This creates the directory if it did not previously exist.

Returns
The filepath to the module specific directory.

Return type
str

`getModName()`

Return the lowercased name of this module.

Notes

This pulls the `mod_name` attribute on the class. This allows an implementer to set a arbitrary name for the module. If this attribute is not set, it defaults to `self.__class__.__name__.lower()` and sets `mod_name` to that value.

Returns
The module name.

Return type
(str)

`getModPath(*paths)`

Construct a path relative to this module's working directory.

Parameters
`*paths` – A list of path strings

Notes

This creates the module specific directory if it does not exist.

Returns
The full path (or None if no cortex dir is configured).

Return type
(str)

`getModelDefs()`

`getStormCmds()`

Module implementers may override this to provide a list of Storm commands which will be loaded into the Cortex.

Returns
A list of Storm Command classes (not instances).

Return type
list

async initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

mod_name = None

async preCoreModule()

Module implementers may override this method to execute code immediately after a module has been loaded.

Notes

The initCoreModule function is preferred for overriding instead of preCoreModule().

No Cortex layer/storage operations will function in preCoreModule.

Any exception raised within this method will halt additional loading of the module.

Returns
None

synapse.lib.modules module

Module which implements the synapse module API/convention.

synapse.lib.msgpack module

class synapse.lib.msgpack.Unpk

Bases: object

An extension of the msgpack streaming Unpacker which reports sizes.

Notes

String objects are decoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow decoding bad input strings.

feed(*byts*)

Feed bytes to the unpacker and return completed objects.

Parameters
byts (*bytes*) – Bytes to unpack.

Notes

It is intended that this function is called multiple times with bytes from some sort of a stream, as it will unpack and return objects as they are available.

Returns
List of tuples containing the item size and the unpacked item.

Return type
list

synapse.lib.msgpack.**deepcopy**(*item*, *use_list=False*)

Copy a msgpack serializable by packing then unpacking it. For complex primitives, this runs in about 1/3 the time of copy.deepcopy()

synapse.lib.msgpack.**dumpfile**(*item*, *path*)

Dump an object to a file by path.

Parameters

- **item** (*object*) – The object to serialize.
- **path** (*str*) – The file path to save.

Returns
None

synapse.lib.msgpack.**en**(*item*)

Use msgpack to serialize a compatible python object.

Parameters
item (*obj*) – The object to serialize

Notes

String objects are encoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow encoding bad input strings.

Returns
The serialized bytes in msgpack format.

Return type
bytes

synapse.lib.msgpack.**getvars**(*varz*)

synapse.lib.msgpack.**isok**(*item*)

Returns True if the item can be msgpacked (by testing packing).

synapse.lib.msgpack.**iterfd**(*fd*)

Generator which unpacks a file object of msgpacked content.

Parameters
fd – File object to consume data from.

Notes

String objects are decoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow decoding bad input strings.

Yields
Objects from a msgpack stream.

synapse.lib.msgpack.**iterfile**(*path*, *since=-1*)

Generator which yields msgpack objects from a file path.

Parameters
path – File path to open and consume data from.

Notes

String objects are decoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow decoding bad input strings.

Yields
Objects from a msgpack stream.

synapse.lib.msgpack.**loadfile**(*path*)

Load and upack the msgpack bytes from a file by path.

Parameters
path (*str*) – The file path to a message pack file.

Raises
msgpack.exceptions.ExtraData – If the file contains multiple objects.

Returns
The decoded python object.

Return type
(obj)

synapse.lib.msgpack.**un**(*byts*, *use_list=False*)

Use msgpack to de-serialize a python object.

Parameters
byts (*bytes*) – The bytes to de-serialize

Notes

String objects are decoded using utf8 encoding. In order to handle potentially malformed input, `unicode_errors='surrogatepass'` is set to allow decoding bad input strings.

Returns
The de-serialized object

Return type
obj

synapse.lib.multislabseqn module

class synapse.lib.multislabseqn.**MultiSlabSeqn**

Bases: *Base*

An append-optimized sequence of byte blobs stored across multiple slabs for fast rotating/culling

async add(*item: Any*, *indx=None*) → int

Add a single item to the sequence.

async cull(*offs: int*) → bool

Remove entries up to (and including) the given offset.

async get(*offs: int*) → Any

Retrieve a single row by offset

getOffsetEvent(*offs: int*) → Event

Returns an asyncio Event that will be set when the particular offset is written. The event will be set if the offset has already been reached.

async gets(*offs*, *wait=True*) → AsyncIterator[Tuple[int, Any]]

Just like iter, but optionally waits for new entries once the end is reached.

index() → int

Return the current index to be used

async iter(*offs: int*) → AsyncIterator[Tuple[int, Any]]

Iterate over items in a sequence from a given offset.

Parameters
offs (*int*) – The offset to begin iterating from.

Yields
(indx, valu) – The index and valu of the item.

async last() → Tuple[int, Any] | None

async rotate() → int

Rotate the Nexus log at the current index.

Note: After this executes the tailseqn will be empty. Waiting for this indx to be written will indicate when it is possible to cull 1 minus the return value such that the rotated seqn is deleted.

Returns
The starting index of the new seqn

Return type
int

setIndex(*indx: int*) → None

static slabFilename(*dirn: str*, *indx: int*)

async waitForOffset(*offs: int*, *timeout=None*) → bool

Returns
true if the event got set, False if timed out

synapse.lib.nexus module

class synapse.lib.nexus.**ChangeDist**

Bases: *Base*

A utility class to distribute new change entries to mirrors/followers

update() → bool

class synapse.lib.nexus.**NexsRoot**

Bases: *Base*

async cull(*offs*)

async eat(*nexsiden*, *event*, *args*, *kwargs*, *meta*)

Actually mutate for the given nexsiden instance.

async enNexsLog()

getChangeDist(*offs: int*) → AsyncIterator[*ChangeDist*]

async index()

async isNexsReady()

async issue(*nexsiden*, *event*, *args*, *kwargs*, *meta=None*)

If I'm not a follower, mutate, otherwise, ask the leader to make the change and wait for the follower loop to hand me the result through a future.

async iter(*offs: int*, *tellready=False*) → AsyncIterator[Any]

Returns an iterator of change entries in the log

async promote()

async recover() → None

Replays the last entry in the nexus log in case we crashed between writing the log and applying it.

Notes

This must be called at cell startup after subsystems are initialized but before any write transactions might happen.

The log can only have recorded 1 entry ahead of what is applied. All log actions are idempotent, so replaying the last action that (might have) already happened is harmless.

async rotate()

async runMirrorLoop(*proxy*)

async setNexsReady(*status*)

async setindex(*indx*)

async startup()

async waitOffs(*offs*, *timeout=None*)

class synapse.lib.nexus.**Pusher**

Bases: *Base*

A mixin-class to manage distributing changes where one might plug in mirroring or consensus protocols

classmethod onPush(*event: str*, *passitem=False*) → Callable

Decorator that registers a method to be a handler for a named event

Parameters

- **event** – string that distinguishes one handler from another. Must be unique per Pusher subclass
- **passitem** – whether to pass the (offs, mesg) tuple to the handler as "nexsitem"

classmethod onPushAuto(*event: str*, *passitem=False*) → Callable

Decorator that does the same as onPush, except automatically creates the top half method

Parameters

- **event** – string that distinguishes one handler from another. Must be unique per Pusher subclass
- **passitem** – whether to pass the (offs, mesg) tuple to the handler as "nexsitem"

async saveToNexs(*name*, **args*, ***kwargs*)

setNexsRoot(*nexsroot*)

class synapse.lib.nexus.**RegMethType**(*name: str*, *bases: List[type]*, *attrs: Dict[str, Any]*)

Bases: type

Metaclass that collects all methods in class with _regme prop into a class member called _regclstupls

synapse.lib.node module

class synapse.lib.node.**Node**(*snap*, *sode*, *bylayer=None*)

Bases: object

A Cortex hypergraph node.

NOTE: This object is for local Cortex use during a single Xact.

async **addEdge**(*verb*, *n2iden*)

async **addTag**(*tag*, *valu=(None, None)*)

Add a tag to a node.

Parameters

- **tag** (*str*) – The tag to add to the node.
- **valu** – The optional tag value. If specified, this must be a value that norms as a valid time interval as an ival.

Returns
This returns None.

Return type
None

async **delEdge**(*verb*, *n2iden*)

async **delTag**(*tag*, *init=False*)

Delete a tag from the node.

async **delTagProp**(*tag*, *name*)

async **delete**(*force=False*)

Delete a node from the cortex.

The following tear-down operations occur in order:

- validate that you have permissions to delete the node
- validate that you have permissions to delete all tags
- validate that there are no remaining references to the node.
- **delete all the tags (bottom up)**
  - fire onDelTag() handlers
  - delete tag properties from storage
  - log tag:del splices
- **delete all secondary properties**
  - fire onDelProp handler
  - delete secondary property from storage
  - log prop:del splices
- **delete the primary property**
  - fire onDel handlers for the node
  - delete primary property from storage

- log node:del splices

async filter(*runt*, *text*, *opts=None*, *path=None*)

get(*name*)

Return a secondary property value from the Node.

Parameters
name (*str*) – The name of a secondary property.

Returns
The secondary property value or None.

Return type
(obj)

getByLayer()

Return a dictionary that translates the node's bylayer dict to a primitive.

async getData(*name*, *defv=None*)

async getEmbeds(*embeds*)

Return a dictionary of property embeddings.

getNodeRefs()

Return a list of (prop, (form, valu)) refs out for the node.

async getStorNodes()

Return a list of the raw storage nodes for each layer.

getTag(*name*, *defval=None*)

getTagProp(*tag*, *prop*, *defval=None*)

Return the value (or defval) of the given tag property.

getTagProps(*tag*)

getTags(*leaf=False*)

has(*name*)

async hasData(*name*)

hasTag(*name*)

hasTagProp(*tag*, *prop*)

Check if a #foo.bar:baz tag property exists on the node.

iden()

async iterData()

async iterDataKeys()

async iterEdgesN1(*verb=None*)

async iterEdgesN2(*verb=None*)

pack(*dorepr=False*)

Return the serializable/packed version of the node.

Parameters
dorepr (*bool*) – Include repr information for human readable versions of properties.

Returns
An (ndef, info) node tuple.

Return type
(tuple)

async pop(*name*, *init=False*)

Remove a property from a node and return the value

async popData(*name*)

repr(*name=None*, *defv=None*)

reprs()

Return a dictionary of repr values for props whose repr is different than the system mode value.

async seen(*tick*, *source=None*)

Update the .seen interval and optionally a source specific seen node.

async set(*name*, *valu*, *init=False*)

Set a property on the node.

Parameters

- **name** (*str*) – The name of the property.
- **valu** (*obj*) – The value of the property.
- **init** (*bool*) – Set to True to disable read-only enforcement

Returns
True if the property was changed.

Return type
(bool)

async setData(*name*, *valu*)

async setTagProp(*tag*, *name*, *valu*)

Set the value of the given tag property.

async storm(*runt*, *text*, *opts=None*, *path=None*)

Parameters
path (Path) – If set, then vars from path are copied into the new runtime, and vars are copied back out into path at the end

Note: If opts is not None and opts['vars'] is set and path is not None, then values of path vars take precedent

tagpropreprs()

Return a dictionary of repr values for tagprops whose repr is different than the system mode value.

class synapse.lib.node.**Path**(*vars*, *nodes*)

Bases: object

A path context tracked through the storm runtime.

clone()

finiframe()

Pop a scope frame from the path, restoring runt if at the top :param runt: A storm runtime to restore if we're at the top :type runt: Runtime :param merge: Set to true to merge vars back up into the next frame :type merge: bool

fork(*node*)

getVar(*name*, *defv=<synapse.common.NoValu object>*)

initframe(*initvars=None*)

meta(*name*, *valu*)

Add node specific metadata to be returned with the node.

async pack(*path=False*)

async popVar(*name*)

async setVar(*name*, *valu*)

synapse.lib.node.**iden**(*pode*)

Return the iden (buid) of the packed node.

Parameters
pode (*tuple*) – A packed node.

Returns
The node iden.

Return type
str

synapse.lib.node.**ndef**(*pode*)

Return a node definition (<form>,<valu>) tuple from the node.

Parameters
pode (*tuple*) – A packed node.

Returns
The (<form>,<valu>) tuple for the node

Return type
((str,obj))

synapse.lib.node.**prop**(*pode*, *prop*)

Return the valu of a given property on the node.

Parameters

- **pode** (*tuple*) – A packed node.
- **prop** (*str*) – Property to retrieve.

Notes

The prop argument may be the full property name (foo:bar:baz), relative property name (:baz) , or the unadorned property name (baz).

Returns:

synapse.lib.node.**props**(*pode*)

Get the props from the node.

Parameters
pode (*tuple*) – A packed node.

Notes

This will include any universal props present on the node.

Returns
A dictionary of properties.

Return type
dict

synapse.lib.node.**reprNdef**(*pode*)

Get the ndef of the pode with a human readable value.

Parameters
pode (*tuple*) – A packed node.

Notes

The human readable value is only available if the node came from a storm query execution where the `repr` key was passed into the `opts` argument with a True value.

Returns
A tuple of form and the human readable value.

Return type
(str, str)

synapse.lib.node.**reprProp**(*pode*, *prop*)

Get the human readable value for a secondary property from the pode.

Parameters

- **pode** (*tuple*) – A packed node.
- **prop** –

Notes

The human readable value is only available if the node came from a storm query execution where the `repr` key was passed into the `opts` argument with a True value.

The prop argument may be the full property name (foo:bar:baz), relative property name (:baz) , or the unadorned property name (baz).

Returns
The human readable property value. If the property is not present, returns None.

Return type
str

synapse.lib.node.**reprTag**(*pode*, *tag*)

Get the human readable value for the tag timestamp from the pode.

Parameters

- **pode** (*tuple*) – A packed node.
- **tag** (*str*) – The tag to get the value for.

Notes

The human readable value is only available if the node came from a storm query execution where the `repr` key was passed into the `opts` argument with a True value.

If the tag does not have a timestamp, this returns a empty string.

Returns
The human readable value for the tag. If the tag is not present, returns None.

Return type
str

synapse.lib.node.**reprTagProps**(*pode*, *tag*)

Get the human readable values for any tagprops on a tag for a given node.

Parameters

- **pode** (*tuple*) – A packed node.
- **tag** (*str*) – The tag to get the tagprops reprs for.

Notes

The human readable value is only available if the node came from a storm query execution where the `repr` key was passed into the `opts` argument with a True value.

If the tag does not have any tagprops associated with it, this returns an empty list.

Returns
A list of tuples, containing the name of the tagprop and the repr value.

Return type
list

synapse.lib.node.**tagged**(*pode*, *tag*)

Check if a packed node has a given tag.

Parameters

- **pode** (*tuple*) – A packed node.
- **tag** (*str*) – The tag to check.

Examples

Check if a node is tagged with "woot" and dostuff if it is.

if s_node.tagged(node,'woot'):
dostuff()

Notes

If the tag starts with *#*, this is removed prior to checking.

Returns
True if the tag is present. False otherwise.

Return type
bool

synapse.lib.node.**tags**(*pode*, *leaf=False*)

Get all the tags for a given node.

Parameters

- **pode** (*tuple*) – A packed node.
- **leaf** (*bool*) – If True, only return leaf tags

Returns
A list of tag strings.

Return type
list

synapse.lib.node.**tagsnice**(*pode*)

Get all the leaf tags and the tags that have values or tagprops.

Parameters
pode (*tuple*) – A packed node.

Returns
A list of tag strings.

Return type
list

synapse.lib.oauth module

class synapse.lib.oauth.**OAuthMixin**

Bases: *Pusher*

Mixin for Cells to organize and execute OAuth token refreshes.

async addOAuthProvider(*conf*)

async clearOAuthAccessToken(*provideriden*, *useriden*)

Remove a client access token by clearing the configuration. This will prevent further refreshes (if scheduled), and a new auth code will be required the next time an access token is requested.

async delOAuthProvider(*iden*)

async getOAuthAccessToken(*provideriden*, *useriden*)

async getOAuthClient(*provideriden*, *useriden*)

async getOAuthProvider(*iden*)

listOAuthClients()

Returns
List of (provideriden, useriden, conf) for each client.

Return type
list

async listOAuthProviders()

async setOAuthAuthCode(*provideriden*, *useriden*, *authcode*, *code_verifier=None*)

Typically set as the end result of a successful OAuth flow. An initial access token and refresh token will be immediately requested, and the client will be loaded into the schedule to be background refreshed.

synapse.lib.oauth.**normOAuthTokenData**(*issued_at*, *data*)

Normalize timestamps to be in epoch millis and set expires_at/refresh_at.

synapse.lib.output module

Tools for easily hookable output from cli-like tools.

class synapse.lib.output.**OutPut**

Bases: object

printf(*mesg*, *addnl=True*)

class synapse.lib.output.**OutPutBytes**

Bases: *OutPutFd*

class synapse.lib.output.**OutPutFd**(*fd*, *enc='utf8'*)

Bases: *OutPut*

class synapse.lib.output.**OutPutStr**

Bases: *OutPut*

synapse.lib.parser module

class synapse.lib.parser.**AstConverter**(*text*)

Bases: Transformer

Convert AST from parser into synapse AST, depth first.

If a method with a name that matches the current rule exists, that will be called, otherwise __default__ will be used

cmdrargs(*meta*, *kids*)

embedquery(*meta*, *kids*)

evalvalu(*meta*, *kids*)

exprdict(*meta*, *kids*)

exprlist(*meta*, *kids*)

funcargs(*meta*, *kids*)

A list of function parameters (as part of a function definition)

funccall(*meta*, *kids*)

metaToAstInfo(*meta*, *isterm=False*)

operrelprop_join(*meta*, *kids*)

operrelprop_pivot(*meta*, *kids*, *isjoin=False*)

raiseBadSyntax(*mesg*, *astinfo*)

stormcmdargs(*meta*, *kids*)

subquery(*meta*, *kids*)

switchcase(*meta*, *kids*)

varderef(*meta*, *kids*)

varlist(*meta*, *kids*)

yieldvalu(*meta*, *kids*)

class synapse.lib.parser.**AstInfo**(*text*, *soff*, *eoff*, *sline*, *eline*, *scol*, *ecol*, *isterm*)

Bases: tuple

ecol

Alias for field number 6

eline

Alias for field number 4

eoff

Alias for field number 2

isterm

Alias for field number 7

scol

Alias for field number 5

sline

Alias for field number 3

soff

Alias for field number 1

text

Alias for field number 0

class synapse.lib.parser.**CmdStringer**(*visit_tokens: bool = True*)

Bases: Transformer

alist(*meta*, *kids*)

cmdstring(*meta*, *kids*)

valu(*meta*, *kids*)

class synapse.lib.parser.**Parser**(*text*, *offs=0*)

Bases: object

Storm query parser

cmdrargs()

Parse command args that might have storm queries as arguments

eval()

lookup()

query()

Parse the storm query

Returns (s_ast.Query): instance of parsed query

search()

synapse.lib.parser.**format_unescape**(*valu*)

synapse.lib.parser.**massage_vartokn**(*astinfo*, *x*)

synapse.lib.parser.**parseEval**(*text*)

synapse.lib.parser.**parseQuery**(*text*, *mode='storm'*)

Parse a storm query and return the Lark AST. Cached here to speed up unit tests

synapse.lib.parser.**parse_cmd_string**(*text*, *off*)

Parse a command line string which may be quoted.

synapse.lib.parser.**unescape**(*valu*)

Parse a string for backslash-escaped characters and omit them. The full list of escaped characters can be found at https://docs.python.org/3/reference/lexical_analysis.html#string-and-bytes-literals

synapse.lib.provenance module

synapse.lib.provenance.**claim**(*typ*, ***info*)

Add an entry to the provenance stack for the duration of the context

synapse.lib.provenance.**dupstack**(*newtask*)

Duplicate the current provenance stack onto another task

synapse.lib.provenance.**get**()

Returns

A tuple of (stack iden (or None if not set), the current provenance stack)

synapse.lib.provenance.**reset**()

Reset the stack to its initial state

For testing purposes

synapse.lib.provenance.**setiden**(*iden*, *waswritten*)

Sets the cached stack iden, waswritten for the current provenance stack. We use waswritten to cache whether we've written the stack and so we can tell the snap whether to fire a prov:new event

synapse.lib.queue module

class synapse.lib.queue.**AQueue**

Bases: *Base*

An async queue with chunk optimized sync compatible consumer.

put(*item*)

Add an item to the queue.

async slice()

class synapse.lib.queue.**Queue**(*maxsize=None*)

Bases: object

An asyncio Queue with batch methods and graceful close.

async close()

async put(*item*)

async puts(*items*)

async size()

async slice(*size=1000*)

async slices(*size=1000*)

class synapse.lib.queue.**Window**

Bases: *Base*

A Queue like object which yields added items. If the queue ever reaches its maxsize, it will be fini()d. On fini(), the Window will continue to yield results until empty and then return.

async put(*item*)

Add a single item to the Window.

async puts(*items*)

Add multiple items to the window.

synapse.lib.ratelimit module

class synapse.lib.ratelimit.**RateLimit**(*rate*, *per*)

Bases: object

A RateLimit class may be used to detect/enforce rate limits.

Example

allow 20 uses per 10 sec (2/sec) rlimit = RateLimit(20,10)

Notes

It is best (even in a "calls per day" type config) to specify a smaller "per" to force rate "smoothing".

allows()

Returns True if the rate limit has not been reached.

Example

if not rlimit.allows():
    rasie RateExceeded()

ok to go...

synapse.lib.reflect module

synapse.lib.reflect.**getClsNames**(*item*)

Return a list of "fully qualified" class names for an instance.

Example

for name in getClsNames(foo):
    print(name)

synapse.lib.reflect.**getItemLocals**(*item*)

Iterate the locals of an item and yield (name,valu) pairs.

Example

for name,valu in getItemLocals(item):
dostuff()

synapse.lib.reflect.**getMethName**(*meth*)

Return a fully qualified string for the <mod>.<class>.<func> name of a given method.

synapse.lib.reflect.**getShareInfo**(*item*)

Get a dictionary of special annotations for a Telepath Proxy.

Parameters
item – Item to inspect.

Notes

This will set the `_syn_telemeth` attribute on the item and the items class, so this data is only computed once.

Returns
A dictionary of methods requiring special handling by the proxy.

Return type
dict

synapse.lib.rstorm module

class synapse.lib.rstorm.**OutPutRst**

Bases: *OutPutStr*

Rst specific helper for output intended to be indented in RST text as a literal block.

prefix = ' '

printf(*mesg*, *addnl=True*)

class synapse.lib.rstorm.**StormCliOutput**

Bases: *StormCli*

async handleErr(*mesg*)

printf(*mesg*, *addnl=True*, *color=None*)

async runRstCmdLine(*text*, *ctx*, *stormopts=None*)

class synapse.lib.rstorm.**StormOutput**(*core*, *ctx*, *stormopts=None*, *opts=None*)

Bases: *StormCmd*

Produce standard output from a stream of storm runtime messages. Must be instantiated for a single query with a rstorm context.

printf(*mesg*, *addnl=True*, *color=None*)

async runCmdLine(*line*)

Run a line of command input for this command.

Parameters
line (*str*) – Line to execute

Examples

Run the foo command with some arguments:

await foo.runCmdLine('foo –opt baz woot.com')

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.lib.rstorm.**StormRst**

Bases: *Base*

async run()

Parses the specified RST file with Storm directive handling.

Returns
List of line strings for the RST output

Return type
list

synapse.lib.rstorm.**getCell**(*ctor*, *conf*)

synapse.lib.scope module

class synapse.lib.scope.**Scope**(**frames*, ***vals*)

Bases: `object`

The Scope object assists in creating nested varible scopes.

Example

with Scope() as scope:

scope.set('foo',10)

with scope:
scope.set('foo',20) dostuff(scope) # 'foo' is 20…

dostuff(scope) # 'foo' is 10 again…

add(*name*, **vals*)

Add values as iter() compatible items in the current scope frame.

copy()

Create a shallow copy of the current Scope.

Returns
A new scope which is a copy of the current scope.

Return type
Scope

enter(*vals=None*)

Add an additional scope frame.

get(*name*, *defval=None*)

Retrieve a value from the closest scope frame.

iter(*name*)

Iterate through values added with add() from each scope frame.

leave()

Pop the current scope frame.

pop(*name*, *defval=None*)

Pop and return a value (from the last frame) of the scope.

Parameters
name (*str*) – The name of the scope variable.

Returns
The scope variable value or None

Return type
obj

set(*name*, *valu*)

Set a value in the current scope frame.

update(*vals*)

Set multiple values in the current scope frame.

synapse.lib.scope.**clone**(*task: Task*) → None

Clone the current task Scope onto the provided task.

Parameters
task (*asyncio.Task*) – The task object to attach the scope too.

Notes

This must be run from an asyncio IO loop.

If the current task does not have a scope, we clone the default global Scope.

This will `enter()` the scope, and add a task callback to `leave()` the scope.

Returns
None

synapse.lib.scope.**ctor**(*name*, *func*, **args*, ***kwargs*)

Add a ctor callback to the global scope.

synapse.lib.scope.**enter**(*vals=None*)

Return the task's local scope for use in a with block

synapse.lib.scope.**get**(*name*, *defval=None*)

Access this task's scope with default values from glob.

synapse.lib.scope.**pop**(*name*)

Pop and return a task scope variable. :param name: The task scope variable name. :type name: str

Returns
The scope value or None

Return type
obj

synapse.lib.scope.**set**(*name*, *valu*)

Set a value in the current frame of the local task scope.

synapse.lib.scope.**update**(*vals*)

synapse.lib.scrape module

synapse.lib.scrape.**contextScrape**(*text*, *form=None*, *refang=True*, *first=False*)

Scrape types from a blob of text and yield info dictionaries.

Parameters

- **text** (*str*) – Text to scrape.
- **form** (*str*) – Optional form to scrape. If present, only scrape items which match the provided form.
- **refang** (*bool*) – Whether to remove de-fanging schemes from text before scraping.
- **first** (*bool*) – If true, only yield the first item scraped.

Notes

The dictionaries yielded by this function contains the following keys:

match
The raw matching text found in the input text.

offset
The offset into the text where the match was found.

valu
The resulting value.

form
The corresponding form for the valu.

Returns
Yield info dicts of results.

Return type
(dict)

synapse.lib.scrape.**cve_check**(*match: Match*)

synapse.lib.scrape.**fqdn_check**(*match: Match*)

synapse.lib.scrape.**fqdn_prefix_check**(*match: Match*)

synapse.lib.scrape.**genFangRegex**(*fangs*, *flags=RegexFlag.I*)

synapse.lib.scrape.**genMatches**(*text: str*, *regx: compile*, *opts: dict*)

Generate regular expression matches for a blob of text.

Parameters

- **text** (*str*) – The text to generate matches for.
- **regx** (*regex.Regex*) – A compiled regex object. The regex must contained a named match group for `valu`.
- **opts** (*dict*) – An options dictionary.

Notes

The dictionaries yielded by this function contains the following keys:

raw_valu
The raw matching text found in the input text.

offset
The offset into the text where the match was found.

valu
The resulting value - this may be altered by callbacks.

The options dictionary can contain a `callback` key. This function is expected to take a single argument, a regex.Match object, and return a tuple of the new valu and info dictionary. The new valu is used as the `valu` key in the returned dictionary, and any other information in the info dictionary is pushed into the return dictionary as well.

Yields
dict – A dictionary of match results.

`synapse.lib.scrape.getForms()`

Get a list of forms recognized by the scrape APIs.

Returns
A list of form values.

Return type
list

`synapse.lib.scrape.refang_text(txt)`

Remove address de-fanging in text blobs, .e.g. example[.]com to example.com

Matches to keys in FANGS is case-insensitive, but replacement will always be with the lowercase version of the re-fanged value. For example, HXXP://FOO.COM will be returned as http://FOO.COM

Returns
Re-fanged text blob

Return type
(str)

synapse.lib.scrape.**refang_text2**(*txt: str*, *re: compile = regex.Regex('fxp:\|fxps:\|hxxp:\|hxxps:\|fxp\\[s\\]:\|hxxp\\[s\\]:\|ftp\\[:\\]\|fxp\\[:\\]\|ftps\\[:\\]\|fxps\\[flags=regex.I | regex.V0)*, *fangs: dict = {'(.)': '.', '()': '', '()': '', '()': '', '.]': '.', '[.': '.', '[.]': '.', '[:]': ':', '[@]': '@', '[at]': '@', '[dot]': '.', '[]': '', '[]': '', '[]': '', \\.': '.', 'ftp(:)': 'ftp:', 'ftp[:': 'ftp:', 'ftp[://]': 'ftp://', 'ftp[:]': 'ftp:', 'ftps(:)': 'ftps:', 'ftps[:': 'ftps:', 'ftps[://]': 'ftps://', 'ftps[:]': 'ftps:', 'fxp(:)': 'ftp:', 'fxp:': 'ftp:', 'fxp[:': 'ftp:', 'fxp[://]': 'ftp://', 'fxp[:]': 'ftp:', 'fxp[s]:': 'ftps:', 'fxps(:)': 'ftps:', 'fxps:': 'ftps:', 'fxps[:': 'ftps:', 'fxps[://]': 'ftps://', 'fxps[:]': 'ftps:', 'http(:)': 'http:', 'http[:': 'http:', 'http[://]': 'http://', 'http[:]': 'http:', 'https(:)': 'https:', 'https[:': 'https:', 'https[://]': 'https://', 'https[:]': 'https:', 'hxxp(:)': 'http:', 'hxxp:': 'http:', 'hxxp[:': 'http:', 'hxxp[://]': 'http://', 'hxxp[:]': 'http:', 'hxxp[s]:': 'https:', 'hxxps(:)': 'https:', 'hxxps:': 'https:', 'hxxps[:': 'https:', 'hxxps[://]': 'https://', 'hxxps[:]': 'https:'}*)

Remove address de-fanging in text blobs, .e.g. example[.]com to example.com

Notes

Matches to keys in FANGS is case-insensitive, but replacement will always be with the lowercase version of the re-fanged value. For example, `HXXP://FOO.COM` will be returned as `http://FOO.COM`

Parameters
txt (*str*) – The text to re-fang.

Returns
A tuple containing the new text, and a dictionary containing offset information where the new text was altered with respect to the original text.

Return type
tuple(str, dict)

synapse.lib.scrape.**scrape**(*text*, *ptype=None*, *refang=True*, *first=False*)

Scrape types from a blob of text and return node tuples.

Parameters

- **text** (*str*) – Text to scrape.
- **ptype** (*str*) – Optional ptype to scrape. If present, only scrape items which match the provided type.
- **refang** (*bool*) – Whether to remove de-fanging schemes from text before scraping.
- **first** (*bool*) – If true, only yield the first item scraped.

Returns
Yield tuples of node ndef values.

Return type
(str, object)

synapse.lib.share module

class synapse.lib.share.**Share**

Bases: *Base*

Class to wrap a dynamically shared object.

synapse.lib.slaboffs module

class synapse.lib.slaboffs.**SlabOffs**(*slab:* Slab, *db: str*)

Bases: object

A helper for storing offset integers by iden.

As with all slab objects, this is meant for single-thread async loop use.

delete(*iden*)

get(*iden*)

set(*iden*, *offs*)

synapse.lib.slabseqn module

class synapse.lib.slabseqn.**SlabSeqn**(*slab*, *name: str*)

Bases: object

An append optimized sequence of byte blobs.

Parameters

- **lenv** (*lmdb.Environment*) – The LMDB Environment.
- **name** (*str*) – The name of the sequence.

add(*item*, *indx=None*)

Add a single item to the sequence.

async aiter(*offs*, *wait=False*, *timeout=None*)

Iterate over items in a sequence from a given offset.

Parameters

- **offs** (*int*) – The offset to begin iterating from.
- **wait** (*boolean*) – Once caught up, yield new results in realtime.
- **timeout** (*int*) – Max time to wait for a new item.

Yields

(indx, valu) – The index and valu of the item.

async cull(*offs*)

Remove entries up to (and including) the given offset.

first()

get(*offs*)

Retrieve a single row by offset

getByIndxByts(*indxbyts*)

getOffsetEvent(*offs*)

Returns an asyncio Event that will be set when the particular offset is written. The event will be set if the offset has already been reached.

getraw(*byts*)

async gets(*offs*, *wait=True*)

Returns an async generator of indx/valu tuples, optionally waiting and continuing to yield them as new entries are added

Parameters

- **offs** (*int*) – The offset to begin iterating from.
- **wait** (*bool*) – Whether to continue yielding tupls when it hits the end of the sequence.

Yields

(indx, valu) – The index and valu of the item.

index()

Return the current index to be used

iter(*offs*)

Iterate over items in a sequence from a given offset.

Parameters

offs (*int*) – The offset to begin iterating from.

Yields

(indx, valu) – The index and valu of the item.

iterBack(*offs*)

Iterate backwards over items in a sequence from a given offset.

Parameters

offs (*int*) – The offset to begin iterating from.

Yields

(indx, valu) – The index and valu of the item.

last()

nextindx()

Determine the next insert offset according to storage.

Returns

The next insert offset.

Return type

int

pop(*offs*)

Pop a single entry at the given offset.

rows(*offs*)

Iterate over raw indx, bytes tuples from a given offset.

save(*items*)

Save a series of items to a sequence.

Parameters
items (*tuple*) – The series of items to save into the sequence.

Returns
The index of the first item

slice(*offs*, *size*)

sliceBack(*offs*, *size*)

stat()

trim(*offs*)

Delete entries starting at offset and moving forward.

async waitForOffset(*offs*, *timeout=None*)

Returns
true if the event got set, False if timed out

synapse.lib.snap module

class synapse.lib.snap.**ProtoNode**(*ctx*, *buid*, *form*, *valu*, *node*)

Bases: object

A prototype node used for staging node adds using a SnapEditor.

TODO: This could eventually fully mirror the synapse.lib.node.Node API and be used to slipstream into sections of the pipeline to facilitate a bulk edit / transaction

async addEdge(*verb*, *n2iden*)

async addTag(*tag*, *valu=(None, None)*, *tagnode=None*)

async delEdge(*verb*, *n2iden*)

get(*name*)

async getData(*name*)

getNodeEdit()

getTag(*tag*)

getTagProp(*tag*, *name*)

iden()

async set(*name*, *valu*, *norminfo=None*)

async setData(*name*, *valu*)

async setTagProp(*tag*, *name*, *valu*)

class synapse.lib.snap.**Scrubber**(*rules*)

Bases: object

scrub(*pode*)

class synapse.lib.snap.**Snap**

Bases: *Base*

A "snapshot" is a transaction across multiple Cortex layers.

The Snap object contains the bulk of the Cortex API to facilitate performance through careful use of transaction boundaries.

Transactions produce the following EventBus events:

(...any splice...) ('log', {'level': 'mesg': }) ('print', {}),

async addFeedData(*name*, *items*)

async addFeedNodes(*name*, *items*)

Call a feed function and return what it returns (typically yields Node()s).

Parameters

- **name** (*str*) – The name of the feed record type.
- **items** (*list*) – A list of records of the given feed type.

Returns
The return value from the feed function. Typically Node() generator.

Return type
(object)

async addNode(*name*, *valu*, *props=None*, *norminfo=None*)

Add a node by form name and value with optional props.

Parameters

- **name** (*str*) – The form of node to add.
- **valu** (*obj*) – The value for the node.
- **props** (*dict*) – Optional secondary properties for the node.

Notes

If a props dictionary is provided, it may be mutated during node construction.

Returns
A Node object. It may return None if the snap is unable to add or lift the node.

Return type
s_node.Node

async addNodes(*nodedefs*)

Add/merge nodes in bulk.

The addNodes API is designed for bulk adds which will also set properties, add tags, add edges, and set nodedata to existing nodes. Nodes are specified as a list of the following tuples:

((form, valu), {'props':{}, 'tags':{}})

Parameters
nodedefs (*list*) – A list of nodedef tuples.

Returns
A list of xact messages.

Return type
(list)

async addStormRuntime(*query*, *opts=None*, *user=None*)

async applyNodeEdit(*edit*)

async applyNodeEdits(*edits*)
Sends edits to the write layer and evaluates the consequences (triggers, node object updates)

buidcachesize = 100000

async clearCache()

clearCachedNode(*buid*)

disableTriggers()

eval(*text*, *opts=None*, *user=None*)
Run a storm query and yield Node() objects.

getEditor()

async getNodeByBuid(*buid*)
Retrieve a node tuple by binary id.

Parameters
buid (*bytes*) – The binary ID for the node.

Returns
The node object or None.

Return type
Optional[s_node.Node]

async getNodeByNdef(*ndef*)
Return a single Node by (form,valu) tuple.

Parameters
- **ndef** ((*str,obj*)) – A (form,valu) ndef tuple. valu must be
- **normalized.** –

Returns
The Node or None.

Return type
(*synapse.lib.node.Node*)

async getNodeData(*buid*, *name*, *defv=None*)
Get nodedata from closest to write layer, no merging involved

getNodeEditor(*node*)

async getRuntNodes(*full*, *valu=None*, *cmpr=None*)

async getSnapMeta()

Retrieve snap metadata to store along side nodeEdits.

getStormRuntime(*query*, *opts=None*, *user=None*)

async getTagNode(*name*)

Retrieve a cached tag node. Requires name is normed. Does not add.

async getTagNorm(*tagname*)

async hasNodeData(*buid*, *name*)

Return True if the buid has nodedata set on it under the given name False otherwise

async hasNodeEdge(*buid1*, *verb*, *buid2*)

async iterNodeData(*buid*)

Returns: Iterable[Tuple[str, Any]]

async iterNodeDataKeys(*buid*)

Yield each data key from the given node by buid.

async iterNodeEdgesN1(*buid*, *verb=None*)

async iterNodeEdgesN2(*buid*, *verb=None*)

async iterStormPodes(*text*, *opts*, *user=None*)

Yield packed node tuples for the given storm query text.

async nodes(*text*, *opts=None*, *user=None*)

async nodesByDataName(*name*)

async nodesByProp(*full*)

async nodesByPropArray(*full*, *cmpr*, *valu*)

async nodesByPropTypeValu(*name*, *valu*)

async nodesByPropValu(*full*, *cmpr*, *valu*)

async nodesByTag(*tag*, *form=None*)

async nodesByTagProp(*form*, *tag*, *name*)

async nodesByTagPropValu(*form*, *tag*, *name*, *cmpr*, *valu*)

async nodesByTagValu(*tag*, *cmpr*, *valu*, *form=None*)

async printf(*mesg*)

async saveNodeEdits(*edits*, *meta*)

storm(*text*, *opts=None*, *user=None*)

Execute a storm query and yield (Node(), Path()) tuples.

tagcachesize = 1000

async warn(*mesg*, *log=True*, ***info*)

async warnonce(*mesg*, *log=True*, ***info*)

class synapse.lib.snap.**SnapEditor**(*snap*)

Bases: object

A SnapEditor allows tracking node edits with subs/deps as a transaction.

async addNode(*formname*, *valu*, *props=None*, *norminfo=None*)

async getNodeByBuid(*buid*)

getNodeEdits()

loadNode(*node*)

synapse.lib.spooled module

class synapse.lib.spooled.**Dict**

Bases: *Spooled*

get(*key*, *defv=None*)

has(*key*)

items()

keys()

async set(*key*, *val*)

class synapse.lib.spooled.**Set**

Bases: *Spooled*

A minimal set-like implementation that will spool to a slab on large growth.

async add(*valu*)

discard(*valu*)

class synapse.lib.spooled.**Spooled**

Bases: *Base*

A Base class that can be used to implement objects which fallback to lmdb.

These objects are intended to fallback from Python to lmbd slabs, which aligns them together. Under memory pressure, these objects have a better shot of getting paged out.

synapse.lib.storm module

class synapse.lib.storm.**BackgroundCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute a query pipeline as a background task. NOTE: Variables are passed through but nodes are not

async execStormCmd(*runt*, *genr*)

Abstract base method

async execStormTask(*query*, *opts*)

getArgParser()

name = 'background'

class synapse.lib.storm.**BatchCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Run a query with batched sets of nodes.

The batched query will have the set of inbound nodes available in the variable $nodes.

This command also takes a conditional as an argument. If the conditional evaluates to true, the nodes returned by the batched query will be yielded, if it evaluates to false, the inbound nodes will be yielded after executing the batched query.

NOTE: This command is intended to facilitate use cases such as queries to external
APIs with aggregate node values to reduce quota consumption. As this command interrupts the node stream, it should be used carefully to avoid unintended slowdowns in the pipeline.

Example

// Execute a query with batches of 5 nodes, then yield the inbound nodes batch $lib.false –size 5 { $lib.print($nodes) }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'batch'

class synapse.lib.storm.**Cmd**(*runt*, *runtsafe*)

Bases: `object`

A one line description of the command.

Command usage details and long form description.

Example

cmd –help

Notes

Python Cmd implementers may override the `forms` attribute with a dictionary to provide information about Synapse forms which are possible input and output nodes that a Cmd may recognize. A list of (key, form) tuples may also be added to provide information about forms which may have additional nodedata added to them by the Cmd.

Example:

```
{
    'input': (
        'inet:ipv4',
        'tel:mob:telem',
    ),
```

(continues on next page)

(continued from previous page)

```
    'output': (
        'geo:place',
    ),
    'nodedata': (
        ('foodata', 'inet:http:request'),
        ('bardata', 'inet:ipv4'),
    ),
}
```

asroot = False

async execStormCmd(*runt*, *genr*)

Abstract base method

forms = {}

getArgParser()

classmethod getCmdBrief()

getDescr()

getName()

classmethod getStorNode(*form*)

isReadOnly()

name = 'cmd'

pkgname = ''

readonly = False

async setArgv(*argv*)

svciden = ''

class synapse.lib.storm.**CopyToCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Copy nodes from the current view into another view.

Examples

// Copy all nodes tagged with #cno.mal.redtree to the target view.

#cno.mal.redtree | copyto 33c971ac77943da91392dadd0eec0571

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'copyto'

class synapse.lib.storm.**CountCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Iterate through query results, and print the resulting number of nodes which were lifted. This does not yield the nodes counted, unless the –yield switch is provided.

Example

Count the number of IPV4 nodes with a given ASN. inet:ipv4:asn=20 | count

Count the number of IPV4 nodes with a given ASN and yield them. inet:ipv4:asn=20 | count –yield

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'count'

readonly = True

class synapse.lib.storm.**DelNodeCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Delete nodes produced by the previous query logic.

(no nodes are returned)

Example

inet:fqdn=vertex.link | delnode

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'delnode'

class synapse.lib.storm.**DiffCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Generate a list of nodes with changes in the top layer of the current view.

Examples

// Lift all nodes with any changes

diff

// Lift ou:org nodes that were added in the top layer.

diff –prop ou:org

// Lift inet:ipv4 nodes with the :asn property modified in the top layer.

diff –prop inet:ipv4:asn

// Lift the nodes with the tag #cno.mal.redtree added in the top layer.

diff –tag cno.mal.redtree

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'diff'

readonly = True

class synapse.lib.storm.DivertCmd(*runt*, *runtsafe*)

Bases: *Cmd*

Either consume a generator or yield it's results based on a conditional.

NOTE: This command is purpose built to facilitate the –yield convention common to storm commands.

NOTE: The genr argument must not be a function that returns, else it will be invoked for each inbound node.

Example

divert $cmdopts.yield $fooBarBaz()

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'divert'

class synapse.lib.storm.DmonManager

Bases: *Base*

Manager for StormDmon objects.

async addDmon(*iden*, *ddef*)

getDmon(*iden*)

getDmonDef(*iden*)

getDmonDefs()

getDmonRunlog(*iden*)

async popDmon(*iden*)

Remove the dmon and fini it if its exists.

async start()

Start all the dmons.

async stop()

Stop all the dmons.

class synapse.lib.storm.EdgesDelCmd(*runt*, *runtsafe*)

Bases: *Cmd*

Bulk delete light edges from input nodes.

Examples

Delete all “foo” light edges from an inet:ipv4 inet:ipv4=1.2.3.4 | edges.del foo

Delete light edges with any verb from a node inet:ipv4=1.2.3.4 | edges.del *

Delete all “foo” light edges to an inet:ipv4 inet:ipv4=1.2.3.4 | edges.del foo –n2

async delEdges(*node*, *verb*, *n2=False*)

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'edges.del'

class synapse.lib.storm.**GraphCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Generate a subgraph from the given input nodes and command line options.

Example

Using the graph command:

```
inet:fqdn | graph
            --degrees 2
            --filter { -#nope }
            --pivot { <- meta:seen <- meta:source }
            --form-pivot inet:fqdn {<- * | limit 20}
            --form-pivot inet:fqdn {-> * | limit 20}
            --form-filter inet:fqdn {-inet:fqdn:issuffix=1}
            --form-pivot syn:tag {-> *}
            --form-pivot * {-> #}
```

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'graph'

class synapse.lib.storm.**HelpCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

List available commands and a brief description for each.

Examples

// Get all available commands and their brief descriptions.

help

// Only get commands which have "model" in the name.

help model

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'help'

class synapse.lib.storm.**IdenCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Lift nodes by iden.

Example

iden b25bc9eec7e159dce879f9ec85fb791f83b505ac55b346fcb64c3c51e98d1175 | count

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'iden'

readonly = True

class synapse.lib.storm.**IntersectCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Yield an intersection of the results of running inbound nodes through a pivot.

Note: This command must consume the entire inbound stream to produce the intersection. This type of stream consuming before yielding results can cause the query to appear laggy in comparison with normal incremental stream operations.

Examples

// Show the it:mitre:attack:technique nodes common to several groups

it:mitre:attack:group*in=(G0006, G0007) | intersect { -> it:mitre:attack:technique }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'intersect'

class synapse.lib.storm.**LiftByVerb**(*runt*, *runtsafe*)

Bases: *Cmd*

Lift nodes from the current view by an light edge verb.

Examples

Lift all the n1 nodes for the light edge "foo" lift.byverb "foo"

Lift all the n2 nodes for the light edge "foo" lift.byverb –n2 "foo"

Notes

Only a single instance of a node will be yielded from this command when that node is lifted via the light edge membership.

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

async iterEdgeNodes(*verb*, *idenset*, *n2=False*)

name = 'lift.byverb'

class synapse.lib.storm.**LimitCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Limit the number of nodes generated by the query in the given position.

Example

inet:ipv4 | limit 10

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'limit'

readonly = True

class synapse.lib.storm.**MaxCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Consume nodes and yield only the one node with the highest value for an expression.

Examples

// Yield the file:bytes node with the highest :size property file:bytes#foo.bar | max :size

// Yield the file:bytes node with the highest value for $tick file:bytes#foo.bar +.seen ($tick, $tock) = .seen | max $tick

// Yield the it:dev:str node with the longest length it:dev:str | max $lib.len($node.value())

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'max'

readonly = True

class synapse.lib.storm.**MergeCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Merge edits from the incoming nodes down to the next layer.

NOTE: This command requires the current view to be a fork.

NOTE: The arguments for including/excluding tags can accept tag glob
expressions for specifying tags. For more information on tag glob expressions, check the Synapse documentation for $node.globtags().

Examples

// Having tagged a new #cno.mal.redtree subgraph in a forked view...

#cno.mal.redtree | merge –apply

// Print out what the merge command *would* do but dont.

#cno.mal.redtree | merge

// Merge any org nodes with changes in the top layer.

diff | +ou:org | merge –apply

// Merge all tags other than cno.* from ou:org nodes with edits in the // top layer.

diff | +ou:org | merge –only-tags –exclude-tags cno.** –apply

// Merge only tags rep.vt.* and rep.whoxy.* from ou:org nodes with edits // in the top layer.

diff | +ou:org | merge –include-tags rep.vt.* rep.whoxy.* –apply

// Lift only inet:ipv4 nodes with a changed :asn property in top layer // and merge all changes.

diff –prop inet:ipv4:asn | merge –apply

// Lift only nodes with an added #cno.mal.redtree tag in the top layer and merge them.

diff –tag cno.mal.redtree | merge –apply

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'merge'

class synapse.lib.storm.**MinCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Consume nodes and yield only the one node with the lowest value for an expression.

Examples

// Yield the file:bytes node with the lowest :size property file:bytes#foo.bar | min :size

// Yield the file:bytes node with the lowest value for $tick file:bytes#foo.bar +.seen ($tick, $tock) = .seen | min $tick

// Yield the it:dev:str node with the shortest length it:dev:str | min $lib.len($node.value())

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'min'

readonly = True

class synapse.lib.storm.**MoveNodesCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Move storage nodes between layers.

Storage nodes will be removed from the source layers and the resulting storage node in the destination layer will contain the merged values (merged in bottom up layer order by default).

Examples

// Move storage nodes for ou:org nodes to the top layer

ou:org | movenodes –apply

// Print out what the movenodes command *would* do but dont.

ou:org | movenodes

// In a view with many layers, only move storage nodes from the bottom layer // to the top layer.

$layers = $lib.view.get().layers $top = $layers.0.iden $bot = $layers.”-1”.iden

ou:org | movenodes –srclayers $bot –destlayer $top

// In a view with many layers, move storage nodes to the top layer and // prioritize values from the bottom layer over the other layers.

$layers = $lib.view.get().layers $top = $layers.0.iden $mid = $layers.1.iden $bot = $layers.2.iden

ou:org | movenodes –precedence $bot $top $mid

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'movenodes'

class synapse.lib.storm.**MoveTagCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Rename an entire tag tree and preserve time intervals.

Example

movetag foo.bar baz.faz.bar

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'movetag'

class synapse.lib.storm.**OnceCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

The once command ensures that a node makes it through the once command but a single time, even across independent queries. The gating is keyed by a required name parameter to the once command, so a node can be run through different queries, each a single time, so long as the names differ.

For example, to run an enrichment command on a set of nodes just once:

file:bytes#my.files | once enrich:foo | enrich.foo

If you insert the once command with the same name on the same nodes, they will be dropped from the pipeline. So in the above example, if we run it again, the enrichment will not run a second time, as all the nodes will be dropped from the pipeline before reaching the enrich.foo portion of the pipeline.

Simlarly, running this:

file:bytes#my.files | once enrich:foo

Also yields no nodes. And even though the rest of the pipeline is different, this query:

file:bytes#my.files | once enrich:foo | enrich.bar

would not run the enrich.bar command, as the name "enrich:foo" has already been seen to occur on the file:bytes passing through the once command, so all of the nodes will be dropped from the pipeline.

However, this query:

file:bytes#my.files | once look:at:my:nodes

Would yield all the file:bytes tagged with #my.files, as the name parameter given to the once command differs from the original "enrich:foo".

The once command utilizes a node's nodedata cache, and you can use the –asof parameter to update the named action's timestamp in order to bypass/update the once timestamp. So this command:

inet:ipv4#my.addresses | once node:enrich –asof now | my.enrich.command

Will yield all the enriched nodes the first time around. The second time that command is run, all of those nodes will be re-enriched, as the asof timestamp will be greater the second time around, so no nodes will be dropped.

As state tracking data for the once command is stored as nodedata, it is stored in your view's write layer, making it view-specific. So if you have two views, A and B, and they do not share any layers between them, and you execute this query in view A:

inet:ipv4=8.8.8.8 | once enrich:address | enrich.baz

And then you run it in view B, the node will still pass through the once command to the enrich.baz portion of the pipeline, as the nodedata for the once command does not yet exist in view B.

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'once'

class synapse.lib.storm.**ParallelCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute part of a query pipeline in parallel. This can be useful to minimize round-trip delay during enrichments.

Examples

inet:ipv4#foo | parallel { $place = $lib.import(foobar).lookup(:latlong) [:place=$place] }

NOTE: Storm variables set within the parallel query pipelines do not interact.

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'parallel'

async nextitem(*inq*)

async pipeline(*runt*, *query*, *inq*, *outq*)

readonly = True

class synapse.lib.storm.**Parser**(*prog=None*, *descr=None*, *root=None*)

Bases: object

add_argument(**names*, ***opts*)

help(*mesg=None*)

parse_args(*argv*)

set_inputs(*idefs*)

class synapse.lib.storm.**PureCmd**(*cdef*, *runt*, *runtsafe*)

Bases: *Cmd*

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

getDescr()

getName()

readonly = True

class synapse.lib.storm.**ReIndexCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Use admin privileges to re index/normalize node properties.

NOTE: Currently does nothing but is reserved for future use.

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'reindex'

class synapse.lib.storm.**RunAsCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute a storm query as a specified user.

NOTE: This command requires admin privileges.

Examples

// Create a node as another user. runas someuser { [inet:fqdn=foo.com] }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'runas'

class synapse.lib.storm.**Runtime**

Bases: *Base*

A Runtime represents the instance of a running query.

The runtime should maintain a firm API boundary using the snap. Parallel query execution requires that the snap be treated as an opaque object which is called through, but not dereferenced.

addInput(*node*)

Add a Node() object as input to the query runtime.

allowed(*perms*, *gateiden=None*, *default=False*)

cancel()

confirm(*perms*, *gateiden=None*, *default=False*)

Raise AuthDeny if user doesn't have global permissions and write layer permissions

async coreDynCall(*todo*, *perm=None*)

async dyncall(*iden*, *todo*, *gatekeys=()*)

async dyniter(*iden*, *todo*, *gatekeys=()*)

async emit(*item*)

async emitter()

async execute(*genr=None*)

getCmdRuntime(*query*, *opts=None*)

Yield a runtime with proper scoping for use in executing a pure storm command.

getGraph()

async getInput()

async getModRuntime(*query*, *opts=None*)

Construct a non-context managed runtime for use in module imports.

async getOneNode(*propname*, *valu*, *filt=None*, *cmpr='='*)

Return exactly 1 node by <prop> <cmpr> <valu>

getOpt(*name*, *defval=None*)

getScopeVars()

Return a dict of all the vars within this and all parent scopes.

async getStormQuery(*text*)

getSubRuntime(*query*, *opts=None*)

Yield a runtime with shared scope that will populate changes upward.

async getTeleProxy(*url*, ***opts*)

getVar(*name*, *defv=None*)

initPath(*node*)

async initSubRuntime(*query*, *opts=None*)

Construct and return sub-runtime with a shared scope. (caller must fini)

isAdmin(*gateiden=None*)

isRuntVar(*name*)

layerConfirm(*perms*)

async popVar(*name*)

async printf(*mesg*)

async reqGateKeys(*gatekeys*)

async reqUserCanReadLayer(*layriden*)

setGraph(*gdef*)

setOpt(*name*, *valu*)

async setVar(*name*, *valu*)

async storm(*text*, *opts=None*, *genr=None*)

Execute a storm runtime which inherits from this storm runtime.

tick()

async warn(*mesg*, ***info*)

async warnonce(*mesg*, ***info*)

class synapse.lib.storm.ScrapeCmd(*runt*, *runtsafe*)

Bases: *Cmd*

Use textual properties of existing nodes to find other easily recognizable nodes.

Examples

Scrape properties from inbound nodes and create standalone nodes. inet:search:query | scrape

Scrape properties from inbound nodes and make refs light edges to the scraped nodes. inet:search:query | scrape –refs

Scrape only the :engine and :text props from the inbound nodes. inet:search:query | scrape :text :engine

Scrape properties inbound nodes and yield newly scraped nodes. inet:search:query | scrape –yield

Skip re-fanging text before scraping. inet:search:query | scrape –skiprefang

Limit scrape to specific forms. inet:search:query | scrape –forms (inet:fqdn, inet:ipv4)

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'scrape'

class synapse.lib.storm.SleepCmd(*runt*, *runtsafe*)

Bases: *Cmd*

Introduce a delay between returning each result for the storm query.

NOTE: This is mostly used for testing / debugging.

Example

#foo.bar | sleep 0.5

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'sleep'

readonly = True

class synapse.lib.storm.SpinCmd(*runt*, *runtsafe*)

Bases: *Cmd*

Iterate through all query results, but do not yield any. This can be used to operate on many nodes without returning any.

Example

foo:bar:size=20 [+#hehe] | spin

async execStormCmd(*runt*, *genr*)

Abstract base method

name = 'spin'

readonly = True

class synapse.lib.storm.**SpliceListCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Deprecated command to retrieve a list of splices backwards from the end of the splicelog.

Examples

Show the last 10 splices. splice.list | limit 10

Show splices after a specific time. splice.list –mintime "2020/01/06 15:38:10.991"

Show splices from a specific timeframe. splice.list –mintimestamp 1578422719360 –maxtimestamp 1578422719367

Notes

If both a time string and timestamp value are provided for a min or max, the timestamp will take precedence over the time string value.

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'splice.list'

readonly = True

class synapse.lib.storm.**SpliceUndoCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Deprecated command to reverse the actions of syn:splice runt nodes.

Examples

Undo the last 5 splices. splice.list | limit 5 | splice.undo

Undo splices after a specific time. splice.list –mintime "2020/01/06 15:38:10.991" | splice.undo

Undo splices from a specific timeframe. splice.list –mintimestamp 1578422719360 –maxtimestamp 1578422719367 | splice.undo

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'splice.undo'

async undoNodeAdd(*runt*, *splice*, *node*)

async undoNodeDel(*runt*, *splice*, *node*)

async undoPropDel(*runt*, *splice*, *node*)

async undoPropSet(*runt*, *splice*, *node*)

async undoTagAdd(*runt*, *splice*, *node*)

async undoTagDel(*runt*, *splice*, *node*)

async undoTagPropDel(*runt*, *splice*, *node*)

async undoTagPropSet(*runt*, *splice*, *node*)

class synapse.lib.storm.**StormDmon**

Bases: *Base*

A background storm runtime which is restarted by the cortex.

async bump()

async dmonloop()

pack()

async run()

async stop()

class synapse.lib.storm.**SudoCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Deprecated sudo command.

Left in for 2.x.x so that Storm command with it are still valid to execute.

async execStormCmd(*runt*, *genr*)

Abstract base method

name = 'sudo'

class synapse.lib.storm.**TagPruneCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Prune a tag (or tags) from nodes.

This command will delete the tags specified as parameters from incoming nodes, as well as all of their parent tags that don't have other tags as children.

For example, given a node with the tags:

#parent #parent.child #parent.child.grandchild

Pruning the parent.child.grandchild tag would remove all tags. If the node had the tags:

#parent #parent.child #parent.child.step #parent.child.grandchild

Pruning the parent.child.grandchild tag will only remove the parent.child.grandchild tag as the parent tags still have other children.

Examples

Prune the parent.child.grandchild tag inet:ipv4=1.2.3.4 | tag.prune parent.child.grandchild

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

hasChildTags(*node*, *tag*)

name = 'tag.prune'

class synapse.lib.storm.**TeeCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute multiple Storm queries on each node in the input stream, joining output streams together.

Commands are executed in order they are given; unless the `--parallel` switch is provided.

Examples

Perform a pivot out and pivot in on a inet:ivp4 node inet:ipv4=1.2.3.4 | tee { -> * } { <- * }

Also emit the inbound node inet:ipv4=1.2.3.4 | tee –join { -> * } { <- * }

Execute multiple enrichment queries in parallel. inet:ipv4=1.2.3.4 | tee -p { enrich.foo } { enrich.bar } { enrich.baz }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'tee'

async pipeline(*runt*, *outq*, *genr=None*)

readonly = True

class synapse.lib.storm.**TreeCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Walk elements of a tree using a recursive pivot.

Examples

pivot upward yielding each FQDN inet:fqdn=www.vertex.link | tree { :domain -> inet:fqdn }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'tree'

readonly = True

class synapse.lib.storm.**UniqCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Filter nodes by their uniq iden values. When this is used a Storm pipeline, only the first instance of a given node is allowed through the pipeline.

A relative property or variable may also be specified, which will cause this command to only allow through the first node with a given value for that property or value rather than checking the node iden.

Examples

Filter duplicate nodes after pivoting from inet:ipv4 nodes tagged with #badstuff #badstuff +inet:ipv4 ->* | uniq

Unique inet:ipv4 nodes by their :asn property #badstuff +inet:ipv4 | uniq :asn

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'uniq'

readonly = True

class synapse.lib.storm.**ViewExecCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

Execute a storm query in a different view.

NOTE: Variables are passed through but nodes are not

Examples

// Move some tagged nodes to another view inet:fqdn#foo.bar $fqdn=$node.value() | view.exec 95d5f31f0fb414d2b00069d3b1ee64c6 { [inet:fqdn=$fqdn] }

async execStormCmd(*runt*, *genr*)

Abstract base method

getArgParser()

name = 'view.exec'

readonly = True

synapse.lib.storm_format module

class synapse.lib.storm_format.**StormLexer**(*parser*)

Bases: Lexer

get_tokens_unprocessed(*text*)

This method should process the text and return an iterable of `(index, tokentype, value)` tuples where `index` is the starting position of the token within the input text.

It must be overridden by subclasses. It is recommended to implement it as a generator to maximize effectiveness.

synapse.lib.storm_format.**highlight_storm**(*parser*, *text*)

Prints a storm query with syntax highlighting

synapse.lib.stormctrl module

exception synapse.lib.stormctrl.**StormBreak**(*item=None*)

Bases: *StormCtrlFlow*

exception synapse.lib.stormctrl.**StormContinue**(*item=None*)

Bases: *StormCtrlFlow*

exception synapse.lib.stormctrl.**StormCtrlFlow**(*item=None*)

Bases: Exception

exception synapse.lib.stormctrl.**StormExit**(*item=None*)

Bases: *StormCtrlFlow*

exception synapse.lib.stormctrl.**StormReturn**(*item=None*)

Bases: *StormCtrlFlow*

exception synapse.lib.stormctrl.**StormStop**(*item=None*)

Bases: *StormCtrlFlow*

synapse.lib.stormhttp module

class synapse.lib.stormhttp.**HttpResp**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a HTTP response.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormhttp.**LibHttp**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library exposing an HTTP client API.

async codereason(*code*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async inetHttpConnect(*url*, *headers=None*, *ssl_verify=True*, *timeout=300*, *params=None*, *proxy=None*)

strify(*item*)

async urldecode(*text*)

async urlencode(*text*)

class synapse.lib.stormhttp.**WebSocket**

Bases: *Base*, *StormType*

Implements the Storm API for a Websocket.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async rx(*timeout=None*)

async tx(*mesg*)

synapse.lib.stormsvc module

class synapse.lib.stormsvc.**StormSvc**

Bases: `object`

The StormSvc mixin class used to make a remote storm service with commands.

async getStormSvcInfo()

async getStormSvcPkgs()

class synapse.lib.stormsvc.**StormSvcClient**

Bases: *Base*

A StormService is a wrapper for a telepath proxy to a service accessible from the storm runtime.

synapse.lib.stormtypes module

class synapse.lib.stormtypes.**Bool**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a boolean instance.

class synapse.lib.stormtypes.**Bytes**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Bytes object.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async slice(*start*, *end=None*)

async unpack(*fmt*, *offset=0*)

class synapse.lib.stormtypes.**CmdOpts**(*valu*, *path=None*)

Bases: *Dict*

A dictionary like object that holds a reference to a command options namespace. (This allows late-evaluation of command arguments rather than forcing capture)

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

async stormrepr()

async value()

class synapse.lib.stormtypes.**CronJob**(*runt*, *cdef*, *path=None*)

Bases: *Prim*

Implements the Storm api for a cronjob instance.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**Dict**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Dictionary object.

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

async stormrepr()

async value()

class synapse.lib.stormtypes.**Gate**(*runt*, *valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for an AuthGate.

class synapse.lib.stormtypes.**Layer**(*runt*, *ldef*, *path=None*)

Bases: *Prim*

Implements the Storm api for a layer instance.

async getEdges()

async getEdgesByN1(*nodeid*)

async getEdgesByN2(*nodeid*)

async getMirrorStatus()

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async getStorNode(*nodeid*)

async getStorNodes()

async liftByProp(*propname*, *propvalu=None*, *propcmpr='='*)

async liftByTag(*tagname*, *formname=None*)

async verify(*config=None*)

class synapse.lib.stormtypes.Lib(*runt*, *name=()*)

Bases: *StormType*

A collection of storm methods under a name

addLibFuncs()

async deref(*name*)

async dyncall(*iden*, *todo*, *gatekeys=()*)

async dyniter(*iden*, *todo*, *gatekeys=()*)

async initLibAsync()

async stormrepr()

class synapse.lib.stormtypes.LibAuth(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Auth in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async getPermDef(*perm*)

async getPermDefs()

static ruleFromText(*text*)

async textFromRule(*rule*)

class synapse.lib.stormtypes.**LibAxon**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for interacting with the Cortex's Axon.

async csvrows(*sha256*, *dialect='excel'*, ***fmtparams*)

async del_(*sha256*)

async dels(*sha256s*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async jsonlines(*sha256*)

async list(*offs=0*, *wait=False*, *timeout=None*)

async metrics()

async readlines(*sha256*)

strify(*item*)

async urlfile(**args*, ***kwargs*)

async wget(*url*, *headers=None*, *params=None*, *method='GET'*, *json=None*, *body=None*, *ssl=True*, *timeout=None*, *proxy=None*)

async wput(*sha256*, *url*, *headers=None*, *params=None*, *method='PUT'*, *ssl=True*, *timeout=None*, *proxy=None*)

class synapse.lib.stormtypes.**LibBase**(*runt*, *name=()*)

Bases: *Lib*

The Base Storm Library. This mainly contains utility functionality.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async trycast(*name*, *valu*)

class synapse.lib.stormtypes.**LibBase64**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for encoding and decoding base64 data.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.LibBytes(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with bytes storage.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.LibCron(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Cron Jobs in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.LibCsv(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with csvtool.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.LibDmon(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with StormDmons.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibExport**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for exporting data.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async toaxon(*query*, *opts=None*)

class synapse.lib.stormtypes.**LibFeed**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Cortex feed functions.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibGates**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Auth Gates in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibGlobals**(*runt*, *name*)

Bases: *Lib*

A Storm Library for interacting with global variables which are persistent across the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibJsonStor**(*runt*, *name=()*)

Bases: *Lib*

Implements cortex JSON storage.

addLibFuncs()

async cacheget(*path*, *key*, *asof='now'*, *envl=False*)

async cacheset(*path*, *key*, *valu*)

async get(*path*, *prop=None*)

async has(*path*)

async iter(*path=None*)

async set(*path*, *valu*, *prop=None*)

class synapse.lib.stormtypes.**LibLayer**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Layers in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibLift**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with lift helpers.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibPipe**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for interacting with non-persistent queues.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibPkg**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Storm Packages.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibPs**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with running tasks on the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibQueue**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with persistent Queues in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibRegx**(*runt*, *name=()*)

Bases: *Lib*

A Storm library for searching/matching with regular expressions.

async findall(*pattern*, *text*, *flags=0*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async matches(*pattern*, *text*, *flags=0*)

async replace(*pattern*, *replace*, *text*, *flags=0*)

async search(*pattern*, *text*, *flags=0*)

class synapse.lib.stormtypes.**LibRoles**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Auth Roles in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibService**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Storm Services.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibStats**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for statistics related functionality.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async tally()

class synapse.lib.stormtypes.**LibStr**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with strings.

async concat(**args*)

async format(*text*, ***kwargs*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async join(*sepr*, *items*)

class synapse.lib.stormtypes.LibTags(*runt*, *name=()*)

Bases: Lib

Storm utility functions for tags.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async prefix(*names*, *prefix*, *ispart=False*)

class synapse.lib.stormtypes.LibTelepath(*runt*, *name=()*)

Bases: Lib

A Storm Library for making Telepath connections to remote services.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.LibTime(*runt*, *name=()*)

Bases: Lib

A Storm Library for interacting with timestamps.

async day(*tick*)

async dayofmonth(*tick*)

async dayofweek(*tick*)

async dayofyear(*tick*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async hour(*tick*)

async minute(*tick*)

async month(*tick*)

async monthofyear(*tick*)

async **second**(*tick*)

async **toUTC**(*tick*, *timezone*)

async **year**(*tick*)

class synapse.lib.stormtypes.**LibTrigger**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Triggers in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibUser**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with data about the current user.

addLibFuncs()

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibUsers**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Auth Users in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibVars**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with runtime variables.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**LibView**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for interacting with Views in the Cortex.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**List**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a List instance.

async extend(*valu*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

async setitem(*name*, *valu*)

async slice(*start*, *end=None*)

async stormrepr()

async value()

class synapse.lib.stormtypes.**Node**(*node*, *path=None*)

Bases: *Prim*

Implements the Storm api for a node instance.

getByLayer()

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async getStorNodes()

class synapse.lib.stormtypes.**NodeData**(*node*, *path=None*)

Bases: *Prim*

A Storm Primitive representing the NodeData stored for a Node.

async cacheget(*name*, *asof='now'*)

async cacheset(*name*, *valu*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**NodeProps**(*node*, *path=None*)

Bases: *Prim*

A Storm Primitive representing the properties on a Node.

async get(*name*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

async list()

async set(*prop*, *valu*)

async setitem(*name*, *valu*)

Set a property on a Node.

Parameters

- **name** (*str*) – The name of the property to set.
- **valu** – The value being set.

Raises

- **s_exc** – NoSuchProp: If the property being set is not valid for the node.
- **s_exc.BadTypeValu** – If the value of the property fails to normalize.

value()

class synapse.lib.stormtypes.**Number**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Number instance.

Storm Numbers are high precision fixed point decimals corresponding to the the hugenum storage type.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async stormrepr()

class synapse.lib.stormtypes.**Path**(*node*, *path=None*)

Bases: *Prim*

Implements the Storm API for the Path object.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**PathMeta**(*path*)

Bases: *Prim*

Put the storm deref/setitem/iter convention on top of path meta information.

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

class synapse.lib.stormtypes.**PathVars**(*path*)

Bases: *Prim*

Put the storm deref/setitem/iter convention on top of path variables.

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

class synapse.lib.stormtypes.**Pipe**(*runt*, *size*)

Bases: *StormType*

A Storm Pipe provides fast ephemeral queues.

async close()

Close the pipe for writing. This will cause the slice()/slices() API to return once drained.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**Prim**(*valu*, *path=None*)

Bases: *StormType*

The base type for all Storm primitive values.

async bool()

async iter()

async nodes()

async stormrepr()

value()

class synapse.lib.stormtypes.**Proxy**(*runt*, *proxy*, *path=None*)

Bases: *StormType*

Implements the Storm API for a Telepath proxy.

These can be created via `$lib.telepath.open()`. Storm Service objects are also Telepath proxy objects.

Methods called off of these objects are executed like regular Telepath RMI calls.

An example of calling a method which returns data:

```
$prox = $lib.telepath.open($url)
$result = $prox.doWork($data)
return ( $result )
```

An example of calling a method which is a generator:

```
$prox = $lib.telepath.open($url)
for $item in = $prox.genrStuff($data) {
    $doStuff($item)
}
```

async deref(*name*)

async stormrepr()

class synapse.lib.stormtypes.**ProxyGenrMethod**(*meth*, *path=None*)

Bases: *StormType*

async stormrepr()

class synapse.lib.stormtypes.**ProxyMethod**(*runt*, *meth*, *path=None*)

Bases: *StormType*

async stormrepr()

class synapse.lib.stormtypes.**Query**(*text*, *varz*, *runt*, *path=None*)

Bases: *Prim*

A storm primitive representing an embedded query.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

async nodes()

async stormrepr()

class synapse.lib.stormtypes.Queue(*runt*, *name*, *info*)

Bases: *StormType*

A StormLib API instance of a named channel in the Cortex multiqueue.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async stormrepr()

class synapse.lib.stormtypes.Role(*runt*, *valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Role.

async gates()

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async getRules(*gateiden=None*)

async stormrepr()

async value()

class synapse.lib.stormtypes.Service(*runt*, *ssvc*)

Bases: *Proxy*

async deref(*name*)

class synapse.lib.stormtypes.Set(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a Set object.

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

async stormrepr()

class synapse.lib.stormtypes.**StatTally**(*path=None*)

Bases: *Prim*

A tally object.

An example of using it:

```
$tally = $lib.stats.tally()

$tally.inc(foo)

for $name, $total in $tally {
    $doStuff($name, $total)
}
```

async get(*name*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async inc(*name*, *valu=1*)

async iter()

async sorted(*byname=False*, *reverse=False*)

value()

class synapse.lib.stormtypes.**StormHiveDict**(*runt*, *info*)

Bases: *Prim*

A Storm Primitive representing a HiveDict.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async iter()

value()

class synapse.lib.stormtypes.**StormType**(*path=None*)

Bases: `object`

The base type for storm runtime value objects.

async deref(*name*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object .locls dictionary.

Returns
A key/value pairs.

Return type
dict

ismutable()

async setitem(*name*, *valu*)

class synapse.lib.stormtypes.StormTypesRegistry

Bases: object

addStormLib(*path*, *ctor*)

addStormType(*path*, *ctor*)

base_undefined_types = ('any', 'int', 'lib', 'null', 'time', 'prim', 'undef', 'float', 'generator')

delStormLib(*path*)

delStormType(*path*)

getLibDocs()

getTypeDocs()

iterLibs()

iterTypes()

known_types = {'auth:gate', 'auth:role', 'auth:user', 'auth:user:json', 'auth:user:profile', 'auth:user:vars', 'boolean', 'bytes', 'cmdopts', 'cronjob', 'dict', 'hive:dict', 'inet:http:oauth:v1:client', 'inet:http:resp', 'inet:http:socket', 'inet:imap:server', 'inet:smtp:message', 'json:schema', 'layer', 'list', 'model:form', 'model:property', 'model:tagprop', 'model:type', 'node', 'node:data', 'node:path', 'node:path:meta', 'node:path:vars', 'node:props', 'number', 'pipe', 'proj:comment', 'proj:comments', 'proj:epic', 'proj:epics', 'proj:project', 'proj:sprint', 'proj:sprints', 'proj:ticket', 'proj:tickets', 'queue', 'set', 'stat:tally', 'stix:bundle', 'storm:query', 'str', 'telepath:proxy', 'text', 'trigger', 'view', 'xml:element'}

registerLib(*ctor*)

Decorator to register a StormLib

registerType(*ctor*)

Decorator to register a StormPrim

rtypes = {}

undefined_types = {'any', 'float', 'generator', 'int', 'lib', 'null', 'prim', 'time', 'undef'}

class synapse.lib.stormtypes.**Str**(*valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a String object.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**Text**(*valu*, *path=None*)

Bases: *Prim*

A mutable text type for simple text construction.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

class synapse.lib.stormtypes.**Trigger**(*runt*, *tdef*)

Bases: *Prim*

Implements the Storm API for a Trigger.

async deref(*name*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async move(*viewiden*)

async pack()

async set(*name*, *valu*)

class synapse.lib.stormtypes.**Undef**

Bases: `object`

class synapse.lib.stormtypes.**User**(*runt*, *valu*, *path=None*)

Bases: *Prim*

Implements the Storm API for a User.

async gates()

async getAllowedReason(*permname*, *gateiden=None*, *default=False*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async getRules(*gateiden=None*)

async stormrepr()

async value()

class synapse.lib.stormtypes.**UserJson**(*runt*, *valu*)

Bases: *Prim*

Implements per-user JSON storage.

async get(*path*, *prop=None*)

async has(*path*)

async iter(*path=None*)

async set(*path*, *valu*, *prop=None*)

class synapse.lib.stormtypes.**UserProfile**(*runt*, *valu*, *path=None*)

Bases: *Prim*

The Storm deref/setitem/iter convention on top of User profile information.

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

async value()

class synapse.lib.stormtypes.**UserVars**(*runt*, *valu*, *path=None*)

Bases: *Prim*

The Storm deref/setitem/iter convention on top of User vars information.

async deref(*name*)

async iter()

async setitem(*name*, *valu*)

class synapse.lib.stormtypes.**View**(*runt*, *vdef*, *path=None*)

Bases: *Prim*

Implements the Storm api for a View instance.

async addNode(*form*, *valu*, *props=None*)

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

async viewDynCall(*todo*, *perm*)

async viewDynIter(*todo*, *perm*)

synapse.lib.stormtypes.**allowed**(*perm*, *gateiden=None*)

synapse.lib.stormtypes.**confirm**(*perm*, *gateiden=None*)

synapse.lib.stormtypes.**fromprim**(*valu*, *path=None*, *basetypes=True*)

synapse.lib.stormtypes.**getCallSig**(*func*) → Signature

Get the callsig of a function, stripping self if present.

synapse.lib.stormtypes.**getDoc**(*obj*, *errstr*)

Helper to get __doc__

synapse.lib.stormtypes.**intify**(*x*)

synapse.lib.stormtypes.**ismutable**(*valu*)

async synapse.lib.stormtypes.**kwarg_format**(*_text*, ***kwargs*)

Replaces instances curly-braced argument names in text with their values

synapse.lib.stormtypes.**ruleFromText**(*text*)

Get a rule tuple from a text string.

Parameters
text (*str*) – The string to process.

Returns
A tuple containing a bool and a list of permission parts.

Return type
(bool, tuple)

synapse.lib.stormtypes.**stormfunc**(*readonly=False*)

async synapse.lib.stormtypes.**tobool**(*valu*, *noneok=False*)

async synapse.lib.stormtypes.**tobuidhex**(*valu*, *noneok=False*)

async synapse.lib.stormtypes.**tocmprvalu**(*valu*)

async synapse.lib.stormtypes.**toint**(*valu*, *noneok=False*)

async synapse.lib.stormtypes.**toiter**(*valu*, *noneok=False*)

async synapse.lib.stormtypes.**tonumber**(*valu*, *noneok=False*)

async synapse.lib.stormtypes.**toprim**(*valu*, *path=None*)

async synapse.lib.stormtypes.**torepr**(*valu*, *usestr=False*)

async synapse.lib.stormtypes.**tostor**(*valu*)

async synapse.lib.stormtypes.**tostr**(*valu*, *noneok=False*)

synapse.lib.stormwhois module

class synapse.lib.stormwhois.**LibWhois**(*runt*, *name=()*)

Bases: *Lib*

A Storm Library for providing a consistent way to generate guids for WHOIS / Registration Data in Storm.

getObjLocals()

Get the default list of key-value pairs which may be added to the object `.locls` dictionary.

Returns
A key/value pairs.

Return type
dict

synapse.lib.structlog module

class synapse.lib.structlog.**JsonFormatter**(**args*, ***kwargs*)

Bases: Formatter

format(*record: LogRecord*)

Format the specified record as text.

The record's attribute dictionary is used as the operand to a string formatting operation which yields the returned string. Before formatting the dictionary, a couple of preparatory steps are carried out. The message attribute of the record is computed using LogRecord.getMessage(). If the formatting string uses the time (as determined by a call to usesTime(), formatTime() is called to format the event time. If there is exception information, it is formatted using formatException() and appended to the message.

synapse.lib.task module

class synapse.lib.task.**Task**

Bases: *Base*

The synapse Task object implements concepts similar to process trees for asyncio.Task instances.

async **kill**()

pack()

async **worker**(*coro*, *name='worker'*)

synapse.lib.task.**current**()

Return the current synapse task.

async synapse.lib.task.**executor**(*func*, **args*, ***kwargs*)

Execute a function in an executor thread.

Parameters
todo (*(func,args,kwargs)*) – A todo tuple.

synapse.lib.task.**loop**()

synapse.lib.task.**user**()

Return the current task user.

synapse.lib.task.**username**()

Return the current task user name.

synapse.lib.task.**vardefault**(*name*, *func*)

Add a default constructor for a particular task-local variable

All future calls to taskVarGet with the same name will return the result of calling func

synapse.lib.task.**varget**(*name*, *defval=None*, *task=None*)

Access a task local variable by name

Precondition:
If task is None, this must be called from task context

synapse.lib.task.**varinit**(*task=None*)

Initializes (or re-initializes for testing purposes) all of a task's task-local variables

Precondition:
If task is None, this must be called from task context

synapse.lib.task.**varset**(*name*, *valu*, *task=None*)

Set a task-local variable

Parameters
task – If task is None, uses current task

Precondition:
If task is None, this must be called from task context

synapse.lib.thishost module

synapse.lib.thishost.**get**(*prop*)

Retrieve a property from the hostinfo dictionary.

Example

import synapse.lib.thishost as s_thishost

if s_thishost.get('platform') == 'windows':
dostuff()

synapse.lib.thishost.**hostaddr**(*dest='8.8.8.8'*)

Retrieve the ipv4 address for this host (optionally as seen from dest). .. rubric:: Example

addr = s_socket.hostaddr()

synapse.lib.thisplat module

synapse.lib.threads module

synapse.lib.threads.**current**()

synapse.lib.threads.**iden**()

synapse.lib.time module

Time related utilities for synapse "epoch millis" time values.

synapse.lib.time.**day**(*tick*)

synapse.lib.time.**dayofmonth**(*tick*)

synapse.lib.time.**dayofweek**(*tick*)

synapse.lib.time.**dayofyear**(*tick*)

synapse.lib.time.**delta**(*text*)

Parse a simple time delta string and return the delta.

synapse.lib.time.**hour**(*tick*)

synapse.lib.time.**ival**(**times*)

synapse.lib.time.**minute**(*tick*)

synapse.lib.time.**month**(*tick*)

synapse.lib.time.**parse**(*text*, *base=None*, *chop=False*)

Parse a time string into an epoch millis value.

Parameters

- **text** (*str*) – Time string to parse
- **base** (*int or None*) – Milliseconds to offset the time from
- **chop** (*bool*) – Whether to chop the digit-only string to 17 chars

Returns

Epoch milliseconds

Return type

int

synapse.lib.time.**parsetz**(*text*)

Parse timezone from time string, with UTC as the default.

Parameters

text (*str*) – Time string

Returns

A tuple of text with tz chars removed and base milliseconds to offset time.

Return type

tuple

synapse.lib.time.**repr**(*tick*, *pack=False*)

Return a date string for an epoch-millis timestamp.

Parameters
tick (*int*) – The timestamp in milliseconds since the epoch.

Returns
A date time string

Return type
(str)

synapse.lib.time.**second**(*tick*)

synapse.lib.time.**toUTC**(*tick*, *fromzone*)

synapse.lib.time.**wildrange**(*text*)

Parse an interval from a wild card time stamp: 2021/10/31*

synapse.lib.time.**year**(*tick*)

synapse.lib.trigger module

class synapse.lib.trigger.**Trigger**(*view*, *tdef*)

Bases: object

async execute(*node*, *vars=None*, *view=None*)

Actually execute the query

get(*name*)

getStorNode(*form*)

pack()

async set(*name*, *valu*)

Set one of the dynamic elements of the trigger definition.

class synapse.lib.trigger.**Triggers**(*view*)

Bases: object

Manages "triggers", conditions where changes in data result in new storm queries being executed.

Note: These methods should not be called directly under normal circumstances. Use the owning "View" object to ensure that mirrors/clusters members get the same changes.

---

get(*iden*)

list()

async load(*tdef*)

pop(*iden*)

async runNodeAdd(*node*, *view=None*)

async **runNodeDel**(*node*, *view=None*)

async **runPropSet**(*node*, *prop*, *oldv*, *view=None*)

async **runTagAdd**(*node*, *tag*, *view=None*)

async **runTagDel**(*node*, *tag*, *view=None*)

synapse.lib.trigger.**reqValidTdef**(*conf*)

synapse.lib.types module

class synapse.lib.types.**Array**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

isarray = True

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.lib.types.**Bool**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 2

class synapse.lib.types.**Comp**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

getCompOffs(*name*)

If this type is a compound, return the field offset for the given property name or None.

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 13

class synapse.lib.types.**Data**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

norm(*valu*)

Normalize the value for a given type.

Parameters

valu (*obj*) – The value to normalize.

Returns
The normalized valu, info tuple.

Return type
((obj,dict))

Notes

The info dictionary uses the following key conventions:
subs (dict): The normalized sub-fields as name: valu entries.

postTypeInit()

stortype: int = 13

class synapse.lib.types.**Duration**(*modl*, *name*, *info*, *opts*)

Bases: *IntBase*

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 5

class synapse.lib.types.**Edge**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

getCompOffs(*name*)

If this type is a compound, return the field offset for the given property name or None.

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 13

class synapse.lib.types.**FieldHelper**(*modl*, *tname*, *fields*)

Bases: defaultdict

Helper for Comp types. Performs Type lookup/creation upon first use.

class synapse.lib.types.**Float**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 22

class synapse.lib.types.**Guid**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

stortype: int = 10

class synapse.lib.types.**Hex**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

stortype: int = 1

class synapse.lib.types.**HugeNum**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

norm(*valu*)

Normalize the value for a given type.

Parameters
valu (*obj*) – The value to normalize.

Returns
The normalized valu, info tuple.

Return type
((obj,dict))

Notes

The info dictionary uses the following key conventions:
subs (dict): The normalized sub-fields as name: valu entries.

stortype: int = 23

class synapse.lib.types.**Int**(*modl*, *name*, *info*, *opts*)

Bases: *IntBase*

merge(*oldv*, *newv*)

Allow types to "merge" data from two sources based on value precedence.

Parameters

- **valu** (*object*) – The current value.
- **newv** (*object*) – The updated value.

Returns
The merged value.

Return type
(object)

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.lib.types.**IntBase**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

class synapse.lib.types.**Ival**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

An interval, i.e. a range, of times

merge(*oldv*, *newv*)

Allow types to "merge" data from two sources based on value precedence.

Parameters

- **valu** (*object*) – The current value.
- **newv** (*object*) – The updated value.

Returns
The merged value.

Return type
(object)

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 12

class synapse.lib.types.**Loc**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stems(*valu*)

stortype: int = 15

class synapse.lib.types.**Ndef**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 13

class synapse.lib.types.**NodeProp**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

stortype: int = 13

class synapse.lib.types.**Range**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 13

class synapse.lib.types.**Str**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 1

class synapse.lib.types.**Tag**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.lib.types.**TagPart**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.lib.types.**Taxon**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.lib.types.**Taxonomy**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.lib.types.**Time**(*modl*, *name*, *info*, *opts*)

Bases: *IntBase*

getTickTock(*vals*)

Get a tick, tock time pair.

Parameters
vals (*list*) – A pair of values to norm.

Returns
A ordered pair of integers.

Return type
(int, int)

merge(*oldv*, *newv*)

Allow types to "merge" data from two sources based on value precedence.

Parameters

- **valu** (*object*) – The current value.
- **newv** (*object*) – The updated value.

Returns
The merged value.

Return type
(object)

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 11

class synapse.lib.types.**TimeEdge**(*modl*, *name*, *info*, *opts*)

Bases: *Edge*

getCompOffs(*name*)

If this type is a compound, return the field offset for the given property name or None.

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 13

class synapse.lib.types.**Type**(*modl*, *name*, *info*, *opts*)

Bases: object

clone(*opts*)

Create a new instance of this type with the specified options.

Parameters
opts (*dict*) – The type specific options for the new instance.

cmpr(*val1*, *name*, *val2*)

Compare the two values using the given type specific comparator.

extend(*name*, *opts*, *info*)

Extend this type to construct a sub-type.

Parameters

- **name** (*str*) – The name of the new sub-type.
- **opts** (*dict*) – The type options for the sub-type.
- **info** (*dict*) – The type info for the sub-type.

Returns
A new sub-type instance.

Return type
(synapse.types.Type)

getCmprCtor(*name*)

getCompOffs(*name*)

If this type is a compound, return the field offset for the given property name or None.

getLiftHintCmpr(*valu*, *cmpr*)

getLiftHintCmprCtor(*name*)

getStorCmprs(*cmpr*, *valu*)

getStorNode(*form*)

getTypeDef()

getTypeVals(*valu*)

isarray = False

merge(*oldv*, *newv*)

Allow types to "merge" data from two sources based on value precedence.

Parameters

- **valu** (*object*) – The current value.
- **newv** (*object*) – The updated value.

Returns
The merged value.

Return type
(object)

norm(*valu*)

Normalize the value for a given type.

Parameters
valu (*obj*) – The value to normalize.

Returns
The normalized valu, info tuple.

Return type
((obj,dict))

Notes

The info dictionary uses the following key conventions:
subs (dict): The normalized sub-fields as name: valu entries.

pack()

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

setCmprCtor(*name*, *func*)

Set a comparator ctor for a given named comparison operation.

Parameters

- **name** (*str*) – Name of the comparison operation.
- **func** – Function which returns a comparator.

Notes

Comparator ctors should expect to get the right-hand-side of the comparison as their argument, and the returned function should expect to get the left hand side of the comparison and return a boolean from there.

setLiftHintCmprCtor(*name*, *func*)

setNormFunc(*typo*, *func*)

Register a normalizer function for a given python type.

Parameters

- **typo** (*type*) – A python type/class to normalize.
- **func** (*function*) – A callback which normalizes a python value.

stortype: int = None

class synapse.lib.types.**Velocity**(*modl*, *name*, *info*, *opts*)

Bases: *IntBase*

oflight = 299792458000

postTypeInit()

stortype: int = 9

synapse.lib.urlhelp module

synapse.lib.urlhelp.**chopurl**(*url*)

A sane "stand alone" url parser.

Example

info = chopurl(url)

synapse.lib.urlhelp.**sanitizeUrl**(*url*)

Returns a URL with the password (if present) replaced with ****

RFC 3986 3.2.1 'Applications should not render as clear text any data after the first colon (":") character found within a userinfo subcomponent unless the data after the colon is the empty string (indicating no password)'

Essentially, replace everything between the 2nd colon (if it exists) and the first succeeding at sign. Return the original string otherwise.

Note: this depends on this being a reasonably-well formatted URI that starts with a scheme (e.g. http) and '//:' Failure of this condition yields the original string.

synapse.lib.version module

Synapse utilites for dealing with Semvar versioning. This includes the Synapse version information.

synapse.lib.version.**fmtVersion**(**vsnparts*)

Join a string of parts together with a . separator.

Parameters
***vsnparts** –

Returns:

synapse.lib.version.**matches**(*vers*, *cmprvers*)

Check if a version string matches a version comparison string.

synapse.lib.version.**packVersion**(*major*, *minor=0*, *patch=0*)

Pack a set of major/minor/patch integers into a single integer for storage.

Parameters

- **major** (*int*) – Major version level integer.
- **minor** (*int*) – Minor version level integer.
- **patch** (*int*) – Patch version level integer.

Returns
System normalized integer value to represent a software version.

Return type
int

synapse.lib.version.**parseSemver**(*text*)

Parse a Semantic Version string into is component parts.

Parameters

- **text** (*str*) – A text string to parse into semver components. This string has whitespace and leading 'v'
- **it.** (*characters stripped off of*) –

Examples

Parse a string into it semvar parts:

```
parts = parseSemver('v1.2.3')
```

Returns
The dictionary will contain the keys 'major', 'minor' and 'patch' pointing to integer values. The dictionary may also contain keys for 'build' and 'pre' information if that data is parsed out of a semver string. None is returned if the string is not a valid Semver string.

Return type
dict

synapse.lib.version.**parseVersionParts**(*text*, *seps=('.', '-', '_', '+')*)

Extract a list of major/minor/version integer strings from a string.

Parameters

- **text** (*str*) – String to parse
- **seps** (*tuple*) – A tuple or list of separators to use when parsing the version string.

Examples

Parse a simple version string into a major and minor parts:

```
parts = parseVersionParts('1.2')
```

Parse a complex version string into a major and minor parts:

```
parts = parseVersionParts('wowsoft_1.2')
```

Parse a simple version string into a major, minor and patch parts. Parts after the "3." are dropped from the results:

```
parts = parseVersionParts('1.2.3.4.5')
```

Notes

This attempts to brute force out integers from the version string by stripping any leading ascii letters and part separators, and then regexing out numeric parts optionally followed by part separators. It will stop at the first mixed-character part encountered. For example, "1.2-3a" would only parse out the "1" and "2" from the string.

Returns
Either a empty dictionary or dictionary containing up to three keys, 'major', 'minor' and 'patch'.

Return type
dict

synapse.lib.version.**reqVersion**(*valu*, *reqver*, *exc=<class 'synapse.exc.BadVersion'>*, *mesg='Provided version does not match required version.'*)

Require a given version tuple is valid for a given requirements string.

Parameters

- **Optional[Tuple[int** (*valu*) – Major, minor and patch value to check.
- **int** – Major, minor and patch value to check.
- **int]]** – Major, minor and patch value to check.
- **reqver** (*str*) – A requirements version string.
- **exc** (*s_exc.SynErr*) – The synerr class to raise.
- **mesg** (*str*) – The message to pass in the exception.

Returns
If the value is in bounds of minver and maxver.

Return type
None

Raises
s_exc.BadVersion – If a precondition is incorrect or a version value is out of bounds.

synapse.lib.version.**unpackVersion**(*ver*)

Unpack a system normalized integer representing a softare version into its component parts.

Parameters
ver (*int*) – System normalized integer value to unpack into a tuple.

Returns
A tuple containing the major, minor and patch values shifted out of the integer.

Return type
(int, int, int)

synapse.lib.view module

class synapse.lib.view.**View**

Bases: *Pusher*

A view represents a cortex as seen from a specific set of layers.

The view class is used to implement Copy-On-Write layers as well as interact with a subset of the layers configured in a Cortex.

async addLayer(*layriden*, *indx=None*)

async addNode(*form*, *valu*, *props=None*, *user=None*)

async addNodeEdits(*edits*, *meta*)

A telepath compatible way to apply node edits to a view.

NOTE: This does cause trigger execution.

async addTrigQueue(*triginfo*, *nexsitem*)

async addTrigger(*tdef*)

Adds a trigger to the view.

async callStorm(*text*, *opts=None*)

async callStormIface(*name*, *todo*)

async delTrigQueue(*offs*)

async delTrigger(*iden*)

async delete()

Delete the metadata for this view.

Note: this does not delete any layer storage.

async eval(*text*, *opts=None*)

Evaluate a storm query and yield Nodes only.

async finiTrigTask()

async fork(*ldef=None*, *vdef=None*)

Make a new view inheriting from this view with the same layers and a new write layer on top

Parameters

- **ldef** – layer parameter dict
- **vdef** – view parameter dict
- **cortex.addLayer** (*Passed through to*) –

Returns

new view object, with an iden the same as the new write layer iden

async getEdgeVerbs()

async getEdges(*verb=None*)

async getFormCounts()

async getStorNodes(*buid*)

Return a list of storage nodes for the given buid in layer order.

async getTrigger(*iden*)

init2()

We have a second round of initialization so the views can get a handle to their parents which might not be initialized yet

async initTrigTask()

isForkOf(*viewiden*)

isafork()

async iterStormPodes(*text*, *opts=None*)

async listTriggers()

List all the triggers in the view.

async merge(*useriden=None*, *force=False*)

Merge this view into its parent. All changes made to this view will be applied to the parent. Parent's triggers will be run.

async mergeAllowed(*user=None*, *force=False*)

Check whether a user can merge a view into its parent.

async mergeStormIface(*name*, *todo*)

Allow an interface which specifies a generator use case to yield (priority, value) tuples and merge results from multiple generators yielded in ascending priority order.

async nodes(*text*, *opts=None*)

A simple non-streaming way to return a list of nodes.

async pack()

async runNodeAdd(*node*, *view=None*)

async runNodeDel(*node*, *view=None*)

async runPropSet(*node*, *prop*, *oldv*, *view=None*)

Handle when a prop set trigger event fired

async runTagAdd(*node*, *tag*, *valu*, *view=None*)

async runTagDel(*node*, *tag*, *valu*, *view=None*)

async scrapeIface(*text*, *unique=False*, *refang=True*)

async setLayers(*layers*)

Set the view layers from a list of idens. NOTE: view layers are stored "top down" (the write layer is self.layers[0])

async setTriggerInfo(*iden*, *name*, *valu*)

async setViewInfo(*name*, *valu*)

Set a mutable view property.

async snap(*user*)

async classmethod snapctor(**args*, ***kwargs*)

async storNodeEdits(*edits*, *meta*)

async storm(*text*, *opts=None*)

Evaluate a storm query and yield result messages. :Yields: *((str,dict))* – Storm messages.

async stormlist(*text*, *opts=None*)

async wipeAllowed(*user=None*)

Check whether a user can wipe the write layer in the current view.

async wipeLayer(*useriden=None*)

Delete the data in the write layer by generating del nodeedits. Triggers will be run.

class synapse.lib.view.**ViewApi**

Bases: *CellApi*

async getCellIden()

async getEditSize()

saveNodeEdits(*edits*, *meta*)

async storNodeEdits(*edits*, *meta*)

async syncNodeEdits2(*offs*, *wait=True*)

synapse.lookup package

Submodules

synapse.lookup.cvss module

synapse.lookup.iana module

synapse.lookup.iso3166 module

Provides data for the ISO 3166-1 Country codes.

Reference:
https://en.wikipedia.org/wiki/ISO_3166

synapse.lookup.iso3166.**makeColLook**(*rows*, *scol*, *dcol*)

synapse.lookup.macho module

synapse.lookup.macho.**getLoadCmdTypes**()

synapse.lookup.macho.**getSectionTypes**()

synapse.lookup.pe module

synapse.lookup.pe.**getLangCodes**()

synapse.lookup.pe.**getRsrcTypes**()

synapse.lookup.phonenum module

synapse.lookup.phonenum.**formPhoneNode**(*node*, *valu*)

synapse.lookup.phonenum.**getPhoneInfo**(*numb*)

Walk the phone info tree to find the best-match info for the given number.

Example

info = getPhoneInfo(17035551212) country = info.get('cc')

synapse.lookup.phonenum.**initPhoneTree**()

synapse.lookup.phonenum.**phnode**(*valu*)

synapse.models package

Subpackages

synapse.models.gov package

Submodules

synapse.models.gov.cn module

class synapse.models.gov.cn.**GovCnModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.gov.intl module

class synapse.models.gov.intl.**GovIntlModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.gov.us module

class synapse.models.gov.us.**GovUsModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

Submodules

synapse.models.auth module

class synapse.models.auth.**AuthModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.base module

class synapse.models.base.**BaseModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.belief module

class synapse.models.belief.**BeliefModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.biz module

class synapse.models.biz.**BizModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.crypto module

class synapse.models.crypto.**CryptoModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.dns module

class synapse.models.dns.**DnsModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

class synapse.models.dns.**DnsName**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

synapse.models.economic module

class synapse.models.economic.**EconModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.files module

class synapse.models.files.**FileBase**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.files.**FileBytes**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.files.**FileModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

async initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

class synapse.models.files.**FilePath**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

synapse.models.geopol module

class synapse.models.geopol.**PolModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.geospace module

class synapse.models.geospace.**Area**(*modl*, *name*, *info*, *opts*)

Bases: *Int*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.models.geospace.**Dist**(*modl*, *name*, *info*, *opts*)

Bases: *Int*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.models.geospace.**GeoModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

class synapse.models.geospace.**LatLong**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 14

synapse.models.inet module

class synapse.models.inet.**Addr**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.inet.**Cidr4**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.inet.**Cidr6**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.inet.**Email**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

class synapse.models.inet.**Fqdn**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 17

class synapse.models.inet.**HttpCookie**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

getTypeVals(*valu*)

class synapse.models.inet.**IPv4**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

The base type for an IPv4 address.

getCidrRange(*text*)

getNetRange(*text*)

getTypeVals(*valu*)

postTypeInit()

repr(*norm*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 4

class synapse.models.inet.**IPv4Range**(*modl*, *name*, *info*, *opts*)

Bases: *Range*

postTypeInit()

class synapse.models.inet.**IPv6**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

getCidrRange(*text*)

getNetRange(*text*)

getTypeVals(*valu*)

postTypeInit()

stortype: int = 18

class synapse.models.inet.**IPv6Range**(*modl*, *name*, *info*, *opts*)

Bases: *Range*

postTypeInit()

class synapse.models.inet.**InetModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

async initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

class synapse.models.inet.**Rfc2822Addr**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

An RFC 2822 compatible email address parser

postTypeInit()

class synapse.models.inet.**Url**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

synapse.models.inet.**getAddrType**(*ip*)

synapse.models.infotech module

class synapse.models.infotech.**Cpe22Str**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

CPE 2.2 Formatted String https://cpe.mitre.org/files/cpe-specification_2.2.pdf

class synapse.models.infotech.**Cpe23Str**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

CPE 2.3 Formatted String

```
https://nvlpubs.nist.gov/nistpubs/Legacy/IR/nistir7695.pdf

(Section 6.2)

cpe:2.3: part : vendor : product : version : update : edition :
    language : sw_edition : target_sw : target_hw : other

* = "any"
- = N/A
```

class synapse.models.infotech.**ItModule**(*core*, *conf=None*)

Bases: *CoreModule*

bruteVersionStr(*valu*)

This API is deprecated.

Brute force the version out of a string.

Parameters
valu (*str*) – String to attempt to get version information for.

Notes

This first attempts to parse strings using the it:semver normalization before attempting to extract version parts out of the string.

Returns
The system normalized version integer and a subs dictionary.

Return type
int, dict

getModelDefs()

async initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

class synapse.models.infotech.**SemVer**(*modl*, *name*, *info*, *opts*)

Bases: *Int*

Provides support for parsing a semantic version string into its component parts. This normalizes a version string into an integer to allow version ordering. Prerelease information is disregarded for integer comparison purposes, as we cannot map an arbitrary pre-release version into a integer value

Major, minor and patch levels are represented as integers, with a max width of 20 bits. The comparable integer value representing the semver is the bitwise concatenation of the major, minor and patch levels.

Prerelease and build information will be parsed out and available as strings if that information is present.

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

synapse.models.infotech.**chopCpe22**(*text*)

CPE 2.2 Formatted String https://cpe.mitre.org/files/cpe-specification_2.2.pdf

synapse.models.infotech.**cpesplit**(*text*)

synapse.models.infotech.**zipCpe22**(*parts*)

synapse.models.language module

class synapse.models.language.**LangModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.material module

A data model focused on material objects.

class synapse.models.material.**MatModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.media module

class synapse.models.media.**MediaModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.orgs module

class synapse.models.orgs.**OuModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.person module

class synapse.models.person.**PsModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.proj module

class synapse.models.proj.**ProjectModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

async initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

synapse.models.risk module

class synapse.models.risk.**CvssV2**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

class synapse.models.risk.**CvssV3**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

class synapse.models.risk.**RiskModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.syn module

class synapse.models.syn.**SynModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

initCoreModule()

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

synapse.models.telco module

class synapse.models.telco.**Imei**(*modl*, *name*, *info*, *opts*)

Bases: *Int*

postTypeInit()

class synapse.models.telco.**Imsi**(*modl*, *name*, *info*, *opts*)

Bases: *Int*

postTypeInit()

class synapse.models.telco.**Phone**(*modl*, *name*, *info*, *opts*)

Bases: *Str*

postTypeInit()

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

class synapse.models.telco.**TelcoModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.models.telco.**chop_imei**(*imei*)

synapse.models.telco.**digits**(*text*)

synapse.models.telco.**imeicsum**(*text*)

Calculate the imei check byte.

synapse.models.transport module

class synapse.models.transport.**TransportModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

synapse.servers package

Submodules

synapse.servers.aha module

synapse.servers.axon module

synapse.servers.cell module

async synapse.servers.cell.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.servers.cortex module

synapse.servers.cryotank module

synapse.servers.jsonstor module

synapse.servers.stemcell module

synapse.servers.stemcell.**getStemCell**(*dirn*)

async synapse.servers.stemcell.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tests package

Submodules

synapse.tests.nopmod module

A python module used for testing dmon dynamic module loading.

synapse.tests.utils module

This contains the core test helper code used in Synapse.

This gives the opportunity for third-party users of Synapse to test their code using some of the same helpers used to test Synapse.

The core class, synapse.tests.utils.SynTest is a subclass of unittest.TestCase, with several wrapper functions to allow for easier calls to assert* functions, with less typing. There are also Synapse specific helpers, to load Cortexes and whole both multi-component environments into memory.

Since SynTest is built from unittest.TestCase, the use of SynTest is compatible with the unittest, nose and pytest frameworks. This does not lock users into a particular test framework; while at the same time allowing base use to be invoked via the built-in Unittest library, with one important exception: due to an unfortunate design approach, you cannot use the unittest module command line to run a *single* async unit test. pytest works fine though.

class synapse.tests.utils.**AsyncStreamEvent**(**args*, ***kwargs*)

Bases: StringIO, Event

A combination of a io.StringIO object and an asyncio.Event object.

setMesg(*mesg*)

Clear the internal event and set a new message that is used to set the event.

Parameters
mesg (*str*) – The string to monitor for.

Returns
None

async wait(*timeout=None*)

Block until the internal flag is true.

If the internal flag is true on entry, return True immediately. Otherwise, block until another coroutine calls set() to set the flag to true, then return True.

write(*s*)

Write string to file.

Returns the number of characters written, which is always equal to the length of the string.

class synapse.tests.utils.**CmdGenerator**(*cmds*)

Bases: object

addCmd(*cmd*)

Add a command to the end of the list of commands returned by the CmdGenerator.

Parameters
cmd (*str*) – Command to add to the list of commands to return.

class synapse.tests.utils.**DeprModule**(*core*, *conf=None*)

Bases: *CoreModule*

getModelDefs()

class synapse.tests.utils.**HttpReflector**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *Handler*

Test handler which reflects get/post data back to the caller

async get()

async head()

async post()

class synapse.tests.utils.**LibTst**(*runt*, *name=()*)

Bases: *Lib*

LibTst for testing!

addLibFuncs()

async beep(*valu*)

Example storm func

class synapse.tests.utils.**PickleableMagicMock**(**args*, ***kw*)

Bases: MagicMock

class synapse.tests.utils.**StormPkgTest**(**args*, ***kwargs*)

Bases: *SynTest*

assetdir = None

getTestCore(*conf=None*, *dirn=None*)

Get a simple test Cortex as an async context manager.

Returns
A Cortex object.

Return type
s_cortex.Cortex

async initTestCore(*core*)

pkgprotos = ()

vcr = None

class synapse.tests.utils.**StreamEvent**(**args*, ***kwargs*)

Bases: StringIO, Event

A combination of a io.StringIO object and a threading.Event object.

setMesg(*mesg*)

Clear the internal event and set a new message that is used to set the event.

Parameters
mesg (*str*) – The string to monitor for.

Returns
None

`write`(*s*)

Write string to file.

Returns the number of characters written, which is always equal to the length of the string.

`class synapse.tests.utils.SynTest`(**args*, ***kwargs*)

Bases: `TestCase`

Mark all async test methods as s_glob.synchelp decorated.

Note: This precludes running a single unit test via path using the unittest module.

`async addCreatorDeleterRoles`(*core*)

Add two roles to a Cortex *proxy*, the *creator* and *deleter* roles. Creator allows for node:add, prop:set and tag:add actions. Deleter allows for node:del, prop:del and tag:del actions.

Parameters
core – Auth enabled cortex.

`addSvcToAha`(*aha*, *svcname*, *ctor*, *conf=None*, *dirn=None*, *provinfo=None*)

Creates as service and provision it in a Aha network via the provisioning API.

This assumes the Aha cell has a provision:listen and aha:urls set.

Parameters

- **aha** (*s_aha.AhaCell*) – Aha cell.
- **svcname** (*str*) – Service name.
- **ctor** – Service class to add.
- **conf** (*dict*) – Optional service conf.
- **dirn** (*str*) – Optional directory.
- **provinfo** (*dict*)) – Optional provisioning info.

Notes

The config data for the cell is pushed into dirn/cell.yaml. The cells are created with the `ctor.anit()` function.

`async addSvcToCore`(*svc*, *core*, *svcname='svc'*)

Add a service to a Cortex using telepath over tcp.

`async agenlen`(*x*, *obj*, *msg=None*)

Assert that the async generator produces x items

`async agenraises`(*exc*, *gfunc*)

Helper to validate that an async generator will throw an exception.

Parameters

- **exc** – Exception class to catch
- **gfunc** – async Generator

async asyncraises(*exc*, *coro*)

checkNode(*node*, *expected*)

async checkNodes(*core*, *ndefs*)

eq(*x*, *y*, *msg=None*)

Assert X is equal to Y

eqOrNan(*x*, *y*, *msg=None*)

Assert X is equal to Y or they are both NaN (needed since NaN != NaN)

eqish(*x*, *y*, *places=6*, *msg=None*)

Assert X is equal to Y within places decimal places

async execToolMain(*func*, *argv*)

extendOutpFromPatch(*outp*, *patch*)

Extend an Outp with lines from a magicMock object from withCliPromptMock.

Parameters

- **outp** (TstOutPut) – The outp to extend.
- **patch** (*mock.MagicMock*) – The patch object.

Returns

Returns none.

Return type

None

false(*x*, *msg=None*)

Assert X is False

ge(*x*, *y*, *msg=None*)

Assert that X is greater than or equal to Y

genraises(*exc*, *gfunc*, **args*, ***kwargs*)

Helper to validate that a generator function will throw an exception.

Parameters

- **exc** – Exception class to catch
- **gfunc** – Generator function to call.
- ***args** – Args passed to the generator function.
- ****kwargs** – Kwargs passed to the generator function.

Notes

Wrap a generator function in a list() call and execute that in a bound local using `self.raises(exc, boundlocal)`. The `list()` will consume the generator until complete or an exception occurs.

getAsyncLoggerStream(*logname*, *mesg=''*)

Async version of getLoggerStream.

Parameters

- **logname** (*str*) – Name of the logger to get.

- **mesg** (*str*) – A string which, if provided, sets the StreamEvent event if a message containing the string is written to the log.

Notes

The event object mixed in for the AsyncStreamEvent is a asyncio.Event object. This requires the user to await the Event specific calls as neccesary.

Examples

Do an action and wait for a specific log message to be written:

```
with self.getAsyncLoggerStream('synapse.foo.bar',
                               'big badda boom happened') as stream:
    # Do something that triggers a log message
    await doSomething()
    # Wait for the mesg to be written to the stream
    await stream.wait(timeout=10)

stream.seek(0)
mesgs = stream.read()
# Do something with messages
```

Returns
An AsyncStreamEvent object.

Return type
AsyncStreamEvent

getHttpSess(*auth=None*, *port=None*)

Get an aiohttp ClientSession with a CookieJar.

Parameters

- **auth** (*str, str*) – A tuple of username and password information for http auth.
- **port** (*int*) – Port number to connect to.

Notes

If auth and port are provided, the session will login to a Synapse cell hosted at localhost:port.

Returns
An aiohttp.ClientSession object.

Return type
aiohttp.ClientSession

getLoggerStream(*logname*, *mesg=''*)

Get a logger and attach a io.StringIO object to the logger to capture log messages.

Parameters

- **logname** (*str*) – Name of the logger to get.
- **mesg** (*str*) – A string which, if provided, sets the StreamEvent event if a message

- **log.**(*containing the string is written to the*) –

Examples

Do an action and get the stream of log messages to check against:

```
with self.getLoggerStream('synapse.foo.bar') as stream:
    # Do something that triggers a log message
    doSomething()

stream.seek(0)
mesgs = stream.read()
# Do something with messages
```

Do an action and wait for a specific log message to be written:

```
with self.getLoggerStream('synapse.foo.bar', 'big badda boom happened') as␣
↪stream:
    # Do something that triggers a log message
    doSomething()
    stream.wait(timeout=10)  # Wait for the mesg to be written to the stream

stream.seek(0)
mesgs = stream.read()
# Do something with messages
```

You can also reset the message and wait for another message to occur:

```
with self.getLoggerStream('synapse.foo.bar', 'big badda boom happened') as␣
↪stream:
    # Do something that triggers a log message
    doSomething()
    stream.wait(timeout=10)
    stream.setMesg('yo dawg')  # This will now wait for the 'yo dawg' string to␣
↪be written.
    stream.wait(timeout=10)

stream.seek(0)
mesgs = stream.read()
# Do something with messages
```

Notes

This **only** captures logs for the current process.

Yields
StreamEvent – A StreamEvent object

getMagicPromptColors(*patch*)

Get the colored lines from a MagicMock object from withCliPromptMock.

Parameters
patch (*mock.MagicMock*) – The MagicMock object from withCliPromptMock.

Returns
A list of tuples, containing color and line data.

Return type
list

getMagicPromptLines(*patch*)

Get the text lines from a MagicMock object from withCliPromptMock.

Parameters
patch (*mock.MagicMock*) – The MagicMock object from withCliPromptMock.

Returns
A list of lines.

Return type
list

getRegrAxon(*vers*, *conf=None*)

getRegrCore(*vers*, *conf=None*)

getRegrDir(**path*)

getStructuredAsyncLoggerStream(*logname*, *mesg=''*)

Async version of getLoggerStream which uses structured logging.

Parameters

- **logname** (*str*) – Name of the logger to get.
- **mesg** (*str*) – A string which, if provided, sets the StreamEvent event if a message containing the string is written to the log.

Notes

The event object mixed in for the AsyncStreamEvent is a asyncio.Event object. This requires the user to await the Event specific calls as needed. The messages written to the stream will be JSON lines.

Examples

Do an action and wait for a specific log message to be written:

```
with self.getStructuredAsyncLoggerStream('synapse.foo.bar',
                                         '"some JSON string"') as stream:
    # Do something that triggers a log message
    await doSomething()
    # Wait for the mesg to be written to the stream
    await stream.wait(timeout=10)

data = stream.getvalue()
raw_mesgs = [m for m in data.split('\n') if m]
msgs = [json.loads(m) for m in raw_mesgs]
# Do something with messages
```

Returns
An AsyncStreamEvent object.

Return type
AsyncStreamEvent

`getTestAha`(*conf=None*, *dirn=None*)

`getTestAhaProv`(*conf=None*, *dirn=None*)

Get an Aha cell that is configured for provisioning on aha.loop.vertex.link.

Parameters

- **conf** – Optional configuraiton information for the Aha cell.
- **dirn** – Optional path to create the Aha cell in.

Returns
The provisioned Aha cell.

Return type
s_aha.AhaCell

`getTestAxon`(*dirn=None*, *conf=None*)

Get a test Axon as an async context manager.

Returns
A Axon object.

Return type
s_axon.Axon

`getTestCell`(*ctor*, *conf=None*, *dirn=None*)

Get a test Cell.

`getTestCertDir`(*dirn*)

Patch the synapse.lib.certdir.certdir singleton and supporting functions with a CertDir instance backed by the provided directory.

Parameters
dirn (*str*) – The directory used to back the new CertDir singleton.

Returns
The patched CertDir object that is the current singleton.

Return type
s_certdir.CertDir

`getTestConfDir`(*name*, *conf=None*)

`getTestCore`(*conf=None*, *dirn=None*)

Get a simple test Cortex as an async context manager.

Returns
A Cortex object.

Return type
s_cortex.Cortex

`getTestCoreAndProxy`(*conf=None*, *dirn=None*)

Get a test Cortex and the Telepath Proxy to it.

Returns
The Cortex and a Proxy representing a CoreApi object.

Return type
(s_cortex.Cortex, s_cortex.CoreApi)

getTestCoreProxSvc(*ssvc*, *ssvc_conf=None*, *core_conf=None*)

Get a test Cortex, the Telepath Proxy to it, and a test service instance.

Parameters

- **ssvc** – Ctor to the Test Service.
- **ssvc_conf** – Service configuration.
- **core_conf** – Cortex configuration.

Returns
The Cortex, Proxy, and service instance.

Return type
(s_cortex.Cortex, s_cortex.CoreApi, testsvc)

getTestCryo(*dirn=None*, *conf=None*)

Get a simple test Cryocell as an async context manager.

Returns
Test cryocell.

Return type
s_cryotank.CryoCell

getTestCryoAndProxy(*dirn=None*)

Get a test Cryocell and the Telepath Proxy to it.

Returns
CryoCell, s_cryotank.CryoApi): The CryoCell and a Proxy representing a CryoApi object.

Return type
(s_cryotank

getTestDir(*mirror=None*, *copyfrom=None*, *chdir=False*, *startdir=None*)

Get a temporary directory for test purposes. This destroys the directory afterwards.

Parameters

- **mirror** (*str*) – A Synapse test directory to mirror into the test directory.
- **copyfrom** (*str*) – An arbitrary directory to copy into the test directory.
- **chdir** (*boolean*) – If true, chdir the current process to that directory. This is undone when the context manager exits.
- **startdir** (*str*) – The directory under which to place the temporary directory

Notes

The mirror argument is normally used to mirror test directory under `synapse/tests/files`. This is accomplished by passing in the name of the directory (such as `testcore`) as the mirror argument.

If the `mirror` argument is an absolute directory, that directory will be copied to the test directory.

Returns
The path to a temporary directory.

Return type
str

getTestDmon()

getTestFilePath(**names*)

getTestHive()

getTestHiveDmon()

getTestHiveFromDirn(*dirn*)

getTestJsonStor(*dirn=None*, *conf=None*)

getTestOutp()
Get a Output instance with a expects() function.

Returns
A TstOutPut instance.

Return type
TstOutPut

getTestProxy(*dmon*, *name*, ***kwargs*)

getTestReadWriteCores(*conf=None*, *dirn=None*)
Get a read/write core pair.

Notes

By default, this returns the same cortex. It is expected that a test which needs two distinct Cortexes implements the bridge themselves.

Returns
A tuple of Cortex objects.

Return type
(s_cortex.Cortex, s_cortex.Cortex)

getTestSynDir()
Combines getTestDir() and setSynDir() into one.

getTestTeleHive()

getTestUrl(*dmon*, *name*, ***opts*)

gt(*x*, *y*, *msg=None*)
Assert that X is greater than Y

isin(*member*, *container*, *msg=None*)
Assert a member is inside of a container.

isinstance(*obj*, *cls*, *msg=None*)
Assert a object is the instance of a given class or tuple of classes.

istufo(*obj*)
Check to see if an object is a tufo.

Parameters
obj (*object*) – Object being inspected.

Notes

This does not make any assumptions about the contents of the dictionary. This validates the object to be a tuple of length two, containing a str or None as the first value, and a dict as the second value.

Returns
None

le(*x*, *y*, *msg=None*)

Assert that X is less than or equal to Y

len(*x*, *obj*, *msg=None*)

Assert that the length of an object is equal to X

lt(*x*, *y*, *msg=None*)

Assert that X is less than Y

ne(*x*, *y*)

Assert X is not equal to Y

nn(*x*, *msg=None*)

Assert X is not None

none(*x*, *msg=None*)

Assert X is None

noprop(*info*, *prop*)

Assert a property is not present in a dictionary.

notin(*member*, *container*, *msg=None*)

Assert a member is not inside of a container.

printed(*msgs*, *text*)

raises(**args*, ***kwargs*)

Assert a function raises an exception.

redirectStdin(*new_stdin*)

Temporary replace stdin.

Parameters
new_stdin (*file-like object*) – file-like object.

Examples

Patch stdin with a string buffer:

```
inp = io.StringIO('stdin stuff\nanother line\n')
with self.redirectStdin(inp):
    main()
```

Here's a way to use this for code that's expecting the stdin buffer to have bytes:

```
inp = Mock()
inp.buffer = io.BytesIO(b'input data')
with self.redirectStdin(inp):
    main()
```

Returns
None

async runCoreNodes(*core*, *query*, *opts=None*)

Run a storm query through a Cortex as a SchedCoro and return the results.

setSynDir(*dirn*)

Sets s_common.syndir to a specific directory and then unsets it afterwards.

Parameters
dirn (*str*) – Directory to set syndir to.

Notes

This is to be used as a context manager.

setTstEnvars(***props*)

Set Environment variables for the purposes of running a specific test.

Parameters

- ****props** – A kwarg list of envars to set. The values set are run
- **strings.** (*through str() to ensure we're setting*) –

Examples

Run a test while a envar is set:

```
with self.setEnvars(magic='haha') as nop:
    ret = dostuff()
    self.true(ret)
```

Notes

This helper explicitly sets and unsets values in os.environ, as os.putenv does not automatically updates the os.environ object.

Yields
None. This context manager yields None. Upon exiting, envars are either removed from os.environ or reset to their previous values.

skip(*mesg*)

skipIfNexusReplay()

Allow skipping a test if SYNDEV_NEXUS_REPLAY envar is set.

Raises
unittest.SkipTest if SYNDEV_NEXUS_REPLAY envar is set to true value. –

skipIfNoInternet()

Allow skipping a test if SYN_TEST_SKIP_INTERNET envar is set.

Raises
unittest.SkipTest if SYN_TEST_SKIP_INTERNET envar is set to a integer greater than 1. –

skipIfNoPath(*path*, *mesg=None*)

Allows skipping a test if the test/files path does not exist.

Parameters

- **path** (*str*) – Path to check.
- **mesg** (*str*) – Optional additional message.

Raises

unittest.SkipTest if the path does not exist. –

skipLongTest()

Allow skipping a test if SYN_TEST_SKIP_LONG envar is set.

Raises

unittest.SkipTest if SYN_TEST_SKIP_LONG envar is set to a integer greater than 1. –

sorteq(*x*, *y*, *msg=None*)

Assert two sorted sequences are the same.

stablebuid(*valu=None*)

A stable buid generation for testing purposes

stableguid(*valu=None*)

A stable guid generation for testing purposes

stormHasNoErr(*mesgs*)

Raise an AssertionError if there is a message of type "err" in the list.

Parameters

mesgs (*list*) – A list of storm messages.

stormHasNoWarnErr(*mesgs*)

Raise an AssertionError if there is a message of type "err" or "warn" in the list.

Parameters

mesgs (*list*) – A list of storm messages.

stormIsInErr(*mesg*, *mesgs*)

Check if a string is present in all of the error messages from a stream of storm messages.

Parameters

- **mesg** (*str*) – A string to check.
- **mesgs** (*list*) – A list of storm messages.

stormIsInPrint(*mesg*, *mesgs*, *deguid=False*)

Check if a string is present in all of the print messages from a stream of storm messages.

Parameters

- **mesg** (*str*) – A string to check.
- **mesgs** (*list*) – A list of storm messages.

stormIsInWarn(*mesg*, *mesgs*)

Check if a string is present in all of the warn messages from a stream of storm messages.

Parameters

- **mesg** (*str*) – A string to check.

- **mesgs** (*list*) – A list of storm messages.

stormNotInPrint(*mesg*, *mesgs*)

Assert a string is not present in all of the print messages from a stream of storm messages.

Parameters

- **mesg** (*str*) – A string to check.
- **mesgs** (*list*) – A list of storm messages.

thisHostMust(***props*)

Requires a host having a specific property.

Parameters
****props** –

Raises
unittest.SkipTest if the required property is missing. –

thisHostMustNot(***props*)

Requires a host to not have a specific property.

Parameters
****props** –

Raises
unittest.SkipTest if the required property is missing. –

true(*x*, *msg=None*)

Assert X is True

withCliPromptMock()

Context manager to mock our use of Prompt Toolkit's print_formatted_text function.

Returns
Yields a mock.MagikMock object.

Return type
mock.MagicMock

withCliPromptMockExtendOutp(*outp*)

Context manager to mock our use of Prompt Toolkit's print_formatted_text function and extend the lines to an an output object.

Parameters
outp (TstOutPut) – The outp to extend.

Notes

This extends the outp with the lines AFTER the context manager has exited.

Returns
Yields a mock.MagicMock object.

Return type
mock.MagicMock

withNexusReplay(*replay=False*)

Patch so that the Nexus apply log is applied twice. Useful to verify idempotency.

Parameters
replay (*bool*) – Set the default value of resolving the existence of SYNDEV_NEXUS_REPLAY variable. This can be used to force the apply patch without using the environment variable.

Notes

This is applied if the environment variable SYNDEV_NEXUS_REPLAY is set to a non zero value or the replay argument is set to True.

Returns
An exitstack object.

Return type
contextlib.ExitStack

withSetLoggingMock()

Context manager to mock calls to the setlogging function to avoid unittests calling logging.basicconfig.

Returns
Yields a mock.MagicMock object.

Return type
mock.MagicMock

withStableUids()

A context manager that generates guids and buids in sequence so that successive test runs use the same data

withTestCmdr(*cmdg*)

class synapse.tests.utils.**TestCmd**(*runt*, *runtsafe*)

Bases: *Cmd*

A test command

async execStormCmd(*runt*, *genr*)

Abstract base method

forms = {'input': ['test:str', 'inet:ipv6'], 'nodedata': [('foo', 'inet:ipv4'), ('bar', 'inet:fqdn')], 'output': ['inet:fqdn']}

getArgParser()

name = 'testcmd'

class synapse.tests.utils.**TestModule**(*core*, *conf=None*)

Bases: *CoreModule*

async addTestRecords(*snap*, *items*)

getModelDefs()

getStormCmds()

Module implementers may override this to provide a list of Storm commands which will be loaded into the Cortex.

Returns
A list of Storm Command classes (not instances).

Return type
list

`async initCoreModule()`

Module implementers may override this method to initialize the module after the Cortex has completed and is accessible to perform storage operations.

Notes

This is the preferred function to override for implementing custom code that needs to be executed during Cortex startup.

Any exception raised within this method will remove the module from the list of currently loaded modules.

This is called for modules after getModelDefs() and getStormCmds() has been called, in order to allow for model loading and storm command loading prior to code execution offered by initCoreModule.

A failure during initCoreModule will not unload data model or storm commands registered by the module.

Returns
None

`testguid = '8f1401de15918358d5247e21ca29a814'`

`class synapse.tests.utils.TestRunt(name, **kwargs)`

Bases: `object`

`getStorNode(form)`

`class synapse.tests.utils.TestSubType(modl, name, info, opts)`

Bases: *Type*

`norm(valu)`

Normalize the value for a given type.

Parameters
valu (*obj*) – The value to normalize.

Returns
The normalized valu, info tuple.

Return type
((obj,dict))

Notes

The info dictionary uses the following key conventions:
subs (dict): The normalized sub-fields as name: valu entries.

`repr(norm)`

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

`stortype: int = 4`

class synapse.tests.utils.**TestType**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

postTypeInit()

stortype: int = 1

class synapse.tests.utils.**ThreeType**(*modl*, *name*, *info*, *opts*)

Bases: *Type*

norm(*valu*)

Normalize the value for a given type.

Parameters
valu (*obj*) – The value to normalize.

Returns
The normalized valu, info tuple.

Return type
((obj,dict))

Notes

The info dictionary uses the following key conventions:
subs (dict): The normalized sub-fields as name: valu entries.

repr(*valu*)

Return a printable representation for the value. This may return a string or a tuple of values for display purposes.

stortype: int = 2

class synapse.tests.utils.**TstEnv**

Bases: object

add(*name*, *item*, *fini=False*)

async fini()

class synapse.tests.utils.**TstOutPut**

Bases: *OutPutStr*

clear()

expect(*substr*, *throw=True*)

Check if a string is present in the messages captured by the OutPutStr object.

Parameters

- **substr** (*str*) – String to check for the existence of.
- **throw** (*bool*) – If True, a missing substr results in a Exception being thrown.

Returns
True if the string is present; False if the string is not present and throw is False.

Return type
bool

async synapse.tests.utils.**alist**(*coro*)

synapse.tests.utils.**deguidify**(*x*)

synapse.tests.utils.**norm**(*z*)

synapse.tools package

Subpackages

synapse.tools.aha package

Subpackages

synapse.tools.aha.provision package

Submodules

synapse.tools.aha.provision.service module

async synapse.tools.aha.provision.service.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.aha.provision.user module

async synapse.tools.aha.provision.user.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

Submodules

synapse.tools.aha.easycert module

synapse.tools.aha.easycert.**getArgParser**()

async synapse.tools.aha.easycert.**main**(*argv*, *outp=None*)

synapse.tools.aha.enroll module

async synapse.tools.aha.enroll.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.aha.list module

async synapse.tools.aha.list.**main**(*argv*, *outp=None*)

synapse.tools.cryo package

Submodules

synapse.tools.cryo.cat module

async synapse.tools.cryo.cat.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.cryo.list module

async synapse.tools.cryo.list.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.hive package

Submodules

synapse.tools.hive.load module

async synapse.tools.hive.load.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.hive.save module

async synapse.tools.hive.save.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

Submodules

synapse.tools.autodoc module

class synapse.tools.autodoc.**DocHelp**(*ctors*, *types*, *forms*, *props*, *univs*)

Bases: object

Helper to pre-compute all doc strings hierarchically

async synapse.tools.autodoc.**docConfdefs**(*ctor*)

async synapse.tools.autodoc.**docModel**(*outp*, *core*)

async synapse.tools.autodoc.**docStormTypes**()

async synapse.tools.autodoc.**docStormpkg**(*pkgpath*)

async synapse.tools.autodoc.**docStormsvc**(*ctor*)

async synapse.tools.autodoc.**main**(*argv*, *outp=None*)

synapse.tools.autodoc.**makeargparser**()

synapse.tools.autodoc.**processCtors**(*rst*, *dochelp*, *ctors*)

Parameters

- **rst** (RstHelp) –
- **dochelp** (DocHelp) –
- **ctors** (*list*) –

Returns
None

synapse.tools.autodoc.**processFormsProps**(*rst*, *dochelp*, *forms*, *univ_names*)

async synapse.tools.autodoc.**processStormCmds**(*rst*, *pkgname*, *commands*)

Parameters

- **rst** (RstHelp) –
- **pkgname** (*str*) –
- **commands** (*list*) –

Returns
None

synapse.tools.autodoc.**processTypes**(*rst*, *dochelp*, *types*)

Parameters

- **rst** (RstHelp) –
- **dochelp** (DocHelp) –
- **ctors** (*list*) –

Returns
None

synapse.tools.autodoc.**processUnivs**(*rst*, *dochelp*, *univs*)

synapse.tools.axon2axon module

async synapse.tools.axon2axon.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.backup module

synapse.tools.backup.**backup**(*srcdir*, *dstdir*, *skipdirs=None*)

Create a backup of a Synapse application.

Parameters

- **srcdir** (*str*) – Path to the directory to backup.
- **dstdir** (*str*) – Path to backup target directory.

- **skipdirs** (*list or None*) – Optional list of relative directory name glob patterns to exclude from the backup.

Note: Running this method from the same process as a running user of the directory may lead to a segmentation fault

synapse.tools.backup.**backup_lmdb**(*env*, *dstdir*, *txn=None*)

synapse.tools.backup.**capturelmdbs**(*srcdir*, *skipdirs=None*, *onlydirs=None*)

A context manager that opens all the lmdb files under a srcdir and makes a read transaction. All transactions are aborted and environments closed when the context is exited.

Yields

Dict[str, Tuple[lmdb.Environment, lmdb.Transaction]] – Maps path to environment, transaction

synapse.tools.backup.**main**(*argv*)

synapse.tools.backup.**parse_args**(*argv*)

synapse.tools.backup.**txnbackup**(*lmdbinfo*, *srcdir*, *dstdir*, *skipdirs=None*)

Create a backup of a Synapse application under a (hopefully consistent) set of transactions.

Parameters

- **lmdbinfo** (*Dict[str, Tuple[lmdb.Environment, lmdb.Transaction]]*) – Maps of path to environment, transaction
- **srcdir** (*str*) – Path to the directory to backup.
- **dstdir** (*str*) – Path to backup target directory.
- **skipdirs** (*list or None*) – Optional list of relative directory name glob patterns to exclude from the backup.

Note: Running this method from the same process as a running user of the directory may lead to a segmentation fault

synapse.tools.cellauth module

async synapse.tools.cellauth.**handleList**(*opts*)

async synapse.tools.cellauth.**handleModify**(*opts*)

async synapse.tools.cellauth.**main**(*argv*, *outprint=None*)

synapse.tools.cellauth.**makeargparser**()

async synapse.tools.cellauth.**printuser**(*user*, *details=False*, *cell=None*)

synapse.tools.cellauth.**reprrule**(*rule*)

synapse.tools.cmdr module

async synapse.tools.cmdr.**main**(*argv*)

async synapse.tools.cmdr.**runcmdr**(*argv*, *item*)

synapse.tools.csvtool module

async synapse.tools.csvtool.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.csvtool.**makeargparser**(*outp*)

async synapse.tools.csvtool.**runCsvExport**(*opts*, *outp*, *text*, *stormopts*)

async synapse.tools.csvtool.**runCsvImport**(*opts*, *outp*, *text*, *stormopts*)

synapse.tools.easycert module

synapse.tools.easycert.**main**(*argv*, *outp=None*)

synapse.tools.feed module

async synapse.tools.feed.**addFeedData**(*core*, *outp*, *feedformat*, *debug=False*, **paths*, *chunksize=1000*, *offset=0*, *viewiden=None*)

synapse.tools.feed.**getItems**(**paths*)

async synapse.tools.feed.**main**(*argv*, *outp=None*)

synapse.tools.feed.**makeargparser**()

synapse.tools.genpkg module

synapse.tools.genpkg.**getStormStr**(*fn*)

synapse.tools.genpkg.**loadOpticFiles**(*pkgdef*, *path*)

synapse.tools.genpkg.**loadOpticWorkflows**(*pkgdef*, *path*)

synapse.tools.genpkg.**loadPkgProto**(*path*, *opticdir=None*, *no_docs=False*, *readonly=False*)

Get a Storm Package definition from disk.

Parameters

- **path** (*str*) – Path to the package .yaml file on disk.
- **opticdir** (*str*) – Path to optional Optic module code to add to the Storm Package.
- **no_docs** (*bool*) – If true, omit inline documentation content if it is not present on disk.
- **readonly** (*bool*) – If set, open files in read-only mode. If files are missing, that will raise a NoSuchFile exception.

Returns
A Storm package definition.

Return type
dict

async synapse.tools.genpkg.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.genpkg.**tryLoadPkgProto**(*fp*, *opticdir=None*, *readonly=False*)

Try to get a Storm Package prototype from disk with or without inline documentation.

Parameters

- **fp** (*str*) – Path to the package .yaml file on disk.
- **opticdir** (*str*) – Path to optional Optic module code to add to the Storm Package.
- **readonly** (*bool*) – If set, open files in read-only mode. If files are missing, that will raise a NoSuchFile exception.

Returns
A Storm package definition.

Return type
dict

synapse.tools.guid module

synapse.tools.guid.**main**(*argv*, *outp=None*)

synapse.tools.healthcheck module

synapse.tools.healthcheck.**format_component**(*e*, *mesg: str*) → dict

async synapse.tools.healthcheck.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.healthcheck.**makeargparser**()

synapse.tools.healthcheck.**serialize**(*ret*)

synapse.tools.json2mpk module

synapse.tools.json2mpk.**getArgParser**()

synapse.tools.json2mpk.**main**(*argv*, *outp=None*)

synapse.tools.livebackup module

async synapse.tools.livebackup.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.modrole module

async synapse.tools.modrole.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.moduser module

async synapse.tools.moduser.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.promote module

async synapse.tools.promote.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.pullfile module

async synapse.tools.pullfile.**main**(*argv*, *outp=None*)

synapse.tools.pullfile.**setup**()

synapse.tools.pushfile module

async synapse.tools.pushfile.**main**(*argv*, *outp=None*)

synapse.tools.pushfile.**makeargparser**()

synapse.tools.rstorm module

async synapse.tools.rstorm.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.tools.storm module

class synapse.tools.storm.**ExportCmd**(*cli*, ***opts*)

Bases: *StormCliCmd*

Export the results of a storm query into a nodes file.

Example

// Export nodes to a file !export dnsa.nodes { inet:fqdn#mynodes -> inet:dns:a }

// Export nodes to a file and only include specific tags !export fqdn.nodes { inet:fqdn#mynodes } –include-tags footag

getArgParser()

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.tools.storm.**HelpCmd**(*cli*, ***opts*)

Bases: *CmdHelp*

List interpreter extended commands and display help output.

Example

!help foocmd

class synapse.tools.storm.**PullFileCmd**(*cli*, ***opts*)

Bases: *StormCliCmd*

Download a file by sha256 and store it locally.

Example

!pullfile c00adfcc316f8b00772cdbce2505b9ea539d74f42861801eceb1017a44344ed3 /path/to/savefile

getArgParser()

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.tools.storm.**PushFileCmd**(*cli*, ***opts*)

Bases: *StormCliCmd*

Upload a file and create a file:bytes node.

Example

!pushfile /path/to/file

getArgParser()

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.tools.storm.**QuitCmd**(*cli*, ***opts*)

Bases: *CmdQuit*

Quit the current command line interpreter.

Example

!quit

class synapse.tools.storm.**RunFileCmd**(*cli*, ***opts*)

Bases: *StormCliCmd*

Run a local storm file.

Example

!runfile /path/to/file.storm

getArgParser()

async runCmdOpts(*opts*)

Perform the command actions. Must be implemented by Cmd implementers.

Parameters
opts (*dict*) – Options dictionary.

class synapse.tools.storm.**StormCli**

Bases: *Cli*

async handleErr(*mesg*)

histfile = 'storm_history'

initCmdClasses()

printf(*mesg*, *addnl=True*, *color=None*)

async runCmdLine(*line*, *opts=None*)

Run a single command line.

Parameters
line (*str*) – Line to execute.

Examples

Execute the 'woot' command with the 'help' switch:

await cli.runCmdLine('woot –help')

Returns
Arbitrary data from the cmd class.

Return type
object

async storm(*text*, *opts=None*)

class synapse.tools.storm.**StormCliCmd**(*cli*, ***opts*)

Bases: *Cmd*

getArgParser()

getCmdOpts(*text*)

Use the _cmd_syntax def to split/parse/normalize the cmd line.

Parameters
text (*str*) – Command to process.

Notes

This is implemented independent of argparse (et al) due to the need for syntax aware argument splitting. Also, allows different split per command type

Returns
An opts dictionary.

Return type
dict

synapse.tools.storm.**getArgParser**()

async synapse.tools.storm.**main**(*argv*, *outp=<synapse.lib.output.OutPut object>*)

synapse.utils package

Subpackages

synapse.utils.stormcov package

synapse.utils.stormcov.**coverage_init**(*reg*, *options*)

Submodules

synapse.utils.stormcov.plugin module

class synapse.utils.stormcov.plugin.**PivotTracer**(*parent*)

Bases: FileTracer

PARSE_METHODS = {'getNodeByNdef', 'nodesByPropArray', 'nodesByPropValu', 'nodesByTag'}

dynamic_source_filename(*filename*, *frame*)

Get a dynamically computed source file name.

Some plug-ins need to compute the source file name dynamically for each frame.

This function will not be invoked if *has_dynamic_source_filename()* returns False.

Returns the source file name for this frame, or None if this frame shouldn't be measured.

has_dynamic_source_filename()

Does this FileTracer have dynamic source file names?

FileTracers can provide dynamically determined file names by implementing *dynamic_source_filename()*. Invoking that function is expensive. To determine whether to invoke it, coverage.py uses the result of this function to know if it needs to bother invoking *dynamic_source_filename()*.

See CoveragePlugin.file_tracer() for details about static and dynamic file names.

Returns True if *dynamic_source_filename()* should be called to get dynamic source file names.

line_number_range(*frame*)

Get the range of source line numbers for a given a call frame.

The call frame is examined, and the source line number in the original file is returned. The return value is a pair of numbers, the starting line number and the ending line number, both inclusive. For example, returning (5, 7) means that lines 5, 6, and 7 should be considered executed.

This function might decide that the frame doesn't indicate any lines from the source file were executed. Return (-1, -1) in this case to tell coverage.py that no lines should be recorded for this frame.

class synapse.utils.stormcov.plugin.**StormCtrlTracer**(*parent*)

Bases: FileTracer

dynamic_source_filename(*filename*, *frame*)

Get a dynamically computed source file name.

Some plug-ins need to compute the source file name dynamically for each frame.

This function will not be invoked if *has_dynamic_source_filename()* returns False.

Returns the source file name for this frame, or None if this frame shouldn't be measured.

has_dynamic_source_filename()

Does this FileTracer have dynamic source file names?

FileTracers can provide dynamically determined file names by implementing *dynamic_source_filename()*. Invoking that function is expensive. To determine whether to invoke it, coverage.py uses the result of this function to know if it needs to bother invoking *dynamic_source_filename()*.

See CoveragePlugin.file_tracer() for details about static and dynamic file names.

Returns True if *dynamic_source_filename()* should be called to get dynamic source file names.

line_number_range(*frame*)

Get the range of source line numbers for a given a call frame.

The call frame is examined, and the source line number in the original file is returned. The return value is a pair of numbers, the starting line number and the ending line number, both inclusive. For example, returning (5, 7) means that lines 5, 6, and 7 should be considered executed.

This function might decide that the frame doesn't indicate any lines from the source file were executed. Return (-1, -1) in this case to tell coverage.py that no lines should be recorded for this frame.

class synapse.utils.stormcov.plugin.**StormPlugin**(*options*)

Bases: CoveragePlugin, FileTracer

PARSE_METHODS = {'compute', 'getPivsIn', 'getPivsOut', 'lift', 'once'}

dynamic_source_filename(*filename*, *frame*, *force=False*)

Get a dynamically computed source file name.

Some plug-ins need to compute the source file name dynamically for each frame.

This function will not be invoked if *has_dynamic_source_filename()* returns False.

Returns the source file name for this frame, or None if this frame shouldn't be measured.

file_reporter(*filename*)

Get the `FileReporter` class to use for a file.

Plug-in type: file tracer.

This will only be invoked if *filename* returns non-None from *file_tracer()*. It's an error to return None from this method.

Returns a `FileReporter` object to use to report on *filename*, or the string *"python"* to have coverage.py treat the file as Python.

file_tracer(*filename*)

Get a `FileTracer` object for a file.

Plug-in type: file tracer.

Every Python source file is offered to your plug-in to give it a chance to take responsibility for tracing the file. If your plug-in can handle the file, it should return a `FileTracer` object. Otherwise return None.

There is no way to register your plug-in for particular files. Instead, this method is invoked for all files as they are executed, and the plug-in decides whether it can trace the file or not. Be prepared for *filename* to refer to all kinds of files that have nothing to do with your plug-in.

The file name will be a Python file being executed. There are two broad categories of behavior for a plug-in, depending on the kind of files your plug-in supports:

- Static file names: each of your original source files has been converted into a distinct Python file. Your plug-in is invoked with the Python file name, and it maps it back to its original source file.
- Dynamic file names: all of your source files are executed by the same Python file. In this case, your plug-in implements `FileTracer.dynamic_source_filename()` to provide the actual source file for each execution frame.

filename is a string, the path to the file being considered. This is the absolute real path to the file. If you are comparing to other paths, be sure to take this into account.

Returns a `FileTracer` object to use to trace *filename*, or None if this plug-in cannot trace this file.

find_executable_files(*src_dir*)

Yield all of the executable files in *src_dir*, recursively.

Plug-in type: file tracer.

Executability is a plug-in-specific property, but generally means files which would have been considered for coverage analysis, had they been included automatically.

Returns or yields a sequence of strings, the paths to files that could have been executed, including files that had been executed.

find_storm_files(*dirn*)

find_subqueries(*tree*, *path*)

has_dynamic_source_filename()

Does this FileTracer have dynamic source file names?

FileTracers can provide dynamically determined file names by implementing *dynamic_source_filename()*. Invoking that function is expensive. To determine whether to invoke it, coverage.py uses the result of this function to know if it needs to bother invoking *dynamic_source_filename()*.

See `CoveragePlugin.file_tracer()` for details about static and dynamic file names.

Returns True if *dynamic_source_filename()* should be called to get dynamic source file names.

line_number_range(*frame*)

Get the range of source line numbers for a given a call frame.

The call frame is examined, and the source line number in the original file is returned. The return value is a pair of numbers, the starting line number and the ending line number, both inclusive. For example, returning (5, 7) means that lines 5, 6, and 7 should be considered executed.

This function might decide that the frame doesn't indicate any lines from the source file were executed. Return (-1, -1) in this case to tell coverage.py that no lines should be recorded for this frame.

class synapse.utils.stormcov.plugin.**StormReporter**(*filename*, *parser*)

Bases: `FileReporter`

lines()

Get the executable lines in this file.

Your plug-in must determine which lines in the file were possibly executable. This method returns a set of those line numbers.

Returns a set of line numbers.

source()

Get the source for the file.

Returns a Unicode string.

The base implementation simply reads the *self.filename* file and decodes it as UTF-8. Override this method if your file isn't readable as a text file, or if you need other encoding support.

10.1.2 Submodules

10.1.3 synapse.axon module

class synapse.axon.**Axon**

Bases: *Cell*

byterange = False

cellapi

alias of *AxonApi*

confdefs = {'http:proxy': {'description': 'An aiohttp-socks compatible proxy URL to use in the wget API.', 'type': 'string'}, 'max:bytes': {'description': 'The maximum number of bytes that can be stored in the Axon.', 'hidecmdl': True, 'minimum': 1, 'type': 'integer'}, 'max:count': {'description': 'The maximum number of files that can be stored in the Axon.', 'hidecmdl': True, 'minimum': 1, 'type': 'integer'}, 'tls:ca:dir': {'description': 'An optional directory of CAs which are added to the TLS CA chain for wget and wput APIs.', 'type': 'string'}}

async csvrows(*sha256*, *dialect='excel'*, ***fmtparams*)

async del_(*sha256*)

Remove the given bytes from the Axon by sha256.

Parameters
sha256 (*bytes*) – The sha256, in bytes, to remove from the Axon.

Returns
True if the file is removed; false if the file is not present.

Return type
boolean

async dels(*sha256s*)

Given a list of sha256 hashes, delete the files from the Axon.

Parameters
sha256s (*list*) – A list of sha256 hashes in bytes form.

Returns
A list of booleans, indicating if the file was deleted or not.

Return type
list

async get(*sha256*, *offs=None*, *size=None*)

Get bytes of a file.

Parameters

- **sha256** (*bytes*) – The sha256 hash of the file in bytes.
- **offs** (*int*) – The offset to start reading from.
- **size** (*int*) – The total number of bytes to read.

Examples

Get the bytes from an Axon and process them:

```
buf = b''
async for bytz in axon.get(sha256):
    buf =+ bytz

await dostuff(buf)
```

Yields
bytes – Chunks of the file bytes.

Raises
synapse.exc.NoSuchFile – If the file does not exist.

async getCellInfo()

Return metadata specific for the Cell.

Notes

By default, this function returns information about the base Cell implementation, which reflects the base information in the Synapse Cell.

It is expected that implementers override the following Class attributes in order to provide meaningful version information:

`COMMIT` - A Git Commit `VERSION` - A Version tuple. `VERSTRING` - A Version string.

Returns
A Dictionary of metadata.

Return type
Dict

async has(*sha256*)

Check if the Axon has a file.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
True if the Axon has the file; false otherwise.

Return type
boolean

async hashes(*offs*, *wait=False*, *timeout=None*)

Yield hash rows for files that exist in the Axon in added order starting at an offset.

Parameters

- **offs** (*int*) – The index offset.
- **wait** (*boolean*) – Wait for new results and yield them in realtime.
- **timeout** (*int*) – Max time to wait for new results.

Yields
(int, (bytes, int)) – An index offset and the file SHA-256 and size.

Note: If the same hash was deleted and then added back, the same hash will be yielded twice.

---

async hashset(*sha256*)

Calculate additional hashes for a file in the Axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
A dictionary containing hashes of the file.

Return type
dict

async history(*tick*, *tock=None*)

Yield hash rows for files that existing in the Axon after a given point in time.

Parameters

- **tick** (*int*) – The starting time (in epoch milliseconds).

- **tock** (*int*) – The ending time to stop iterating at (in epoch milliseconds).

Yields
(int, (bytes, int)) – A tuple containing time of the hash was added and the file SHA-256 and size.

holdHashLock(*hashbyts*)

A context manager that synchronizes edit access to a blob.

Parameters
hashbyts (*bytes*) – The blob to hold the lock for.

async initServiceRuntime()

async initServiceStorage()

async iterMpkFile(*sha256*)

Yield items from a MsgPack (.mpk) file in the Axon.

Parameters
sha256 (*str*) – The sha256 hash of the file as a string.

Yields
Unpacked items from the bytes.

async jsonlines(*sha256*)

async metrics()

Get the runtime metrics of the Axon.

Returns
A dictionary of runtime data about the Axon.

Return type
dict

async postfiles(*fields*, *url*, *params=None*, *headers=None*, *method='POST'*, *ssl=True*, *timeout=None*, *proxy=None*)

Send files from the axon as fields in a multipart/form-data HTTP request.

Parameters

- **fields** (*list*) – List of dicts containing the fields to add to the request as form-data.
- **url** (*str*) – The URL to retrieve.
- **params** (*dict*) – Additional parameters to add to the URL.
- **headers** (*dict*) – Additional HTTP headers to add in the request.
- **method** (*str*) – The HTTP method to use.
- **ssl** (*bool*) – Perform SSL verification.
- **timeout** (*int*) – The timeout of the request, in seconds.
- **proxy** (*bool|str|null*) – Use a specific proxy or disable proxy use.

Notes

The dictionaries in the fields list may contain the following values:

```
{
    'name': <str> - Name of the field.
    'sha256': <str> - SHA256 hash of the file to submit for this field.
    'value': <str> - Value for the field. Ignored if a sha256 has been␣
↪specified.
    'filename': <str> - Optional filename for the field.
    'content_type': <str> - Optional content type for the field.
    'content_transfer_encoding': <str> - Optional content-transfer-encoding␣
↪header for the field.
}
```

The dictionary returned by this may contain the following values:

```
{
    'ok': <boolean> - False if there were exceptions retrieving the URL.
    'err': <str> - An error message if there was an exception when retrieving␣
↪the URL.
    'url': <str> - The URL retrieved (which could have been redirected)
    'code': <int> - The response code.
    'body': <bytes> - The response body.
    'headers': <dict> - The response headers as a dictionary.
}
```

Returns
An information dictionary containing the results of the request.

Return type
dict

async put(*byts*)

Store bytes in the Axon.

Parameters
byts (*bytes*) – The bytes to store in the Axon.

Notes

This API should not be used for files greater than 128 MiB in size.

Returns
A tuple with the file size and sha256 hash of the bytes.

Return type
tuple(int, bytes)

async puts(*files*)

Store a set of bytes in the Axon.

Parameters
files (*list*) – A list of bytes to store in the Axon.

Notes

This API should not be used for storing more than 128 MiB of bytes at once.

Returns
A list containing tuples of file size and sha256 hash of the saved bytes.

Return type
list(tuple(int, bytes))

async readlines(*sha256*)

async save(*sha256*, *genr*, *size*)

Save a generator of bytes to the Axon.

Parameters

- **sha256** (*bytes*) – The sha256 hash of the file in bytes.
- **genr** – The bytes generator function.

Returns
The size of the bytes saved.

Return type
int

async size(*sha256*)

Get the size of a file in the Axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
The size of the file, in bytes. If not present, None is returned.

Return type
int

async upload()

Get an Upload object.

Notes

The UpLoad object should be used to manage uploads greater than 128 MiB in size.

Examples

Use an UpLoad object to upload a file to the Axon:

```
async with await axon.upload() as upfd:
    # Assumes bytesGenerator yields bytes
    async for byts in bytsgenerator():
        await upfd.write(byts)
    await upfd.save()
```

Use a single UpLoad object to save multiple files:

```
async with await axon.upload() as upfd:
    for fp in file_paths:
        # Assumes bytesGenerator yields bytes
        async for byts in bytsgenerator(fp):
            await upfd.write(byts)
        await upfd.save()
```

Returns
An Upload manager object.

Return type
UpLoad

async wants(*sha256s*)

Get a list of sha256 values the axon does not have from a input list.

Parameters
sha256s (*list*) – A list of sha256 values as bytes.

Returns
A list of bytes containing the sha256 hashes the Axon does not have.

Return type
list

async wget(*url*, *params=None*, *headers=None*, *json=None*, *body=None*, *method='GET'*, *ssl=True*, *timeout=None*, *proxy=None*)

Stream a file download directly into the Axon.

Parameters

- **url** (*str*) – The URL to retrieve.
- **params** (*dict*) – Additional parameters to add to the URL.
- **headers** (*dict*) – Additional HTTP headers to add in the request.
- **json** – A JSON body which is included with the request.
- **body** – The body to be included in the request.
- **method** (*str*) – The HTTP method to use.
- **ssl** (*bool*) – Perform SSL verification.
- **timeout** (*int*) – The timeout of the request, in seconds.
- **proxy** (*bool|str|null*) – Use a specific proxy or disable proxy use.

Notes

The response body will be stored, regardless of the response code. The ok value in the reponse does not reflect that a status code, such as a 404, was encountered when retrieving the URL.

The dictionary returned by this may contain the following values:

```
{
    'ok': <boolean> - False if there were exceptions retrieving the URL.
    'url': <str> - The URL retrieved (which could have been redirected). This␣
```

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```
↪is a url-decoded string.
    'code': <int> - The response code.
    'mesg': <str> - An error message if there was an exception when retrieving␣
↪the URL.
    'headers': <dict> - The response headers as a dictionary.
    'size': <int> - The size in bytes of the response body.
    'hashes': {
        'md5': <str> - The MD5 hash of the response body.
        'sha1': <str> - The SHA1 hash of the response body.
        'sha256': <str> - The SHA256 hash of the response body.
        'sha512': <str> - The SHA512 hash of the response body.
    },
    'request': {
        'url': The request URL. This is a url-decoded string.
        'headers': The request headers.
        'method': The request method.
    }
    'history': A sequence of response bodies to track any redirects, not␣
↪including hashes.
}
```

Returns
An information dictionary containing the results of the request.

Return type
dict

async wput(*sha256*, *url*, *params=None*, *headers=None*, *method='PUT'*, *ssl=True*, *timeout=None*, *filename=None*, *filemime=None*, *proxy=None*)

Stream a blob from the axon as the body of an HTTP request.

class synapse.axon.**AxonApi**

Bases: *CellApi*, *Share*

async csvrows(*sha256*, *dialect='excel'*, ***fmtparams*)

Yield CSV rows from a CSV file.

Parameters

- **sha256** (*bytes*) – The sha256 hash of the file.
- **dialect** (*str*) – The CSV dialect to use.
- ****fmtparams** – The CSV dialect format parameters.

Notes

The dialect and fmtparams expose the Python csv.reader() parameters.

Examples

Get the rows from a CSV file and process them:

```
async for row in axon.csvrows(sha256):
    await dostuff(row)
```

Get the rows from a tab separated file and process them:

```
async for row in axon.csvrows(sha256, delimiter='	'):
    await dostuff(row)
```

Yields
list – Decoded CSV rows.

async del_(*sha256*)

Remove the given bytes from the Axon by sha256.

Parameters
sha256 (*bytes*) – The sha256, in bytes, to remove from the Axon.

Returns
True if the file is removed; false if the file is not present.

Return type
boolean

async dels(*sha256s*)

Given a list of sha256 hashes, delete the files from the Axon.

Parameters
sha256s (*list*) – A list of sha256 hashes in bytes form.

Returns
A list of booleans, indicating if the file was deleted or not.

Return type
list

async get(*sha256*, *offs=None*, *size=None*)

Get bytes of a file.

Parameters

- **sha256** (*bytes*) – The sha256 hash of the file in bytes.
- **offs** (*int*) – The offset to start reading from.
- **size** (*int*) – The total number of bytes to read.

Examples

Get the bytes from an Axon and process them:

```
buf = b''
async for bytz in axon.get(sha256):
    buf =+ bytz

await dostuff(buf)
```

Yields
bytes – Chunks of the file bytes.

Raises
synapse.exc.NoSuchFile – If the file does not exist.

async has(*sha256*)

Check if the Axon has a file.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
True if the Axon has the file; false otherwise.

Return type
boolean

async hashes(*offs*, *wait=False*, *timeout=None*)

Yield hash rows for files that exist in the Axon in added order starting at an offset.

Parameters

- **offs** (*int*) – The index offset.
- **wait** (*boolean*) – Wait for new results and yield them in realtime.
- **timeout** (*int*) – Max time to wait for new results.

Yields
(int, (bytes, int)) – An index offset and the file SHA-256 and size.

async hashset(*sha256*)

Calculate additional hashes for a file in the Axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
A dictionary containing hashes of the file.

Return type
dict

async history(*tick*, *tock=None*)

Yield hash rows for files that existing in the Axon after a given point in time.

Parameters

- **tick** (*int*) – The starting time (in epoch milliseconds).
- **tock** (*int*) – The ending time to stop iterating at (in epoch milliseconds).

Yields
(int, (bytes, int)) – A tuple containing time of the hash was added and the file SHA-256 and size.

`async iterMpkFile(sha256)`

Yield items from a MsgPack (.mpk) file in the Axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Yields
Unpacked items from the bytes.

`async jsonlines(sha256)`

Yield JSON objects from JSONL (JSON lines) file.

Parameters
sha256 (*bytes*) – The sha256 hash of the file.

Yields
object – Decoded JSON objects.

`async metrics()`

Get the runtime metrics of the Axon.

Returns
A dictionary of runtime data about the Axon.

Return type
dict

`async postfiles(fields, url, params=None, headers=None, method='POST', ssl=True, timeout=None, proxy=None)`

`async put(byts)`

Store bytes in the Axon.

Parameters
byts (*bytes*) – The bytes to store in the Axon.

Notes

This API should not be used for files greater than 128 MiB in size.

Returns
A tuple with the file size and sha256 hash of the bytes.

Return type
tuple(int, bytes)

`async puts(files)`

Store a set of bytes in the Axon.

Parameters
files (*list*) – A list of bytes to store in the Axon.

Notes

This API should not be used for storing more than 128 MiB of bytes at once.

Returns
A list containing tuples of file size and sha256 hash of the saved bytes.

Return type
list(tuple(int, bytes))

async readlines(*sha256*)

Yield lines from a multi-line text file in the axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file.

Yields
str – Lines of text

async size(*sha256*)

Get the size of a file in the Axon.

Parameters
sha256 (*bytes*) – The sha256 hash of the file in bytes.

Returns
The size of the file, in bytes. If not present, None is returned.

Return type
int

async upload()

Get an Upload object.

Notes

The UpLoad object should be used to manage uploads greater than 128 MiB in size.

Examples

Use an UpLoad object to upload a file to the Axon:

```
async with axonProxy.upload() as upfd:
    # Assumes bytesGenerator yields bytes
    async for byts in bytsgenerator():
        upfd.write(byts)
    upfd.save()
```

Use a single UpLoad object to save multiple files:

```
async with axonProxy.upload() as upfd:
    for fp in file_paths:
        # Assumes bytesGenerator yields bytes
        async for byts in bytsgenerator(fp):
            upfd.write(byts)
        upfd.save()
```

Returns
An Upload manager object.

Return type
UpLoadShare

async wants(*sha256s*)

Get a list of sha256 values the axon does not have from a input list.

Parameters
sha256s (*list*) – A list of sha256 values as bytes.

Returns
A list of bytes containing the sha256 hashes the Axon does not have.

Return type
list

async wget(*url*, *params=None*, *headers=None*, *json=None*, *body=None*, *method='GET'*, *ssl=True*, *timeout=None*, *proxy=None*)

Stream a file download directly into the Axon.

Parameters

- **url** (*str*) – The URL to retrieve.
- **params** (*dict*) – Additional parameters to add to the URL.
- **headers** (*dict*) – Additional HTTP headers to add in the request.
- **json** – A JSON body which is included with the request.
- **body** – The body to be included in the request.
- **method** (*str*) – The HTTP method to use.
- **ssl** (*bool*) – Perform SSL verification.
- **timeout** (*int*) – The timeout of the request, in seconds.

Notes

The response body will be stored, regardless of the response code. The ok value in the reponse does not reflect that a status code, such as a 404, was encountered when retrieving the URL.

The dictionary returned by this may contain the following values:

```
{
    'ok': <boolean> - False if there were exceptions retrieving the URL.
    'url': <str> - The URL retrieved (which could have been redirected). This␣
↪is a url-decoded string.
    'code': <int> - The response code.
    'mesg': <str> - An error message if there was an exception when retrieving␣
↪the URL.
    'headers': <dict> - The response headers as a dictionary.
    'size': <int> - The size in bytes of the response body.
    'hashes': {
        'md5': <str> - The MD5 hash of the response body.
        'sha1': <str> - The SHA1 hash of the response body.
        'sha256': <str> - The SHA256 hash of the response body.
```

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```
        'sha512': <str> - The SHA512 hash of the response body.
    },
    'request': {
        'url': The request URL. This is a url-decoded string.
        'headers': The request headers.
        'method': The request method.
    }
    'history': A sequence of response bodies to track any redirects, not␣
↪including hashes.
}
```

Returns
An information dictionary containing the results of the request.

Return type
dict

async wput(*sha256*, *url*, *params=None*, *headers=None*, *method='PUT'*, *ssl=True*, *timeout=None*, *proxy=None*)

class synapse.axon.**AxonFileHandler**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonHandlerMixin*, *Handler*

async getAxonInfo()

class synapse.axon.**AxonHandlerMixin**

Bases: object

getAxon()

Get a reference to the Axon interface used by the handler.

class synapse.axon.**AxonHttpBySha256InvalidV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonFileHandler*

async delete(*sha256*)

async get(*sha256*)

async head(*sha256*)

class synapse.axon.**AxonHttpBySha256V1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonFileHandler*

async delete(*sha256*)

async get(*sha256*)

async head(*sha256*)

class synapse.axon.**AxonHttpDelV1**(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonHandlerMixin*, *Handler*

async post()

class synapse.axon.AxonHttpHasV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonHandlerMixin*, *Handler*

async get(*sha256*)

class synapse.axon.AxonHttpUploadV1(*application: Application*, *request: HTTPServerRequest*, ***kwargs: Any*)

Bases: *AxonHandlerMixin*, *StreamHandler*

async data_received(*chunk*)

Implement this method to handle streamed request data.

Requires the *.stream_request_body* decorator.

May be a coroutine for flow control.

on_connection_close()

Called in async handlers if the client closed the connection.

Override this to clean up resources associated with long-lived connections. Note that this method is called only if the connection was closed during asynchronous processing; if you need to do cleanup after every request override *on_finish* instead.

Proxies may keep a connection open for a time (perhaps indefinitely) after the client has gone away, so this method may not be called promptly after the end user closes their connection.

on_finish()

Called after the end of a request.

Override this method to perform cleanup, logging, etc. This method is a counterpart to *prepare*. on_finish may not produce any output, as it is called after the response has been sent to the client.

async post()

Called after all data has been read.

async prepare()

Called at the beginning of a request before *get*/*post*/etc.

Override this method to perform common initialization regardless of the request method.

Asynchronous support: Use async def or decorate this method with *.gen.coroutine* to make it asynchronous. If this method returns an Awaitable execution will not proceed until the Awaitable is done.

New in version 3.1: Asynchronous support.

async put()

class synapse.axon.UpLoad

Bases: *Base*

An object used to manage uploads to the Axon.

async save()

Save the currently uploaded bytes to the Axon.

Notes

This resets the Upload object, so it can be reused.

Returns
A tuple of sizes in bytes and the sha256 hash of the saved files.

Return type
tuple(int, bytes)

async write(*byts*)

Write bytes to the Upload object.

Parameters
byts (*bytes*) – Bytes to write to the current Upload object.

Returns
Returns None.

Return type
(None)

class synapse.axon.**UpLoadProxy**

Bases: *Share*

async save()

async write(*byts*)

class synapse.axon.**UpLoadShare**

Bases: *UpLoad*, *Share*

typename = 'upload'

10.1.4 synapse.cells module

10.1.5 synapse.common module

class synapse.common.**NoValu**

Bases: object

class synapse.common.**aclosing**(*thing*)

Bases: AbstractAsyncContextManager

Async context manager for safely finalizing an asynchronously cleaned-up resource such as an async generator, calling its aclose() method.

Code like this:

```
async with aclosing(<module>.fetch(<arguments>)) as agen:
    <block>
```

is equivalent to this:

```
agen = <module>.fetch(<arguments>)
try:
    <block>
```

(continues on next page)

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```
finally:
    await agen.aclose()
```

async synapse.common.**agen**(**items*)

async synapse.common.**aspin**(*genr*)

Async version of spin

synapse.common.**buid**(*valu=None*)

A binary GUID like sequence of 32 bytes.

Parameters

- **valu** (*object*) – Optional, if provided, the hash of the msgpack
- **to** (*encoded form of the object is returned. This can be used*) –
- **buids.** (*create stable*) –

Notes

By default, this returns a random 32 byte value.

Returns
A 32 byte value.

Return type
bytes

synapse.common.**chunks**(*item*, *size*)

Divide an iterable into chunks.

Parameters

- **item** – Item to slice
- **size** (*int*) – Maximum chunk size.

Notes

This supports Generator objects and objects which support calling the __getitem__() method with a slice object.

Yields
Slices of the item containing up to "size" number of items.

synapse.common.**config**(*conf*, *confdefs*)

Initialize a config dict using the given confdef tuples.

synapse.common.**debase64**(*b*)

synapse.common.**deprecated**(*name*, *curv='2.x'*, *eolv='3.0.0'*)

synapse.common.**ehex**(*byts*)

Encode a bytes variable to a string using binascii.hexlify.

Parameters
byts (*bytes*) – Bytes to encode.

Returns
A string representing the bytes.

Return type
str

synapse.common.**enbase64**(*b*)

synapse.common.**envbool**(*name*, *defval='false'*)

Resolve an environment variable to a boolean value.

Parameters

- **name** (*str*) – Environment variable to resolve.
- **defval** (*str*) – Default string value to resolve as.

Notes

False values will be consider strings "0" or "false" after lower casing.

Returns
True if the envar is set, false if it is set to a false value.

Return type
boolean

synapse.common.**err**(*e*, *fulltb=False*)

synapse.common.**errinfo**(*name*, *mesg*)

synapse.common.**excinfo**(*e*)

Populate err,errmsg,errtrace info from exc.

synapse.common.**firethread**(*f*)

A decorator for making a function fire a thread.

synapse.common.**flatten**(*item*)

Normalize a primitive object for cryptographic signing.

Parameters
item – The python primitive object to normalize.

Notes

Only None, bool, int, bytes, strings, lists, tuples and dictionaries are acceptable input. List objects will be converted to tuples. Dictionary objects must have keys which can be sorted.

Returns
A new copy of the object.

synapse.common.**gendir**(**paths*, ***opts*)

Return the absolute path of the joining of the arguments, creating a directory at the resulting path if one does not exist.

Performs home directory(~) and environment variable expansion.

Parameters

- ***paths** (*[str,...]*) – A list of path elements

- ****opts** – arguments as kwargs to os.makedirs

synapse.common.**genfile**(**paths*)

Create or open (for read/write) a file path join.

Parameters
***paths** – A list of paths to join together to make the file.

Notes

If the file already exists, the fd returned is opened in `r+b` mode. Otherwise, the fd is opened in `w+b` mode.

The file position is set to the start of the file. The user is responsible for truncating (`fd.truncate()`) if the existing file contents are not desired, or seeking to the end (`fd.seek(0, 2)`) to append.

Returns
A file-object which can be read/written too.

Return type
io.BufferedRandom

synapse.common.**genpath**(**paths*)

Return an absolute path of the joining of the arguments as path elements

Performs home directory(~) and environment variable expansion on the joined path

Parameters
***paths** (*[str,...]*) – A list of path elements

Note: All paths used by Synapse operations (i.e. everything but the data) shall use this function or one of its callers before storing as object properties.

---

synapse.common.**getDirSize**(**paths*)

Get the size of a directory.

Parameters
***paths** (*str*) – A list of path elements.

Notes

This is equivalent to `du -B 1 -s` and `du -bs`.

Returns
Tuple of total real and total apparent size of all normal files and directories underneath `*paths` plus `*paths` itself.

Return type
tuple

synapse.common.**getSslCtx**(*cadir*, *purpose=Purpose.SERVER_AUTH*)

Create as SSL Context and load certificates from a given directory.

Parameters

- **cadir** (*str*) – Path to load certificates from.
- **purpose** – SSLContext purposes flags.

Returns
A SSL Context object.

Return type
ssl.SSLContext

synapse.common.**getSynDir**(**paths*)

synapse.common.**getSynPath**(**paths*)

synapse.common.**getTempDir**(*dirn=None*)

synapse.common.**getbytes**(**paths*, ***opts*)

synapse.common.**getfile**(**paths*, ***opts*)

Return a file at the path resulting from joining of the arguments, or None if the file does not exist.

Parameters

- ***paths** (*[str,...]*) – A list of path elements
- ****opts** – arguments as kwargs to io.open

Returns
A file-object which can be read/written too.

Return type
io.BufferedRandom

synapse.common.**guid**(*valu=None*)

Get a 16 byte guid value.

By default, this is a random guid value.

Parameters
valu – Object used to construct the guid valu from. This must be able to be msgpack'd.

Returns
32 character, lowercase ascii string.

Return type
str

synapse.common.**hugeadd**(*x*, *y*)

Add two decimal.Decimal with proper precision to support synapse hugenums.

synapse.common.**hugediv**(*x*, *y*)

Divide two decimal.Decimal with proper precision to support synapse hugenums.

synapse.common.**hugemod**(*x*, *y*)

synapse.common.**hugemul**(*x*, *y*)

Multiply two decimal.Decimal with proper precision to support synapse hugenums.

synapse.common.**hugenum**(*valu*)

Return a decimal.Decimal with proper precision for use as a synapse hugenum.

synapse.common.**hugepow**(*x*, *y*)

Return the first operand to the power of the second operand.

synapse.common.**hugeround**(*x*)

Round a decimal.Decimal with proper precision for synapse hugenums.

synapse.common.**hugescaleb**(*x*, *y*)

Return the first operand with its exponent adjusted by the second operand.

synapse.common.**hugesub**(*x*, *y*)

Subtract two decimal.Decimal with proper precision to support synapse hugenums.

synapse.common.**int64en**(*i*)

Encode an unsigned 64-bit int into 8 byte big-endian bytes

synapse.common.**int64un**(*b*)

Decode an unsigned 64-bit int from 8 byte big-endian

synapse.common.**intify**(*x*)

Ensure (or coerce) a value into being an integer or None.

Parameters
x (*obj*) – An object to intify

Returns
The int value (or None)

Return type
(int)

synapse.common.**isbuidhex**(*text*)

synapse.common.**isguid**(*text*)

synapse.common.**iterfd**(*fd*, *size=10000000*)

Generator which yields bytes from a file descriptor.

Parameters

- **fd** (*file*) – A file-like object to read bytes from.
- **size** (*int*) – Size, in bytes, of the number of bytes to read from the
- **time.** (*fd at a given*) –

Notes

If the first read call on the file descriptor is a empty bytestring, that zero length bytestring will be yielded and the generator will then be exhausted. This behavior is intended to allow the yielding of contents of a zero byte file.

Yields
bytes – Bytes from the file descriptor.

synapse.common.**iterzip**(**args*, *fillvalue=None*)

synapse.common.**jslines**(**paths*)

synapse.common.**jsload**(**paths*)

synapse.common.**jsonsafe_nodeedits**(*nodeedits*)

Hexlify the buid of each node:edits

synapse.common.**jssave**(*js*, **paths*)

synapse.common.**listdir**(**paths*, *glob=None*)

List the (optionally glob filtered) full paths from a dir.

Parameters

- ***paths** (*[str,...]*) – A list of path elements
- **glob** (*str*) – An optional fnmatch glob str

synapse.common.**makedirs**(*path*, *mode=511*)

async synapse.common.**merggenr**(*genrs*, *cmprkey*)

Iterate multiple sorted async generators and yield their results in order.

Parameters

- **genrs** (*Sequence[AsyncGenerator[T]]*) – a sequence of async generator that each yield sorted items
- **cmprkey** (*Callable[T, T, bool]*) – a comparison function over the items yielded

---

Note: If the genrs yield increasing items, cmprkey should return True if the first parameter is less than the second parameter, e.g lambda x, y: x < y.

---

async synapse.common.**merggenr2**(*genrs*, *cmprkey=None*, *reverse=False*)

Optimized version of merggenr based on heapq.merge

synapse.common.**normLogLevel**(*valu*)

Norm a log level value to a integer.

Parameters
valu – The value to norm (a string or integer).

Returns
A valid Logging log level.

Return type
int

synapse.common.**now**()

Get the current epoch time in milliseconds.

This relies on time.time(), which is system-dependent in terms of resolution.

Examples

Get the current time and make a row for a Cortex:

```
tick = now()
row = (someiden, 'foo:prop', 1, tick)
core.addRows([row])
```

Returns
Epoch time in milliseconds.

Return type
int

synapse.common.**reqJsonSafeStrict**(*item*)

Require the item to be safe to serialize to JSON without type coercion issues.

Parameters
item – The python primitive to check.

Returns
None

Raises
s_exc.BadArg – If the item contains invalid data.

synapse.common.**reqbytes**(**paths*)

synapse.common.**reqdir**(**paths*)

Return the absolute path of the joining of the arguments, raising an exception if a directory does not exist at the resulting path.

Performs home directory(~) and environment variable expansion.

Parameters
***paths** (*[str,...]*) – A list of path elements

synapse.common.**reqfile**(**paths*, ***opts*)

Return a file at the path resulting from joining of the arguments, raising an exception if the file does not exist.

Parameters

- ***paths** (*[str,...]*) – A list of path elements
- ****opts** – arguments as kwargs to io.open

Returns
A file-object which can be read/written too.

Return type
io.BufferedRandom

synapse.common.**reqjsonsafe**(*item*)

Returns None if item is json serializable, otherwise raises an exception. Uses default type coercion from built-in json.dumps.

synapse.common.**reqpath**(**paths*)

Return the absolute path of the joining of the arguments, raising an exception if a file doesn't exist at resulting path

Parameters
***paths** (*[str,...]*) – A list of path elements

synapse.common.**result**(*retn*)

Return a value or raise an exception from a retn tuple.

synapse.common.**retnexc**(*e*)

Construct a retn tuple for the given exception.

synapse.common.**setlogging**(*mlogger*, *defval=None*, *structlog=None*, *log_setup=True*)

Configure synapse logging.

Parameters

- **mlogger** (*logging.Logger*) – Reference to a logging.Logger()
- **defval** (*str*) – Default log level. May be an integer.

- **structlog** (*bool*) – Enabled structured (jsonl) logging output.

Notes

This calls logging.basicConfig and should only be called once per process.

Returns
None

synapse.common.**signedint64en**(*i*)

Encode a signed 64-bit int into 8 byte big-endian bytes

synapse.common.**signedint64un**(*b*)

Decode a signed 64-bit int from 8 byte big-endian

synapse.common.**spin**(*genr*)

Crank through a generator but discard the yielded values.

Parameters
genr – Any generator or iterable valu.

Notes

This generator is exhausted via the `collections.dequeue()` constructor with a `maxlen=0`, which will quickly exhaust an iterator staying in C code as much as possible.

Returns
None

synapse.common.**switchext**(**paths*, *ext*)

Return an absolute path of the joining of the arguments with the extension replaced.

If an extension does not exist, it will be added.

Parameters

- ***paths** (*[str,...]*) – A list of path elements
- **ext** (*str*) – A file extension (e.g. '.txt'). It should begin with a period.

synapse.common.**todo**(*_todoname*, **args*, ***kwargs*)

Construct and return a todo tuple of (name, args, kwargs).

Note: the odd name for the first parameter is to avoid collision with keys in kwargs.

synapse.common.**tuplify**(*obj*)

Convert a nested set of python primitives into tupleized forms via msgpack.

synapse.common.**uhex**(*text*)

Decode a hex string into bytes.

Parameters
text (*str*) – Text to decode.

Returns
The decoded bytes.

Return type
bytes

synapse.common.**unjsonsafe_nodeedits**(*nodeedits*)

synapse.common.**verstr**(*vtup*)

Convert a version tuple to a string.

synapse.common.**vertup**(*vstr*)

Convert a version string to a tuple.

Example

ver = vertup('1.3.30')

synapse.common.**worker**(*meth*, **args*, ***kwargs*)

synapse.common.**yamlload**(**paths*)

synapse.common.**yamlmod**(*obj*, **paths*)

Combines/creates a yaml file and combines with obj. obj and file must be maps/dict or empty.

synapse.common.**yamlpop**(*key*, **paths*)

Pop a key out of a yaml file.

Parameters

- **key** (*str*) – Name of the key to remove.
- ***paths** – Path to a yaml file. The file must be a map / dictionary.

Returns

None

synapse.common.**yamlsave**(*obj*, **paths*)

10.1.6 synapse.cortex module

class synapse.cortex.**CoreApi**

Bases: *CellApi*

The CoreApi is exposed when connecting to a Cortex over Telepath.

Many CoreApi methods operate on packed nodes consisting of primitive data structures which can be serialized with msgpack/json.

An example of a packaged Node:

```
( (<form>, <valu>), {

    "props": {
        <name>: <valu>,
        ...
    },
    "tags": {
        "foo": <time>,
        "foo.bar": <time>,
    },
})
```

async addCronJob(*cdef*)

This API is deprecated.

Add a cron job to the cortex

A cron job is a persistently-stored item that causes storm queries to be run in the future. The specification for the times that the queries run can be one-shot or recurring.

Parameters

- **query** (*str*) – The storm query to execute in the future
- **reqs** (*Union[Dict[str, Union[int, List[int]]], List[Dict[...]]]*) – Either a dict of the fixed time fields or a list of such dicts. The keys are in the set ('year', 'month', 'dayofmonth', 'dayofweek', 'hour', 'minute'. The values must be positive integers, except for the key of 'dayofmonth' in which it may also be a negative integer which represents the number of days from the end of the month with -1 representing the last day of the month. All values may also be lists of valid values.
- **incunit** (*Optional[str]*) – A member of the same set as above, with an additional member 'day'. If is None (default), then the appointment is one-shot and will not recur.
- **incvals** (*Union[int, List[int]*) – A integer or a list of integers of the number of units

Returns (bytes):
An iden that can be used to later modify, query, and delete the job.

Notes

reqs must have fields present or incunit must not be None (or both) The incunit if not None it must be larger in unit size than all the keys in all reqs elements.

async addFeedData(*name*, *items*, *, *viewiden=None*)

async addForm(*formname*, *basetype*, *typeopts*, *typeinfo*)

Add an extended form to the data model.

Extended forms *must* begin with _

async addFormProp(*form*, *prop*, *tdef*, *info*)

Add an extended property to the given form.

Extended properties *must* begin with _

async addNode(*form*, *valu*, *props=None*)

Deprecated in 2.0.0.

async addNodeTag(*iden*, *tag*, *valu=(None, None)*)

This API is deprecated.

Add a tag to a node specified by iden.

Parameters

- **iden** (*str*) – A hex encoded node BUID.
- **tag** (*str*) – A tag string.
- **valu** (*tuple*) – A time interval tuple or (None, None).

async addNodes(*nodes*)

Add a list of packed nodes to the cortex.

Parameters
nodes (*list*) – [((form, valu), {'props':{}, 'tags':{}}), ...]

Yields
(tuple) – Packed node tuples ((form,valu), {'props': {}, 'tags':{}})

Deprecated in 2.0.0

addStormDmon(*ddef*)

async addStormPkg(*pkgdef*, *verify=False*)

async addTagProp(*name*, *tdef*, *info*)

Add a tag property to record data about tags on nodes.

async addUnivProp(*name*, *tdef*, *info*)

Add an extended universal property.

Extended properties *must* begin with _

addUserNotif(*useriden*, *mesgtype*, *mesgdata=None*)

bumpStormDmon(*iden*)

async callStorm(*text*, *opts=None*)

Return the value expressed in a return() statement within storm.

cloneLayer(*iden*, *ldef=None*)

async count(*text*, *opts=None*)

Count the number of nodes which result from a storm query.

Parameters

- **text** (*str*) – Storm query text.
- **opts** (*dict*) – Storm query options.

Returns
The number of nodes resulting from the query.

Return type
(int)

async delCronJob(*iden*)

This API is deprecated.

Delete a cron job

Parameters
iden (*bytes*) – The iden of the cron job to be deleted

async delForm(*formname*)

Remove an extended form from the data model.

async delFormProp(*form*, *name*)

Remove an extended property from the given form.

async delNodeProp(*iden*, *name*)

Delete a property from a single node. Deprecated in 2.0.0.

async delNodeTag(*iden*, *tag*)

Delete a tag from the node specified by iden. Deprecated in 2.0.0.

Parameters

- **iden** (*str*) – A hex encoded node BUID.
- **tag** (*str*) – A tag string.

async delStormCmd(*name*)

Remove a pure storm command from the cortex.

delStormDmon(*iden*)

async delStormPkg(*iden*)

async delTagProp(*name*)

Remove a previously added tag property.

async delUnivProp(*name*)

Remove an extended universal property.

delUserNotif(*indx*)

async disableCronJob(*iden*)

This API is deprecated.

Enable a cron job

Parameters

iden (*bytes*) – The iden of the cron job to be changed

disableMigrationMode()

disableStormDmon(*iden*)

async editCronJob(*iden*, *name*, *valu*)

Update a value in a cron definition.

async enableCronJob(*iden*)

This API is deprecated.

Enable a cron job

Parameters

iden (*bytes*) – The iden of the cron job to be changed

enableMigrationMode()

enableStormDmon(*iden*)

async eval(*text*, *opts=None*)

Evaluate a storm query and yield packed nodes.

NOTE: This API is deprecated as of 2.0.0 and will be removed in 3.0.0

async exportStorm(*text*, *opts=None*)

Execute a storm query and package nodes for export/import.

NOTE: This API yields nodes after an initial complete lift
in order to limit exported edges.

async feedFromAxon(*sha256*, *opts=None*)

Import a msgpack .nodes file from the axon.

async getAxonBytes(*sha256*)

async getAxonUpload()

getCoreInfo()

Return static generic information about the cortex including model definition

async getCoreInfoV2()

Return static generic information about the cortex including model definition

getCoreMods()

async getFeedFuncs()

Get a list of Cortex feed functions.

Notes

Each feed dictionary has the name of the feed function, the full docstring for the feed function, and the first line of the docstring broken out in their own keys for easy use.

Returns
A tuple of dictionaries.

Return type
tuple

async getModelDefs()

async getModelDict()

Return a dictionary which describes the data model.

Returns
A model description dictionary.

Return type
(dict)

async getPropNorm(*prop*, *valu*)

Get the normalized property value based on the Cortex data model.

Parameters

- **prop** (*str*) – The property to normalize.
- **valu** – The value to normalize.

Returns
A two item tuple, containing the normed value and the info dictionary.

Return type
(tuple)

Raises

- **s_exc.NoSuchProp** – If the prop does not exist.
- **s_exc.BadTypeValu** – If the value fails to normalize.

getStormDmon(*iden*)

getStormDmonLog(*iden*)

getStormDmons()

getStormPkg(*name*)

getStormPkgs()

async getStormVar(*name*, *default=None*)

async getTypeNorm(*name*, *valu*)

Get the normalized type value based on the Cortex data model.

Parameters

- **name** (*str*) – The type to normalize.
- **valu** – The value to normalize.

Returns

A two item tuple, containing the normed value and the info dictionary.

Return type

(tuple)

Raises

- **s_exc.NoSuchType** – If the type does not exist.
- **s_exc.BadTypeValu** – If the value fails to normalize.

getUserNotif(*indx*)

async iterFormRows(*layriden*, *form*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes of a single form, optionally (re)starting at startvalue

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **form** (*str*) – A form name
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns

AsyncIterator[Tuple(buid, valu)]

async iterPropRows(*layriden*, *form*, *prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular secondary property, optionally (re)starting at startvalue

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **form** (*str*) – A form name.

- **prop** (*str*) – A secondary property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterTagPropRows(*layriden*, *tag*, *prop*, *form=None*, *stortype=None*, *startvalu=None*)

Yields (buid, valu) that match a tag:prop, optionally (re)starting at startvalu.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **tag** (*str*) – tag name
- **prop** (*str*) – prop name
- **form** (*Optional[str]*) – optional form name
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterTagRows(*layriden*, *tag*, *form=None*, *starttupl=None*)

Yields (buid, (valu, form)) values that match a tag and optional form, optionally (re)starting at starttupl.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **tag** (*str*) – the tag to match
- **form** (*Optional[str]*) – if present, only yields buids of nodes that match the form.
- **starttupl** (*Optional[Tuple[buid, form]]*) – if present, (re)starts the stream of values there.

Returns
AsyncIterator[Tuple(buid, (valu, form))]

Note: This yields (buid, (tagvalu, form)) instead of just buid, valu in order to allow resuming an interrupted call by feeding the last value retrieved into starttupl

---

async iterUnivRows(*layriden*, *prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular universal property, optionally (re)starting at startvalue

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **prop** (*str*) – A universal property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

`iterUserNotifs`(*useriden*, *size=None*)

`async listCronJobs`()

This API is deprecated.

Get information about all the cron jobs accessible to the current user

`async popStormVar`(*name*, *default=None*)

`async reqValidStorm`(*text*, *opts=None*)

Parse a Storm query to validate it.

Parameters

- **text** (*str*) – The text of the Storm query to parse.
- **opts** (*dict*) – A Storm options dictionary.

Returns
If the query is valid.

Return type
True

Raises
BadSyntaxError – If the query is invalid.

`saveLayerNodeEdits`(*layriden*, *edits*, *meta*)

`async setNodeProp`(*iden*, *name*, *valu*)

Set a property on a single node. Deprecated in 2.0.0.

`async setStormCmd`(*cdef*)

Set the definition of a pure storm command in the cortex.

`async setStormVar`(*name*, *valu*)

`async spliceHistory`()

This API is deprecated.

Yield splices backwards from the end of the splice log.

Will only return the user's own splices unless they are an admin.

`splices`(*offs=None*, *size=None*, *layriden=None*)

This API is deprecated.

Return the list of splices at the given offset.

`splicesBack`(*offs=None*, *size=None*)

This API is deprecated.

Return the list of splices backwards from the given offset.

`stat`()

`async storm`(*text*, *opts=None*)

Evaluate a storm query and yield result messages.

Yields
((str,dict)) – Storm messages.

async syncIndexEvents(*matchdef*, *offsdict=None*, *wait=True*)

async syncLayerNodeEdits(*offs*, *layriden=None*, *wait=True*)

Yield (indx, mesg) nodeedit sets for the given layer beginning at offset.

Once caught up, this API will begin yielding nodeedits in real-time. The generator will only terminate on network disconnect or if the consumer falls behind the max window size of 10,000 nodeedit messages.

async syncLayersEvents(*offsdict=None*, *wait=True*)

async updateCronJob(*iden*, *query*)

This API is deprecated.

Change an existing cron job's query

Parameters

iden (*bytes*) – The iden of the cron job to be changed

async watch(*wdef*)

This API is deprecated.

Hook cortex/view/layer watch points based on a specified watch definition.

Example

wdef = { 'tags': ['foo.bar', 'baz.*'] }

async for mesg in core.watch(wdef):
dostuff(mesg)

watchAllUserNotifs(*offs=None*)

class synapse.cortex.**Cortex**

Bases: *OAuthMixin*, *Cell*

A Cortex implements the synapse hypergraph.

The bulk of the Cortex API lives on the Snap() object which can be obtained by calling Cortex.snap() in a with block. This allows callers to manage transaction boundaries explicitly and dramatically increases performance.

async addCoreQueue(*name*, *info*)

async addCronJob(*cdef*)

Add a cron job to the cortex. Convenience wrapper around agenda.add

A cron job is a persistently-stored item that causes storm queries to be run in the future. The specification for the times that the queries run can be one-shot or recurring.

Parameters

- **query** (*str*) – The storm query to execute in the future
- **reqs** (*Union[Dict[str, Union[int, List[int]]], List[Dict[...]]]*) – Either a dict of the fixed time fields or a list of such dicts. The keys are in the set ('year', 'month', 'dayofmonth', 'dayofweek', 'hour', 'minute'. The values must be positive integers, except for the key of 'dayofmonth' in which it may also be a negative integer which represents the number of days from the end of the month with -1 representing the last day of the month. All values may also be lists of valid values.
- **incunit** (*Optional[str]*) – A member of the same set as above, with an additional member 'day'. If is None (default), then the appointment is one-shot and will not recur.

- **incvals** (*Union[int, List[int]*) – A integer or a list of integers of the number of units

Returns (bytes):
An iden that can be used to later modify, query, and delete the job.

Notes

reqs must have fields present or incunit must not be None (or both) The incunit if not None it must be larger in unit size than all the keys in all reqs elements. Non-recurring jobs may also have a req of 'now' which will cause the job to also execute immediately.

async addFeedData(*name*, *items*, *, *viewiden=None*)

Add data using a feed/parser function.

Parameters

- **name** (*str*) – The name of the feed record format.
- **items** (*list*) – A list of items to ingest.
- **viewiden** (*str*) – The iden of a view to use. If a view is not specified, the default view is used.

async addForm(*formname*, *basetype*, *typeopts*, *typeinfo*)

async addFormProp(*form*, *prop*, *tdef*, *info*)

async addLayer(*ldef=None*, *nexs=True*)

Add a Layer to the cortex.

Parameters

- **ldef** (*Optional[Dict]*) – layer configuration
- **nexs** (*bool*) – whether to record a nexus transaction (internal use only)

async addLayrPull(*layriden*, *pdef*)

async addLayrPush(*layriden*, *pdef*)

async addNode(*user*, *form*, *valu*, *props=None*)

async addNodeTag(*user*, *iden*, *tag*, *valu=(None, None)*)

Add a tag to a node specified by iden.

Parameters

- **iden** (*str*) – A hex encoded node BUID.
- **tag** (*str*) – A tag string.
- **valu** (*tuple*) – A time interval tuple or (None, None).

async addNodes(*nodedefs*, *view=None*)

Quickly add/modify a list of nodes from node definition tuples. This API is the simplest/fastest way to add nodes, set node props, and add tags to nodes remotely.

Parameters
nodedefs (*list*) – A list of node definition tuples. See below.

A node definition tuple is defined as:

((form, valu), {'props':{}, 'tags':{})

The "props" or "tags" keys may be omitted.

addRuntLift(*prop*, *func*)

Register a runt lift helper for a given prop.

Parameters

- **prop** (*str*) – Full property name for the prop to register the helper for.
- **func** –

Returns
None.

Return type
None

addRuntPropDel(*full*, *func*)

Register a prop set helper for a runt form

addRuntPropSet(*full*, *func*)

Register a prop set helper for a runt form

addStormCmd(*ctor*)

Add a synapse.lib.storm.Cmd class to the cortex.

async addStormDmon(*ddef*)

Add a storm dmon task.

async addStormGraph(*gdef*, *user=None*)

addStormLib(*path*, *ctor*)

async addStormMacro(*mdef*, *user=None*)

async addStormPkg(*pkgdef*, *verify=False*)

Add the given storm package to the cortex.

This will store the package for future use.

async addStormSvc(*sdef*)

Add a registered storm service to the cortex.

async addTagProp(*name*, *tdef*, *info*)

async addUnivProp(*name*, *tdef*, *info*)

async addUserNotif(*useriden*, *mesgtype*, *mesgdata=None*)

async addView(*vdef*, *nexs=True*)

async bumpStormDmon(*iden*)

async callStorm(*text*, *opts=None*)

cellapi

alias of *CoreApi*

async cloneLayer(*iden*, *ldef=None*)

Make a copy of a Layer in the cortex.

Parameters

- **iden** (*str*) – Layer iden to clone
- **ldef** (*Optional[Dict]*) – Layer configuration overrides

Note: This should only be called with a reasonably static Cortex due to possible races.

```
confbase = {'_log_conf': {'description': 'Opaque structure used for logging by
spawned processes.', 'hideconf': True, 'type': 'object'}, 'aha:admin':
{'description': 'An AHA client certificate CN to register as a local admin user.',
'type': 'string'}, 'aha:leader': {'description': 'The AHA service name to claim
as the active instance of a storm service.', 'type': 'string'}, 'aha:name':
{'description': 'The name of the cell service in the aha service registry.',
'type': 'string'}, 'aha:network': {'description': 'The AHA service network. This
makes aha:name/aha:leader relative names.', 'type': 'string'}, 'aha:provision':
{'description': 'The telepath URL of the aha provisioning service.', 'items':
{'type': 'string'}, 'type': ['string', 'array']}, 'aha:registry': {'description':
'The telepath URL of the aha service registry.', 'items': {'type': 'string'},
'type': ['string', 'array']}, 'aha:svcinfo': {'description': 'An AHA svcinfo
object. If set, this overrides self discovered Aha service information.',
'hidecmdl': True, 'hidedocs': True, 'properties': {'urlinfo': {'properties':
{'host': {'type': 'string'}, 'port': {'type': 'integer'}, 'schema': {'type':
'string'}}, 'required': ('host', 'port', 'scheme'), 'type': 'object'}},
'required': ('urlinfo',), 'type': 'object'}, 'aha:user': {'description': 'The
username of this service when connecting to others.', 'type': 'string'},
'auth:anon': {'description': 'Allow anonymous telepath access by mapping to the
given user name.', 'type': 'string'}, 'auth:conf': {'description': 'Extended
configuration to be used by an alternate auth constructor.', 'hideconf': True,
'type': 'object'}, 'auth:ctor': {'description': 'Allow the construction of the
cell auth object to be hooked at runtime.', 'hideconf': True, 'type': 'string'},
'auth:passwd': {'description': 'Set to <passwd> (local only) to bootstrap the root
user password.', 'type': 'string'}, 'backup:dir': {'description': 'A directory
outside the service directory where backups will be saved. Defaults to ./backups in
the service storage directory.', 'type': 'string'}, 'cell:ctor': {'description':
'An optional python path to the Cell class. Used by stemcell.', 'hideconf': True,
'type': 'string'}, 'cell:guid': {'description': 'An optional hard-coded GUID to
store as the permanent GUID for the service.', 'hideconf': True, 'type':
'string'}, 'dmon:listen': {'description': 'A config-driven way to specify the
telepath bind URL.', 'type': ['string', 'null']}, 'https:headers': {'description':
'Headers to add to all HTTPS server responses.', 'hidecmdl': True, 'type':
'object'}, 'https:parse:proxy:remoteip': {'default': False, 'description':
'Enable the HTTPS server to parse X-Forwarded-For and X-Real-IP headers to determine
requester IP addresses.', 'type': 'boolean'}, 'https:port': {'description': 'A
config-driven way to specify the HTTPS port.', 'type': ['integer', 'null']},
'inaugural': {'description': 'Data used to drive configuration of the service upon
first startup.', 'hidedocs': True, 'properties': {'roles': {'items':
{'additionalProperties': False, 'properties': {'name': {'pattern':
'^(?!all$).+$', 'type': 'string'}, 'rules': {'items': {'items': [{'type':
'boolean'}, {'type': 'array', 'items': {'type': 'string'}}], 'maxItems': 2,
'minItems': 2, 'type': 'array'}, 'type': 'array'}}, 'required': ['name'],
'type': 'object'}, 'type': 'array'}, 'users': {'items': {'additionalProperties':
False, 'properties': {'admin': {'default': False, 'type': 'boolean'}, 'email':
{'type': 'string'}, 'name': {'pattern': '^(?!root$).+$', 'type': 'string'},
'roles': {'items': {'type': 'string'}, 'type': 'array'}, 'rules': {'items':
{'items': [{'type': 'boolean'}, {'type': 'array', 'items': {'type':
'string'}}], 'maxItems': 2, 'minItems': 2, 'type': 'array'}, 'type': 'array'}},
'required': ['name'], 'type': 'object'}, 'type': 'array'}}, 'type': 'object'},
'limit:disk:free': {'default': 5, 'description': 'Minimum disk free space
percentage before setting the cell read-only.', 'maximum': 100, 'minimum': 0,
'type': ['integer', 'null']}, 'mirror': {'description': 'A telepath URL for our
upstream mirror (we must be a backup!).', 'hidecmdl': False, 'hidedocs': False,
'type': ['string', 'null']}, 'nexslog:async': {'default': False, 'description':
'(Experimental) Map the nexus log LMDB instance with map_async=True.', 'hidecmdl':
True, 'hidedocs': True, 'type': 'boolean'}, 'nexslog:en': {'default': True,
'description': 'Record all changes to a stream file on disk. Required for mirroring
(on both sides).', 'type': 'boolean'}, 'onboot:optimize': {'default': False,
'description': 'Delay startup to optimize LMDB databases during boot to recover
```

confdefs = {'axon': {'description': 'A telepath URL for a remote axon.', 'type': 'string'}, 'cron:enable': {'default': True, 'description': 'Enable cron jobs running.', 'type': 'boolean'}, 'http:proxy': {'description': 'An aiohttp-socks compatible proxy URL to use storm HTTP API.', 'type': 'string'}, 'jsonstor': {'description': 'A telepath URL for a remote jsonstor.', 'type': 'string'}, 'layer:lmdb:map_async': {'default': True, 'description': 'Set the default lmdb:map_async value in LMDB layers.', 'type': 'boolean'}, 'layer:lmdb:max_replay_log': {'default': 10000, 'description': 'Set the max size of the replay log for all layers.', 'type': 'integer'}, 'layers:lockmemory': {'default': False, 'description': 'Should new layers lock memory for performance by default.', 'type': 'boolean'}, 'layers:logedits': {'default': True, 'description': 'Whether nodeedits are logged in each layer.', 'type': 'boolean'}, 'max:nodes': {'description': 'Maximum number of nodes which are allowed to be stored in a Cortex.', 'hidecmdl': True, 'minimum': 1, 'type': 'integer'}, 'modules': {'default': [], 'description': 'A list of module classes to load.', 'type': 'array'}, 'provenance:en': {'default': False, 'description': 'This no longer does anything.', 'hideconf': True, 'type': 'boolean'}, 'storm:interface:scrape': {'default': True, 'description': 'Enable Storm scrape interfaces when using $lib.scrape APIs.', 'type': 'boolean'}, 'storm:interface:search': {'default': True, 'description': 'Enable Storm search interfaces for lookup mode.', 'type': 'boolean'}, 'storm:log': {'default': False, 'description': 'Log storm queries via system logger.', 'type': 'boolean'}, 'storm:log:level': {'default': 'INFO', 'description': 'Logging log level to emit storm logs at.', 'type': ['integer', 'string']}, 'tls:ca:dir': {'description': 'An optional directory of CAs which are added to the TLS CA chain for Storm HTTP API calls.', 'type': 'string'}, 'trigger:enable': {'default': True, 'description': 'Enable triggers running.', 'type': 'boolean'}}

async coreQueueCull(*name*, *offs*)

async coreQueueGet(*name*, *offs=0*, *cull=True*, *wait=False*)

async coreQueueGets(*name*, *offs=0*, *cull=True*, *wait=False*, *size=None*)

async coreQueuePop(*name*, *offs*)

async coreQueuePuts(*name*, *items*)

async coreQueueSize(*name*)

async count(*text*, *opts=None*)

async delCoreQueue(*name*)

async delCronJob(*iden*)

Delete a cron job

Parameters

iden (*bytes*) – The iden of the cron job to be deleted

async delForm(*formname*)

async delFormProp(*form*, *prop*)

async delJsonObj(*path*)

async delJsonObjProp(*path*, *prop*)

async delLayer(*iden*)

async delLayrPull(*layriden*, *pulliden*)

async delLayrPush(*layriden*, *pushiden*)

async delNodeTag(*user*, *iden*, *tag*)

Delete a tag from the node specified by iden.

Parameters

- **iden** (*str*) – A hex encoded node BUID.
- **tag** (*str*) – A tag string.

async delStormCmd(*name*)

Remove a previously set pure storm command.

async delStormDmon(*iden*)

Stop and remove a storm dmon.

async delStormGraph(*iden*, *user=None*)

async delStormMacro(*name*, *user=None*)

async delStormPkg(*name*)

async delStormSvc(*iden*)

async delTagModel(*tagname*)

Delete all the model specification properties for a tag.

Parameters

tagname (*str*) – The name of the tag.

async delTagProp(*name*)

async delUnivProp(*prop*)

async delUserNotif(*indx*)

async delView(*iden*)

async disableCronJob(*iden*)

Enable a cron job

Parameters

iden (*bytes*) – The iden of the cron job to be changed

async disableStormDmon(*iden*)

async editCronJob(*iden*, *name*, *valu*)

Modify a cron job definition.

async enableCronJob(*iden*)

Enable a cron job

Parameters

iden (*bytes*) – The iden of the cron job to be changed

async enableStormDmon(*iden*)

async eval(*text*, *opts=None*)

Evaluate a storm query and yield packed nodes.

NOTE: This API is deprecated as of 2.0.0 and will be removed in 3.0.0

async exportStorm(*text*, *opts=None*)

async exportStormToAxon(*text*, *opts=None*)

async feedFromAxon(*sha256*, *opts=None*)

async getAxon()

async getCellApi(*link*, *user*, *path*)

Get an instance of the telepath Client object for a given user, link and path.

Parameters

- **link** (*s_link.Link*) – The link object.
- **user** (*s_hive.HiveUser*) – The heavy user object.
- **path** (*str*) – The path requested.

Notes

This defaults to the self.cellapi class. Implementors may override the default class attribute for cellapi to share a different interface.

Returns
The shared object for this cell.

Return type
object

getCoreInfo()

This API is deprecated.

async getCoreInfoV2()

getCoreMod(*name*)

getCoreMods()

async getCoreQueue(*name*)

getDataModel()

async getDeprLocks()

Return a dictionary of deprecated properties and their lock status.

getFeedFunc(*name*)

Get a data ingest function.

async getFeedFuncs()

async getFormCounts()

Return total form counts for all existing layers

async getJsonObj(*path*)

async getJsonObjProp(*path*, *prop*)

async getJsonObjs(*path*)

getLayer(*iden=None*)

Get a Layer object.

Parameters
iden (*str*) – The layer iden to retrieve.

Returns
A Layer object.

Return type
Layer

async getLayerDef(*iden=None*)

async getLayerDefs()

async getModelDefs()

async getModelDict()

async getNodeByNdef(*ndef*, *view=None*)

Return a single Node() instance by (form,valu) tuple.

async getPropNorm(*prop*, *valu*)

Get the normalized property value based on the Cortex data model.

Parameters

- **prop** (*str*) – The property to normalize.
- **valu** – The value to normalize.

Returns
A two item tuple, containing the normed value and the info dictionary.

Return type
(tuple)

Raises

- **s_exc.NoSuchProp** – If the prop does not exist.
- **s_exc.BadTypeValu** – If the value fails to normalize.

getStormCmd(*name*)

getStormCmds()

async getStormDmon(*iden*)

async getStormDmonLog(*iden*)

async getStormDmons()

async getStormDocs()

Get a struct containing the Storm Types documentation.

Returns
A Dictionary of storm documentation information.

Return type
dict

async getStormGraph(*iden*, *user=None*)

async getStormGraphs(*user=None*)

async getStormIfaces(*name*)

getStormLib(*path*)

getStormMacro(*name*, *user=None*)

async getStormMacros(*user=None*)

async getStormMod(*name*, *reqvers=None*)

async getStormMods()

async getStormPkg(*name*)

async getStormPkgs()

async getStormQuery(*text*, *mode='storm'*)

getStormRuntime(*query*, *opts=None*)

getStormSvc(*name*)

getStormSvcs()

async getStormVar(*name*, *default=None*)

async getTagModel(*tagname*)

Retrieve the tag model specification for a tag.

Returns
The tag model specification or None.

Return type
(dict)

async getTagPrune(*tagname*)

async getTypeNorm(*name*, *valu*)

Get the normalized type value based on the Cortex data model.

Parameters

- **name** (*str*) – The type to normalize.
- **valu** – The value to normalize.

Returns
A two item tuple, containing the normed value and the info dictionary.

Return type
(tuple)

Raises

- **s_exc.NoSuchType** – If the type does not exist.
- **s_exc.BadTypeValu** – If the value fails to normalize.

async getUserNotif(*indx*)

getView(*iden=None*, *user=None*)

Get a View object.

Parameters
iden (*str*) – The View iden to retrieve.

Returns
A View object.

Return type
View

async getViewDef(*iden*)

async getViewDefs(*deporder=False*)

async hasJsonObj(*path*)

hiveapi

alias of *HiveApi*

async initServiceActive()

async initServicePassive()

async initServiceRuntime()

async initServiceStorage()

isTagValid(*tagname*)

Check if a tag name is valid according to tag model regular expressions.

Returns
True if the tag is valid.

Return type
(bool)

async itemsStormVar()

async iterFormRows(*layriden*, *form*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes of a single form, optionally (re)starting at startvalu.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **form** (*str*) – A form name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterPropRows(*layriden*, *form*, *prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular secondary property, optionally (re)starting at startvalu.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **form** (*str*) – A form name.
- **prop** (*str*) – A universal property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterTagPropRows(*layriden*, *tag*, *prop*, *form=None*, *stortype=None*, *startvalu=None*)

Yields (buid, valu) that match a tag:prop, optionally (re)starting at startvalu.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **tag** (*str*) – tag name
- **prop** (*str*) – prop name
- **form** (*Optional[str]*) – optional form name
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns
AsyncIterator[Tuple(buid, valu)]

async iterTagRows(*layriden*, *tag*, *form=None*, *starttupl=None*)

Yields (buid, (valu, form)) values that match a tag and optional form, optionally (re)starting at starttupl.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **tag** (*str*) – the tag to match
- **form** (*Optional[str]*) – if present, only yields buids of nodes that match the form.
- **starttupl** (*Optional[Tuple[buid, form]]*) – if present, (re)starts the stream of values there.

Returns
AsyncIterator[Tuple(buid, (valu, form))]

Note: This yields (buid, (tagvalu, form)) instead of just buid, valu in order to allow resuming an interrupted call by feeding the last value retrieved into starttupl

---

async iterUnivRows(*layriden*, *prop*, *stortype=None*, *startvalu=None*)

Yields buid, valu tuples of nodes with a particular universal property, optionally (re)starting at startvalu.

Parameters

- **layriden** (*str*) – Iden of the layer to retrieve the nodes
- **prop** (*str*) – A universal property name.
- **stortype** (*Optional[int]*) – a STOR_TYPE_* integer representing the type of form:prop
- **startvalu** (*Any*) – The value to start at. May only be not None if stortype is not None.

Returns

AsyncIterator[Tuple(buid, valu)]

async iterUserNotifs(*useriden*, *size=None*)

layerapi

alias of *LayerApi*

async classmethod layrctor(**args*, ***kwargs*)

async listCoreQueues()

async listCronJobs()

Get information about all the cron jobs accessible to the current user

listLayers()

async listTagModel()

Retrieve a list of the tag model specifications.

Returns

A list of tag model specification tuples.

Return type

([(str, dict), ...])

listViews()

async loadCoreModule(*ctor*, *conf=None*)

Load a single cortex module with the given ctor and conf.

Parameters

- **ctor** (*str*) – The python module class path
- **conf** (*dict*) – Config dictionary for the module

async loadStormPkg(*pkgdef*)

Load a storm package into the storm library for this cortex.

NOTE: This will *not* persist the package (allowing service dynamism).

async modStormGraph(*iden*, *info*, *user=None*)

async modStormMacro(*name*, *info*, *user=None*)

async moveCronJob(*useriden*, *croniden*, *viewiden*)

async nodes(*text*, *opts=None*)

A simple non-streaming way to return a list of nodes.

offTagAdd(*name*, *func*)

Unregister a callback for tag addition.

Parameters

- **name** (*str*) – The name of the tag or tag glob.
- **func** (*function*) – The callback func(node, tagname, tagval).

offTagDel(*name*, *func*)

Unregister a callback for tag deletion.

Parameters

- **name** (*str*) – The name of the tag or tag glob.
- **func** (*function*) – The callback func(node, tagname, tagval).

onTagAdd(*name*, *func*)

Register a callback for tag addition.

Parameters

- **name** (*str*) – The name of the tag or tag glob.
- **func** (*function*) – The callback func(node, tagname, tagval).

onTagDel(*name*, *func*)

Register a callback for tag deletion.

Parameters

- **name** (*str*) – The name of the tag or tag glob.
- **func** (*function*) – The callback func(node, tagname, tagval).

async popStormVar(*name*, *default=None*)

async popTagModel(*tagname*, *name*)

Pop a property from the model specification of a tag.

Parameters

- **tagname** (*str*) – The name of the tag.
- **name** (*str*) – The name of the specification property.

Returns

The current value of the property.

Return type

(object)

reqStormMacro(*name*, *user=None*)

async reqValidStorm(*text*, *opts=None*)

Parse a storm query to validate it.

Parameters

- **text** (*str*) – The text of the Storm query to parse.
- **opts** (*dict*) – A Storm options dictionary.

Returns
If the query is valid.

Return type
True

Raises
BadSyntaxError – If the query is invalid.

async reqValidStormGraph(*gdef*)

async runLayrPull(*layr*, *pdef*)

async runLayrPush(*layr*, *pdef*)

async runRuntLift(*full*, *valu=None*, *cmpr=None*, *view=None*)
Execute a runt lift function.

Parameters

- **full** (*str*) – Property to lift by.
- **valu** –
- **cmpr** –

Returns

Yields bytes, list tuples where the list contains a series of
key/value pairs which are used to construct a Node object.

Return type
bytes, list

async runRuntPropDel(*node*, *prop*)

async runRuntPropSet(*node*, *prop*, *valu*)

async runStormDmon(*iden*, *ddef*)

async runStormSvcEvent(*iden*, *name*)

async saveLayerNodeEdits(*layriden*, *edits*, *meta*)

async setDeprLock(*name*, *locked*)

setFeedFunc(*name*, *func*)
Set a data ingest function.

def func(snap, items):
loaditems…

async setJsonObj(*path*, *item*)

async setJsonObjProp(*path*, *prop*, *item*)

async setStormCmd(*cdef*)

async setStormGraphPerm(*gden*, *scope*, *iden*, *level*, *user=None*)

async setStormMacroPerm(*name*, *scope*, *iden*, *level*, *user=None*)

async setStormSvcEvents(*iden*, *edef*)

Set the event callbacks for a storm service. Extends the sdef dict.

Parameters

- **iden** (*str*) – The service iden.
- **edef** (*dict*) – The events definition.

Notes

The edef is formatted like the following:

```
{
    <name> : {
        'storm': <storm>
    }
}
```

where name is one of the following items:

add

Run the given storm ‘*before* the service is first added (a la service.add), but not on a reconnect.

del

Run the given storm *after* the service is removed (a la service.del), but not on a disconnect.

Returns
An updated storm service definition dictionary.

Return type
dict

async setStormVar(*name*, *valu*)

async setTagModel(*tagname*, *name*, *valu*)

Set a model specification property for a tag.

Parameters

- **tagname** (*str*) – The name of the tag.
- **name** (*str*) – The name of the property.
- **valu** (*object*) – The value of the property.

Tag Model Properties:
regex - A list of None or regular expression strings to match each tag level. prune - A number that determines how many levels of pruning are desired.

Examples

await core.setTagModel("cno.cve", "regex", (None, None, "[0-9]{4}", "[0-9]{5}"))

async setUserLocked(*iden*, *locked*)

async setViewLayers(*layers*, *iden=None*)

Parameters

- **layers** (*[str]*) – A top-down list of of layer guids
- **iden** (*str*) – The view iden (defaults to default view).

async snap(*user=None*, *view=None*)

Return a transaction object for the default view.

Parameters

- **user** (*str*) – The user to get the snap for.
- **view** (View) – View object to use when making the snap.

Notes

This must be used as an asynchronous context manager.

Returns
A Snap object for the view.

Return type
s_snap.Snap

async spliceHistory(*user*)

Yield splices backwards from the end of the nodeedit log.

Will only return user's own splices unless they are an admin.

async stat()

async storm(*text*, *opts=None*)

async stormlist(*text*, *opts=None*)

async syncIndexEvents(*matchdef*, *offsdict=None*, *wait=True*)

Yield (offs, layriden, <STYPE>, <item>) tuples from the nodeedit logs of all layers starting from the given nexus/layer offset (they are synchronized). Only edits that match the filter in matchdef will be yielded, plus EDIT_PROGRESS (see layer.syncIndexEvents) messages.

The format of the 4th element of the tuple depends on STYPE. STYPE is one of the following constants:

SYNC_LAYR_ADD: item is an empty tuple () SYNC_LAYR_DEL: item is an empty tuple () SYNC_NODEEDIT: item is (buid, form, ETYPE, VALS, META)) or (None, None, s_layer.EDIT_PROGRESS, (), ())

For edits in the past, events are yielded in offset order across all layers. For current data (wait=True), events across different layers may be emitted slightly out of offset order.

Note: Will not yield any values from layers created with logedits disabled

Parameters

- **matchdef** (*Dict[str, Sequence[str]]*) – a dict describing which events are yielded. See layer.syncIndexEvents for matchdef specification.
- **offsdict** (*Optional(Dict[str,int])*) – starting nexus/editlog offset by layer iden. Defaults to 0 for unspecified layers or if offsdict is None.
- **wait** (*bool*) – whether to pend and stream value until this layer is fini'd

async syncLayerNodeEdits(*iden*, *offs*, *wait=True*)

Yield (offs, mesg) tuples for nodeedits in a layer.

async syncLayersEvents(*offsdict=None*, *wait=True*)

Yield (offs, layriden, STYP, item, meta) tuples for nodeedits for *all* layers, interspersed with add/del layer messages.

STYP is one of the following constants:

SYNC_NODEEDITS: item is a nodeedits (buid, form, edits) SYNC_LAYR_ADD: A layer was added (item and meta are empty) SYNC_LAYR_DEL: A layer was deleted (item and meta are empty)

Parameters

- **offsdict** (*Optional(Dict[str,int])*) – starting nexus/editlog offset by layer iden. Defaults to 0 for unspecified layers or if offsdict is None.
- **wait** (*bool*) – whether to pend and stream value until this layer is fini'd

async updateCronJob(*iden*, *query*)

Change an existing cron job's query

Parameters

iden (*bytes*) – The iden of the cron job to be changed

async verifyStormPkgDeps(*pkgdef*)

viewapi

alias of *ViewApi*

async classmethod viewctor(**args*, ***kwargs*)

async waitStormSvc(*name*, *timeout=None*)

async watch(*wdef*)

Hook cortex/view/layer watch points based on a specified watch definition. (see CoreApi.watch() docs for details)

async watchAllUserNotifs(*offs=None*)

watcher(*wdef*)

synapse.cortex.**cmprkey_buid**(*x*)

synapse.cortex.**cmprkey_indx**(*x*)

synapse.cortex.**getTempCortex**(*mods=None*)

Get a proxy to a cortex backed by a temporary directory.

Parameters

mods (*list*) – A list of modules which are loaded into the cortex.

Notes

The cortex and temporary directory are town down on exit. This should only be called from synchronous code.

Returns
Proxy to the cortex.

synapse.cortex.**stormlogger = <Logger synapse.storm (WARNING)>**

A Cortex implements the synapse hypergraph object.

async synapse.cortex.**wrap_liftgenr**(*iden*, *genr*)

10.1.7 synapse.cryotank module

class synapse.cryotank.**CryoApi**

Bases: *CellApi*

The CryoCell API as seen by a telepath proxy.

This is the API to reference for remote CryoCell use.

delete(*name*)

async init(*name*, *conf=None*)

async last(*name*)

async list()

async metrics(*name*, *offs*, *size=None*)

async offset(*name*, *iden*)

async puts(*name*, *items*, *seqn=None*)

async rows(*name*, *offs*, *size*, *iden=None*)

async slice(*name*, *offs*, *size=None*, *iden=None*)

class synapse.cryotank.**CryoCell**

Bases: *Cell*

cellapi

alias of *CryoApi*

async delete(*name*)

async getCellApi(*link*, *user*, *path*)

Get an instance of the telepath Client object for a given user, link and path.

Parameters

- **link** (*s_link.Link*) – The link object.
- **user** (*s_hive.HiveUser*) – The heavy user object.
- **path** (*str*) – The path requested.

Notes

This defaults to the self.cellapi class. Implementors may override the default class attribute for cellapi to share a different interface.

Returns
The shared object for this cell.

Return type
object

classmethod getEnvPrefix()

Get a list of envar prefixes for config resolution.

async init(*name*, *conf=None*)

Generate a new CryoTank with a given name or get an reference to an existing CryoTank.

Parameters
name (*str*) – Name of the CryoTank.

Returns
A CryoTank instance.

Return type
CryoTank

async list()

Get a list of (name, info) tuples for the CryoTanks.

Returns
A list of tufos.

Return type
list

tankapi

alias of *TankApi*

class synapse.cryotank.CryoTank

Bases: *Base*

A CryoTank implements a stream of structured data.

getOffset(*iden*)

async iden()

async info()

Returns information about the CryoTank instance.

Returns
A dict containing items and metrics indexes.

Return type
dict

last()

Return an (offset, item) tuple for the last element in the tank (or None).

async **metrics**(*offs*, *size=None*)

Yield metrics rows starting at offset.

Parameters

- **offs** (*int*) – The index offset.
- **size** (*int*) – The maximum number of records to yield.

Yields

((int, dict)) – An index offset, info tuple for metrics.

async **puts**(*items*, *seqn=None*)

Add the structured data from items to the CryoTank.

Parameters

- **items** (*list*) – A list of objects to store in the CryoTank.
- **seqn** (*iden, offs*) – An iden / offset pair to record.

Returns

The ending offset of the items or seqn.

Return type

int

async **rows**(*offs*, *size=None*, *iden=None*)

Yield a number of raw items from the CryoTank starting at a given offset.

Parameters

- **offs** (*int*) – The index of the desired datum (starts at 0)
- **size** (*int*) – The max number of items to yield.

Yields

((indx, bytes)) – Index and msgpacked bytes.

setOffset(*iden*, *offs*)

async **slice**(*offs*, *size=None*, *iden=None*)

Yield a number of items from the CryoTank starting at a given offset.

Parameters

- **offs** (*int*) – The index of the desired datum (starts at 0)
- **size** (*int*) – The max number of items to yield.

Yields

((index, object)) – Index and item values.

class synapse.cryotank.**TankApi**

Bases: *CellApi*

async **iden**()

async **metrics**(*offs*, *size=None*)

async **offset**(*iden*)

async **puts**(*items*, *seqn=None*)

async **slice**(*offs*, *size=None*, *iden=None*)

10.1.8 synapse.daemon module

class synapse.daemon.**AsyncGenr**

Bases: *Share*

typename = 'genr'

class synapse.daemon.**Daemon**

Bases: *Base*

async getSessInfo()

async listen(*url*, ***opts*)

Bind and listen on the given host/port with possible SSL.

Parameters

- **host** (*str*) – A hostname or IP address.
- **port** (*int*) – The TCP port to bind.

async setReady(*ready*)

share(*name*, *item*)

Share an object via the telepath protocol.

Parameters

- **name** (*str*) – Name of the shared object
- **item** (*object*) – The object to share over telepath.

class synapse.daemon.**Genr**

Bases: *Share*

typename = 'genr'

class synapse.daemon.**Sess**

Bases: *Base*

getSessItem(*name*)

pack()

popSessItem(*name*)

setSessItem(*name*, *item*)

async synapse.daemon.**t2call**(*link*, *meth*, *args*, *kwargs*)

Call the given `meth(*args, **kwargs)` and handle the response to provide telepath task v2 events to the given link.

10.1.9 synapse.datamodel module

An API to assist with the creation and enforcement of cortex data models.

class synapse.datamodel.**Edge**(*modl*, *edgetype*, *edgeinfo*)

Bases: object

pack()

class synapse.datamodel.**Form**(*modl*, *name*, *info*)

Bases: object

The Form class implements data model logic for a node form.

delProp(*name*)

getFormDef()

getRefsOut()

getStorNode(*form*)

offAdd(*func*)

Unregister a callback for tag addition.

Parameters

- **name** (*str*) – The name of the tag.
- **func** (*function*) – The callback func(node)

onAdd(*func*)

Add a callback for adding this type of node.

The callback is executed after node construction.

Parameters

func (*function*) – A callback func(node)

def func(xact, node):

dostuff()

onDel(*func*)

pack()

prop(*name: str*)

Return a secondary property for this form by relative prop name.

Parameters

name (*str*) – The relative property name.

Returns

The property or None.

Return type

(*synapse.datamodel.Prop*)

setProp(*name*, *prop*)

async wasAdded(*node*)

Fire the onAdd() callbacks for node creation.

async wasDeleted(*node*)

Fire the onDel() callbacks for node deletion.

class synapse.datamodel.**Model**

Bases: `object`

The data model used by a Cortex hypergraph.

addBaseType(*item*)

Add a Type instance to the data model.

addDataModels(*mods*)

Add a list of (name, mdef) tuples.

A model definition (mdef) is structured as follows:

```
{
    "ctors":(
        ('name', 'class.path.ctor', {}, {'doc': 'The foo thing.'}),
    ),

    "types":(
        ('name', ('basetype', {typeopts}), {info}),
    ),

    "forms":(
        (formname, (typename, typeopts), {info}, (
            (propname, (typename, typeopts), {info}),
        )),
    ),
    "univs":(
        (propname, (typename, typeopts), {info}),
    )
    "tagprops":(
        (tagpropname, (typename, typeopts), {info}),
    )
    "interfaces":(
        (ifacename, {
            'props': ((propname, (typename, typeopts), {info}),),
            'doc': docstr,
            'interfaces': (ifacename,)
        }),
    )
}
```

Parameters

mods (*list*) – The list of tuples.

Returns

None

addEdge(*edgetype*, *edgeinfo*)

addForm(*formname*, *forminfo*, *propdefs*)

addFormProp(*formname*, *propname*, *tdef*, *info*)

addIface(*name*, *info*)

addTagProp(*name*, *tdef*, *info*)

addType(*typename*, *basename*, *typeopts*, *typeinfo*)

addUnivProp(*name*, *tdef*, *info*)

delForm(*formname*)

delFormProp(*formname*, *propname*)

delTagProp(*name*)

delType(*typename*)

delUnivProp(*propname*)

form(*name*)

getArrayPropsByType(*name*)

getModelDefs()

Returns
A list of one model definition compatible with addDataModels that represents the current data model

getModelDict()

getProps()

getPropsByType(*name*)

getTagProp(*name*)

getTypeClone(*typedef*)

prop(*name*)

tagprop(*name*)

type(*name*)
Return a synapse.lib.types.Type by name.

univ(*name*)

class synapse.datamodel.**Prop**(*modl*, *form*, *name*, *typedef*, *info*)
Bases: object

The Prop class represents a property defined within the data model.

getCompOffs()
Return the offset of this field within the compound primary prop or None.

getPropDef()

getStorNode(*form*)

onDel(*func*)

Add a callback for deleting this property.

The callback is executed after the property is deleted.

Parameters
func (*function*) – A prop del callback.

The callback is called within the current transaction, with the node, and the old property value (or None).

def func(node, oldv):
dostuff()

onSet(*func*)

Add a callback for setting this property.

The callback is executed after the property is set.

Parameters
func (*function*) – A prop set callback.

The callback is called within the current transaction, with the node, and the old property value (or None).

def func(node, oldv):
dostuff()

pack()

async wasDel(*node*, *oldv*)

async wasSet(*node*, *oldv*)

Fire the onset() handlers for this property.

Parameters

- **node** (synapse.lib.node.Node) – The node whose property was set.
- **oldv** (*obj*) – The previous value of the property.

class synapse.datamodel.**TagProp**(*model*, *name*, *tdef*, *info*)

Bases: object

getStorNode(*form*)

getTagPropDef()

pack()

10.1.10 synapse.exc module

Exceptions used by synapse, all inheriting from SynErr

exception synapse.exc.**AuthDeny**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BackupAlreadyRunning**(**args*, ***info*)

Bases: *SynErr*

Only one backup may be running at a time

exception synapse.exc.**BadArg**(**args*, ***info*)
Bases: *SynErr*

Improper function arguments

exception synapse.exc.**BadCast**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadCertBytes**(**args*, ***info*)
Bases: *SynErr*

Raised by certdir when the certificate fails to load.

exception synapse.exc.**BadCertHost**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadCertVerify**(**args*, ***info*)
Bases: *SynErr*

Raised by certdir when there is a failure to verify a certificate context.

exception synapse.exc.**BadCmdName**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadCmprType**(**args*, ***info*)
Bases: *SynErr*

Attempt to compare two incomparable values

exception synapse.exc.**BadCmprValu**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadConfValu**(**args*, ***info*)
Bases: *SynErr*

The configuration value provided is not valid.

This should contain the config name, valu and mesg.

exception synapse.exc.**BadCoreStore**(**args*, ***info*)
Bases: *SynErr*

The storage layer has encountered an error

exception synapse.exc.**BadCtorType**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadDataValu**(**args*, ***info*)
Bases: *SynErr*

Cannot process the data as intended.

exception synapse.exc.**BadEccExchange**(**args*, ***info*)
Bases: *CryptoErr*

Raised when there is an issue doing a ECC Key Exchange

exception synapse.exc.**BadFileExt**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadFormDef**(**args*, ***info*)
Bases: *SynErr*

exception synapse.exc.**BadHivePath**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadIndxValu**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadJsonText**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadLiftValu**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadMesgFormat**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadMesgVers**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadOperArg**(**args*, ***info*)

Bases: *SynErr*

Improper storm function arguments

exception synapse.exc.**BadOptValu**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadPkgDef**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadPropDef**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadStorageVersion**(**args*, ***info*)

Bases: *SynErr*

Stored persistent data is incompatible with running software

exception synapse.exc.**BadSyntax**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadTag**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadTime**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadTypeDef**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadTypeValu**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadUrl**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**BadVersion**(**args*, ***info*)

Bases: *SynErr*

Generic Bad Version exception.

exception synapse.exc.**CantDelCmd**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantDelForm**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantDelNode**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantDelProp**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantDelType**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantDelUniv**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantMergeView**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CantRevLayer**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**CliFini**(**args*, ***info*)

Bases: *SynErr*

Raised when the CLI is to exit.

exception synapse.exc.**CryptoErr**(**args*, ***info*)

Bases: *SynErr*

Raised when there is a synapse.lib.crypto error.

exception synapse.exc.**DataAlreadyExists**(**args*, ***info*)

Bases: *SynErr*

Cannot copy data to a location that already contains data

exception synapse.exc.**DbOutOfSpace**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DmonSpawn**(**args*, ***info*)

Bases: *SynErr*

Raised by a dispatched telepath method that has answered the call using a spawned process. (control flow that is compatible with aborting standard calls, generators, and async generators).

exception synapse.exc.**DupFileName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupFormName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupIden**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupIndx**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupPropName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupRoleName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupStormSvc**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupTagPropName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**DupUserName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**FatalErr**(**args*, ***info*)

Bases: *SynErr*

Raised when a fatal error has occurred which an application cannot recover from.

exception synapse.exc.**FeatureNotSupported**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**FileExists**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**HitLimit**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**InconsistentStorage**(**args*, ***info*)

Bases: *SynErr*

Stored persistent data is inconsistent

exception synapse.exc.**IsDeprLocked**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**IsFini**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**IsReadOnly**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**IsRuntForm**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**LayerInUse**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**LinkBadCert**(**args*, ***info*)

Bases: *LinkErr*

exception synapse.exc.**LinkErr**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**LinkShutDown**(**args*, ***info*)

Bases: *LinkErr*

exception synapse.exc.**LmdbLock**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**LowSpace**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**ModAlreadyLoaded**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**MustBeJsonSafe**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NeedConfValu**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoCertKey**(**args*, ***info*)

Bases: *SynErr*

Raised when a Cert object requires a RSA Private Key to perform an operation and the key is not present.

exception synapse.exc.**NoSuchAbrv**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchAct**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchAuthGate**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchCert**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchCmd**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchCmpr**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchCond**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchCtor**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchDecoder**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchDir**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchDyn**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchEncoder**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchFile**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchForm**(**args*, ***info*)

Bases: *SynErr*

classmethod init(*name*, *mesg=None*)

exception synapse.exc.**NoSuchFunc**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchIden**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchImpl**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchIndx**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchLayer**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchLift**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchMeth**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchName**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchObj**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchOpt**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchPath**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchPivot**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchPkg**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchProp**(**args*, ***info*)

Bases: *SynErr*

classmethod init(*name*, *mesg=None*)

exception synapse.exc.**NoSuchRole**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchStormSvc**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchTagProp**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchType**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchUniv**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchUser**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchVar**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NoSuchView**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NotANumberCompared**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NotMsgpackSafe**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**NotReady**(**args*, ***info*)

Bases: *Retry*

exception synapse.exc.**ParserExit**(**args*, ***info*)

Bases: *SynErr*

Raised by synapse.lib.cmd.Parser on Parser exit()

exception synapse.exc.**PathExists**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**ReadOnlyLayer**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**ReadOnlyProp**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**RecursionLimitHit**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**Retry**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**SchemaViolation**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**SlabAlreadyOpen**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**SlabInUse**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**SpawnExit**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**StepTimeout**(**args*, ***info*)

Bases: *SynErr*

Raised when a TestStep.wait() call times out.

exception synapse.exc.**StormPkgConflicts**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**StormPkgRequires**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**StormRaise**(**args*, ***info*)

Bases: *SynErr*

This represents a user provided exception inside of a Storm runtime. It requires a errname key.

exception synapse.exc.**StormRuntimeError**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**StormVarListError**(**args*, ***info*)

Bases: *StormRuntimeError*

exception synapse.exc.**SynErr**(**args*, ***info*)

Bases: Exception

get(*name*, *defv=None*)

Return a value from the errinfo dict.

Example

try:
foothing()

except SynErr as e:
blah = e.get('blah')

items()

set(*name*, *valu*)

Set a value in the errinfo dict.

setdefault(*name*, *valu*)

Set a value in errinfo dict if it is not already set.

exception synapse.exc.**TeleRedir**(**args*, ***info*)

Bases: *SynErr*

exception synapse.exc.**TimeOut**(**args*, ***info*)

Bases: *SynErr*

10.1.11 synapse.glob module

synapse.glob.**iAmLoop**()

synapse.glob.**initloop**()

synapse.glob.**setGreedCoro**(*loop: AbstractEventLoop*)

synapse.glob.**sync**(*coro*, *timeout=None*)

Schedule a coroutine to run on the global loop and return it's result.

Parameters
coro (*coroutine*) – The coroutine instance.

Notes

This API is thread safe and should only be called by non-loop threads.

synapse.glob.**synchelp**(*f*)

The synchelp decorator allows the transparent execution of a coroutine using the global loop from a thread other than the event loop. In both use cases, the actual work is done by the global event loop.

Examples

Use as a decorator:

```
@s_glob.synchelp
async def stuff(x, y):
    await dostuff()
```

Calling the stuff function as regular async code using the standard await syntax:

```
valu = await stuff(x, y)
```

Calling the stuff function as regular sync code outside of the event loop thread:

```
valu = stuff(x, y)
```

10.1.12 synapse.mindmeld module

10.1.13 synapse.telepath module

An RMI framework for synapse.

class synapse.telepath.**Aware**

Bases: object

The telepath.Aware mixin allows shared objects to handle individual links managed by the Daemon.

async getTeleApi(*link*, *mesg*, *path*)

Return a shared object for this link. :param link: A network link. :type link: synapse.lib.link.Link :param mesg: The tele:syn handshake message. :type mesg: (str,dict)

onTeleShare(*dmon*, *name*)

class synapse.telepath.**Client**

Bases: *Base*

A Telepath client object which reconnects and allows waiting for link up.

Notes

The conf data allows changing parameters such as timeouts, retry period, and link pool size. The default conf data can be seen below:

```
conf = {
    'timeout': 10,
    'retrysleep': 0.2,
    'link_poolsize': 4,
}
```

async offlink(*func*)

async onlink(*func*)

async proxy(*timeout=10*)

async task(*todo*, *name=None*)

async waitready(*timeout=10*)

class synapse.telepath.**Genr**

Bases: *Share*

class synapse.telepath.**GenrIter**(*proxy*, *todo*, *share*)

Bases: object

An object to help delay a telepath call until iteration.

async list()

class synapse.telepath.**GenrMethod**(*proxy*, *name*, *share=None*)

Bases: *Method*

class synapse.telepath.**Method**(*proxy*, *name*, *share=None*)

Bases: object

The telepath Method is used to provide proxy method calls.

class synapse.telepath.**Pipeline**

Bases: *Base*

class synapse.telepath.**Proxy**

Bases: *Base*

A telepath Proxy is used to call remote APIs on a shared object.

Example

import synapse.telepath as s_telepath

open the "foo" object shared in a dmon on localhost:3344

async def doFooThing():

    proxy = await s_telepath.openurl('tcp://127.0.0.1:3344/foo')

    valu = await proxy.getFooValu(x, y)

The proxy (and openurl function) may also be used from sync code:

    proxy = s_telepath.openurl('tcp://127.0.0.1:3344/foo')

    valu = proxy.getFooValu(x, y)

async call(*methname*, **args*, ***kwargs*)

Call a remote method by name.

Parameters

- **methname** (*str*) – The name of the remote method.
- ***args** – Arguments to the method call.
- ****kwargs** – Keyword arguments to the method call.

Most use cases will likely use the proxy methods directly:

The following two are effectively the same:

valu = proxy.getFooBar(x, y) valu = proxy.call('getFooBar', x, y)

async getPipeline(*genr*, *name=None*)

Construct a proxy API call pipeline in order to make multiple telepath API calls while minimizing round trips.

Parameters

- **genr** (*async generator*) – An async generator that yields todo tuples.
- **name** (*str*) – The name of the shared object on the daemon.

Example

def genr():
    yield s_common.todo('getFooByBar', 10) yield s_common.todo('getFooByBar', 20)

for retn in proxy.getPipeline(genr()):
    valu = s_common.result(retn)

async getPoolLink()

async handshake(*auth=None*)

async task(*todo*, *name=None*)

async taskv2(*todo*, *name=None*)

class synapse.telepath.**Share**

Bases: *Base*

The telepath client side of a dynamically shared object.

class synapse.telepath.**Task**

Bases: object

A telepath Task is used to internally track calls/responses.

reply(*retn*)

async result()

class synapse.telepath.**TeleSSLObject**(**args*, ***kwargs*)

Bases: SSLObject

do_handshake()

Start the SSL/TLS handshake.

async synapse.telepath.**addAhaUrl**(*url*)

Add (incref) an aha registry URL.

NOTE: You may also add a list of redundant URLs.

synapse.telepath.**alias**(*name*)

Resolve a telepath alias via ~/.syn/aliases.yaml

Parameters

name (*str*) – Name of the alias to resolve.

Notes

An exact match against the aliases will always be returned first. If no exact match is found and the name contains a '/' in it, the value before the slash is looked up and the remainder of the path is joined to any result. This is done to support dynamic Telepath share names.

Returns

The url string, if present in the alias. None will be returned if there are no matches.

Return type

str

synapse.telepath.**chopurl**(*url*, ***opts*)

async synapse.telepath.**delAhaUrl**(*url*)

Remove (decref) an aha registry URL.

NOTE: You may also remove a list of redundant URLs.

async synapse.telepath.**getAhaProxy**(*urlinfo*)

Return a telepath proxy by looking up a host from an aha registry.

synapse.telepath.**loadTeleCell**(*dirn*)

async synapse.telepath.**loadTeleEnv**(*path*)

synapse.telepath.**mergeAhaInfo**(*info0*, *info1*)

synapse.telepath.**modurl**(*url*, ***info*)

async synapse.telepath.**openinfo**(*info*)

synapse.telepath.**withTeleEnv**()

synapse.telepath.**zipurl**(*info*)

Reconstruct a URL string from a parsed telepath info dict.

CHAPTER

ELEVEN

SYNAPSE HTTP/REST API

Many components within the Synapse ecosystem provide HTTP/REST APIs to provide a portable interface. Some of these APIs are RESTful, while other (streaming data) APIs are technically not.

11.1 HTTP/REST API Conventions

All Synapse RESTful APIs use HTTP GET/POST methods to retrieve and modify data. All POST requests expect a JSON body. Each RESTful API call will return a result wrapper dictionary with one of two conventions.

For a successful API call:

```
{"status": "ok", "result": "some api result here"}
```

or for an unsuccessful API call:

```
{"status": "err": "code": "ErrCodeString", "mesg": "A human friendly message."}
```

Streaming HTTP API endpoints, such as the interface provided to retrieve nodes from a Synapse Cortex, provide JSON results via HTTP chunked encoding where each chunk is a single result.

The client example code in these docs is given with the Python "aiohttp" and "requests" modules. They should be enough to understand the basic operation of the APIs.

For additional examples, see the code examples at HTTPAPI Examples.

11.2 Authentication

Most Synapse HTTP APIs require an authenticated user. HTTP API endpoints requiring authentication may be accessed using either HTTP Basic authentication via the HTTP "Authorization" header or as part of an authenticated session.

To create and use an authenticated session, the HTTP client library must support cookies.

11.2.1 /api/v1/login

The login API endpoint may be used to create an authenticated session. This session may then be used to call other HTTP API endpoints as the authenticated user. This expects a `user` and `passwd` provided in the body of a `POST` request. The reusable session cookie is returned in a `Set-Cookie` header.

Both of the Python examples use session managers which manage the session cookie automatically.

```
import aiohttp

async def logInExample(ssl=False):

    async with aiohttp.ClientSession() as sess:

        info = {'user': 'visi', 'passwd': 'secret'}
        async with sess.post('https://localhost:4443/api/v1/login', json=info, ssl=ssl)␣
↪as resp:
            item = await resp.json()
            if item.get('status') != 'ok':
                code = item.get('code')
                mesg = item.get('mesg')
                raise Exception(f'Login error ({code}): {mesg}')

            # we are now clear to make additional HTTP API calls using sess
```

```
import requests

def logInExample(ssl=False):

    sess = requests.session()

    url = 'https://localhost:4443/api/v1/login'
    info = {'user': 'visi', 'passwd': 'secret'}
    resp = sess.post(url, json=info, verify=ssl)
    item = resp.json()

    if item.get('status') != 'ok':
        code = item.get('code')
        mesg = item.get('mesg')
        raise Exception(f'Login error ({code}): {mesg}')

    # we are now clear to make additional HTTP API calls using sess
```

11.2.2 /api/v1/active

Method

GET

This is an unauthenticated API that returns the leader status of Cell.

Returns

A dictionary with the `active` key set to True or False.

11.2.3 /api/v1/auth/users

Method
GET

Returns
A list of dictionaries, each of which represents a user on the system.

11.2.4 /api/v1/auth/roles

Method
GET

Returns
A list of dictionaries, each of which represents a role on the system.

11.2.5 /api/v1/auth/adduser

Method
POST

This API endpoint allows the caller to add a user to the system.

Input
This API expects the following JSON body:

```
{ "name": "myuser" }
```

Any additional "user dictionary" fields (other than "iden") may be specified.

Returns
The newly created user dictionary.

11.2.6 /api/v1/auth/addrole

Method
POST

This API endpoint allows the caller to add a role to the system.

Input
This API expects the following JSON body:

```
{ "name": "myrole" }
```

Any additional "role dictionary" fields (other than "iden") may be specified.

Returns
The newly created role dictionary.

11.2.7 /api/v1/auth/delrole

Method
POST

This API endpoint allows the caller to delete a role from the system.

Input
This API expects the following JSON body:

```
{ "name": "myrole" }
```

Returns
null

11.2.8 /api/v1/auth/user/<id>

Method
POST

This API allows the caller to modify specified elements of a user dictionary.

Input
This API expects a JSON dictionary containing any updated values for the user.

Returns
The updated user dictionary.

Method
GET

This API allows the caller to retrieve a user dictionary.

Returns
A user dictionary.

11.2.9 /api/v1/auth/password/<id>

Method
POST

This API allows the caller to change a user's password. The authenticated user must either be an admin or the user whose password is being changed.

Input
This API expects a JSON dictionary containing the a key `passwd` with the new password string.

Returns
The updated user dictionary.

11.2.10 /api/v1/auth/role/<id>

Method
POST

This API allows the caller to modify specified elements of a role dictionary.

Input
This API expects a dictionary containing any updated values for the role.

Returns
The updated role dictionary.

Method
GET

This API allows the caller to retrieve a role dictionary.

Returns
A role dictionary.

11.2.11 /api/v1/auth/grant

Method
POST

This API allows the caller to grant a role to a given user.

Input
This API expects the following JSON body:

```
{
    "user": "<id>",
    "role": "<id>"
}
```

Returns
The updated user dictionary.

11.2.12 /api/v1/auth/revoke

Method
POST

This API allows the caller to revoke a role which was previously granted to a user.

Input
This API expects the following JSON body:

```
{
    "user": "<id>",
    "role": "<id>"
}
```

Returns
The updated user dictionary.

11.3 Cortex

A Synapse Cortex implements an HTTP API for interacting with the hypergraph and data model. Some of the provided APIs are pure REST APIs for simple data model operations and single/simple node modification. However, many of the HTTP APIs provided by the Cortex are streaming APIs which use HTTP chunked encoding to deliver a stream of results as they become available.

11.3.1 /api/v1/feed

The Cortex feed API endpoint allows the caller to add nodes in bulk.

Method

POST

Input

The API expects the following JSON body:

```
{
    "items": [ <node>, ... ],
    # and optionally...
    "view": <iden>,
}
```

Each <node> is expected to be in packed tuple form:

```
[ [<formname>, <formvalu>], {...} ]
```

Returns

The API returns `{"status": "ok", "result": null}` on success and any failures are returned using the previously mentioned REST API convention.

11.3.2 /api/v1/storm

The Storm API endpoint allows the caller to execute a Storm query on the Cortex and stream back the messages generated during the Storm runtime execution. In addition to returning nodes, these messsages include events for node edits, tool console output, etc. This streaming API has back-pressure, and will handle streaming millions of results as the reader consumes them. For more information about Storm APIs, including opts behavior, see *Storm API Guide*.

Method

GET

Input

The API expects the following JSON body:

```
{
    "query": "a storm query here",

    # optional
    "opts": {
       ...
    }

    # optional
```

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```
    "stream": "jsonlines"
}
```

Returns

The API returns a series of messages generated by the Storm runtime. Each message is returned as an HTTP chunk, allowing readers to consume the resulting messages as a stream.

The `stream` argument to the body modifies how the results are streamed back. Currently this optional argument can be set to `jsonlines` to get newline separated JSON data.

Examples

The following two examples show querying the `api/v1/storm` endpoint and receiving multiple message types.

aiohttp example:

```
import json
import pprint

# Assumes sess is an aiotthp client session that has previously logged in

query = '.created $lib.print($node.repr(".created")) | limit 3'
data = {'query': query, 'opts': {'repr': True}}
url = 'https://localhost:4443/api/v1/storm'

async with sess.get(url, json=data) as resp:
    async for byts, x in resp.content.iter_chunks():

        if not byts:
            break

        mesg = json.loads(byts)
        pprint.pprint(mesg)
```

requests example:

```
import json
import pprint
# Assumes sess is an requests client session that has previously logged in

query = '.created $lib.print($node.repr(".created")) | limit 3'
data = {'query': query, 'opts': {'repr': True}}
url = 'https://localhost:4443/api/v1/storm'

resp = sess.get(url, json=data, stream=True)
for chunk in resp.iter_content(chunk_size=None, decode_unicode=True):
    mesg = json.loads(chunk)
    pprint.pprint(mesg)
```

When working with these APIs across proxies, we have experienced issues with NGINX interfering with the chunked encoding. This may require more careful message reconstruction. The following shows using aiohttp to do that message reconstruction.

```
import json
import pprint
# Assumes sess is an requests client session that has previously logged in

query = '.created $lib.print($node.repr(".created")) | limit 3'
data = {'query': query, 'opts': {'repr': True}}
url = 'https://localhost:4443/api/v1/storm'

async with sess.get(url, json=data) as resp:

    buf = b""

    async for byts, chunkend in resp.content.iter_chunks():

        if not byts:
            break

        buf += byts
        if not chunkend:
            continue

        mesg = json.loads(buf)
        buf = b""

        pprint.pprint(buf)
```

11.3.3 /api/v1/storm/call

The Storm Call API endpoint allows the caller to execute a Storm query on the Cortex and get a single return value back from the runtime. This is analogous to using the `callStorm()` Telepath API. This expects to return a value from the Storm query using the Storm `return( )` syntax. For more information about Storm APIs, including opts behavior, see *Storm API Guide*.

Method

GET

Input

The API expects the following JSON body:

```
{
    "query": "a storm query here",

    # optional
    "opts": {
        ...
    }
}
```

Returns

The API returns `{"status": "ok", "result": return_value}` on success and any failures are returned using the previously mentioned REST API convention.

Examples

The following two examples show querying the `api/v1/storm/call` endpoint and receiving a return

value.

aiohttp example:

```
import pprint

# Assumes sess is an aiotthp client session that has previously logged in

query = '$foo = $lib.str.format("hello {valu}", valu="world") return ($foo)'
data = {'query': query}
url = 'https://localhost:4443/api/v1/storm/call'

async with sess.get(url, json=data) as resp:
    info = await resp.json()
    pprint.pprint(info)
```

requests example:

```
import pprint
# Assumes sess is an requests client session that has previously logged in

query = '$foo = $lib.str.format("hello {valu}", valu="world") return ($foo)'
data = {'query': query}
url = 'https://localhost:4443/api/v1/storm/call'

resp = sess.get(url, json=data)
info = resp.json()
pprint.pprint(info)
```

11.3.4 /api/v1/storm/nodes

Warning: This API is deprecated in Synapse `v2.110.0` and will be removed in a future version.

The Storm nodes API endpoint allows the caller to execute a Storm query on the Cortex and stream back the resulting nodes. This streaming API has back-pressure, and will handle streaming millions of results as the reader consumes them.

Method

GET

Input

See /api/v1/storm for expected JSON body input.

Returns

The API returns the resulting nodes from the input Storm query. Each node is returned as an HTTP chunk, allowing readers to consume the resulting nodes as a stream.

Each serialized node will have the following structure:

```
[
    [<form>, <valu>],       # The [ typename, typevalue ] definition of the␣
↪node.
    {
```

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```
        "iden": <hash>,     # A stable identifier for the node.
        "tags": {},         # The tags on the node.
        "props": {},        # The node's secondary properties.

        # optionally (if query opts included {"repr": True}
        "reprs": {}         # Presentation values for props which need it.
    }
]
```

The `stream` argument, documented in the /api/v1/storm endpoint, modifies how the nodes are streamed back. Currently this optional argument can be set to `jsonlines` to get newline separated JSON data.

11.3.5 /api/v1/storm/export

The Storm export API endpoint allows the caller to execute a Storm query on the Cortex and export the resulting nodes in msgpack format such that they can be directly ingested with the `syn.nodes` feed function.

Method

GET

Input

See /api/v1/storm for expected JSON body input.

Returns

The API returns the resulting nodes from the input Storm query. This API yields nodes after an initial complete lift in order to limit exported edges.

Each exported node will be in msgpack format.

There is no Content-Length header returned, since the API cannot predict the volume of data a given query may produce.

11.3.6 /api/v1/model

Method

GET

This API allows the caller to retrieve the current Cortex data model.

Input

The API takes no input.

Returns

The API returns the model in a dictionary, including the types, forms and tagprops. Secondary property information is also included for each form:

```
{
    "types": {
        ...  # dictionary of type definitions
    },
    "forms": {
        ...  # dictionary of form definitions, including secondary properties
    },
    "tagprops": {
```

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```
        ...  # dictionary of tag property definitions
    }
}
```

11.3.7 /api/v1/model/norm

Method

GET, POST

This API allows the caller to normalize a value based on the Cortex data model. This may be called via a GET or POST requests.

Input

The API expects the following JSON body:

```
{
    "prop": "prop:name:here",
    "value": <value>,
}
```

Returns

The API returns the normalized value as well as any parsed subfields or type specific info:

```
{
    "norm": <value>,
    "info": {
        "subs": {},
        ...
    }
}
```

11.3.8 /api/v1/storm/vars/get

Method

GET

This API allows the caller to retrieve a storm global variable.

Input

The API expects the following JSON body:

```
{
    "name": "varnamehere",
    "default": null,
}
```

Returns

The API returns the global variable value or the specified default using the REST API convention described earlier.

11.3.9 /api/v1/storm/vars/set

Method

POST

This API allows the caller to set a storm global variable.

Input

The API expects the following JSON body:

```
{
    "name": "varnamehere",
    "value": <value>,
}
```

Returns

The API returns *true* using using the REST API convention described earlier.

11.3.10 /api/v1/storm/vars/pop

Method

POST

This API allows the caller to pop/delete a storm global variable.

Input

The API expects the following JSON body:

```
{
    "name": "varnamehere",
    "default": <value>,
}
```

Returns

The API returns the the current value of the variable or default using using the REST API convention described earlier.

11.3.11 /api/v1/core/info

Method

GET

This API allows the caller to retrieve the current Cortex version, data model definitions, and Storm information.

Input

The API takes no input.

Returns

The API returns the model in a dictionary, including the types, forms and tagprops. Secondary property information is also included for each form:

```
{
    "version": [ <major>, <minor>, <patch> ], # Version tuple
    "modeldict": {
        ...  # dictionary of model definitions
```

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```
    },
    "stormdocs": {
        "libraries": [
            ... # list of information about Storm libraries.
        ],
        "types": [
            ... # list of information about Storm types.
        ]
    }
}
```

11.4 Aha

A Synapse Aha service implements an HTTP for assisting with provisioning.

11.4.1 /api/v1/aha/provision/service

Method

POST

Input

The API expects the following JSON body:

```
{
    "name": " ... name of the service being provisioned",
    "provinfo": {
        "dmon:port": # optional integer, default Telepath listening port.
        "https:port": # optional integer, default HTTPS listening port.
        "mirror": # optional string, service to Mirror.
        "conf": {
            ... # optional, default service configuration values.
        }
    }
}
```

Returns

The API returns the following provisioning information. The data is returned using using the REST API convention described earlier:

```
{
    "url": "< the AHA provisioning URL >",
}
```

11.5 Axon

A Synapse Axon implements an HTTP API for uploading and downloading files. The HTTP APIs use HTTP chunked encoding for handling large files.

11.5.1 /api/v1/axon/files/del

This API allows the caller to delete multiple files from the Axon by the SHA-256.

Method

POST

Input

The API expects the following JSON body:

```
{
    "sha256s": [<sha256>, ...],
}
```

Returns

The API returns an array of SHA-256 and boolean values representing whether each was found in the Axon and deleted. The array is returned using using the REST API convention described earlier.

11.5.2 /api/v1/axon/files/put

This API allows the caller to upload and save a file to the Axon. This may be called via a PUT or POST request.

Method

PUT, POST

Input

The API expects a stream of byte chunks.

Returns

On successful upload, or if the file already existed, the API returns information about the file:

```
{
  "md5": "<the md5sum value of the uploaded bytes>",
  "sha1": "<the sha1 value of the uploaded bytes>",
  "sha256": "<the sha256 value of the uploaded bytes>",
  "sha512": "<the sha512 value of the uploaded bytes>",
  "size": <the size of the uploaded bytes>
}
```

11.5.3 /api/v1/axon/files/has/sha256/<SHA-256>

This API allows the caller to check if a file exists in the Axon as identified by the SHA-256.

Method
GET

Returns
True if the file exists; False if the file does not exist.

11.5.4 /api/v1/axon/files/by/sha256/<SHA-256>

This API allows the caller to retrieve or remove a file from the Axon as identified by the SHA-256. If the file does not exist a 404 will be returned.

Method
GET

Returns
If the file exists a stream of byte chunks will be returned to the caller. A `Range` header with a single `bytes` value can be provided to get a subset of a file.

Method
HEAD

Returns
If the file exists, the `Content-Length` header will be set for the size of the file. If a `Range` header with a single `bytes` value is provided, the `Content-Length` header will describe the size of the range, and the `Content-Range` header will also be set to describe the range of the requested bytes.

Method
DELETE

Returns
Boolean via the REST API convention described earlier. If the file is not found an error is returned.

CHAPTER

TWELVE

SYNAPSE DATA MODEL

This contains documentation for Synapse Data Model, including the data model deprecation policy.

The current sections are:

12.1 Synapse Data Model - Types

12.1.1 Base Types

Base types are defined via Python classes.

array

A typed array which indexes each field. It is implemented by the following class: `synapse.lib.types.Array`.

The base type `array` has the following default options set:

- type: `int`

bool

The base boolean type. It is implemented by the following class: `synapse.lib.types.Bool`.

comp

The base type for compound node fields. It is implemented by the following class: `synapse.lib.types.Comp`.

cvss:v2

A CVSS v2 vector string. It is implemented by the following class: `synapse.models.risk.CvssV2`.

An example of `cvss:v2`:

- `(AV:L/AC:L/Au:M/C:P/I:C/A:N)`

cvss:v3

A CVSS v3.x vector string. It is implemented by the following class: `synapse.models.risk.CvssV3`.

An example of `cvss:v3`:

- `AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L`

data

Arbitrary json compatible data. It is implemented by the following class: `synapse.lib.types.Data`.

duration

A duration value. It is implemented by the following class: `synapse.lib.types.Duration`.

The base type `duration` has the following default options set:

- signed: `False`

edge

An digraph edge base type. It is implemented by the following class: `synapse.lib.types.Edge`.

file:base

A file name with no path. It is implemented by the following class: `synapse.models.files.FileBase`.

An example of `file:base`:

- `woot.exe`

file:bytes

The file bytes type with SHA256 based primary property. It is implemented by the following class: `synapse.models.files.FileBytes`.

file:path

A normalized file path. It is implemented by the following class: `synapse.models.files.FilePath`.

An example of `file:path`:

- `c:/windows/system32/calc.exe`

float

The base floating point type. It is implemented by the following class: `synapse.lib.types.Float`.

The base type `float` has the following default options set:

- fmt: `%f`
- min: `None`
- minisvalid: `True`
- max: `None`
- maxisvalid: `True`

geo:area

A geographic area (base unit is square mm). It is implemented by the following class: `synapse.models.geospace.Area`.

An example of `geo:area`:

- `10 sq.km`

geo:dist

A geographic distance (base unit is mm). It is implemented by the following class: `synapse.models.geospace.Dist`.

An example of `geo:dist`:

- `10 km`

geo:latlong

A Lat/Long string specifying a point on Earth. It is implemented by the following class: `synapse.models.geospace.LatLong`.

An example of `geo:latlong`:

- `-12.45,56.78`

guid

The base GUID type. It is implemented by the following class: `synapse.lib.types.Guid`.

hex

The base hex type. It is implemented by the following class: `synapse.lib.types.Hex`.

The base type `hex` has the following default options set:

- size: `0`

hugenum

A potentially huge/tiny number. [x] <= 73075081866545145910184 2 with a fractional precision of 24 decimal digits. It is implemented by the following class: `synapse.lib.types.HugeNum`.

The base type `hugenum` has the following default options set:

- units: `None`
- modulo: `None`

inet:addr

A network layer URL-like format to represent tcp/udp/icmp clients and servers. It is implemented by the following class: `synapse.models.inet.Addr`.

An example of `inet:addr`:

- `tcp://1.2.3.4:80`

inet:cidr4

An IPv4 address block in Classless Inter-Domain Routing (CIDR) notation. It is implemented by the following class: `synapse.models.inet.Cidr4`.

An example of `inet:cidr4`:

- `1.2.3.0/24`

inet:cidr6

An IPv6 address block in Classless Inter-Domain Routing (CIDR) notation. It is implemented by the following class: `synapse.models.inet.Cidr6`.

An example of `inet:cidr6`:

- `2001:db8::/101`

inet:dns:name

A DNS query name string. Likely an FQDN but not always. It is implemented by the following class: `synapse.models.dns.DnsName`.

An example of `inet:dns:name`:

- `vertex.link`

inet:email

An e-mail address. It is implemented by the following class: `synapse.models.inet.Email`.

inet:fqdn

A Fully Qualified Domain Name (FQDN). It is implemented by the following class: `synapse.models.inet.Fqdn`.

An example of `inet:fqdn`:

- `vertex.link`

inet:http:cookie

An individual HTTP cookie string. It is implemented by the following class: `synapse.models.inet.HttpCookie`.

An example of `inet:http:cookie`:

- `PHPSESSID=el4ukv0kqbvoirg7nkp4dncpk3`

inet:ipv4

An IPv4 address. It is implemented by the following class: `synapse.models.inet.IPv4`.

An example of `inet:ipv4`:

- `1.2.3.4`

inet:ipv4range

An IPv4 address range. It is implemented by the following class: `synapse.models.inet.IPv4Range`.

An example of `inet:ipv4range`:

- `1.2.3.4-1.2.3.8`

inet:ipv6

An IPv6 address. It is implemented by the following class: `synapse.models.inet.IPv6`.

An example of `inet:ipv6`:

- `2607:f8b0:4004:809::200e`

inet:ipv6range

An IPv6 address range. It is implemented by the following class: `synapse.models.inet.IPv6Range`.

An example of `inet:ipv6range`:

- `(2607:f8b0:4004:809::200e, 2607:f8b0:4004:809::2011)`

inet:rfc2822:addr

An RFC 2822 Address field. It is implemented by the following class: `synapse.models.inet.Rfc2822Addr`.

An example of `inet:rfc2822:addr`:

- `"Visi Kenshoto" <visi@vertex.link>`

inet:url

A Universal Resource Locator (URL). It is implemented by the following class: `synapse.models.inet.Url`.

An example of `inet:url`:

- `http://www.woot.com/files/index.html`

int

The base 64 bit signed integer type. It is implemented by the following class: `synapse.lib.types.Int`.

The base type `int` has the following default options set:

- size: `8`
- signed: `True`
- fmt: `%d`
- min: `None`
- max: `None`
- ismin: `False`
- ismax: `False`

it:sec:cpe

A NIST CPE 2.3 Formatted String. It is implemented by the following class: `synapse.models.infotech.Cpe23Str`.

The base type `it:sec:cpe` has the following default options set:

- lower: `True`

it:sec:cpe:v2_2

A NIST CPE 2.2 Formatted String. It is implemented by the following class: `synapse.models.infotech.Cpe22Str`.

The base type `it:sec:cpe:v2_2` has the following default options set:

- lower: `True`

it:semver

Semantic Version type. It is implemented by the following class: `synapse.models.infotech.SemVer`.

ival

A time window/interval. It is implemented by the following class: `synapse.lib.types.Ival`.

loc

The base geo political location type. It is implemented by the following class: `synapse.lib.types.Loc`.

ndef

The node definition type for a (form,valu) compound field. It is implemented by the following class: `synapse.lib.types.Ndef`.

nodeprop

The nodeprop type for a (prop,valu) compound field. It is implemented by the following class: `synapse.lib.types.NodeProp`.

range

A base range type. It is implemented by the following class: `synapse.lib.types.Range`.

The base type `range` has the following default options set:

- type: `('int', {})`

str

The base string type. It is implemented by the following class: `synapse.lib.types.Str`.

The base type `str` has the following default options set:

- enums: `None`
- regex: `None`
- lower: `False`
- strip: `False`
- replace: `()`
- onespace: `False`
- globsuffix: `False`

syn:tag

The base type for a synapse tag. It is implemented by the following class: `synapse.lib.types.Tag`.

The base type `syn:tag` has the following default options set:

- enums: `None`
- regex: `None`
- lower: `False`
- strip: `False`
- replace: `()`
- onespace: `False`
- globsuffix: `False`

syn:tag:part

A tag component string. It is implemented by the following class: `synapse.lib.types.TagPart`.

The base type `syn:tag:part` has the following default options set:

- enums: `None`
- regex: `None`
- lower: `False`
- strip: `False`
- replace: `()`
- onespace: `False`
- globsuffix: `False`

taxon

A component of a hierarchical taxonomy. It is implemented by the following class: `synapse.lib.types.Taxon`.

The base type `taxon` has the following default options set:

- enums: `None`
- regex: `None`
- lower: `False`
- strip: `False`
- replace: `()`
- onespace: `False`
- globsuffix: `False`

taxonomy

A hierarchical taxonomy. It is implemented by the following class: `synapse.lib.types.Taxonomy`.

The base type `taxonomy` has the following default options set:

- enums: `None`
- regex: `None`
- lower: `False`
- strip: `False`
- replace: `()`
- onespace: `False`
- globsuffix: `False`

tel:mob:imei

An International Mobile Equipment Id. It is implemented by the following class: `synapse.models.telco.Imei`.

An example of `tel:mob:imei`:

- `490154203237518`

tel:mob:imsi

An International Mobile Subscriber Id. It is implemented by the following class: `synapse.models.telco.Imsi`.

An example of `tel:mob:imsi`:

- `310150123456789`

tel:phone

A phone number. It is implemented by the following class: `synapse.models.telco.Phone`.

An example of `tel:phone`:

- `+15558675309`

time

A date/time value. It is implemented by the following class: `synapse.lib.types.Time`.

The base type `time` has the following default options set:

- ismin: `False`
- ismax: `False`

timeedge

An digraph edge base type with a unique time. It is implemented by the following class: `synapse.lib.types.TimeEdge`.

velocity

A velocity with base units in mm/sec. It is implemented by the following class: `synapse.lib.types.Velocity`.

The base type `velocity` has the following default options set:

- relative: `False`

12.1.2 Types

Regular types are derived from BaseTypes.

auth:access

An instance of using creds to access a resource. The `auth:access` type is derived from the base type: `guid`.

auth:creds

A unique set of credentials used to access a resource. The `auth:creds` type is derived from the base type: `guid`.

belief:subscriber

A contact which subscribes to a belief system. The `belief:subscriber` type is derived from the base type: `guid`.

belief:system

A belief system such as an ideology, philosophy, or religion. The `belief:system` type is derived from the base type: `guid`.

belief:system:type:taxonomy

A hierarchical taxonomy of belief system types. The `belief:system:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `belief:system:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

belief:tenet

A concrete tenet potentially shared by multiple belief systems. The `belief:tenet` type is derived from the base type: `guid`.

biz:bundle

A bundle allows construction of products which bundle instances of other products. The `biz:bundle` type is derived from the base type: `guid`.

biz:deal

A sales or procurement effort in pursuit of a purchase. The `biz:deal` type is derived from the base type: `guid`.

biz:dealstatus

A deal/rfp status taxonomy. The `biz:dealstatus` type is derived from the base type: `taxonomy`.

The type `biz:dealstatus` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

biz:dealtype

A deal type taxonomy. The `biz:dealtype` type is derived from the base type: `taxonomy`.

The type `biz:dealtype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

biz:listing

A product or service being listed for sale at a given price by a specific seller. The `biz:listing` type is derived from the base type: `guid`.

biz:prodtype

A product type taxonomy. The `biz:prodtype` type is derived from the base type: `taxonomy`.

The type `biz:prodtype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

biz:product

A product which is available for purchase. The `biz:product` type is derived from the base type: `guid`.

biz:rfp

An RFP (Request for Proposal) soliciting proposals. The `biz:rfp` type is derived from the base type: `guid`.

biz:service

A service which is performed by a specific organization. The `biz:service` type is derived from the base type: `guid`.

biz:service:type:taxonomy

A taxonomy of service offering types. The `biz:service:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `biz:service:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

biz:stake

A stake or partial ownership in a company. The `biz:stake` type is derived from the base type: `guid`.

crypto:algorithm

A cryptographic algorithm name. The `crypto:algorithm` type is derived from the base type: `str`.

An example of `crypto:algorithm`:

- `aes256`

The type `crypto:algorithm` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

crypto:currency:address

An individual crypto currency address. The `crypto:currency:address` type is derived from the base type: `comp`.

An example of `crypto:currency:address`:

- `btc/1BvBMSEYstWetqTFn5Au4m4GFg7xJaNVN2`

The type `crypto:currency:address` has the following options set:

- fields: `(('coin', 'crypto:currency:coin'), ('iden', 'str'))`
- sepr: `/`

crypto:currency:block

An individual crypto currency block record on the blockchain. The `crypto:currency:block` type is derived from the base type: `comp`.

The type `crypto:currency:block` has the following options set:

- fields: `(('coin', 'crypto:currency:coin'), ('offset', 'int'))`
- sepr: `/`

crypto:currency:client

A fused node representing a crypto currency address used by an Internet client. The `crypto:currency:client` type is derived from the base type: `comp`.

An example of `crypto:currency:client`:

- `(1.2.3.4, (btc, 1BvBMSEYstWetqTFn5Au4m4GFg7xJaNVN2))`

The type `crypto:currency:client` has the following options set:

- fields: `(('inetaddr', 'inet:client'), ('coinaddr', 'crypto:currency:address'))`

crypto:currency:coin

An individual crypto currency type. The `crypto:currency:coin` type is derived from the base type: `str`.

An example of `crypto:currency:coin`:

- `btc`

The type `crypto:currency:coin` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

crypto:currency:transaction

An individual crypto currency transaction recorded on the blockchain. The `crypto:currency:transaction` type is derived from the base type: `guid`.

crypto:key

A cryptographic key and algorithm. The `crypto:key` type is derived from the base type: `guid`.

crypto:payment:input

A payment made into a transaction. The `crypto:payment:input` type is derived from the base type: `guid`.

crypto:payment:output

A payment received from a transaction. The `crypto:payment:output` type is derived from the base type: `guid`.

crypto:smart:contract

A smart contract. The `crypto:smart:contract` type is derived from the base type: `guid`.

crypto:smart:effect:burntoken

A smart contract effect which destroys a non-fungible token. The `crypto:smart:effect:burntoken` type is derived from the base type: `guid`.

crypto:smart:effect:edittokensupply

A smart contract effect which increases or decreases the supply of a fungible token. The `crypto:smart:effect:edittokensupply` type is derived from the base type: `guid`.

crypto:smart:effect:minttoken

A smart contract effect which creates a new non-fungible token. The `crypto:smart:effect:minttoken` type is derived from the base type: `guid`.

crypto:smart:effect:proxytoken

A smart contract effect which grants a non-owner address the ability to manipulate a specific non-fungible token. The `crypto:smart:effect:proxytoken` type is derived from the base type: `guid`.

crypto:smart:effect:proxytokenall

A smart contract effect which grants a non-owner address the ability to manipulate all non-fungible tokens of the owner. The `crypto:smart:effect:proxytokenall` type is derived from the base type: `guid`.

crypto:smart:effect:proxytokens

A smart contract effect which grants a non-owner address the ability to manipulate fungible tokens. The `crypto:smart:effect:proxytokens` type is derived from the base type: `guid`.

crypto:smart:effect:transfertoken

A smart contract effect which transfers ownership of a non-fungible token. The `crypto:smart:effect:transfertoken` type is derived from the base type: `guid`.

crypto:smart:effect:transfertokens

A smart contract effect which transfers fungible tokens. The `crypto:smart:effect:transfertokens` type is derived from the base type: `guid`.

crypto:smart:token

A token managed by a smart contract. The `crypto:smart:token` type is derived from the base type: `comp`.

The type `crypto:smart:token` has the following options set:

- fields: `(('contract', 'crypto:smart:contract'), ('tokenid', 'hugenum'))`

crypto:x509:cert

A unique X.509 certificate. The `crypto:x509:cert` type is derived from the base type: `guid`.

crypto:x509:crl

A unique X.509 Certificate Revocation List. The `crypto:x509:crl` type is derived from the base type: `guid`.

crypto:x509:revoked

A revocation relationship between a CRL and an X.509 certificate. The `crypto:x509:revoked` type is derived from the base type: `comp`.

The type `crypto:x509:revoked` has the following options set:

- fields: `(('crl', 'crypto:x509:crl'), ('cert', 'crypto:x509:cert'))`

crypto:x509:san

An X.509 Subject Alternative Name (SAN). The `crypto:x509:san` type is derived from the base type: `comp`.

The type `crypto:x509:san` has the following options set:

- fields: `(('type', 'str'), ('value', 'str'))`

crypto:x509:signedfile

A digital signature relationship between an X.509 certificate and a file. The `crypto:x509:signedfile` type is derived from the base type: `comp`.

The type `crypto:x509:signedfile` has the following options set:

- fields: `(('cert', 'crypto:x509:cert'), ('file', 'file:bytes'))`

econ:acct:balance

A snapshot of the balance of an account at a point in time. The `econ:acct:balance` type is derived from the base type: `guid`.

econ:acct:payment

A payment or crypto currency transaction. The `econ:acct:payment` type is derived from the base type: `guid`.

econ:acquired

Deprecated. Please use econ:purchase -(acquired)> *. The `econ:acquired` type is derived from the base type: `comp`.

The type `econ:acquired` has the following options set:

- fields: `(('purchase', 'econ:purchase'), ('item', 'ndef'))`

econ:currency

The name of a system of money in general use. The `econ:currency` type is derived from the base type: `str`.

An example of `econ:currency`:

- `usd`

The type `econ:currency` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

econ:fin:bar

A sample of the open, close, high, low prices of a security in a specific time window. The `econ:fin:bar` type is derived from the base type: `guid`.

econ:fin:exchange

A financial exchange where securities are traded. The `econ:fin:exchange` type is derived from the base type: `guid`.

econ:fin:security

A financial security which is typically traded on an exchange. The `econ:fin:security` type is derived from the base type: `guid`.

econ:fin:tick

A sample of the price of a security at a single moment in time. The `econ:fin:tick` type is derived from the base type: `guid`.

econ:pay:card

A single payment card. The `econ:pay:card` type is derived from the base type: `guid`.

econ:pay:cvv

A Card Verification Value (CVV). The `econ:pay:cvv` type is derived from the base type: `str`.

The type `econ:pay:cvv` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[0-9]{1,6}$`
- replace: `()`
- strip: `False`

econ:pay:iin

An Issuer Id Number (IIN). The `econ:pay:iin` type is derived from the base type: `int`.

The type `econ:pay:iin` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `999999`
- min: `0`
- signed: `True`
- size: `8`

econ:pay:mii

A Major Industry Identifier (MII). The `econ:pay:mii` type is derived from the base type: `int`.

The type `econ:pay:mii` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `9`
- min: `0`
- signed: `True`
- size: `8`

econ:pay:pan

A Primary Account Number (PAN) or card number. The `econ:pay:pan` type is derived from the base type: `str`.

The type `econ:pay:pan` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^(?<iin>(?<mii>[0-9]{1})[0-9]{5})[0-9]{1,13}$`
- replace: `()`
- strip: `False`

econ:pay:pin

A Personal Identification Number. The `econ:pay:pin` type is derived from the base type: `str`.

The type `econ:pay:pin` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[0-9]{3,6}$`
- replace: `()`
- strip: `False`

econ:price

The amount of money expected, required, or given in payment for something. The `econ:price` type is derived from the base type: `hugenum`.

An example of `econ:price`:

- `2.20`

The type `econ:price` has the following options set:

- modulo: `None`
- norm: `False`
- units: `None`

econ:purchase

A purchase event. The `econ:purchase` type is derived from the base type: `guid`.

econ:receipt:item

A line item included as part of a purchase. The `econ:receipt:item` type is derived from the base type: `guid`.

edge:has

A digraph edge which records that N1 has N2. The `edge:has` type is derived from the base type: `edge`.

edge:refs

A digraph edge which records that N1 refers to or contains N2. The `edge:refs` type is derived from the base type: `edge`.

edge:wentto

A digraph edge which records that N1 went to N2 at a specific time. The `edge:wentto` type is derived from the base type: `timeedge`.

edu:class

An instance of an edu:course taught at a given time. The `edu:class` type is derived from the base type: `guid`.

edu:course

A course of study taught by an org. The `edu:course` type is derived from the base type: `guid`.

file:archive:entry

An archive entry representing a file and metadata within a parent archive file. The `file:archive:entry` type is derived from the base type: `guid`.

file:filepath

The fused knowledge of the association of a file:bytes node and a file:path. The `file:filepath` type is derived from the base type: `comp`.

The type `file:filepath` has the following options set:

- fields: `(('file', 'file:bytes'), ('path', 'file:path'))`

file:ismime

Records one, of potentially multiple, mime types for a given file. The `file:ismime` type is derived from the base type: `comp`.

The type `file:ismime` has the following options set:

- fields: `(('file', 'file:bytes'), ('mime', 'file:mime'))`

file:mime

A file mime name string. The `file:mime` type is derived from the base type: `str`.

An example of `file:mime`:

- `text/plain`

The type `file:mime` has the following options set:

- globsuffix: `False`
- lower: `1`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

file:mime:gif

The GUID of a set of mime metadata for a .gif file. The `file:mime:gif` type is derived from the base type: `guid`.

file:mime:jpg

The GUID of a set of mime metadata for a .jpg file. The `file:mime:jpg` type is derived from the base type: `guid`.

file:mime:macho:loadcmd

A generic load command pulled from the Mach-O headers. The `file:mime:macho:loadcmd` type is derived from the base type: `guid`.

file:mime:macho:section

A section inside a Mach-O binary denoting a named region of bytes inside a segment. The `file:mime:macho:section` type is derived from the base type: `guid`.

file:mime:macho:segment

A named region of bytes inside a Mach-O binary. The `file:mime:macho:segment` type is derived from the base type: `guid`.

file:mime:macho:uuid

A specific load command denoting a UUID used to uniquely identify the Mach-O binary. The `file:mime:macho:uuid` type is derived from the base type: `guid`.

file:mime:macho:version

A specific load command used to denote the version of the source used to build the Mach-O binary. The `file:mime:macho:version` type is derived from the base type: `guid`.

file:mime:msdoc

The GUID of a set of mime metadata for a Microsoft Word file. The `file:mime:msdoc` type is derived from the base type: `guid`.

file:mime:msppt

The GUID of a set of mime metadata for a Microsoft Powerpoint file. The `file:mime:msppt` type is derived from the base type: `guid`.

file:mime:msxls

The GUID of a set of mime metadata for a Microsoft Excel file. The `file:mime:msxls` type is derived from the base type: `guid`.

file:mime:pe:export

The fused knowledge of a file:bytes node containing a pe named export. The `file:mime:pe:export` type is derived from the base type: `comp`.

The type `file:mime:pe:export` has the following options set:

- fields: `(('file', 'file:bytes'), ('name', 'str'))`

file:mime:pe:resource

The fused knowledge of a file:bytes node containing a pe resource. The `file:mime:pe:resource` type is derived from the base type: `comp`.

The type `file:mime:pe:resource` has the following options set:

- fields:


```
[
 [
  "file",
  "file:bytes"
 ],
 [
  "type",
  "pe:resource:type"
 ],
 [
  "langid",
  "pe:langid"
 ],
 [
  "resource",
  "file:bytes"
 ]
]
```


file:mime:pe:section

The fused knowledge a file:bytes node containing a pe section. The `file:mime:pe:section` type is derived from the base type: `comp`.

The type `file:mime:pe:section` has the following options set:

- fields: `(('file', 'file:bytes'), ('name', 'str'), ('sha256', 'hash:sha256'))`

file:mime:pe:vsvers:info

knowledge of a file:bytes node containing vsvers info. The `file:mime:pe:vsvers:info` type is derived from the base type: `comp`.

The type `file:mime:pe:vsvers:info` has the following options set:

- fields: `(('file', 'file:bytes'), ('keyval', 'file:mime:pe:vsvers:keyval'))`

file:mime:pe:vsvers:keyval

A key value pair found in a PE vsversion info structure. The `file:mime:pe:vsvers:keyval` type is derived from the base type: `comp`.

The type `file:mime:pe:vsvers:keyval` has the following options set:

- fields: `(('name', 'str'), ('value', 'str'))`

file:mime:png

The GUID of a set of mime metadata for a .png file. The `file:mime:png` type is derived from the base type: `guid`.

file:mime:rtf

The GUID of a set of mime metadata for a .rtf file. The `file:mime:rtf` type is derived from the base type: `guid`.

file:mime:tif

The GUID of a set of mime metadata for a .tif file. The `file:mime:tif` type is derived from the base type: `guid`.

file:string

Deprecated. Please use the edge -(refs)> it:dev:str. The `file:string` type is derived from the base type: `comp`.

The type `file:string` has the following options set:

- fields: `(('file', 'file:bytes'), ('string', 'str'))`

file:subfile

A parent file that fully contains the specified child file. The `file:subfile` type is derived from the base type: `comp`.

The type `file:subfile` has the following options set:

- fields: `(('parent', 'file:bytes'), ('child', 'file:bytes'))`

geo:address

A street/mailing address string. The `geo:address` type is derived from the base type: `str`.

The type `geo:address` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

geo:altitude

A negative or positive offset from Mean Sea Level (6,371.0088km from Earths core). The `geo:altitude` type is derived from the base type: `geo:dist`.

An example of `geo:altitude`:

- `10 km`

The type `geo:altitude` has the following options set:

- baseoff: `6371008800`
- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

geo:bbox

A geospatial bounding box in (xmin, xmax, ymin, ymax) format. The `geo:bbox` type is derived from the base type: `comp`.

The type `geo:bbox` has the following options set:

- fields:

```
[
 [
  "xmin",
  "geo:longitude"
 ],
 [
  "xmax",
  "geo:longitude"
```

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```
 ],
 [
  "ymin",
  "geo:latitude"
 ],
 [
  "ymax",
  "geo:latitude"
 ]
]
```

- sepr: ,

geo:json

GeoJSON structured JSON data. The `geo:json` type is derived from the base type: `data`.

The type `geo:json` has the following options set:

- schema:

```
{
 "$schema": "http://json-schema.org/draft-07/schema#",
 "definitions": {
  "BoundingBox": {
   "items": {
    "type": "number"
   },
   "minItems": 4,
   "type": "array"
  },
  "Feature": {
   "properties": {
    "bbox": {
     "$ref": "#/definitions/BoundingBox"
    },
    "geometry": {
     "oneOf": [
      {
       "type": "null"
      },
      {
       "$ref": "#/definitions/Point"
      },
      {
       "$ref": "#/definitions/LineString"
      },
      {
       "$ref": "#/definitions/Polygon"
      },
      {
       "$ref": "#/definitions/MultiPoint"
```

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```
      },
      {
       "$ref": "#/definitions/MultiLineString"
      },
      {
       "$ref": "#/definitions/MultiPolygon"
      },
      {
       "$ref": "#/definitions/GeometryCollection"
      }
     ]
    },
    "properties": {
     "oneOf": [
      {
       "type": "null"
      },
      {
       "type": "object"
      }
     ]
    },
    "type": {
     "enum": [
      "Feature"
     ],
     "type": "string"
    }
   },
   "required": [
    "type",
    "properties",
    "geometry"
   ],
   "title": "GeoJSON Feature",
   "type": "object"
  },
  "FeatureCollection": {
   "properties": {
    "bbox": {
     "$ref": "#/definitions/BoundingBox"
    },
    "features": {
     "items": {
      "$ref": "#/definitions/Feature"
     },
     "type": "array"
    },
    "type": {
     "enum": [
      "FeatureCollection"
     ],
```

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```
    "type": "string"
   }
  },
  "required": [
   "type",
   "features"
  ],
  "title": "GeoJSON FeatureCollection",
  "type": "object"
 },
 "GeometryCollection": {
  "properties": {
   "bbox": {
    "$ref": "#/definitions/BoundingBox"
   },
   "geometries": {
    "items": {
     "oneOf": [
      {
       "$ref": "#/definitions/Point"
      },
      {
       "$ref": "#/definitions/LineString"
      },
      {
       "$ref": "#/definitions/Polygon"
      },
      {
       "$ref": "#/definitions/MultiPoint"
      },
      {
       "$ref": "#/definitions/MultiLineString"
      },
      {
       "$ref": "#/definitions/MultiPolygon"
      }
     ]
    },
    "type": "array"
   },
   "type": {
    "enum": [
     "GeometryCollection"
    ],
    "type": "string"
   }
  },
  "required": [
   "type",
   "geometries"
  ],
  "title": "GeoJSON GeometryCollection",
```

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```
  "type": "object"
 },
 "LineString": {
  "properties": {
   "bbox": {
    "$ref": "#/definitions/BoundingBox"
   },
   "coordinates": {
    "$ref": "#/definitions/LineStringCoordinates"
   },
   "type": {
    "enum": [
     "LineString"
    ],
    "type": "string"
   }
  },
  "required": [
   "type",
   "coordinates"
  ],
  "title": "GeoJSON LineString",
  "type": "object"
 },
 "LineStringCoordinates": {
  "items": {
   "$ref": "#/definitions/PointCoordinates"
  },
  "minItems": 2,
  "type": "array"
 },
 "LinearRingCoordinates": {
  "items": {
   "$ref": "#/definitions/PointCoordinates"
  },
  "minItems": 4,
  "type": "array"
 },
 "MultiLineString": {
  "properties": {
   "bbox": {
    "$ref": "#/definitions/BoundingBox"
   },
   "coordinates": {
    "items": {
     "$ref": "#/definitions/LineStringCoordinates"
    },
    "type": "array"
   },
   "type": {
    "enum": [
     "MultiLineString"
```

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```
    ],
    "type": "string"
   }
  },
  "required": [
   "type",
   "coordinates"
  ],
  "title": "GeoJSON MultiLineString",
  "type": "object"
 },
 "MultiPoint": {
  "properties": {
   "bbox": {
    "$ref": "#/definitions/BoundingBox"
   },
   "coordinates": {
    "items": {
     "$ref": "#/definitions/PointCoordinates"
    },
    "type": "array"
   },
   "type": {
    "enum": [
     "MultiPoint"
    ],
    "type": "string"
   }
  },
  "required": [
   "type",
   "coordinates"
  ],
  "title": "GeoJSON MultiPoint",
  "type": "object"
 },
 "MultiPolygon": {
  "properties": {
   "bbox": {
    "$ref": "#/definitions/BoundingBox"
   },
   "coordinates": {
    "items": {
     "$ref": "#/definitions/PolygonCoordinates"
    },
    "type": "array"
   },
   "type": {
    "enum": [
     "MultiPolygon"
    ],
    "type": "string"
```

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```
    }
   },
   "required": [
    "type",
    "coordinates"
   ],
   "title": "GeoJSON MultiPolygon",
   "type": "object"
  },
  "Point": {
   "properties": {
    "bbox": {
     "$ref": "#/definitions/BoundingBox"
    },
    "coordinates": {
     "$ref": "#/definitions/PointCoordinates"
    },
    "type": {
     "enum": [
      "Point"
     ],
     "type": "string"
    }
   },
   "required": [
    "type",
    "coordinates"
   ],
   "title": "GeoJSON Point",
   "type": "object"
  },
  "PointCoordinates": {
   "items": {
    "type": "number"
   },
   "minItems": 2,
   "type": "array"
  },
  "Polygon": {
   "properties": {
    "bbox": {
     "$ref": "#/definitions/BoundingBox"
    },
    "coordinates": {
     "$ref": "#/definitions/PolygonCoordinates"
    },
    "type": {
     "enum": [
      "Polygon"
     ],
     "type": "string"
    }
```

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```
    },
    "required": [
     "type",
     "coordinates"
    ],
    "title": "GeoJSON Polygon",
    "type": "object"
   },
   "PolygonCoordinates": {
    "items": {
     "$ref": "#/definitions/LinearRingCoordinates"
    },
    "type": "array"
   }
  },
  "oneOf": [
   {
    "$ref": "#/definitions/Point"
   },
   {
    "$ref": "#/definitions/LineString"
   },
   {
    "$ref": "#/definitions/Polygon"
   },
   {
    "$ref": "#/definitions/MultiPoint"
   },
   {
    "$ref": "#/definitions/MultiLineString"
   },
   {
    "$ref": "#/definitions/MultiPolygon"
   },
   {
    "$ref": "#/definitions/GeometryCollection"
   },
   {
    "$ref": "#/definitions/Feature"
   },
   {
    "$ref": "#/definitions/FeatureCollection"
   }
  ]
}
```

geo:latitude

A latitude in floating point notation. The `geo:latitude` type is derived from the base type: `float`.

An example of `geo:latitude`:

- `31.337`

The type `geo:latitude` has the following options set:

- fmt: `%f`
- max: `90.0`
- maxisvalid: `True`
- min: `-90.0`
- minisvalid: `True`

geo:longitude

A longitude in floating point notation. The `geo:longitude` type is derived from the base type: `float`.

An example of `geo:longitude`:

- `31.337`

The type `geo:longitude` has the following options set:

- fmt: `%f`
- max: `180.0`
- maxisvalid: `True`
- min: `-180.0`
- minisvalid: `False`

geo:name

An unstructured place name or address. The `geo:name` type is derived from the base type: `str`.

The type `geo:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

geo:nloc

Records a node latitude/longitude in space-time. The `geo:nloc` type is derived from the base type: `comp`.

The type `geo:nloc` has the following options set:

- fields: `(('ndef', 'ndef'), ('latlong', 'geo:latlong'), ('time', 'time'))`

geo:place

A GUID for a geographic place. The `geo:place` type is derived from the base type: `guid`.

geo:place:taxonomy

A taxonomy of place types. The `geo:place:taxonomy` type is derived from the base type: `taxonomy`.

The type `geo:place:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

geo:telem

A geospatial position of a node at a given time. The node should be linked via -(seenat)> edges. The `geo:telem` type is derived from the base type: `guid`.

gov:cn:icp

A Chinese Internet Content Provider ID. The `gov:cn:icp` type is derived from the base type: `int`.

The type `gov:cn:icp` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

gov:cn:mucd

A Chinese PLA MUCD. The `gov:cn:mucd` type is derived from the base type: `int`.

The type `gov:cn:mucd` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

gov:intl:un:m49

UN M49 Numeric Country Code. The `gov:intl:un:m49` type is derived from the base type: `int`.

The type `gov:intl:un:m49` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `999`
- min: `1`
- signed: `True`
- size: `8`

gov:us:cage

A Commercial and Government Entity (CAGE) code. The `gov:us:cage` type is derived from the base type: `str`.

The type `gov:us:cage` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

gov:us:ssn

A US Social Security Number (SSN). The `gov:us:ssn` type is derived from the base type: `int`.

The type `gov:us:ssn` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

gov:us:zip

A US Postal Zip Code. The `gov:us:zip` type is derived from the base type: `int`.

The type `gov:us:zip` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

graph:cluster

A generic node, used in conjunction with Edge types, to cluster arbitrary nodes to a single node in the model. The `graph:cluster` type is derived from the base type: `guid`.

graph:edge

A generic digraph edge to show relationships outside the model. The `graph:edge` type is derived from the base type: `edge`.

graph:event

A generic event node to represent events outside the model. The `graph:event` type is derived from the base type: `guid`.

graph:node

A generic node used to represent objects outside the model. The `graph:node` type is derived from the base type: `guid`.

graph:timeedge

A generic digraph time edge to show relationships outside the model. The `graph:timeedge` type is derived from the base type: `timeedge`.

hash:lm

A hex encoded Microsoft Windows LM password hash. The `hash:lm` type is derived from the base type: `hex`.

An example of `hash:lm`:

- `d41d8cd98f00b204e9800998ecf8427e`

The type `hash:lm` has the following options set:

- size: `32`

hash:md5

A hex encoded MD5 hash. The `hash:md5` type is derived from the base type: `hex`.

An example of `hash:md5`:

- `d41d8cd98f00b204e9800998ecf8427e`

The type `hash:md5` has the following options set:

- size: `32`

hash:ntlm

A hex encoded Microsoft Windows NTLM password hash. The `hash:ntlm` type is derived from the base type: `hex`.

An example of `hash:ntlm`:

- `d41d8cd98f00b204e9800998ecf8427e`

The type `hash:ntlm` has the following options set:

- size: `32`

hash:sha1

A hex encoded SHA1 hash. The hash:sha1 type is derived from the base type: hex.

An example of hash:sha1:

- da39a3ee5e6b4b0d3255bfef95601890afd80709

The type hash:sha1 has the following options set:

- size: 40

hash:sha256

A hex encoded SHA256 hash. The hash:sha256 type is derived from the base type: hex.

An example of hash:sha256:

- ad9f4fe922b61e674a09530831759843b1880381de686a43460a76864ca0340c

The type hash:sha256 has the following options set:

- size: 64

hash:sha384

A hex encoded SHA384 hash. The hash:sha384 type is derived from the base type: hex.

An example of hash:sha384:

- d425f1394e418ce01ed1579069a8bfaa1da8f32cf823982113ccbef531fa36bda9987f389c5af05b5e28035242efab6c

The type hash:sha384 has the following options set:

- size: 96

hash:sha512

A hex encoded SHA512 hash. The hash:sha512 type is derived from the base type: hex.

An example of hash:sha512:

- ca74fe2ff2d03b29339ad7d08ba21d192077fece1715291c7b43c20c9136cd132788239189f3441a87eb23ce2660aa243f

The type hash:sha512 has the following options set:

- size: 128

inet:asn

An Autonomous System Number (ASN). The inet:asn type is derived from the base type: int.

The type inet:asn has the following options set:

- fmt: %d
- ismax: False
- ismin: False
- max: None

- min: None
- signed: True
- size: 8

inet:asnet4

An Autonomous System Number (ASN) and its associated IPv4 address range. The inet:asnet4 type is derived from the base type: comp.

An example of inet:asnet4:

- (54959, (1.2.3.4, 1.2.3.20))

The type inet:asnet4 has the following options set:

- fields: (('asn', 'inet:asn'), ('net4', 'inet:net4'))

inet:asnet6

An Autonomous System Number (ASN) and its associated IPv6 address range. The inet:asnet6 type is derived from the base type: comp.

An example of inet:asnet6:

- (54959, (ff::00, ff::02))

The type inet:asnet6 has the following options set:

- fields: (('asn', 'inet:asn'), ('net6', 'inet:net6'))

inet:banner

A network protocol banner string presented by a server. The inet:banner type is derived from the base type: comp.

The type inet:banner has the following options set:

- fields: (('server', 'inet:server'), ('text', 'it:dev:str'))

inet:client

A network client address. The inet:client type is derived from the base type: inet:addr.

An example of inet:client:

- tcp://1.2.3.4:80

The type inet:client has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

inet:dns:a

The result of a DNS A record lookup. The inet:dns:a type is derived from the base type: comp.

An example of inet:dns:a:

- (vertex.link,1.2.3.4)

The type inet:dns:a has the following options set:

- fields: (('fqdn', 'inet:fqdn'), ('ipv4', 'inet:ipv4'))

inet:dns:aaaa

The result of a DNS AAAA record lookup. The inet:dns:aaaa type is derived from the base type: comp.

An example of inet:dns:aaaa:

- (vertex.link,2607:f8b0:4004:809::200e)

The type inet:dns:aaaa has the following options set:

- fields: (('fqdn', 'inet:fqdn'), ('ipv6', 'inet:ipv6'))

inet:dns:answer

A single answer from within a DNS reply. The inet:dns:answer type is derived from the base type: guid.

inet:dns:cname

The result of a DNS CNAME record lookup. The inet:dns:cname type is derived from the base type: comp.

An example of inet:dns:cname:

- (foo.vertex.link,vertex.link)

The type inet:dns:cname has the following options set:

- fields: (('fqdn', 'inet:fqdn'), ('cname', 'inet:fqdn'))

inet:dns:dynreg

A dynamic DNS registration. The inet:dns:dynreg type is derived from the base type: guid.

inet:dns:mx

The result of a DNS MX record lookup. The inet:dns:mx type is derived from the base type: comp.

An example of inet:dns:mx:

- (vertex.link,mail.vertex.link)

The type inet:dns:mx has the following options set:

- fields: (('fqdn', 'inet:fqdn'), ('mx', 'inet:fqdn'))

inet:dns:ns

The result of a DNS NS record lookup. The `inet:dns:ns` type is derived from the base type: `comp`.

An example of `inet:dns:ns`:

- `(vertex.link,ns.dnshost.com)`

The type `inet:dns:ns` has the following options set:

- fields: `(('zone', 'inet:fqdn'), ('ns', 'inet:fqdn'))`

inet:dns:query

A DNS query unique to a given client. The `inet:dns:query` type is derived from the base type: `comp`.

An example of `inet:dns:query`:

- `(1.2.3.4, woot.com, 1)`

The type `inet:dns:query` has the following options set:

- fields: `(('client', 'inet:client'), ('name', 'inet:dns:name'), ('type', 'int'))`

inet:dns:request

A single instance of a DNS resolver request and optional reply info. The `inet:dns:request` type is derived from the base type: `guid`.

inet:dns:rev

The transformed result of a DNS PTR record lookup. The `inet:dns:rev` type is derived from the base type: `comp`.

An example of `inet:dns:rev`:

- `(1.2.3.4,vertex.link)`

The type `inet:dns:rev` has the following options set:

- fields: `(('ipv4', 'inet:ipv4'), ('fqdn', 'inet:fqdn'))`

inet:dns:rev6

The transformed result of a DNS PTR record for an IPv6 address. The `inet:dns:rev6` type is derived from the base type: `comp`.

An example of `inet:dns:rev6`:

- `(2607:f8b0:4004:809::200e,vertex.link)`

The type `inet:dns:rev6` has the following options set:

- fields: `(('ipv6', 'inet:ipv6'), ('fqdn', 'inet:fqdn'))`

inet:dns:soa

The result of a DNS SOA record lookup. The `inet:dns:soa` type is derived from the base type: `guid`.

inet:dns:txt

The result of a DNS MX record lookup. The `inet:dns:txt` type is derived from the base type: `comp`.

An example of `inet:dns:txt`:

- `(hehe.vertex.link,"fancy TXT record")`

The type `inet:dns:txt` has the following options set:

- fields: `(('fqdn', 'inet:fqdn'), ('txt', 'str'))`

inet:dns:type

A DNS query/answer type integer. The `inet:dns:type` type is derived from the base type: `int`.

The type `inet:dns:type` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

inet:dns:wild:a

A DNS A wild card record and the IPv4 it resolves to. The `inet:dns:wild:a` type is derived from the base type: `comp`.

The type `inet:dns:wild:a` has the following options set:

- fields: `(('fqdn', 'inet:fqdn'), ('ipv4', 'inet:ipv4'))`

inet:dns:wild:aaaa

A DNS AAAA wild card record and the IPv6 it resolves to. The `inet:dns:wild:aaaa` type is derived from the base type: `comp`.

The type `inet:dns:wild:aaaa` has the following options set:

- fields: `(('fqdn', 'inet:fqdn'), ('ipv6', 'inet:ipv6'))`

inet:download

An instance of a file downloaded from a server. The `inet:download` type is derived from the base type: `guid`.

inet:egress

A host using a specific network egress client address. The `inet:egress` type is derived from the base type: `guid`.

inet:email:header

A unique email message header. The `inet:email:header` type is derived from the base type: `comp`.

The type `inet:email:header` has the following options set:

- fields: `(('name', 'inet:email:header:name'), ('value', 'str'))`

inet:email:header:name

An email header name. The `inet:email:header:name` type is derived from the base type: `str`.

An example of `inet:email:header:name`:

- `subject`

The type `inet:email:header:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:email:message

A unique email message. The `inet:email:message` type is derived from the base type: `guid`.

inet:email:message:attachment

A file which was attached to an email message. The `inet:email:message:attachment` type is derived from the base type: `comp`.

The type `inet:email:message:attachment` has the following options set:

- fields: `(('message', 'inet:email:message'), ('file', 'file:bytes'))`

inet:email:message:link

A url/link embedded in an email message. The `inet:email:message:link` type is derived from the base type: `comp`.

The type `inet:email:message:link` has the following options set:

- fields: `(('message', 'inet:email:message'), ('url', 'inet:url'))`

inet:flow

An individual network connection between a given source and destination. The `inet:flow` type is derived from the base type: `guid`.

inet:group

A group name string. The `inet:group` type is derived from the base type: `str`.

The type `inet:group` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:http:header

An HTTP protocol header key/value. The `inet:http:header` type is derived from the base type: `comp`.

The type `inet:http:header` has the following options set:

- fields: `(('name', 'inet:http:header:name'), ('value', 'str'))`

inet:http:header:name

The base string type. The `inet:http:header:name` type is derived from the base type: `str`.

The type `inet:http:header:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:http:param

An HTTP request path query parameter. The `inet:http:param` type is derived from the base type: `comp`.

The type `inet:http:param` has the following options set:

- fields: `(('name', 'str'), ('value', 'str'))`

inet:http:request

A single HTTP request. The `inet:http:request` type is derived from the base type: `guid`.

inet:http:request:header

An HTTP request header. The `inet:http:request:header` type is derived from the base type: `inet:http:header`.

The type `inet:http:request:header` has the following options set:

- fields: `(('name', 'inet:http:header:name'), ('value', 'str'))`

inet:http:response:header

An HTTP response header. The `inet:http:response:header` type is derived from the base type: `inet:http:header`.

The type `inet:http:response:header` has the following options set:

- fields: `(('name', 'inet:http:header:name'), ('value', 'str'))`

inet:http:session

An HTTP session. The `inet:http:session` type is derived from the base type: `guid`.

inet:iface

A network interface with a set of associated protocol addresses. The `inet:iface` type is derived from the base type: `guid`.

inet:mac

A 48-bit Media Access Control (MAC) address. The `inet:mac` type is derived from the base type: `str`.

An example of `inet:mac`:

- `aa:bb:cc:dd:ee:ff`

The type `inet:mac` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^([0-9a-f]{2}[:]){5}([0-9a-f]{2})$`

- replace: ()
- strip: False

inet:net4

An IPv4 address range. The inet:net4 type is derived from the base type: inet:ipv4range.

An example of inet:net4:

- (1.2.3.4, 1.2.3.20)

The type inet:net4 has the following options set:

- type: ('inet:ipv4', {})

inet:net6

An IPv6 address range. The inet:net6 type is derived from the base type: inet:ipv6range.

An example of inet:net6:

- ('ff::00', 'ff::30')

The type inet:net6 has the following options set:

- type: ('inet:ipv6', {})

inet:passwd

A password string. The inet:passwd type is derived from the base type: str.

The type inet:passwd has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

inet:port

A network port. The inet:port type is derived from the base type: int.

An example of inet:port:

- 80

The type inet:port has the following options set:

- fmt: %d
- ismax: False
- ismin: False
- max: 65535

- min: 0
- signed: True
- size: 8

inet:proto

A network protocol name. The inet:proto type is derived from the base type: str.

The type inet:proto has the following options set:

- globsuffix: False
- lower: True
- onespace: False
- regex: ^[a-z0-9+-]+$
- replace: ()
- strip: False

inet:search:query

An instance of a search query issued to a search engine. The inet:search:query type is derived from the base type: guid.

inet:search:result

A single result from a web search. The inet:search:result type is derived from the base type: guid.

inet:server

A network server address. The inet:server type is derived from the base type: inet:addr.

An example of inet:server:

- tcp://1.2.3.4:80

The type inet:server has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

inet:servfile

A file hosted on a server for access over a network protocol. The `inet:servfile` type is derived from the base type: `comp`.

The type `inet:servfile` has the following options set:

- fields: `(('server', 'inet:server'), ('file', 'file:bytes'))`

inet:ssl:cert

An SSL certificate file served by a server. The `inet:ssl:cert` type is derived from the base type: `comp`.

An example of `inet:ssl:cert`:

- `(1.2.3.4:443, guid:d41d8cd98f00b204e9800998ecf8427e)`

The type `inet:ssl:cert` has the following options set:

- fields: `(('server', 'inet:server'), ('file', 'file:bytes'))`

inet:ssl:jarmhash

A TLS JARM fingerprint hash. The `inet:ssl:jarmhash` type is derived from the base type: `str`.

The type `inet:ssl:jarmhash` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^(?<ciphers>[0-9a-f]{30})(?<extensions>[0-9a-f]{32})$`
- replace: `()`
- strip: `True`

inet:ssl:jarmsample

A JARM hash sample taken from a server. The `inet:ssl:jarmsample` type is derived from the base type: `comp`.

The type `inet:ssl:jarmsample` has the following options set:

- fields: `(('server', 'inet:server'), ('jarmhash', 'inet:ssl:jarmhash'))`

inet:tunnel

A specific sequence of hosts forwarding connections such as a VPN or proxy. The `inet:tunnel` type is derived from the base type: `guid`.

inet:tunnel:type:taxonomy

A taxonomy of network tunnel types. The `inet:tunnel:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `inet:tunnel:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:url:mirror

A URL mirror site. The `inet:url:mirror` type is derived from the base type: `comp`.

The type `inet:url:mirror` has the following options set:

- fields: `(('of', 'inet:url'), ('at', 'inet:url'))`

inet:urlfile

A file hosted at a specific Universal Resource Locator (URL). The `inet:urlfile` type is derived from the base type: `comp`.

The type `inet:urlfile` has the following options set:

- fields: `(('url', 'inet:url'), ('file', 'file:bytes'))`

inet:urlredir

A URL that redirects to another URL, such as via a URL shortening service or an HTTP 302 response. The `inet:urlredir` type is derived from the base type: `comp`.

An example of `inet:urlredir`:

- `(http://foo.com/,http://bar.com/)`

The type `inet:urlredir` has the following options set:

- fields: `(('src', 'inet:url'), ('dst', 'inet:url'))`

inet:user

A username string. The `inet:user` type is derived from the base type: `str`.

The type `inet:user` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:web:acct

An account with a given Internet-based site or service. The `inet:web:acct` type is derived from the base type: `comp`.

An example of `inet:web:acct`:

- `twitter.com/invisig0th`

The type `inet:web:acct` has the following options set:

- fields: `(('site', 'inet:fqdn'), ('user', 'inet:user'))`
- sepr: `/`

inet:web:action

An instance of an account performing an action at an Internet-based site or service. The `inet:web:action` type is derived from the base type: `guid`.

inet:web:attachment

An instance of a file being sent to a web service by an account. The `inet:web:attachment` type is derived from the base type: `guid`.

inet:web:channel

A channel within a web service or instance such as slack or discord. The `inet:web:channel` type is derived from the base type: `guid`.

inet:web:chprofile

A change to a web account. Used to capture historical properties associated with an account, as opposed to current data in the inet:web:acct node. The `inet:web:chprofile` type is derived from the base type: `guid`.

inet:web:file

A file posted by a web account. The `inet:web:file` type is derived from the base type: `comp`.

The type `inet:web:file` has the following options set:

- fields: `(('acct', 'inet:web:acct'), ('file', 'file:bytes'))`

inet:web:follows

A web account follows or is connected to another web account. The `inet:web:follows` type is derived from the base type: `comp`.

The type `inet:web:follows` has the following options set:

- fields: `(('follower', 'inet:web:acct'), ('followee', 'inet:web:acct'))`

inet:web:group

A group hosted within or registered with a given Internet-based site or service. The `inet:web:group` type is derived from the base type: `comp`.

An example of `inet:web:group`:

- `somesite.com/mycoolgroup`

The type `inet:web:group` has the following options set:

- fields: `(('site', 'inet:fqdn'), ('id', 'inet:group'))`
- sepr: `/`

inet:web:hashtag

A hashtag used in a web post. The `inet:web:hashtag` type is derived from the base type: `str`.

The type `inet:web:hashtag` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^#[\w]+$`
- replace: `()`
- strip: `False`

inet:web:instance

An instance of a web service such as slack or discord. The `inet:web:instance` type is derived from the base type: `guid`.

inet:web:logon

An instance of an account authenticating to an Internet-based site or service. The `inet:web:logon` type is derived from the base type: `guid`.

inet:web:memb

Deprecated. Please use inet:web:member. The `inet:web:memb` type is derived from the base type: `comp`.

The type `inet:web:memb` has the following options set:

- fields: `(('acct', 'inet:web:acct'), ('group', 'inet:web:group'))`

inet:web:member

Represents a web account membership in a channel or group. The `inet:web:member` type is derived from the base type: `guid`.

inet:web:mesg

A message sent from one web account to another web account or channel. The `inet:web:mesg` type is derived from the base type: `comp`.

An example of `inet:web:mesg`:

- `((twitter.com, invisig0th), (twitter.com, gobbles), 20041012130220)`

The type `inet:web:mesg` has the following options set:

- fields: `(('from', 'inet:web:acct'), ('to', 'inet:web:acct'), ('time', 'time'))`

inet:web:post

A post made by a web account. The `inet:web:post` type is derived from the base type: `guid`.

inet:web:post:link

A link contained within post text. The `inet:web:post:link` type is derived from the base type: `guid`.

inet:whois:contact

An individual contact from a domain whois record. The `inet:whois:contact` type is derived from the base type: `comp`.

The type `inet:whois:contact` has the following options set:

- fields: `(('rec', 'inet:whois:rec'), ('type', ('str', {'lower': True})))`

inet:whois:email

An email address associated with an FQDN via whois registration text. The `inet:whois:email` type is derived from the base type: `comp`.

The type `inet:whois:email` has the following options set:

- fields: `(('fqdn', 'inet:fqdn'), ('email', 'inet:email'))`

inet:whois:ipcontact

An individual contact from an IP block record. The `inet:whois:ipcontact` type is derived from the base type: `guid`.

inet:whois:ipquery

Query details used to retrieve an IP record. The `inet:whois:ipquery` type is derived from the base type: `guid`.

inet:whois:iprec

An IPv4/IPv6 block registration record. The `inet:whois:iprec` type is derived from the base type: `guid`.

inet:whois:rar

A domain registrar. The `inet:whois:rar` type is derived from the base type: `str`.

An example of `inet:whois:rar`:

- `godaddy, inc.`

The type `inet:whois:rar` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:whois:rec

A domain whois record. The `inet:whois:rec` type is derived from the base type: `comp`.

The type `inet:whois:rec` has the following options set:

- fields: `(('fqdn', 'inet:fqdn'), ('asof', 'time'))`

inet:whois:recns

A nameserver associated with a domain whois record. The `inet:whois:recns` type is derived from the base type: `comp`.

The type `inet:whois:recns` has the following options set:

- fields: `(('ns', 'inet:fqdn'), ('rec', 'inet:whois:rec'))`

inet:whois:reg

A domain registrant. The `inet:whois:reg` type is derived from the base type: `str`.

An example of `inet:whois:reg`:

- `woot hostmaster`

The type `inet:whois:reg` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:whois:regid

The registry unique identifier of the registration record. The `inet:whois:regid` type is derived from the base type: `str`.

An example of `inet:whois:regid`:

- `NET-10-0-0-0-1`

The type `inet:whois:regid` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

inet:wifi:ap

An SSID/MAC address combination for a wireless access point. The `inet:wifi:ap` type is derived from the base type: `comp`.

The type `inet:wifi:ap` has the following options set:

- fields: `(('ssid', 'inet:wifi:ssid'), ('bssid', 'inet:mac'))`

inet:wifi:ssid

A WiFi service set identifier (SSID) name. The `inet:wifi:ssid` type is derived from the base type: `str`.

An example of `inet:wifi:ssid`:

- `The Vertex Project`

The type `inet:wifi:ssid` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

iso:3166:cc

An ISO 3166 2 digit country code. The `iso:3166:cc` type is derived from the base type: `str`.

The type `iso:3166:cc` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z]{2}$`
- replace: `()`
- strip: `False`

iso:oid

An ISO Object Identifier string. The `iso:oid` type is derived from the base type: `str`.

The type `iso:oid` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^([0-2])((\.0)|(\.[1-9][0-9]*))*$`
- replace: `()`

- strip: `False`

it:account

A GUID that represents an account on a host or network. The `it:account` type is derived from the base type: `guid`.

it:adid

An advertising identification string. The `it:adid` type is derived from the base type: `str`.

The type `it:adid` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

it:app:snort:hit

An instance of a snort rule hit. The `it:app:snort:hit` type is derived from the base type: `guid`.

it:app:snort:rule

A snort rule. The `it:app:snort:rule` type is derived from the base type: `guid`.

it:app:yara:match

A YARA rule match to a file. The `it:app:yara:match` type is derived from the base type: `comp`.

The type `it:app:yara:match` has the following options set:

- fields: `(('rule', 'it:app:yara:rule'), ('file', 'file:bytes'))`

it:app:yara:procmatch

An instance of a YARA rule match to a process. The `it:app:yara:procmatch` type is derived from the base type: `guid`.

it:app:yara:rule

A YARA rule unique identifier. The `it:app:yara:rule` type is derived from the base type: `guid`.

it:auth:passwdhash

An instance of a password hash. The `it:auth:passwdhash` type is derived from the base type: `guid`.

it:av:filehit

A file that triggered an alert on a specific antivirus signature. The `it:av:filehit` type is derived from the base type: `comp`.

The type `it:av:filehit` has the following options set:

- fields: `(('file', 'file:bytes'), ('sig', 'it:av:sig'))`

it:av:prochit

An instance of a process triggering an alert on a specific antivirus signature. The `it:av:prochit` type is derived from the base type: `guid`.

it:av:sig

A signature name within the namespace of an antivirus engine name. The `it:av:sig` type is derived from the base type: `comp`.

The type `it:av:sig` has the following options set:

- fields: `(('soft', 'it:prod:soft'), ('name', 'it:av:signame'))`

it:av:signame

An antivirus signature name. The `it:av:signame` type is derived from the base type: `str`.

The type `it:av:signame` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:cmd

A unique command-line string. The `it:cmd` type is derived from the base type: `str`.

An example of `it:cmd`:

- `foo.exe --dostuff bar`

The type `it:cmd` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

it:dev:int

A developer selected integer constant. The `it:dev:int` type is derived from the base type: `int`.

The type `it:dev:int` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

it:dev:mutex

A string representing a mutex. The `it:dev:mutex` type is derived from the base type: `str`.

The type `it:dev:mutex` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:dev:pipe

A string representing a named pipe. The `it:dev:pipe` type is derived from the base type: `str`.

The type `it:dev:pipe` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:dev:regkey

A Windows registry key. The `it:dev:regkey` type is derived from the base type: `str`.

An example of `it:dev:regkey`:

- `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run`

The type `it:dev:regkey` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:dev:regval

A Windows registry key/value pair. The `it:dev:regval` type is derived from the base type: `guid`.

it:dev:str

A developer-selected string. The `it:dev:str` type is derived from the base type: `str`.

The type `it:dev:str` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:domain

A logical boundary of authentication and configuration such as a windows domain. The `it:domain` type is derived from the base type: `guid`.

it:exec:bind

An instance of a host binding a listening port. The `it:exec:bind` type is derived from the base type: `guid`.

it:exec:file:add

An instance of a host adding a file to a filesystem. The `it:exec:file:add` type is derived from the base type: `guid`.

it:exec:file:del

An instance of a host deleting a file from a filesystem. The `it:exec:file:del` type is derived from the base type: `guid`.

it:exec:file:read

An instance of a host reading a file from a filesystem. The `it:exec:file:read` type is derived from the base type: `guid`.

it:exec:file:write

An instance of a host writing a file to a filesystem. The `it:exec:file:write` type is derived from the base type: `guid`.

it:exec:loadlib

A library load event in a process. The `it:exec:loadlib` type is derived from the base type: `guid`.

it:exec:mmap

A memory mapped segment located in a process. The `it:exec:mmap` type is derived from the base type: `guid`.

it:exec:mutex

A mutex created by a process at runtime. The `it:exec:mutex` type is derived from the base type: `guid`.

it:exec:pipe

A named pipe created by a process at runtime. The `it:exec:pipe` type is derived from the base type: `guid`.

it:exec:proc

A process executing on a host. May be an actual (e.g., endpoint) or virtual (e.g., malware sandbox) host. The `it:exec:proc` type is derived from the base type: `guid`.

it:exec:query

An instance of an executed query. The `it:exec:query` type is derived from the base type: `guid`.

it:exec:reg:del

An instance of a host deleting a registry key. The `it:exec:reg:del` type is derived from the base type: `guid`.

it:exec:reg:get

An instance of a host getting a registry key. The `it:exec:reg:get` type is derived from the base type: `guid`.

it:exec:reg:set

An instance of a host creating or setting a registry key. The `it:exec:reg:set` type is derived from the base type: `guid`.

it:exec:thread

A thread executing in a process. The `it:exec:thread` type is derived from the base type: `guid`.

it:exec:url

An instance of a host requesting a URL. The `it:exec:url` type is derived from the base type: `guid`.

it:fs:file

A file on a host. The `it:fs:file` type is derived from the base type: `guid`.

it:group

A GUID that represents a group on a host or network. The `it:group` type is derived from the base type: `guid`.

it:host

A GUID that represents a host or system. The `it:host` type is derived from the base type: `guid`.

it:hostname

The name of a host or system. The `it:hostname` type is derived from the base type: `str`.

The type `it:hostname` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

it:hostsoft

A version of a software product which is present on a given host. The `it:hostsoft` type is derived from the base type: `comp`.

The type `it:hostsoft` has the following options set:

- fields: `(('host', 'it:host'), ('softver', 'it:prod:softver'))`

it:hosturl

A url hosted on or served by a host or system. The `it:hosturl` type is derived from the base type: `comp`.

The type `it:hosturl` has the following options set:

- fields: `(('host', 'it:host'), ('url', 'inet:url'))`

it:log:event

A GUID representing an individual log event. The `it:log:event` type is derived from the base type: `guid`.

it:log:event:type:taxonomy

A taxonomy of log event types. The `it:log:event:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `it:log:event:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`

- strip: `False`

it:logon

A GUID that represents an individual logon/logoff event. The `it:logon` type is derived from the base type: `guid`.

it:mitre:attack:group

A Mitre ATT&CK Group ID. The `it:mitre:attack:group` type is derived from the base type: `str`.

An example of `it:mitre:attack:group`:

- `G0100`

The type `it:mitre:attack:group` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^G[0-9]{4}$`
- replace: `()`
- strip: `False`

it:mitre:attack:matrix

An enumeration of ATT&CK matrix values. The `it:mitre:attack:matrix` type is derived from the base type: `str`.

An example of `it:mitre:attack:matrix`:

- `enterprise`

The type `it:mitre:attack:matrix` has the following options set:

- enums:

valu
enterprise
mobile
ics

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:mitre:attack:mitigation

A Mitre ATT&CK Mitigation ID. The `it:mitre:attack:mitigation` type is derived from the base type: `str`.

An example of `it:mitre:attack:mitigation`:

- `M1036`

The type `it:mitre:attack:mitigation` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^M[0-9]{4}$`
- replace: `()`
- strip: `False`

it:mitre:attack:software

A Mitre ATT&CK Software ID. The `it:mitre:attack:software` type is derived from the base type: `str`.

An example of `it:mitre:attack:software`:

- `S0154`

The type `it:mitre:attack:software` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^S[0-9]{4}$`
- replace: `()`
- strip: `False`

it:mitre:attack:status

A Mitre ATT&CK element status. The `it:mitre:attack:status` type is derived from the base type: `str`.

An example of `it:mitre:attack:status`:

- `current`

The type `it:mitre:attack:status` has the following options set:

- enums:

valu
current
deprecated
withdrawn

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:mitre:attack:tactic

A Mitre ATT&CK Tactic ID. The `it:mitre:attack:tactic` type is derived from the base type: `str`.

An example of `it:mitre:attack:tactic`:

- `TA0040`

The type `it:mitre:attack:tactic` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^TA[0-9]{4}$`
- replace: `()`
- strip: `False`

it:mitre:attack:technique

A Mitre ATT&CK Technique ID. The `it:mitre:attack:technique` type is derived from the base type: `str`.

An example of `it:mitre:attack:technique`:

- `T1548`

The type `it:mitre:attack:technique` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^T[0-9]{4}(.[0-9]{3})?$`
- replace: `()`

- strip: False

it:network

A GUID that represents a logical network. The it:network type is derived from the base type: guid.

it:os:android:aaid

An android advertising identification string. The it:os:android:aaid type is derived from the base type: it:adid.

The type it:os:android:aaid has the following options set:

- globsuffix: False
- lower: True
- onespace: False
- regex: None
- replace: ()
- strip: True

it:os:android:ibroadcast

The given software broadcasts the given Android intent. The it:os:android:ibroadcast type is derived from the base type: comp.

The type it:os:android:ibroadcast has the following options set:

- fields: (('app', 'it:prod:soft'), ('intent', 'it:os:android:intent'))

it:os:android:ilisten

The given software listens for an android intent. The it:os:android:ilisten type is derived from the base type: comp.

The type it:os:android:ilisten has the following options set:

- fields: (('app', 'it:prod:soft'), ('intent', 'it:os:android:intent'))

it:os:android:intent

An android intent string. The it:os:android:intent type is derived from the base type: str.

The type it:os:android:intent has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

it:os:android:perm

An android permission string. The `it:os:android:perm` type is derived from the base type: `str`.

The type `it:os:android:perm` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:os:android:reqperm

The given software requests the android permission. The `it:os:android:reqperm` type is derived from the base type: `comp`.

The type `it:os:android:reqperm` has the following options set:

- fields: `(('app', 'it:prod:soft'), ('perm', 'it:os:android:perm'))`

it:os:ios:idfa

An iOS advertising identification string. The `it:os:ios:idfa` type is derived from the base type: `it:adid`.

The type `it:os:ios:idfa` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

it:os:windows:sid

A Microsoft Windows Security Identifier. The `it:os:windows:sid` type is derived from the base type: `str`.

An example of `it:os:windows:sid`:

- `S-1-5-21-1220945662-1202665555-839525555-5555`

The type `it:os:windows:sid` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^S-1-[0-59]-\d{2}-\d{8,10}-\d{8,10}-\d{8,10}-[1-9]\d{3}$`
- replace: `()`

- strip: `False`

it:prod:component

A specific instance of an it:prod:hardware most often as part of an it:host. The `it:prod:component` type is derived from the base type: `guid`.

it:prod:hardware

A specification for a piece of IT hardware. The `it:prod:hardware` type is derived from the base type: `guid`.

it:prod:hardwaretype

An IT hardware type taxonomy. The `it:prod:hardwaretype` type is derived from the base type: `taxonomy`.

The type `it:prod:hardwaretype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:prod:soft

A software product. The `it:prod:soft` type is derived from the base type: `guid`.

it:prod:soft:taxonomy

A software type taxonomy. The `it:prod:soft:taxonomy` type is derived from the base type: `taxonomy`.

The type `it:prod:soft:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:prod:softfile

A file is distributed by a specific software version. The `it:prod:softfile` type is derived from the base type: `comp`.

The type `it:prod:softfile` has the following options set:

- fields: `(('soft', 'it:prod:softver'), ('file', 'file:bytes'))`

it:prod:softid

An identifier issued to a given host by a specific software application. The `it:prod:softid` type is derived from the base type: `guid`.

it:prod:softlib

A software version contains a library software version. The `it:prod:softlib` type is derived from the base type: `comp`.

The type `it:prod:softlib` has the following options set:

- fields: `(('soft', 'it:prod:softver'), ('lib', 'it:prod:softver'))`

it:prod:softname

A software product name. The `it:prod:softname` type is derived from the base type: `str`.

The type `it:prod:softname` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

it:prod:softos

The software version is known to be compatible with the given os software version. The `it:prod:softos` type is derived from the base type: `comp`.

The type `it:prod:softos` has the following options set:

- fields: `(('soft', 'it:prod:softver'), ('os', 'it:prod:softver'))`

it:prod:softreg

A registry entry is created by a specific software version. The `it:prod:softreg` type is derived from the base type: `comp`.

The type `it:prod:softreg` has the following options set:

- fields: `(('softver', 'it:prod:softver'), ('regval', 'it:dev:regval'))`

it:prod:softver

A specific version of a software product. The `it:prod:softver` type is derived from the base type: `guid`.

it:query

A unique query string. The `it:query` type is derived from the base type: `str`.

The type `it:query` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

it:reveng:filefunc

An instance of a function in an executable. The `it:reveng:filefunc` type is derived from the base type: `comp`.

The type `it:reveng:filefunc` has the following options set:

- fields: `(('file', 'file:bytes'), ('function', 'it:reveng:function'))`

it:reveng:funcstr

A reference to a string inside a function. The `it:reveng:funcstr` type is derived from the base type: `comp`.

The type `it:reveng:funcstr` has the following options set:

- fields: `(('function', 'it:reveng:function'), ('string', 'str'))`

it:reveng:function

A function inside an executable. The `it:reveng:function` type is derived from the base type: `guid`.

it:reveng:impfunc

A function from an imported library. The `it:reveng:impfunc` type is derived from the base type: `str`.

The type `it:reveng:impfunc` has the following options set:

- globsuffix: `False`
- lower: `1`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

it:screenshot

A screenshot of a host. The `it:screenshot` type is derived from the base type: `guid`.

it:sec:c2:config

An extracted C2 config from an executable. The `it:sec:c2:config` type is derived from the base type: `guid`.

it:sec:cve

A vulnerability as designated by a Common Vulnerabilities and Exposures (CVE) number. The `it:sec:cve` type is derived from the base type: `str`.

An example of `it:sec:cve`:

- `cve-2012-0158`

The type `it:sec:cve` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `(?i)^CVE-[0-9]{4}-[0-9]{4,}$`
- replace: `(('-', '-'), ('-', '-'), ('-', '-'), ('-', '-'))`
- strip: `False`

it:sec:cwe

NIST NVD Common Weaknesses Enumeration Specification. The `it:sec:cwe` type is derived from the base type: `str`.

An example of `it:sec:cwe`:

- `CWE-120`

The type `it:sec:cwe` has the following options set:

- globsuffix: `False`

- lower: `False`
- onespace: `False`
- regex: `^CWE-[0-9]{1,8}$`
- replace: `()`
- strip: `False`

it:sec:stix:bundle

A STIX bundle. The `it:sec:stix:bundle` type is derived from the base type: `guid`.

it:sec:stix:indicator

A STIX indicator pattern. The `it:sec:stix:indicator` type is derived from the base type: `guid`.

lang:code

An optionally 2 part language code. The `lang:code` type is derived from the base type: `str`.

An example of `lang:code`:

- `pt.br`

The type `lang:code` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z]{2}(.[a-z]{2})?$`
- replace: `()`
- strip: `False`

lang:idiom

Deprecated. Please use lang:translation. The `lang:idiom` type is derived from the base type: `str`.

The type `lang:idiom` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

lang:language

A specific written or spoken language. The `lang:language` type is derived from the base type: `guid`.

lang:name

A name used to refer to a language. The `lang:name` type is derived from the base type: `str`.

The type `lang:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

lang:trans

Deprecated. Please use lang:translation. The `lang:trans` type is derived from the base type: `str`.

The type `lang:trans` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

lang:translation

A translation of text from one language to another. The `lang:translation` type is derived from the base type: `guid`.

mass

A mass which converts to grams as a base unit. The `mass` type is derived from the base type: `hugenum`.

The type `mass` has the following options set:

- modulo: `None`
- units: `{'µg': '0.000001', 'microgram': '0.000001', 'micrograms': '0.000001', 'mg': '0.001', 'milligram': '0.001', 'milligrams': '0.001', 'g': '1', 'grams': '1', 'kg': '1000', 'kilogram': '1000', 'kilograms': '1000', 'lb': '453.592', 'lbs': '453.592', 'pound': '453.592', 'pounds': '453.592', 'stone': '6350.29'}`

mat:item

A GUID assigned to a material object. The `mat:item` type is derived from the base type: `guid`.

mat:itemimage

The base type for compound node fields. The `mat:itemimage` type is derived from the base type: `comp`.

The type `mat:itemimage` has the following options set:

- fields: `(('item', 'mat:item'), ('file', 'file:bytes'))`

mat:spec

A GUID assigned to a material specification. The `mat:spec` type is derived from the base type: `guid`.

mat:specimage

The base type for compound node fields. The `mat:specimage` type is derived from the base type: `comp`.

The type `mat:specimage` has the following options set:

- fields: `(('spec', 'mat:spec'), ('file', 'file:bytes'))`

mat:type

A taxonomy of material item/specification types. The `mat:type` type is derived from the base type: `taxonomy`.

The type `mat:type` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

media:news

A GUID for a news article or report. The `media:news` type is derived from the base type: `guid`.

media:news:taxonomy

A taxonomy of types or sources of news. The `media:news:taxonomy` type is derived from the base type: `taxonomy`.

The type `media:news:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

media:topic

A topic string. The `media:topic` type is derived from the base type: `str`.

The type `media:topic` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

meta:event

An analytically relevant event in a curated timeline. The `meta:event` type is derived from the base type: `guid`.

meta:event:taxonomy

A taxonomy of event types for meta:event nodes. The `meta:event:taxonomy` type is derived from the base type: `taxonomy`.

The type `meta:event:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

meta:note

An analyst note about nodes linked with -(about)> edges. The `meta:note` type is derived from the base type: `guid`.

meta:note:type:taxonomy

An analyst note type taxonomy. The `meta:note:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `meta:note:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

meta:rule

A generic rule linked to matches with -(matches)> edges. The `meta:rule` type is derived from the base type: `guid`.

meta:ruleset

A set of rules linked with -(has)> edges. The `meta:ruleset` type is derived from the base type: `guid`.

meta:seen

Annotates that the data in a node was obtained from or observed by a given source. The `meta:seen` type is derived from the base type: `comp`.

The type `meta:seen` has the following options set:

- fields: `(('source', 'meta:source'), ('node', 'ndef'))`

meta:sophistication

A sophistication score with named values: very low, low, medium, high, and very high. The `meta:sophistication` type is derived from the base type: `int`.

The type `meta:sophistication` has the following options set:

- enums:

int	valu
10	very low
20	low
30	medium
40	high
50	very high

- fmt: %d
- ismax: False
- ismin: False
- max: None
- min: None
- signed: True
- size: 8

meta:source

A data source unique identifier. The meta:source type is derived from the base type: guid.

meta:timeline

A curated timeline of analytically relevant events. The meta:timeline type is derived from the base type: guid.

meta:timeline:taxonomy

A taxonomy of timeline types for meta:timeline nodes. The meta:timeline:taxonomy type is derived from the base type: taxonomy.

The type meta:timeline:taxonomy has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

ou:alias

An alias for the org GUID. The ou:alias type is derived from the base type: str.

An example of ou:alias:

- vertexproject

The type ou:alias has the following options set:

- globsuffix: False
- lower: True
- onespace: False
- regex: ^[0-9a-z_]+$
- replace: ()
- strip: False

ou:attendee

A node representing a person attending a meeting, conference, or event. The `ou:attendee` type is derived from the base type: `guid`.

ou:award

An award issued by an organization. The `ou:award` type is derived from the base type: `guid`.

ou:campaign

Represents an org's activity in pursuit of a goal. The `ou:campaign` type is derived from the base type: `guid`.

ou:campname

A campaign name. The `ou:campname` type is derived from the base type: `str`.

The type `ou:campname` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

ou:camptype

An campaign type taxonomy. The `ou:camptype` type is derived from the base type: `taxonomy`.

The type `ou:camptype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:conference

A conference with a name and sponsoring org. The ou:conference type is derived from the base type: guid.

ou:conference:attendee

Deprecated. Please use ou:attendee. The ou:conference:attendee type is derived from the base type: comp.

The type ou:conference:attendee has the following options set:

- fields: (('conference', 'ou:conference'), ('person', 'ps:person'))

ou:conference:event

A conference event with a name and associated conference. The ou:conference:event type is derived from the base type: guid.

ou:conference:event:attendee

Deprecated. Please use ou:attendee. The ou:conference:event:attendee type is derived from the base type: comp.

The type ou:conference:event:attendee has the following options set:

- fields: (('conference', 'ou:conference:event'), ('person', 'ps:person'))

ou:conflict

Represents a conflict where two or more campaigns have mutually exclusive goals. The ou:conflict type is derived from the base type: guid.

ou:contest

A competitive event resulting in a ranked set of participants. The ou:contest type is derived from the base type: guid.

ou:contest:result

The results from a single contest participant. The ou:contest:result type is derived from the base type: comp.

The type ou:contest:result has the following options set:

- fields: (('contest', 'ou:contest'), ('participant', 'ps:contact'))

ou:contract

An contract between multiple entities. The `ou:contract` type is derived from the base type: `guid`.

ou:contract:type

A pre-defined set of contract types. The `ou:contract:type` type is derived from the base type: `str`.

The type `ou:contract:type` has the following options set:

- enum: `('nda', 'other', 'grant', 'treaty', 'purchase', 'indemnity', 'partnership')`
- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:contribution

Represents a specific instance of contributing material support to a campaign. The `ou:contribution` type is derived from the base type: `guid`.

ou:conttype

A contract type taxonomy. The `ou:conttype` type is derived from the base type: `taxonomy`.

The type `ou:conttype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:employment

An employment type taxonomy. The `ou:employment` type is derived from the base type: `taxonomy`.

An example of `ou:employment`:

- `fulltime.salary`

The type `ou:employment` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`

- regex: None
- replace: ()
- strip: False

ou:goal

An assessed or stated goal which may be abstract or org specific. The ou:goal type is derived from the base type: guid.

ou:goal:type:taxonomy

A taxonomy of goal types. The ou:goal:type:taxonomy type is derived from the base type: taxonomy.

The type ou:goal:type:taxonomy has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: False

ou:goalname

A goal name. The ou:goalname type is derived from the base type: str.

The type ou:goalname has the following options set:

- globsuffix: False
- lower: True
- onespace: True
- regex: None
- replace: ()
- strip: False

ou:hasalias

The knowledge that an organization has an alias. The ou:hasalias type is derived from the base type: comp.

The type ou:hasalias has the following options set:

- fields: (('org', 'ou:org'), ('alias', 'ou:alias'))

ou:hasgoal

Deprecated. Please use ou:org:goals. The `ou:hasgoal` type is derived from the base type: `comp`.

The type `ou:hasgoal` has the following options set:

- fields: `(('org', 'ou:org'), ('goal', 'ou:goal'))`

ou:id:number

A unique id number issued by a specific organization. The `ou:id:number` type is derived from the base type: `comp`.

The type `ou:id:number` has the following options set:

- fields: `(('type', 'ou:id:type'), ('value', 'ou:id:value'))`

ou:id:type

A type of id number issued by an org. The `ou:id:type` type is derived from the base type: `guid`.

ou:id:update

A status update to an org:id:number. The `ou:id:update` type is derived from the base type: `guid`.

ou:id:value

The value of an org:id:number. The `ou:id:value` type is derived from the base type: `str`.

The type `ou:id:value` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

ou:industry

An industry classification type. The `ou:industry` type is derived from the base type: `guid`.

ou:industry:type:taxonomy

An industry type taxonomy. The `ou:industry:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `ou:industry:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:industryname

The name of an industry. The `ou:industryname` type is derived from the base type: `str`.

The type `ou:industryname` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

ou:isic

An International Standard Industrial Classification of All Economic Activities (ISIC) code. The `ou:isic` type is derived from the base type: `str`.

An example of `ou:isic`:

- `C1393`

The type `ou:isic` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[A-Z]([0-9]{2}[0-9]{0,2})?$`
- replace: `()`
- strip: `False`

ou:jobtitle

A title for a position within an org. The `ou:jobtitle` type is derived from the base type: `str`.

The type `ou:jobtitle` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

ou:jobtype

A title for a position within an org. The `ou:jobtype` type is derived from the base type: `taxonomy`.

An example of `ou:jobtype`:

- `it.dev.python`

The type `ou:jobtype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:meet

An informal meeting of people which has no title or sponsor. See also: ou:conference. The `ou:meet` type is derived from the base type: `guid`.

ou:meet:attendee

Deprecated. Please use ou:attendee. The `ou:meet:attendee` type is derived from the base type: `comp`.

The type `ou:meet:attendee` has the following options set:

- fields: `(('meet', 'ou:meet'), ('person', 'ps:person'))`

ou:member

Deprecated. Please use ou:position. The `ou:member` type is derived from the base type: `comp`.

The type `ou:member` has the following options set:

- fields: `(('org', 'ou:org'), ('person', 'ps:person'))`

ou:naics

North American Industry Classification System codes and prefixes. The `ou:naics` type is derived from the base type: `str`.

An example of `ou:naics`:

- `541715`

The type `ou:naics` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[1-9][0-9]{1,5}?$`
- replace: `()`
- strip: `True`

ou:name

The name of an organization. This may be a formal name or informal name of the organization. The `ou:name` type is derived from the base type: `str`.

An example of `ou:name`:

- `acme corporation`

The type `ou:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

ou:opening

A job/work opening within an org. The `ou:opening` type is derived from the base type: `guid`.

ou:org

A GUID for a human organization such as a company or military unit. The `ou:org` type is derived from the base type: `guid`.

ou:org:has

An org owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time. The `ou:org:has` type is derived from the base type: `comp`.

The type `ou:org:has` has the following options set:

- fields: `(('org', 'ou:org'), ('node', 'ndef'))`

ou:orgnet4

An organization's IPv4 netblock. The `ou:orgnet4` type is derived from the base type: `comp`.

The type `ou:orgnet4` has the following options set:

- fields: `(('org', 'ou:org'), ('net', 'inet:net4'))`

ou:orgnet6

An organization's IPv6 netblock. The `ou:orgnet6` type is derived from the base type: `comp`.

The type `ou:orgnet6` has the following options set:

- fields: `(('org', 'ou:org'), ('net', 'inet:net6'))`

ou:orgtype

An org type taxonomy. The `ou:orgtype` type is derived from the base type: `taxonomy`.

The type `ou:orgtype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:position

A position within an org. May be organized into an org chart. The `ou:position` type is derived from the base type: `guid`.

ou:preso

A webinar, conference talk, or other type of presentation. The `ou:preso` type is derived from the base type: `guid`.

ou:role

A named role when participating in an event. The `ou:role` type is derived from the base type: `str`.

An example of `ou:role`:

- `staff`

The type `ou:role` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^\w+$`
- replace: `()`
- strip: `False`

ou:sic

The four digit Standard Industrial Classification Code. The `ou:sic` type is derived from the base type: `str`.

An example of `ou:sic`:

- `0111`

The type `ou:sic` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[0-9]{4}$`
- replace: `()`
- strip: `False`

ou:suborg

Any parent/child relationship between two orgs. May represent ownership, organizational structure, etc. The `ou:suborg` type is derived from the base type: `comp`.

The type `ou:suborg` has the following options set:

- fields: `(('org', 'ou:org'), ('sub', 'ou:org'))`

ou:team

A GUID for a team within an organization. The `ou:team` type is derived from the base type: `guid`.

ou:technique

A specific technique used to achieve a goal. The `ou:technique` type is derived from the base type: `guid`.

ou:technique:taxonomy

An analyst defined taxonomy to classify techniques in different disciplines. The `ou:technique:taxonomy` type is derived from the base type: `taxonomy`.

The type `ou:technique:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ou:user

A user name within an organization. The `ou:user` type is derived from the base type: `comp`.

The type `ou:user` has the following options set:

- fields: `(('org', 'ou:org'), ('user', 'inet:user'))`

ou:vitals

Vital statistics about an org for a given time period. The `ou:vitals` type is derived from the base type: `guid`.

pe:langid

The PE language id. The `pe:langid` type is derived from the base type: `int`.

The type `pe:langid` has the following options set:

- enums:

int	valu
0	neutral
4	zh-Hans
26	hr
127	invariant
1024	default
1025	ar-SA
1026	bg-BG
1027	ca-ES
1029	cs-CZ
1030	da-DK
1031	de-DE
1032	el-GR
1033	en-US
1034	es-ES-traditional
1035	fi-FI
1036	fr-FR
1037	he-IL
1038	hu-HU
1039	is-IS
1040	it-IT
1041	ja-JP
1042	ko-KR
1043	nl-NL
1044	nb-NO
1045	pl-PL
1046	pt-BR
1047	rm-CH
1048	ro-RO
1049	ru-RU
1050	hr-HR
1051	sk-SK
1052	sq-AL
1053	sv-SE
1054	th-TH
1055	tr-TR
1056	ur-PK
1057	id-ID
1058	uk-UA
1059	be-BY
1060	sl-SI
1061	et-EE
1062	lv-LV
1063	lt-LT
1064	tg-TJ

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int	valu
1065	fa-IR
1066	vi-VN
1067	hy-AM
1068	az-AZ-Latin
1069	Basque-Basque
1070	hsb-DE
1071	mk-MK
1074	tn-ZA
1076	xh-ZA
1077	zu-ZA
1078	af-ZA
1079	ka-GE
1080	fo-FO
1081	hi-IN
1082	mt-MT
1083	se-NO
1086	ms-MY
1087	kk-KZ
1088	ky-KG
1089	sw-KE
1090	tk-TM
1091	uz-UZ-Latin
1092	tt-RU
1093	bn-Bangledesh
1094	pa-IN
1095	gu-IN
1096	or-IN
1097	ta-IN
1098	te-IN
1099	kn-IN
1100	ml-IN
1101	as-IN
1102	mr-IN
1103	sa-IN
1104	mn-MN-Cyrllic
1105	bo-CN
1106	cy-GB
1107	kh-KH
1108	lo-LA
1110	gl-ES
1111	kok-IN
1114	syr-SY
1115	si-LK
1116	chr-Cher
1117	iu-CA
1118	am-ET
1121	ne-NP
1122	fy-NL
1123	ps-AF
1124	fil-PH

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int	valu
1125	dv-MV
1128	ha-NG
1130	yo-NG
1131	quz-BO
1132	nso-ZA
1133	ba-RU
1134	lb-LU
1135	kl-GL
1136	ig-NG
1139	ti-ET
1141	haw-US
1144	ii-CN
1146	arn-CL
1148	moh-CA
1150	br-FR
1152	ug-CN
1153	mi-NZ
1154	oc-FR
1155	co-FR
1156	gsw-FR
1157	sah-RU
1158	qut-GT
1159	rw-RW
1160	wo-SN
1164	prs-AF
1170	ku-IQ
2048	sys default
2049	ar-IQ
2051	ca-ES-Valencia
2055	de-CH
2057	en-GB
2058	es-MX
2060	fr-BE
2064	it-CH
2067	nl-BE
2068	no-NO
2070	pt-PT
2074	sr-CS-Latin
2077	sv-FI
2080	ur-IN
2092	az-AZ-Cyrillic
2094	dsb-DE
2098	tn-BW
2107	se-SE
2108	ga-IE
2110	ms-BN
2115	uz-UZ-Cyrillic
2117	bn-IN
2118	pa-PK
2121	ta-LK

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int	valu
2128	mn-MN-Prc
2137	sd-PK
2141	iu-CA-Latin
2143	tzm-DZ
2151	ff-SN
2155	quz-EC
2163	ti-ER
3072	custom default
3073	ar-EG
3076	zh-HK
3079	de-AT
3081	en-AU
3082	es-ES-modern
3084	fr-CA
3098	sr-CS-Cyrillic
3131	se-FI
3179	quz-PE
4096	custom unspecified
4097	ar-LY
4100	zh-SG
4103	de-LU
4105	en-CA
4106	es-GT
4108	fr-CH
4122	hr-BA
4155	smj-NO
5120	ui_custom_default
5121	ar-DZ
5124	zh-MO
5127	de-LI
5129	en-NZ
5130	es-CR
5132	fr-LU
5146	bs-BA-Latin
5179	smj-SE
6145	ar-MA
6153	en-IE
6154	es-PA
6156	fr-MC
6170	sr-code-Latin
6203	sma-NO
7169	ar-TN
7177	en-ZA
7178	es-DO
7194	sr-BA
7227	sma-SE
8193	ar-OM
8201	en-JM
8202	es-VE
8218	bs-BA-Cyrillic

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int	valu
8251	sms-FI
9217	ar-YE
9225	en-029
9226	es-CO
9275	smn-FIl
10241	ar-SY
10249	en-BZ
10250	es-PE
11265	ar-JO
11273	en-TT
11274	es-AR
12289	ar-LB
12297	en-ZW
12298	es-EC
13313	ar-KW
13321	en-PH
13322	es-CL
14337	ar-AE
14346	es-UY
15361	ar-BH
15370	es-PY
16385	ar-QA
16393	en-IN
16394	es-BO
17417	en-MY
17418	es-SV
18441	en-SG
18442	es-HN
19466	es-NI
20490	es-PR
21514	es-US
30746	bs-neutral
31748	zh-Hant
31770	sr-Neutral

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

pe:resource:type

The typecode for the resource. The `pe:resource:type` type is derived from the base type: `int`.

The type `pe:resource:type` has the following options set:

- enums:

int	valu
1	RT_CURSOR
2	RT_BITMAP
3	RT_ICON
4	RT_MENU
5	RT_DIALOG
6	RT_STRING
7	RT_FONTDIR
8	RT_FONT
9	RT_ACCELERATOR
10	RT_RCDATA
11	RT_MESSAGETABLE
12	RT_GROUP_CURSOR
14	RT_GROUP_ICON
16	RT_VERSION
17	RT_DLGINCLUDE
19	RT_PLUGPLAY
20	RT_VXD
21	RT_ANICURSOR
22	RT_ANIICON
23	RT_HTML
24	RT_MANIFEST

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

pol:candidate

A candidate for office in a specific race. The `pol:candidate` type is derived from the base type: `guid`.

pol:country

A GUID for a country. The `pol:country` type is derived from the base type: `guid`.

pol:election

An election involving one or more races for office. The `pol:election` type is derived from the base type: `guid`.

pol:immigration:status

A node which tracks the immigration status of a contact. The `pol:immigration:status` type is derived from the base type: `guid`.

pol:immigration:status:type:taxonomy

A taxonomy of immigration types. The `pol:immigration:status:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `pol:immigration:status:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

pol:iso2

The 2 digit ISO 3166 country code. The `pol:iso2` type is derived from the base type: `str`.

An example of `pol:iso2`:

- `us`

The type `pol:iso2` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z0-9]{2}$`
- replace: `()`
- strip: `False`

pol:iso3

The 3 digit ISO 3166 country code. The `pol:iso3` type is derived from the base type: `str`.

An example of `pol:iso3`:

- `usa`

The type `pol:iso3` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z0-9]{3}$`
- replace: `()`
- strip: `False`

pol:isonum

The ISO integer country code. The `pol:isonum` type is derived from the base type: `int`.

An example of `pol:isonum`:

- `840`

The type `pol:isonum` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

pol:office

An elected or appointed office. The `pol:office` type is derived from the base type: `guid`.

pol:pollingplace

An official place where ballots may be cast for a specific election. The `pol:pollingplace` type is derived from the base type: `guid`.

pol:race

An individual race for office. The `pol:race` type is derived from the base type: `guid`.

pol:term

A term in office held by a specific individual. The `pol:term` type is derived from the base type: `guid`.

pol:vitals

A set of vital statistics about a country. The `pol:vitals` type is derived from the base type: `guid`.

proj:attachment

A file attachment added to a ticket or comment. The `proj:attachment` type is derived from the base type: `guid`.

proj:comment

A user comment on a ticket. The `proj:comment` type is derived from the base type: `guid`.

proj:epic

A collection of tickets related to a topic. The `proj:epic` type is derived from the base type: `guid`.

proj:project

A project in a ticketing system. The `proj:project` type is derived from the base type: `guid`.

proj:sprint

A timeboxed period to complete a set amount of work. The `proj:sprint` type is derived from the base type: `guid`.

proj:ticket

A ticket in a ticketing system. The `proj:ticket` type is derived from the base type: `guid`.

ps:achievement

An instance of an individual receiving an award. The `ps:achievement` type is derived from the base type: `guid`.

ps:contact

A GUID for a contact info record. The `ps:contact` type is derived from the base type: `guid`.

ps:contact:type:taxonomy

A taxonomy of contact types. The `ps:contact:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `ps:contact:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ps:contactlist

A GUID for a list of associated contacts. The `ps:contactlist` type is derived from the base type: `guid`.

ps:education

A period of education for an individual. The `ps:education` type is derived from the base type: `guid`.

ps:name

An arbitrary, lower spaced string with normalized whitespace. The `ps:name` type is derived from the base type: `str`.

An example of `ps:name`:

- `robert grey`

The type `ps:name` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

ps:person

A GUID for a person. The `ps:person` type is derived from the base type: `guid`.

ps:person:has

A person owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time. The `ps:person:has` type is derived from the base type: `comp`.

The type `ps:person:has` has the following options set:

- fields: `(('person', 'ps:person'), ('node', 'ndef'))`

ps:persona

A GUID for a suspected person. The `ps:persona` type is derived from the base type: `guid`.

ps:persona:has

A persona owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time. The `ps:persona:has` type is derived from the base type: `comp`.

The type `ps:persona:has` has the following options set:

- fields: `(('persona', 'ps:persona'), ('node', 'ndef'))`

ps:proficiency

The assessment that a given contact possesses a specific skill. The `ps:proficiency` type is derived from the base type: `guid`.

ps:skill

A specific skill which a person or organization may have. The `ps:skill` type is derived from the base type: `guid`.

ps:skill:type:taxonomy

A taxonomy of skill types. The `ps:skill:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `ps:skill:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

ps:tokn

A single name element (potentially given or sur). The `ps:tokn` type is derived from the base type: `str`.

An example of `ps:tokn`:

- `robert`

The type `ps:tokn` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

ps:vitals

Statistics and demographic data about a person or contact. The `ps:vitals` type is derived from the base type: `guid`.

ps:workhist

A GUID representing entry in a contact's work history. The `ps:workhist` type is derived from the base type: `guid`.

risk:alert

An instance of an alert which indicates the presence of a risk. The `risk:alert` type is derived from the base type: `guid`.

risk:alert:taxonomy

A taxonomy of alert types. The `risk:alert:taxonomy` type is derived from the base type: `taxonomy`.

The type `risk:alert:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:alert:verdict:taxonomy

A taxonomy of verdicts for the origin and validity of the alert. The `risk:alert:verdict:taxonomy` type is derived from the base type: `taxonomy`.

The type `risk:alert:verdict:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:attack

An instance of an actor attacking a target. The `risk:attack` type is derived from the base type: `guid`.

risk:attacktype

A taxonomy of attack types. The `risk:attacktype` type is derived from the base type: `taxonomy`.

The type `risk:attacktype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:availability

A taxonomy of availability status values. The `risk:availability` type is derived from the base type: `taxonomy`.

The type `risk:availability` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:compromise

An instance of a compromise and its aggregate impact. The `risk:compromise` type is derived from the base type: `guid`.

risk:compromisetype

A taxonomy of compromise types. The `risk:compromisetype` type is derived from the base type: `taxonomy`.

An example of `risk:compromisetype`:

- `cno.breach`

The type `risk:compromisetype` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:hasvuln

An instance of a vulnerability present in a target. The `risk:hasvuln` type is derived from the base type: `guid`.

risk:mitigation

A mitigation for a specific risk:vuln. The `risk:mitigation` type is derived from the base type: `guid`.

risk:threat

A threat cluster or subgraph of threat activity, as reported by a specific organization. The `risk:threat` type is derived from the base type: `guid`.

risk:threat:type:taxonomy

A taxonomy of threat types. The `risk:threat:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `risk:threat:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:tool:software

A software tool used in threat activity, as reported by a specific organization. The `risk:tool:software` type is derived from the base type: `guid`.

risk:tool:software:taxonomy

A taxonomy of software / tool types. The `risk:tool:software:taxonomy` type is derived from the base type: `taxonomy`.

The type `risk:tool:software:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:vuln

A unique vulnerability. The `risk:vuln` type is derived from the base type: `guid`.

risk:vuln:soft:range

A contiguous range of software versions which contain a vulnerability. The `risk:vuln:soft:range` type is derived from the base type: `guid`.

risk:vuln:type:taxonomy

A taxonomy of vulnerability types. The `risk:vuln:type:taxonomy` type is derived from the base type: `taxonomy`.

The type `risk:vuln:type:taxonomy` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

risk:vulnname

A vulnerability name such as log4j or rowhammer. The `risk:vulnname` type is derived from the base type: `str`.

The type `risk:vulnname` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `True`
- regex: `None`
- replace: `()`
- strip: `False`

rsa:key

An RSA keypair modulus and public exponent. The `rsa:key` type is derived from the base type: `comp`.

The type `rsa:key` has the following options set:

- fields: `(('mod', 'hex'), ('pub:exp', 'int'))`

syn:cmd

A Synapse storm command. The `syn:cmd` type is derived from the base type: `str`.

The type `syn:cmd` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `True`

syn:cron

A Cortex cron job. The `syn:cron` type is derived from the base type: `guid`.

syn:form

A Synapse form used for representing nodes in the graph. The `syn:form` type is derived from the base type: `str`.

The type `syn:form` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `None`

- replace: ()
- strip: True

syn:nodedata

A nodedata key and the form it may be present on. The syn:nodedata type is derived from the base type: comp.

The type syn:nodedata has the following options set:

- fields: (('key', 'str'), ('form', 'syn:form'))

syn:prop

A Synapse property. The syn:prop type is derived from the base type: str.

The type syn:prop has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: True

syn:role

A Synapse role GUID. The syn:role type is derived from the base type: guid.

The type syn:role has the following options set:

- strip: True

syn:splice

A splice from a layer. The syn:splice type is derived from the base type: guid.

The type syn:splice has the following options set:

- strip: True

syn:tagprop

A user defined tag property. The syn:tagprop type is derived from the base type: str.

The type syn:tagprop has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None

- replace: ()
- strip: True

syn:trigger

A Cortex trigger. The syn:trigger type is derived from the base type: guid.

syn:type

A Synapse type used for normalizing nodes and properties. The syn:type type is derived from the base type: str.

The type syn:type has the following options set:

- globsuffix: False
- lower: False
- onespace: False
- regex: None
- replace: ()
- strip: True

syn:user

A Synapse user GUID. The syn:user type is derived from the base type: guid.

The type syn:user has the following options set:

- strip: True

tel:call

A guid for a telephone call record. The tel:call type is derived from the base type: guid.

tel:mob:carrier

The fusion of a MCC/MNC. The tel:mob:carrier type is derived from the base type: comp.

The type tel:mob:carrier has the following options set:

- fields: (('mcc', 'tel:mob:mcc'), ('mnc', 'tel:mob:mnc'))

tel:mob:cell

A mobile cell site which a phone may connect to. The tel:mob:cell type is derived from the base type: comp.

The type tel:mob:cell has the following options set:

- fields: (('carrier', 'tel:mob:carrier'), ('lac', ('int', {})), ('cid', ('int', {})))

tel:mob:imid

Fused knowledge of an IMEI/IMSI used together. The `tel:mob:imid` type is derived from the base type: `comp`.

An example of `tel:mob:imid`:

- `(490154203237518, 310150123456789)`

The type `tel:mob:imid` has the following options set:

- fields: `(('imei', 'tel:mob:imei'), ('imsi', 'tel:mob:imsi'))`

tel:mob:imsiphone

Fused knowledge of an IMSI assigned phone number. The `tel:mob:imsiphone` type is derived from the base type: `comp`.

An example of `tel:mob:imsiphone`:

- `(310150123456789, "+7(495) 124-59-83")`

The type `tel:mob:imsiphone` has the following options set:

- fields: `(('imsi', 'tel:mob:imsi'), ('phone', 'tel:phone'))`

tel:mob:mcc

ITU Mobile Country Code. The `tel:mob:mcc` type is derived from the base type: `str`.

The type `tel:mob:mcc` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[0-9]{3}$`
- replace: `()`
- strip: `1`

tel:mob:mnc

ITU Mobile Network Code. The `tel:mob:mnc` type is derived from the base type: `str`.

The type `tel:mob:mnc` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `^[0-9]{2,3}$`
- replace: `()`
- strip: `1`

tel:mob:tac

A mobile Type Allocation Code. The `tel:mob:tac` type is derived from the base type: `int`.

An example of `tel:mob:tac`:

- `49015420`

The type `tel:mob:tac` has the following options set:

- fmt: `%d`
- ismax: `False`
- ismin: `False`
- max: `None`
- min: `None`
- signed: `True`
- size: `8`

tel:mob:telem

A single mobile telemetry measurement. The `tel:mob:telem` type is derived from the base type: `guid`.

tel:txtmesg

A guid for an individual text message. The `tel:txtmesg` type is derived from the base type: `guid`.

transport:air:craft

An individual aircraft. The `transport:air:craft` type is derived from the base type: `guid`.

transport:air:flight

An individual instance of a flight. The `transport:air:flight` type is derived from the base type: `guid`.

transport:air:flightnum

A commercial flight designator including airline and serial. The `transport:air:flightnum` type is derived from the base type: `str`.

An example of `transport:air:flightnum`:

- `ua2437`

The type `transport:air:flightnum` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z]{2}[0-9]{1,4}$`

- replace: `((' ', ''),)`
- strip: `True`

transport:air:occupant

An occupant of a specific flight. The `transport:air:occupant` type is derived from the base type: `guid`.

transport:air:port

An IATA assigned airport code. The `transport:air:port` type is derived from the base type: `str`.

The type `transport:air:port` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `None`
- replace: `()`
- strip: `False`

transport:air:tailnum

An aircraft registration number or military aircraft serial number. The `transport:air:tailnum` type is derived from the base type: `str`.

An example of `transport:air:tailnum`:

- `ff023`

The type `transport:air:tailnum` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^[a-z0-9-]{2,}$`
- replace: `()`
- strip: `True`

transport:air:telem

A telemetry sample from an aircraft in transit. The `transport:air:telem` type is derived from the base type: `guid`.

transport:direction

A direction measured in degrees with 0.0 being true North. The `transport:direction` type is derived from the base type: `hugenum`.

The type `transport:direction` has the following options set:

- modulo: `360`
- units: `None`

transport:land:license

A license to operate a land vehicle issued to a contact. The `transport:land:license` type is derived from the base type: `guid`.

transport:land:registration

Registration issued to a contact for a land vehicle. The `transport:land:registration` type is derived from the base type: `guid`.

transport:land:vehicle

An individual vehicle. The `transport:land:vehicle` type is derived from the base type: `guid`.

transport:sea:imo

An International Maritime Organization registration number. The `transport:sea:imo` type is derived from the base type: `str`.

The type `transport:sea:imo` has the following options set:

- globsuffix: `False`
- lower: `True`
- onespace: `False`
- regex: `^imo[0-9]{7}$`
- replace: `((' ', ''),)`
- strip: `True`

transport:sea:mmsi

A Maritime Mobile Service Identifier. The `transport:sea:mmsi` type is derived from the base type: `str`.

The type `transport:sea:mmsi` has the following options set:

- globsuffix: `False`
- lower: `False`
- onespace: `False`
- regex: `[0-9]{9}`

- replace: ()
- strip: False

transport:sea:telem

A telemetry sample from a vessel in transit. The transport:sea:telem type is derived from the base type: guid.

transport:sea:vessel

An individual sea vessel. The transport:sea:vessel type is derived from the base type: guid.

12.2 Synapse Data Model - Forms

12.2.1 Forms

Forms are derived from types, or base types. Forms represent node types in the graph.

auth:access

An instance of using creds to access a resource.

The base type for the form can be found at *auth:access*.

Properties:

:creds / auth:access:creds
: The credentials used to attempt access.

  The property type is *auth:creds*.

:time / auth:access:time
: The time of the access attempt.

  The property type is *time*.

:success / auth:access:success
: Set to true if the access was successful.

  The property type is *bool*.

:person / auth:access:person
: The person who attempted access.

  The property type is *ps:person*.

auth:creds

A unique set of credentials used to access a resource.

The base type for the form can be found at *auth:creds*.

Properties:

:email / auth:creds:email
: The email address used to identify the user.

  The property type is *inet:email*.

:user / auth:creds:user
: The user name used to identify the user.

  The property type is *inet:user*.

:phone / auth:creds:phone
: The phone number used to identify the user.

  The property type is *tel:phone*.

:passwd / auth:creds:passwd
: The password used to authenticate.

  The property type is *inet:passwd*.

:passwdhash / auth:creds:passwdhash
: The password hash used to authenticate.

  The property type is *it:auth:passwdhash*.

:account / auth:creds:account
: The account that the creds allow access to.

  The property type is *it:account*.

:website / auth:creds:website
: The base URL of the website that the credentials allow access to.

  The property type is *inet:url*.

:host / auth:creds:host
: The host that the credentials allow access to.

  The property type is *it:host*.

:wifi:ssid / auth:creds:wifi:ssid
: The WiFi SSID that the credentials allow access to.

  The property type is *inet:wifi:ssid*.

:web:acct / auth:creds:web:acct
: The web account that the credentials allow access to.

  The property type is *inet:web:acct*.

belief:subscriber

A contact which subscribes to a belief system.

The base type for the form can be found at *belief:subscriber*.

Properties:

:contact / belief:subscriber:contact
The contact which subscribes to the belief system.

The property type is *ps:contact*.

:system / belief:subscriber:system
The belief system to which the contact subscribes.

The property type is *belief:system*.

:began / belief:subscriber:began
The time that the contact began to be a subscriber to the belief system.

The property type is *time*.

:ended / belief:subscriber:ended
The time when the contact ceased to be a subscriber to the belief system.

The property type is *time*.

belief:system

A belief system such as an ideology, philosophy, or religion.

The base type for the form can be found at *belief:system*.

Properties:

:name / belief:system:name
The name of the belief system.

The property type is *str*. Its type has the following options set:

- onespace: `True`
- lower: `True`

:desc / belief:system:desc
A description of the belief system. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:type / belief:system:type
A taxonometric type for the belief system.

The property type is *belief:system:type:taxonomy*.

:began / belief:system:began
The time that the belief system was first observed.

The property type is *time*.

belief:system:type:taxonomy

A hierarchical taxonomy of belief system types.

The base type for the form can be found at *belief:system:type:taxonomy*.

Properties:

:title / belief:system:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / belief:system:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / belief:system:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / belief:system:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / belief:system:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / belief:system:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *belief:system:type:taxonomy*.

belief:tenet

A concrete tenet potentially shared by multiple belief systems.

The base type for the form can be found at *belief:tenet*.

Properties:

:name / belief:tenet:name
The name of the tenet.

The property type is *str*. Its type has the following options set:

- onespace: `True`
- lower: `True`

:desc / belief:tenet:desc
A description of the tenet. It has the following property options set:

- disp: {'hint': 'text'}

The property type is *str*.

biz:bundle

A bundle allows construction of products which bundle instances of other products.

The base type for the form can be found at *biz:bundle*.

Properties:

:count / biz:bundle:count
The number of instances of the product or service included in the bundle.

The property type is *int*.

:price / biz:bundle:price
The price of the bundle.

The property type is *econ:price*.

:product / biz:bundle:product
The product included in the bundle.

The property type is *biz:product*.

:service / biz:bundle:service
The service included in the bundle.

The property type is *biz:service*.

:deal / biz:bundle:deal
Deprecated. Please use econ:receipt:item for instances of bundles being sold. It has the following property options set:

- deprecated: True

The property type is *biz:deal*.

:purchase / biz:bundle:purchase
Deprecated. Please use econ:receipt:item for instances of bundles being sold. It has the following property options set:

- deprecated: True

The property type is *econ:purchase*.

biz:deal

A sales or procurement effort in pursuit of a purchase.

The base type for the form can be found at *biz:deal*.

Properties:

:title / biz:deal:title
A title for the deal.

The property type is *str*.

:type / biz:deal:type
The type of deal. It has the following property options set:

- disp: {'hint': 'taxonomy'}

The property type is *biz:dealtype*.

:status / biz:deal:status
The status of the deal. It has the following property options set:

- disp: {'hint': 'taxonomy'}

The property type is *biz:dealstatus*.

:updated / biz:deal:updated
The last time the deal had a significant update.

The property type is *time*.

:contacted / biz:deal:contacted
The last time the contacts communicated about the deal.

The property type is *time*.

:rfp / biz:deal:rfp
The RFP that the deal is in response to.

The property type is *biz:rfp*.

:buyer / biz:deal:buyer
The primary contact information for the buyer.

The property type is *ps:contact*.

:buyer:org / biz:deal:buyer:org
The buyer org.

The property type is *ou:org*.

:buyer:orgname / biz:deal:buyer:orgname
The reported ou:name of the buyer org.

The property type is *ou:name*.

:buyer:orgfqdn / biz:deal:buyer:orgfqdn
The reported inet:fqdn of the buyer org.

The property type is *inet:fqdn*.

:seller / biz:deal:seller
The primary contact information for the seller.

The property type is *ps:contact*.

:seller:org / biz:deal:seller:org
The seller org.

The property type is *ou:org*.

:seller:orgname / biz:deal:seller:orgname
The reported ou:name of the seller org.

The property type is *ou:name*.

:seller:orgfqdn / biz:deal:seller:orgfqdn
The reported inet:fqdn of the seller org.

The property type is *inet:fqdn*.

:currency / biz:deal:currency
The currency of econ:price values associated with the deal.

The property type is *econ:currency*.

:buyer:budget / biz:deal:buyer:budget
The buyers budget for the eventual purchase.

The property type is *econ:price*.

:buyer:deadline / biz:deal:buyer:deadline
When the buyer intends to make a decision.

The property type is *time*.

:offer:price / biz:deal:offer:price
The total price of the offered products.

The property type is *econ:price*.

:offer:expires / biz:deal:offer:expires
When the offer expires.

The property type is *time*.

:purchase / biz:deal:purchase
Records a purchase resulting from the deal.

The property type is *econ:purchase*.

biz:dealstatus

A deal/rfp status taxonomy.

The base type for the form can be found at *biz:dealstatus*.

Properties:

:title / biz:dealstatus:title
A brief title of the definition.

The property type is *str*.

:summary / biz:dealstatus:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / biz:dealstatus:sort
A display sort order for siblings.

The property type is *int*.

:base / biz:dealstatus:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / biz:dealstatus:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / biz:dealstatus:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *biz:dealstatus*.

biz:dealtype

A deal type taxonomy.

The base type for the form can be found at *biz:dealtype*.

Properties:

:title / biz:dealtype:title
A brief title of the definition.

The property type is *str*.

:summary / biz:dealtype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / biz:dealtype:sort
A display sort order for siblings.

The property type is *int*.

:base / biz:dealtype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / biz:dealtype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / biz:dealtype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *biz:dealtype*.

biz:listing

A product or service being listed for sale at a given price by a specific seller.

The base type for the form can be found at *biz:listing*.

Properties:

:seller / biz:listing:seller
The contact information for the seller.

The property type is *ps:contact*.

:product / biz:listing:product
The product being offered.

The property type is *biz:product*.

:service / biz:listing:service
The service being offered.

The property type is *biz:service*.

:current / biz:listing:current
Set to true if the offer is still current.

The property type is *bool*.

:time / biz:listing:time
The first known offering of this product/service by the organization for the asking price.

The property type is *time*.

:expires / biz:listing:expires
Set if the offer has a known expiration date.

The property type is *time*.

:price / biz:listing:price
The asking price of the product or service.

The property type is *econ:price*.

:currency / biz:listing:currency
The currency of the asking price.

The property type is *econ:currency*.

biz:prodtype

A product type taxonomy.

The base type for the form can be found at *biz:prodtype*.

Properties:

:title / biz:prodtype:title
A brief title of the definition.

The property type is *str*.

:summary / biz:prodtype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / biz:prodtype:sort
A display sort order for siblings.

The property type is *int*.

:base / biz:prodtype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / biz:prodtype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / biz:prodtype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *biz:prodtype*.

biz:product

A product which is available for purchase.

The base type for the form can be found at *biz:product*.

Properties:

:name / biz:product:name
The name of the product.

The property type is *str*.

:type / biz:product:type
The type of product. It has the following property options set:

- disp: `{'hint': 'taxonomy'}`

The property type is *biz:prodtype*.

:summary / biz:product:summary
A brief summary of the product. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:maker / biz:product:maker
A contact for the maker of the product.

The property type is *ps:contact*.

:madeby:org / biz:product:madeby:org
Deprecated. Please use biz:product:maker. It has the following property options set:

- deprecated: `True`

The property type is *ou:org*.

:madeby:orgname / biz:product:madeby:orgname
Deprecated. Please use biz:product:maker. It has the following property options set:

- deprecated: `True`

The property type is *ou:name*.

:madeby:orgfqdn / biz:product:madeby:orgfqdn
Deprecated. Please use biz:product:maker. It has the following property options set:

- deprecated: `True`

The property type is *inet:fqdn*.

:price:retail / biz:product:price:retail
The MSRP price of the product.

The property type is *econ:price*.

:price:bottom / biz:product:price:bottom
The minimum offered or observed price of the product.

The property type is *econ:price*.

:price:currency / biz:product:price:currency
The currency of the retail and bottom price properties.

The property type is *econ:currency*.

:bundles / biz:product:bundles
An array of bundles included with the product.

The property type is *array*. Its type has the following options set:

- type: `biz:bundle`
- uniq: `True`
- sorted: `True`

biz:rfp

An RFP (Request for Proposal) soliciting proposals.

The base type for the form can be found at *biz:rfp*.

Properties:

:ext:id / biz:rfp:ext:id
An externally specified identifier for the RFP.

The property type is *str*.

:title / biz:rfp:title
The title of the RFP.

The property type is *str*.

:summary / biz:rfp:summary
A brief summary of the RFP. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:status / biz:rfp:status
The status of the RFP. It has the following property options set:

- disp: `{'hint': 'enum'}`

The property type is *biz:dealstatus*.

:url / biz:rfp:url
The official URL for the RFP.

The property type is *inet:url*.

:file / biz:rfp:file
The RFP document.

The property type is *file:bytes*.

:posted / biz:rfp:posted
The date/time that the RFP was posted.

The property type is *time*.

:quesdue / biz:rfp:quesdue
The date/time that questions are due.

The property type is *time*.

:propdue / biz:rfp:propdue
The date/time that proposals are due.

The property type is *time*.

:contact / biz:rfp:contact
The contact information given for the org requesting offers.

The property type is *ps:contact*.

:purchases / biz:rfp:purchases
Any known purchases that resulted from the RFP.

The property type is *array*. Its type has the following options set:

- type: `econ:purchase`
- uniq: `True`
- sorted: `True`

:requirements / biz:rfp:requirements
A typed array which indexes each field.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- uniq: `True`
- sorted: `True`

biz:service

A service which is performed by a specific organization.

The base type for the form can be found at *biz:service*.

Properties:

:provider / biz:service:provider
The contact info of the entity which performs the service.

The property type is *ps:contact*.

:name / biz:service:name
The name of the service being performed.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:summary / biz:service:summary
A brief summary of the service. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:type / biz:service:type
A taxonomy of service types.

The property type is *biz:service:type:taxonomy*.

:launched / biz:service:launched
The time when the operator first made the service available.

The property type is *time*.

biz:stake

A stake or partial ownership in a company.

The base type for the form can be found at *biz:stake*.

Properties:

:vitals / biz:stake:vitals
The ou:vitals snapshot this stake is part of.

The property type is *ou:vitals*.

:org / biz:stake:org
The resolved org.

The property type is *ou:org*.

:orgname / biz:stake:orgname
The org name as reported by the source of the vitals.

The property type is *ou:name*.

:orgfqdn / biz:stake:orgfqdn
The org FQDN as reported by the source of the vitals.

The property type is *inet:fqdn*.

:name / biz:stake:name
An arbitrary name for this stake. Can be non-contact like “pool”.

The property type is *str*.

:asof / biz:stake:asof
The time the stake is being measured. Likely as part of an ou:vitals.

The property type is *time*.

:shares / biz:stake:shares
The number of shares represented by the stake.

The property type is *int*.

:invested / biz:stake:invested
The amount of money invested in the cap table iteration.

The property type is *econ:price*.

:value / biz:stake:value
The monetary value of the stake.

The property type is *econ:price*.

:percent / biz:stake:percent
The percentage ownership represented by this stake.

The property type is *hugenum*.

:owner / biz:stake:owner
Contact information of the owner of the stake.

The property type is *ps:contact*.

:purchase / biz:stake:purchase
The purchase event for the stake.

The property type is *econ:purchase*.

crypto:algorithm

A cryptographic algorithm name.

The base type for the form can be found at *crypto:algorithm*.

An example of `crypto:algorithm`:

- `aes256`

Properties:

crypto:currency:address

An individual crypto currency address.

The base type for the form can be found at *crypto:currency:address*.

An example of `crypto:currency:address`:

- `btc/1BvBMSEYstWetqTFn5Au4m4GFg7xJaNVN2`

Properties:

:coin / crypto:currency:address:coin
The crypto coin to which the address belongs. It has the following property options set:

- Read Only: `True`

The property type is *crypto:currency:coin*.

:seed / crypto:currency:address:seed
The cryptographic key and or password used to generate the address.

The property type is *crypto:key*.

:iden / crypto:currency:address:iden
The coin specific address identifier. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:desc / crypto:currency:address:desc
A free-form description of the address.

The property type is *str*.

:contact / crypto:currency:address:contact
Contact information associated with the address.

The property type is *ps:contact*.

crypto:currency:block

An individual crypto currency block record on the blockchain.

The base type for the form can be found at *crypto:currency:block*.

Properties:

:coin / crypto:currency:block:coin
The coin/blockchain this block resides on. It has the following property options set:

- Read Only: `True`

The property type is *crypto:currency:coin*.

:offset / crypto:currency:block:offset
The index of this block. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:hash / crypto:currency:block:hash
The unique hash for the block.

The property type is *hex*.

:minedby / crypto:currency:block:minedby
The address which mined the block.

The property type is *crypto:currency:address*.

:time / crypto:currency:block:time
Time timestamp embedded in the block by the miner.

The property type is *time*.

crypto:currency:client

A fused node representing a crypto currency address used by an Internet client.

The base type for the form can be found at *crypto:currency:client*.

An example of `crypto:currency:client`:

- `(1.2.3.4, (btc, 1BvBMSEYstWetqTFn5Au4m4GFg7xJaNVN2))`

Properties:

:inetaddr / crypto:currency:client:inetaddr
The Internet client address observed using the crypto currency address. It has the following property options set:

- Read Only: `True`

The property type is *inet:client*.

:coinaddr / crypto:currency:client:coinaddr
The crypto currency address observed in use by the Internet client. It has the following property options set:

- Read Only: `True`

The property type is *crypto:currency:address*.

crypto:currency:coin

An individual crypto currency type.

The base type for the form can be found at *crypto:currency:coin*.

An example of `crypto:currency:coin`:

- `btc`

Properties:

:name / crypto:currency:coin:name
The full name of the crypto coin.

The property type is *str*.

crypto:currency:transaction

An individual crypto currency transaction recorded on the blockchain.

The base type for the form can be found at *crypto:currency:transaction*.

Properties:

:hash / crypto:currency:transaction:hash
The unique transaction hash for the transaction.

The property type is *hex*.

:desc / crypto:currency:transaction:desc
An analyst specified description of the transaction.

The property type is *str*.

:block / crypto:currency:transaction:block
The block which records the transaction.

The property type is *crypto:currency:block*.

:block:coin / crypto:currency:transaction:block:coin
The coin/blockchain of the block which records this transaction.

The property type is *crypto:currency:coin*.

:block:offset / crypto:currency:transaction:block:offset
The offset of the block which records this transaction.

The property type is *int*.

:success / crypto:currency:transaction:success
Set to true if the transaction was successfully executed and recorded.

The property type is *bool*.

:status:code / crypto:currency:transaction:status:code
A coin specific status code which may represent an error reason.

The property type is *int*.

:status:message / crypto:currency:transaction:status:message
A coin specific status message which may contain an error reason.

The property type is *str*.

:to / crypto:currency:transaction:to
The destination address of the transaction.

The property type is *crypto:currency:address*.

:from / crypto:currency:transaction:from
The source address of the transaction.

The property type is *crypto:currency:address*.

:inputs / crypto:currency:transaction:inputs
Deprecated. Please use crypto:payment:input:transaction. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `crypto:payment:input`
- sorted: `True`
- uniq: `True`

:outputs / crypto:currency:transaction:outputs
Deprecated. Please use crypto:payment:output:transaction. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `crypto:payment:output`
- sorted: `True`
- uniq: `True`

:fee / crypto:currency:transaction:fee
The total fee paid to execute the transaction.

The property type is *econ:price*.

:value / crypto:currency:transaction:value
The total value of the transaction.

The property type is *econ:price*.

:time / crypto:currency:transaction:time
The time this transaction was initiated.

The property type is *time*.

:eth:gasused / crypto:currency:transaction:eth:gasused
The amount of gas used to execute this transaction.

The property type is *int*.

:eth:gaslimit / crypto:currency:transaction:eth:gaslimit
The ETH gas limit specified for this transaction.

The property type is *int*.

:eth:gasprice / crypto:currency:transaction:eth:gasprice
The gas price (in ETH) specified for this transaction.

The property type is *econ:price*.

:contract:input / crypto:currency:transaction:contract:input
Input value to a smart contract call.

The property type is *file:bytes*.

:contract:output / crypto:currency:transaction:contract:output
Output value of a smart contract call.

The property type is *file:bytes*.

crypto:key

A cryptographic key and algorithm.

The base type for the form can be found at *crypto:key*.

Properties:

:algorithm / crypto:key:algorithm
The cryptographic algorithm which uses the key material. It has the following property options set:

- Example: `aes256`

The property type is *crypto:algorithm*.

:mode / crypto:key:mode
The algorithm specific mode in use.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:iv / crypto:key:iv
The hex encoded initialization vector.

The property type is *hex*.

:public / crypto:key:public
The hex encoded public key material if the algorithm has a public/private key pair.

The property type is *hex*.

:public:md5 / crypto:key:public:md5
The MD5 hash of the public key in raw binary form.

The property type is *hash:md5*.

:public:sha1 / crypto:key:public:sha1
The SHA1 hash of the public key in raw binary form.

The property type is *hash:sha1*.

:public:sha256 / crypto:key:public:sha256
The SHA256 hash of the public key in raw binary form.

The property type is *hash:sha256*.

:private / crypto:key:private
The hex encoded private key material. All symmetric keys are private.

The property type is *hex*.

:private:md5 / crypto:key:private:md5
The MD5 hash of the private key in raw binary form.

The property type is *hash:md5*.

:private:sha1 / crypto:key:private:sha1
The SHA1 hash of the private key in raw binary form.

The property type is *hash:sha1*.

:private:sha256 / crypto:key:private:sha256
The SHA256 hash of the private key in raw binary form.

The property type is *hash:sha256*.

:seed:passwd / crypto:key:seed:passwd
The seed password used to generate the key material.

The property type is *inet:passwd*.

:seed:algorithm / crypto:key:seed:algorithm
The algorithm used to generate the key from the seed password. It has the following property options set:

- Example: `pbkdf2`

The property type is *crypto:algorithm*.

crypto:payment:input

A payment made into a transaction.

The base type for the form can be found at *crypto:payment:input*.

Properties:

:transaction / crypto:payment:input:transaction
The transaction the payment was input to.

The property type is *crypto:currency:transaction*.

:address / crypto:payment:input:address
The address which paid into the transaction.

The property type is *crypto:currency:address*.

:value / crypto:payment:input:value
The value of the currency paid into the transaction.

The property type is *econ:price*.

crypto:payment:output

A payment received from a transaction.

The base type for the form can be found at *crypto:payment:output*.

Properties:

:transaction / crypto:payment:output:transaction
The transaction the payment was output from.

The property type is *crypto:currency:transaction*.

:address / crypto:payment:output:address
The address which received payment from the transaction.

The property type is *crypto:currency:address*.

:value / crypto:payment:output:value
The value of the currency received from the transaction.

The property type is *econ:price*.

crypto:smart:contract

A smart contract.

The base type for the form can be found at *crypto:smart:contract*.

Properties:

:transaction / crypto:smart:contract:transaction
The transaction which created the contract.

The property type is *crypto:currency:transaction*.

:address / crypto:smart:contract:address
The address of the contract.

The property type is *crypto:currency:address*.

:bytecode / crypto:smart:contract:bytecode
The bytecode which implements the contract.

The property type is *file:bytes*.

:token:name / crypto:smart:contract:token:name
The ERC-20 token name.

The property type is *str*.

:token:symbol / crypto:smart:contract:token:symbol
The ERC-20 token symbol.

The property type is *str*.

:token:totalsupply / crypto:smart:contract:token:totalsupply
The ERC-20 totalSupply value.

The property type is *hugenum*.

crypto:smart:effect:burntoken

A smart contract effect which destroys a non-fungible token.

The base type for the form can be found at *crypto:smart:effect:burntoken*.

Properties:

:token / crypto:smart:effect:burntoken:token
The non-fungible token that was destroyed.

The property type is *crypto:smart:token*.

:index / crypto:smart:effect:burntoken:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:burntoken:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:edittokensupply

A smart contract effect which increases or decreases the supply of a fungible token.

The base type for the form can be found at *crypto:smart:effect:edittokensupply*.

Properties:

:contract / crypto:smart:effect:edittokensupply:contract
The contract which defines the tokens.

The property type is *crypto:smart:contract*.

:amount / crypto:smart:effect:edittokensupply:amount
The number of tokens added or removed if negative.

The property type is *hugenum*.

:totalsupply / crypto:smart:effect:edittokensupply:totalsupply
The total supply of tokens after this modification.

The property type is *hugenum*.

:index / crypto:smart:effect:edittokensupply:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:edittokensupply:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:minttoken

A smart contract effect which creates a new non-fungible token.

The base type for the form can be found at *crypto:smart:effect:minttoken*.

Properties:

:token / crypto:smart:effect:minttoken:token
The non-fungible token that was created.

The property type is *crypto:smart:token*.

:index / crypto:smart:effect:minttoken:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:minttoken:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:proxytoken

A smart contract effect which grants a non-owner address the ability to manipulate a specific non-fungible token.

The base type for the form can be found at *crypto:smart:effect:proxytoken*.

Properties:

:owner / crypto:smart:effect:proxytoken:owner
The address granting proxy authority to manipulate non-fungible tokens.

The property type is *crypto:currency:address*.

:proxy / crypto:smart:effect:proxytoken:proxy
The address granted proxy authority to manipulate non-fungible tokens.

The property type is *crypto:currency:address*.

:token / crypto:smart:effect:proxytoken:token
The specific token being granted access to.

The property type is *crypto:smart:token*.

:index / crypto:smart:effect:proxytoken:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:proxytoken:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:proxytokenall

A smart contract effect which grants a non-owner address the ability to manipulate all non-fungible tokens of the owner.

The base type for the form can be found at *crypto:smart:effect:proxytokenall*.

Properties:

:contract / crypto:smart:effect:proxytokenall:contract
The contract which defines the tokens.

The property type is *crypto:smart:contract*.

:owner / crypto:smart:effect:proxytokenall:owner
The address granting/denying proxy authority to manipulate all non-fungible tokens of the owner.

The property type is *crypto:currency:address*.

:proxy / crypto:smart:effect:proxytokenall:proxy
The address granted/denied proxy authority to manipulate all non-fungible tokens of the owner.

The property type is *crypto:currency:address*.

:approval / crypto:smart:effect:proxytokenall:approval
The approval status.

The property type is *bool*.

:index / crypto:smart:effect:proxytokenall:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:proxytokenall:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:proxytokens

A smart contract effect which grants a non-owner address the ability to manipulate fungible tokens.

The base type for the form can be found at *crypto:smart:effect:proxytokens*.

Properties:

:contract / crypto:smart:effect:proxytokens:contract
The contract which defines the tokens.

The property type is *crypto:smart:contract*.

:owner / crypto:smart:effect:proxytokens:owner
The address granting proxy authority to manipulate fungible tokens.

The property type is *crypto:currency:address*.

:proxy / crypto:smart:effect:proxytokens:proxy
The address granted proxy authority to manipulate fungible tokens.

The property type is *crypto:currency:address*.

:amount / crypto:smart:effect:proxytokens:amount
The hex encoded amount of tokens the proxy is allowed to manipulate.

The property type is *hex*.

:index / crypto:smart:effect:proxytokens:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:proxytokens:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:transfertoken

A smart contract effect which transfers ownership of a non-fungible token.

The base type for the form can be found at *crypto:smart:effect:transfertoken*.

Properties:

:token / crypto:smart:effect:transfertoken:token
The non-fungible token that was transferred.

The property type is *crypto:smart:token*.

:from / crypto:smart:effect:transfertoken:from
The address the NFT was transferred from.

The property type is *crypto:currency:address*.

:to / crypto:smart:effect:transfertoken:to
The address the NFT was transferred to.

The property type is *crypto:currency:address*.

:index / crypto:smart:effect:transfertoken:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:transfertoken:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:effect:transfertokens

A smart contract effect which transfers fungible tokens.

The base type for the form can be found at *crypto:smart:effect:transfertokens*.

Properties:

:contract / crypto:smart:effect:transfertokens:contract
The contract which defines the tokens.

The property type is *crypto:smart:contract*.

:from / crypto:smart:effect:transfertokens:from
The address the tokens were transferred from.

The property type is *crypto:currency:address*.

:to / crypto:smart:effect:transfertokens:to
The address the tokens were transferred to.

The property type is *crypto:currency:address*.

:amount / crypto:smart:effect:transfertokens:amount
The number of tokens transferred.

The property type is *hugenum*.

:index / crypto:smart:effect:transfertokens:index
The order of the effect within the effects of one transaction.

The property type is *int*.

:transaction / crypto:smart:effect:transfertokens:transaction
The transaction where the smart contract was called.

The property type is *crypto:currency:transaction*.

crypto:smart:token

A token managed by a smart contract.

The base type for the form can be found at *crypto:smart:token*.

Properties:

:contract / crypto:smart:token:contract
The smart contract which defines and manages the token. It has the following property options set:

- Read Only: `True`

The property type is *crypto:smart:contract*.

:tokenid / crypto:smart:token:tokenid
The token ID. It has the following property options set:

- Read Only: `True`

The property type is *hugenum*.

:owner / crypto:smart:token:owner
The address which currently owns the token.

The property type is *crypto:currency:address*.

:nft:url / crypto:smart:token:nft:url
The URL which hosts the NFT metadata.

The property type is *inet:url*.

:nft:meta / crypto:smart:token:nft:meta
The raw NFT metadata.

The property type is *data*.

:nft:meta:name / crypto:smart:token:nft:meta:name
The name field from the NFT metadata.

The property type is *str*.

:nft:meta:description / crypto:smart:token:nft:meta:description
The description field from the NFT metadata. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:nft:meta:image / crypto:smart:token:nft:meta:image
The image URL from the NFT metadata.

The property type is *inet:url*.

crypto:x509:cert

A unique X.509 certificate.

The base type for the form can be found at *crypto:x509:cert*.

Properties:

:file / crypto:x509:cert:file
The file that the certificate metadata was parsed from.

The property type is *file:bytes*.

:subject / crypto:x509:cert:subject
The subject identifier, commonly in X.500/LDAP format, to which the certificate was issued.

The property type is *str*.

:issuer / crypto:x509:cert:issuer
The Distinguished Name (DN) of the Certificate Authority (CA) which issued the certificate.

The property type is *str*.

:issuer:cert / crypto:x509:cert:issuer:cert
The certificate used by the issuer to sign this certificate.

The property type is *crypto:x509:cert*.

:serial / crypto:x509:cert:serial
The certificate serial number as a big endian hex value.

The property type is *hex*. Its type has the following options set:

- size: `40`

:version / crypto:x509:cert:version
The version integer in the certificate. (ex. 2 == v3).

The property type is *int*. Its type has the following options set:

- enums: `((0, 'v1'), (2, 'v3'))`

:validity:notbefore / crypto:x509:cert:validity:notbefore
The timestamp for the beginning of the certificate validity period.

The property type is *time*.

:validity:notafter / crypto:x509:cert:validity:notafter
The timestamp for the end of the certificate validity period.

The property type is *time*.

:md5 / crypto:x509:cert:md5
The MD5 fingerprint for the certificate.

The property type is *hash:md5*.

:sha1 / crypto:x509:cert:sha1
The SHA1 fingerprint for the certificate.

The property type is *hash:sha1*.

:sha256 / crypto:x509:cert:sha256
The SHA256 fingerprint for the certificate.

The property type is *hash:sha256*.

:rsa:key / crypto:x509:cert:rsa:key
The optional RSA public key associated with the certificate.

The property type is *rsa:key*.

:algo / crypto:x509:cert:algo
The X.509 signature algorithm OID.

The property type is *iso:oid*.

:signature / crypto:x509:cert:signature
The hexadecimal representation of the digital signature.

The property type is *hex*.

:ext:sans / crypto:x509:cert:ext:sans
The Subject Alternate Names (SANs) listed in the certificate.

The property type is *array*. Its type has the following options set:

- type: `crypto:x509:san`
- uniq: `True`
- sorted: `True`

:ext:crls / crypto:x509:cert:ext:crls
A list of Subject Alternate Names (SANs) for Distribution Points.

The property type is *array*. Its type has the following options set:

- type: `crypto:x509:san`
- uniq: `True`
- sorted: `True`

:identities:fqdns / crypto:x509:cert:identities:fqdns
The fused list of FQDNs identified by the cert CN and SANs.

The property type is *array*. Its type has the following options set:

- type: `inet:fqdn`
- uniq: `True`
- sorted: `True`

:identities:emails / crypto:x509:cert:identities:emails
The fused list of e-mail addresses identified by the cert CN and SANs.

The property type is *array*. Its type has the following options set:

- type: `inet:email`
- uniq: `True`
- sorted: `True`

:identities:ipv4s / crypto:x509:cert:identities:ipv4s
The fused list of IPv4 addresses identified by the cert CN and SANs.

The property type is *array*. Its type has the following options set:

- type: `inet:ipv4`
- uniq: `True`
- sorted: `True`

:identities:ipv6s / crypto:x509:cert:identities:ipv6s
The fused list of IPv6 addresses identified by the cert CN and SANs.

The property type is *array*. Its type has the following options set:

- type: `inet:ipv6`
- uniq: `True`
- sorted: `True`

:identities:urls / crypto:x509:cert:identities:urls
The fused list of URLs identified by the cert CN and SANs.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

:crl:urls / crypto:x509:cert:crl:urls
The extracted URL values from the CRLs extension.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

:selfsigned / crypto:x509:cert:selfsigned
Whether this is a self-signed certificate.

The property type is *bool*.

crypto:x509:crl

A unique X.509 Certificate Revocation List.

The base type for the form can be found at *crypto:x509:crl*.

Properties:

:file / crypto:x509:crl:file
The file containing the CRL.

The property type is *file:bytes*.

:url / crypto:x509:crl:url
The URL where the CRL was published.

The property type is *inet:url*.

crypto:x509:revoked

A revocation relationship between a CRL and an X.509 certificate.

The base type for the form can be found at *crypto:x509:revoked*.

Properties:

:crl / crypto:x509:revoked:crl
The CRL which revoked the certificate. It has the following property options set:

- Read Only: `True`

The property type is *crypto:x509:crl*.

:cert / crypto:x509:revoked:cert
The certificate revoked by the CRL. It has the following property options set:

- Read Only: `True`

The property type is *crypto:x509:cert*.

crypto:x509:signedfile

A digital signature relationship between an X.509 certificate and a file.

The base type for the form can be found at *crypto:x509:signedfile*.

Properties:

:cert / crypto:x509:signedfile:cert
The certificate for the key which signed the file. It has the following property options set:

- Read Only: `True`

The property type is *crypto:x509:cert*.

:file / crypto:x509:signedfile:file
The file which was signed by the certificates key. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

econ:acct:balance

A snapshot of the balance of an account at a point in time.

The base type for the form can be found at *econ:acct:balance*.

Properties:

:time / econ:acct:balance:time
The time the balance was recorded.

The property type is *time*.

:pay:card / econ:acct:balance:pay:card
The payment card holding the balance.

The property type is *econ:pay:card*.

:crypto:address / econ:acct:balance:crypto:address
The crypto currency address holding the balance.

The property type is *crypto:currency:address*.

:amount / econ:acct:balance:amount
The account balance at the time.

The property type is *econ:price*.

:currency / econ:acct:balance:currency
The currency of the balance amount.

The property type is *econ:currency*.

:delta / econ:acct:balance:delta
The change since last regular sample.

The property type is *econ:price*.

:total:received / econ:acct:balance:total:received
The total amount of currency received by the account.

The property type is *econ:price*.

:total:sent / econ:acct:balance:total:sent
The total amount of currency sent from the account.

The property type is *econ:price*.

econ:acct:payment

A payment or crypto currency transaction.

The base type for the form can be found at *econ:acct:payment*.

Properties:

:txnid / econ:acct:payment:txnid
A payment processor specific transaction id.

The property type is *str*. Its type has the following options set:

- strip: `True`

:fee / econ:acct:payment:fee
The transaction fee paid by the recipient to the payment processor.

The property type is *econ:price*.

:from:pay:card / econ:acct:payment:from:pay:card
The payment card making the payment.

The property type is *econ:pay:card*.

:from:contract / econ:acct:payment:from:contract
A contract used as an aggregate payment source.

The property type is *ou:contract*.

:from:coinaddr / econ:acct:payment:from:coinaddr
The crypto currency address making the payment.

The property type is *crypto:currency:address*.

:from:contact / econ:acct:payment:from:contact
Contact information for the person/org being paid.

The property type is *ps:contact*.

:to:coinaddr / econ:acct:payment:to:coinaddr
The crypto currency address receiving the payment.

The property type is *crypto:currency:address*.

:to:contact / econ:acct:payment:to:contact
Contact information for the person/org being paid.

The property type is *ps:contact*.

:to:contract / econ:acct:payment:to:contract
A contract used as an aggregate payment destination.

The property type is *ou:contract*.

:time / econ:acct:payment:time
The time the payment was processed.

The property type is *time*.

:purchase / econ:acct:payment:purchase
The purchase which the payment was paying for.

The property type is *econ:purchase*.

:amount / econ:acct:payment:amount
The amount of money transferred in the payment.

The property type is *econ:price*.

:currency / econ:acct:payment:currency
The currency of the payment.

The property type is *econ:currency*.

:memo / econ:acct:payment:memo
A small note specified by the payer common in financial transactions.

The property type is *str*.

:crypto:transaction / econ:acct:payment:crypto:transaction
A crypto currency transaction that initiated the payment.

The property type is *crypto:currency:transaction*.

econ:acquired

Deprecated. Please use econ:purchase -(acquired)> *.

The base type for the form can be found at *econ:acquired*.

Properties:

:purchase / econ:acquired:purchase
The purchase event which acquired an item. It has the following property options set:

- Read Only: `True`

The property type is *econ:purchase*.

:item / econ:acquired:item
A reference to the item that was acquired. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:item:form / econ:acquired:item:form
The form of item purchased.

The property type is *str*.

econ:fin:bar

A sample of the open, close, high, low prices of a security in a specific time window.

The base type for the form can be found at *econ:fin:bar*.

Properties:

:security / econ:fin:bar:security
The security measured by the bar.

The property type is *econ:fin:security*.

:ival / econ:fin:bar:ival
The interval of measurement.

The property type is *ival*.

:price:open / econ:fin:bar:price:open
The opening price of the security.

The property type is *econ:price*.

:price:close / econ:fin:bar:price:close
The closing price of the security.

The property type is *econ:price*.

:price:low / econ:fin:bar:price:low
The low price of the security.

The property type is *econ:price*.

:price:high / econ:fin:bar:price:high
The high price of the security.

The property type is *econ:price*.

econ:fin:exchange

A financial exchange where securities are traded.

The base type for the form can be found at *econ:fin:exchange*.

Properties:

:name / econ:fin:exchange:name
A simple name for the exchange. It has the following property options set:

- Example: `nasdaq`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:org / econ:fin:exchange:org
The organization that operates the exchange.

The property type is *ou:org*.

:currency / econ:fin:exchange:currency
The currency used for all transactions in the exchange. It has the following property options set:

- Example: `usd`

The property type is *econ:currency*.

econ:fin:security

A financial security which is typically traded on an exchange.

The base type for the form can be found at *econ:fin:security*.

Properties:

:exchange / econ:fin:security:exchange
The exchange on which the security is traded.

The property type is *econ:fin:exchange*.

:ticker / econ:fin:security:ticker
The identifier for this security within the exchange.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:type / econ:fin:security:type
A user defined type such as stock, bond, option, future, or forex.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:price / econ:fin:security:price
The last known/available price of the security.

The property type is *econ:price*.

:time / econ:fin:security:time
The time of the last know price sample.

The property type is *time*.

econ:fin:tick

A sample of the price of a security at a single moment in time.

The base type for the form can be found at *econ:fin:tick*.

Properties:

:security / econ:fin:tick:security
The security measured by the tick.

The property type is *econ:fin:security*.

:time / econ:fin:tick:time
The time the price was sampled.

The property type is *time*.

:price / econ:fin:tick:price
The price of the security at the time.

The property type is *econ:price*.

econ:pay:card

A single payment card.

The base type for the form can be found at *econ:pay:card*.

Properties:

:pan / econ:pay:card:pan
The payment card number.

The property type is *econ:pay:pan*.

:pan:mii / econ:pay:card:pan:mii
The payment card MII.

The property type is *econ:pay:mii*.

:pan:iin / econ:pay:card:pan:iin
The payment card IIN.

The property type is *econ:pay:iin*.

:name / econ:pay:card:name
The name as it appears on the card.

The property type is *ps:name*.

:expr / econ:pay:card:expr
The expiration date for the card.

The property type is *time*.

:cvv / econ:pay:card:cvv
The Card Verification Value on the card.

The property type is *econ:pay:cvv*.

:pin / econ:pay:card:pin
The Personal Identification Number on the card.

The property type is *econ:pay:pin*.

econ:pay:iin

An Issuer Id Number (IIN).

The base type for the form can be found at *econ:pay:iin*.

Properties:

:org / econ:pay:iin:org
The issuer organization.

The property type is *ou:org*.

:name / econ:pay:iin:name
The registered name of the issuer.

The property type is *str*. Its type has the following options set:

- lower: `True`

econ:purchase

A purchase event.

The base type for the form can be found at *econ:purchase*.

Properties:

:by:contact / econ:purchase:by:contact
The contact information used to make the purchase.

The property type is *ps:contact*.

:from:contact / econ:purchase:from:contact
The contact information used to sell the item.

The property type is *ps:contact*.

:time / econ:purchase:time
The time of the purchase.

The property type is *time*.

:place / econ:purchase:place
The place where the purchase took place.

The property type is *geo:place*.

:paid / econ:purchase:paid
Set to True if the purchase has been paid in full.

The property type is *bool*.

:paid:time / econ:purchase:paid:time
The point in time where the purchase was paid in full.

The property type is *time*.

:settled / econ:purchase:settled
The point in time where the purchase was settled.

The property type is *time*.

:campaign / econ:purchase:campaign
The campaign that the purchase was in support of.

The property type is *ou:campaign*.

:price / econ:purchase:price
The econ:price of the purchase.

The property type is *econ:price*.

:currency / econ:purchase:currency
The econ:price of the purchase.

The property type is *econ:currency*.

econ:receipt:item

A line item included as part of a purchase.

The base type for the form can be found at *econ:receipt:item*.

Properties:

:purchase / econ:receipt:item:purchase
The purchase that contains this line item.

The property type is *econ:purchase*.

:count / econ:receipt:item:count
The number of items included in this line item.

The property type is *int*. Its type has the following options set:

- min: 1

:price / econ:receipt:item:price
The total cost of this receipt line item.

The property type is *econ:price*.

:product / econ:receipt:item:product
The product being being purchased in this line item.

The property type is *biz:product*.

edge:has

A digraph edge which records that N1 has N2.

The base type for the form can be found at *edge:has*.

Properties:

:n1 / edge:has:n1
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n1:form / edge:has:n1:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:n2 / edge:has:n2
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n2:form / edge:has:n2:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

edge:refs

A digraph edge which records that N1 refers to or contains N2.

The base type for the form can be found at *edge:refs*.

Properties:

:n1 / edge:refs:n1
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n1:form / edge:refs:n1:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:n2 / edge:refs:n2
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n2:form / edge:refs:n2:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

edge:wentto

A digraph edge which records that N1 went to N2 at a specific time.

The base type for the form can be found at *edge:wentto*.

Properties:

:n1 / edge:wentto:n1
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n1:form / edge:wentto:n1:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:n2 / edge:wentto:n2
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n2:form / edge:wentto:n2:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:time / edge:wentto:time
A date/time value. It has the following property options set:

- Read Only: `True`

The property type is *time*.

edu:class

An instance of an edu:course taught at a given time.

The base type for the form can be found at *edu:class*.

Properties:

:course / edu:class:course
The course being taught in the class.

The property type is *edu:course*.

:instructor / edu:class:instructor
The primary instructor for the class.

The property type is *ps:contact*.

:assistants / edu:class:assistants
An array of assistant/co-instructor contacts.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:date:first / edu:class:date:first
The date of the first day of class.

The property type is *time*.

:date:last / edu:class:date:last
The date of the last day of class.

The property type is *time*.

:isvirtual / edu:class:isvirtual
Set if the class is known to be virtual.

The property type is *bool*.

:virtual:url / edu:class:virtual:url
The URL a student would use to attend the virtual class.

The property type is *inet:url*.

:virtual:provider / edu:class:virtual:provider
Contact info for the virtual infrastructure provider.

The property type is *ps:contact*.

:place / edu:class:place
The place that the class is held.

The property type is *geo:place*.

edu:course

A course of study taught by an org.

The base type for the form can be found at *edu:course*.

Properties:

:name / edu:course:name
The name of the course. It has the following property options set:

- Example: `organic chemistry for beginners`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / edu:course:desc
A brief course description.

The property type is *str*.

:code / edu:course:code
The course catalog number or designator. It has the following property options set:

- Example: `chem101`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:institution / edu:course:institution
The org or department which teaches the course.

The property type is *ps:contact*.

:prereqs / edu:course:prereqs
The pre-requisite courses for taking this course.

The property type is *array*. Its type has the following options set:

- type: `edu:course`
- uniq: `True`
- sorted: `True`

file:archive:entry

An archive entry representing a file and metadata within a parent archive file.

The base type for the form can be found at *file:archive:entry*.

Properties:

:parent / file:archive:entry:parent
The parent archive file.

The property type is *file:bytes*.

:file / file:archive:entry:file
The file contained within the archive.

The property type is *file:bytes*.

:path / file:archive:entry:path
The file path of the archived file.

The property type is *file:path*.

:user / file:archive:entry:user
The name of the user who owns the archived file.

The property type is *inet:user*.

:added / file:archive:entry:added
The time that the file was added to the archive.

The property type is *time*.

:created / file:archive:entry:created
The created time of the archived file.

The property type is *time*.

:modified / file:archive:entry:modified
The modified time of the archived file.

The property type is *time*.

:comment / file:archive:entry:comment
The comment field for the file entry within the archive.

The property type is *str*.

:posix:uid / file:archive:entry:posix:uid
The POSIX UID of the user who owns the archived file.

The property type is *int*.

:posix:gid / file:archive:entry:posix:gid
The POSIX GID of the group who owns the archived file.

The property type is *int*.

:posix:perms / file:archive:entry:posix:perms
The POSIX permissions mask of the archived file.

The property type is *int*.

:archived:size / file:archive:entry:archived:size
The encoded or compressed size of the archived file within the parent.

The property type is *int*.

file:base

A file name with no path.

The base type for the form can be found at *file:base*.

An example of `file:base`:

- `woot.exe`

Properties:

:ext / file:base:ext
The file extension (if any). It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:bytes

The file bytes type with SHA256 based primary property.

The base type for the form can be found at *file:bytes*.

Properties:

:size / file:bytes:size
The file size in bytes.

The property type is *int*.

:md5 / file:bytes:md5
The md5 hash of the file.

The property type is *hash:md5*.

:sha1 / file:bytes:sha1
The sha1 hash of the file.

The property type is *hash:sha1*.

:sha256 / file:bytes:sha256
The sha256 hash of the file.

The property type is *hash:sha256*.

:sha512 / file:bytes:sha512
The sha512 hash of the file.

The property type is *hash:sha512*.

:name / file:bytes:name
The best known base name for the file.

The property type is *file:base*.

:mime / file:bytes:mime
The "best" mime type name for the file.

The property type is *file:mime*.

:mime:x509:cn / file:bytes:mime:x509:cn
The Common Name (CN) attribute of the x509 Subject.

The property type is *str*.

:mime:pe:size / file:bytes:mime:pe:size
The size of the executable file according to the PE file header.

The property type is *int*.

:mime:pe:imphash / file:bytes:mime:pe:imphash
The PE import hash of the file as calculated by pefile; https://github.com/erocarrera/pefile .

The property type is *hash:md5*.

:mime:pe:compiled / file:bytes:mime:pe:compiled
The compile time of the file according to the PE header.

The property type is *time*.

:mime:pe:pdbpath / file:bytes:mime:pe:pdbpath
The PDB string according to the PE.

The property type is *file:path*.

:mime:pe:exports:time / file:bytes:mime:pe:exports:time
The export time of the file according to the PE.

The property type is *time*.

:mime:pe:exports:libname / file:bytes:mime:pe:exports:libname
The export library name according to the PE.

The property type is *str*.

:mime:pe:richhdr / file:bytes:mime:pe:richhdr
The sha256 hash of the rich header bytes.

The property type is *hash:sha256*.

:exe:compiler / file:bytes:exe:compiler
The software used to compile the file.

The property type is *it:prod:softver*.

:exe:packer / file:bytes:exe:packer
The packer software used to encode the file.

The property type is *it:prod:softver*.

file:filepath

The fused knowledge of the association of a file:bytes node and a file:path.

The base type for the form can be found at *file:filepath*.

Properties:

:file / file:filepath:file
The file seen at a path. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:path / file:filepath:path
The path a file was seen at. It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:dir / file:filepath:path:dir
The parent directory. It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:base / file:filepath:path:base
The name of the file. It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:path:base:ext / file:filepath:path:base:ext
The extension of the file name. It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:ismime

Records one, of potentially multiple, mime types for a given file.

The base type for the form can be found at *file:ismime*.

Properties:

:file / file:ismime:file
The file node that is an instance of the named mime type. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:mime / file:ismime:mime
The mime type of the file. It has the following property options set:

- Read Only: `True`

The property type is *file:mime*.

file:mime

A file mime name string.

The base type for the form can be found at *file:mime*.

An example of `file:mime`:

- `text/plain`

Properties:

file:mime:gif

The GUID of a set of mime metadata for a .gif file.

The base type for the form can be found at *file:mime:gif* .

Properties:

:desc / file:mime:gif:desc
MIME specific description field extracted from metadata.

The property type is *str*.

:comment / file:mime:gif:comment
MIME specific comment field extracted from metadata.

The property type is *str*.

:created / file:mime:gif:created
MIME specific creation timestamp extracted from metadata.

The property type is *time*.

:imageid / file:mime:gif:imageid
MIME specific unique identifier extracted from metadata.

The property type is *str*.

:author / file:mime:gif:author
MIME specific contact information extracted from metadata.

The property type is *ps:contact*.

:latlong / file:mime:gif:latlong
MIME specific lat/long information extracted from metadata.

The property type is *geo:latlong*.

:altitude / file:mime:gif:altitude
MIME specific altitude information extracted from metadata.

The property type is *geo:altitude*.

:file / file:mime:gif:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:gif:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:gif:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:jpg

The GUID of a set of mime metadata for a .jpg file.

The base type for the form can be found at *file:mime:jpg*.

Properties:

:desc / file:mime:jpg:desc
MIME specific description field extracted from metadata.

The property type is *str*.

:comment / file:mime:jpg:comment
MIME specific comment field extracted from metadata.

The property type is *str*.

:created / file:mime:jpg:created
MIME specific creation timestamp extracted from metadata.

The property type is *time*.

:imageid / file:mime:jpg:imageid
MIME specific unique identifier extracted from metadata.

The property type is *str*.

:author / file:mime:jpg:author
MIME specific contact information extracted from metadata.

The property type is *ps:contact*.

:latlong / file:mime:jpg:latlong
MIME specific lat/long information extracted from metadata.

The property type is *geo:latlong*.

:altitude / file:mime:jpg:altitude
MIME specific altitude information extracted from metadata.

The property type is *geo:altitude*.

:file / file:mime:jpg:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:jpg:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:jpg:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:macho:loadcmd

A generic load command pulled from the Mach-O headers.

The base type for the form can be found at *file:mime:macho:loadcmd*.

Properties:

:file / file:mime:macho:loadcmd:file
The Mach-O file containing the load command.

The property type is *file:bytes*.

:type / file:mime:macho:loadcmd:type
The type of the load command.

The property type is *int*. Its type has the following options set:

- enums: ((1, 'segment'), (2, 'symbol table'), (3, 'gdb symbol table'), (4, 'thread'), (5, 'unix thread'), (6, 'fixed VM shared library'), (7, 'fixed VM shared library identification'), (8, 'object identification'), (9, 'fixed VM file inclusion'), (10, 'prepage'), (11, 'dynamic link-edit symbol table'), (12, 'load dynamically linked shared library'), (13, 'dynamically linked shared library identifier'), (14, 'load dynamic linker'), (15, 'dynamic linker identification'), (16, 'prebound dynamically linked shared library'), (17, 'image routines'), (18, 'sub framework'), (19, 'sub umbrella'), (20, 'sub client'), (21, 'sub library'), (22, 'two level namespace lookup hints'), (23, 'prebind checksum'), (24, 'weak import dynamically linked shared library'), (25, '64bit segment'), (26, '64bit image routines'), (27, 'uuid'), (28, 'runpath additions'), (29, 'code signature'), (30, 'split segment info'), (31, 'load and re-export dynamic library'), (32, 'delay load of dynamic library'), (33, 'encrypted segment information'), (34, 'compressed dynamic library information'), (35, 'load upward dylib'), (36, 'minimum osx version'), (37, 'minimum ios version'), (38, 'compressed table of function start addresses'), (39, 'environment variable string for dynamic library'), (40, 'unix thread replacement'), (41, 'table of non-instructions in __text'), (42, 'source version used to build binary'), (43, 'Code signing DRs copied from linked dynamic libraries'))

:size / file:mime:macho:loadcmd:size
The size of the load command structure in bytes.

The property type is *int*.

file:mime:macho:section

A section inside a Mach-O binary denoting a named region of bytes inside a segment.

The base type for the form can be found at *file:mime:macho:section*.

Properties:

:segment / file:mime:macho:section:segment
The Mach-O segment that contains this section.

The property type is *file:mime:macho:segment*.

:name / file:mime:macho:section:name
Name of the section.

The property type is *str*.

:size / file:mime:macho:section:size
Size of the section in bytes.

The property type is *int*.

:type / file:mime:macho:section:type
The type of the section.

The property type is *int*. Its type has the following options set:

- enums: ((0, 'regular'), (1, 'zero fill on demand'), (2, 'only literal C strings'), (3, 'only 4 byte literals'), (4, 'only 8 byte literals'), (5, 'only pointers to literals'), (6, 'only non-lazy symbol pointers'), (7, 'only lazy symbol pointers'), (8, 'only symbol stubs'), (9, 'only function pointers for init'), (10, 'only function pointers for fini'), (11, 'contains symbols to be coalesced'), (12, 'zero fill on deman (greater than 4gb)'), (13, 'only pairs of function pointers for interposing'), (14, 'only 16 byte literals'), (15, 'dtrace object format'), (16, 'only lazy symbols pointers to lazy dynamic libraries'))

:sha256 / file:mime:macho:section:sha256
The sha256 hash of the bytes of the Mach-O section.

The property type is *hash:sha256*.

:offset / file:mime:macho:section:offset
The file offset to the beginning of the section.

The property type is *int*.

file:mime:macho:segment

A named region of bytes inside a Mach-O binary.

The base type for the form can be found at *file:mime:macho:segment*.

Properties:

:name / file:mime:macho:segment:name
The name of the Mach-O segment.

The property type is *str*.

:memsize / file:mime:macho:segment:memsize
The size of the segment in bytes, when resident in memory, according to the load command structure.

The property type is *int*.

:disksize / file:mime:macho:segment:disksize
The size of the segment in bytes, when on disk, according to the load command structure.

The property type is *int*.

:sha256 / file:mime:macho:segment:sha256
The sha256 hash of the bytes of the segment.

The property type is *hash:sha256*.

:offset / file:mime:macho:segment:offset
The file offset to the beginning of the segment.

The property type is *int*.

:file / file:mime:macho:segment:file
The Mach-O file containing the load command.

The property type is *file:bytes*.

:type / file:mime:macho:segment:type
The type of the load command.

The property type is *int*. Its type has the following options set:

- enums: ((1, 'segment'), (2, 'symbol table'), (3, 'gdb symbol table'), (4, 'thread'), (5, 'unix thread'), (6, 'fixed VM shared library'), (7, 'fixed VM shared library identification'), (8, 'object identification'), (9, 'fixed VM file inclusion'), (10, 'prepage'), (11, 'dynamic link-edit symbol table'), (12, 'load dynamically linked shared library'), (13, 'dynamically linked shared library identifier'), (14, 'load dynamic linker'), (15, 'dynamic linker identification'), (16, 'prebound dynamically linked shared library'), (17, 'image routines'), (18, 'sub framework'), (19, 'sub umbrella'), (20, 'sub client'), (21, 'sub library'), (22, 'two level namespace lookup hints'), (23, 'prebind checksum'), (24, 'weak import dynamically linked shared library'), (25, '64bit segment'), (26, '64bit image routines'), (27, 'uuid'), (28, 'runpath additions'), (29, 'code signature'), (30, 'split segment info'), (31, 'load and re-export dynamic library'), (32, 'delay load of dynamic library'), (33, 'encrypted segment information'), (34, 'compressed dynamic library information'), (35, 'load upward dylib'), (36, 'minimum osx version'), (37, 'minimum ios version'), (38, 'compressed table of function start addresses'), (39, 'environment variable string for dynamic library'), (40, 'unix thread replacement'), (41, 'table of non-instructions in __text'), (42, 'source version used to build binary'), (43, 'Code signing DRs copied from linked dynamic libraries'))

:size / file:mime:macho:segment:size
The size of the load command structure in bytes.

The property type is *int*.

file:mime:macho:uuid

A specific load command denoting a UUID used to uniquely identify the Mach-O binary.

The base type for the form can be found at *file:mime:macho:uuid*.

Properties:

:uuid / file:mime:macho:uuid:uuid
The UUID of the Mach-O application (as defined in an LC_UUID load command).

The property type is *guid*.

:file / file:mime:macho:uuid:file
The Mach-O file containing the load command.

The property type is *file:bytes*.

:type / file:mime:macho:uuid:type
The type of the load command.

The property type is *int*. Its type has the following options set:

- enums: ((1, 'segment'), (2, 'symbol table'), (3, 'gdb symbol table'), (4, 'thread'), (5, 'unix thread'), (6, 'fixed VM shared library'), (7, 'fixed VM

shared library identification'), (8, 'object identification'), (9, 'fixed VM file inclusion'), (10, 'prepage'), (11, 'dynamic link-edit symbol table'), (12, 'load dynamically linked shared library'), (13, 'dynamically linked shared library identifier'), (14, 'load dynamic linker'), (15, 'dynamic linker identification'), (16, 'prebound dynamically linked shared library'), (17, 'image routines'), (18, 'sub framework'), (19, 'sub umbrella'), (20, 'sub client'), (21, 'sub library'), (22, 'two level namespace lookup hints'), (23, 'prebind checksum'), (24, 'weak import dynamically linked shared library'), (25, '64bit segment'), (26, '64bit image routines'), (27, 'uuid'), (28, 'runpath additions'), (29, 'code signature'), (30, 'split segment info'), (31, 'load and re-export dynamic library'), (32, 'delay load of dynamic library'), (33, 'encrypted segment information'), (34, 'compressed dynamic library information'), (35, 'load upward dylib'), (36, 'minimum osx version'), (37, 'minimum ios version'), (38, 'compressed table of function start addresses'), (39, 'environment variable string for dynamic library'), (40, 'unix thread replacement'), (41, 'table of non-instructions in __text'), (42, 'source version used to build binary'), (43, 'Code signing DRs copied from linked dynamic libraries'))

:size / file:mime:macho:uuid:size
The size of the load command structure in bytes.

The property type is *int*.

file:mime:macho:version

A specific load command used to denote the version of the source used to build the Mach-O binary.

The base type for the form can be found at *file:mime:macho:version*.

Properties:

:version / file:mime:macho:version:version
The version of the Mach-O file encoded in an LC_VERSION load command.

The property type is *str*.

:file / file:mime:macho:version:file
The Mach-O file containing the load command.

The property type is *file:bytes*.

:type / file:mime:macho:version:type
The type of the load command.

The property type is *int*. Its type has the following options set:

- enums: ((1, 'segment'), (2, 'symbol table'), (3, 'gdb symbol table'), (4, 'thread'), (5, 'unix thread'), (6, 'fixed VM shared library'), (7, 'fixed VM shared library identification'), (8, 'object identification'), (9, 'fixed VM file inclusion'), (10, 'prepage'), (11, 'dynamic link-edit symbol table'), (12, 'load dynamically linked shared library'), (13, 'dynamically linked shared library identifier'), (14, 'load dynamic linker'), (15, 'dynamic linker identification'), (16, 'prebound dynamically linked shared library'), (17, 'image routines'), (18, 'sub framework'), (19, 'sub umbrella'), (20, 'sub client'), (21, 'sub library'), (22, 'two level namespace lookup hints'), (23, 'prebind checksum'), (24, 'weak import dynamically linked shared library'), (25, '64bit segment'), (26, '64bit image routines'), (27, 'uuid'), (28, 'runpath additions'), (29, 'code signature'), (30, 'split segment info'), (31, 'load

```
and re-export dynamic library'), (32, 'delay load of dynamic library'),
(33, 'encrypted segment information'), (34, 'compressed dynamic library
information'), (35, 'load upward dylib'), (36, 'minimum osx version'), (37,
'minimum ios version'), (38, 'compressed table of function start addresses'),
(39, 'environment variable string for dynamic library'), (40, 'unix thread
replacement'), (41, 'table of non-instructions in __text'), (42, 'source version
used to build binary'), (43, 'Code signing DRs copied from linked dynamic
libraries'))
```

:size / file:mime:macho:version:size
The size of the load command structure in bytes.

The property type is *int*.

file:mime:msdoc

The GUID of a set of mime metadata for a Microsoft Word file.

The base type for the form can be found at *file:mime:msdoc*.

Properties:

:title / file:mime:msdoc:title
The title extracted from Microsoft Office metadata.

The property type is *str*.

:author / file:mime:msdoc:author
The author extracted from Microsoft Office metadata.

The property type is *str*.

:subject / file:mime:msdoc:subject
The subject extracted from Microsoft Office metadata.

The property type is *str*.

:application / file:mime:msdoc:application
The creating_application extracted from Microsoft Office metadata.

The property type is *str*.

:created / file:mime:msdoc:created
The create_time extracted from Microsoft Office metadata.

The property type is *time*.

:lastsaved / file:mime:msdoc:lastsaved
The last_saved_time extracted from Microsoft Office metadata.

The property type is *time*.

:file / file:mime:msdoc:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:msdoc:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:msdoc:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:msppt

The GUID of a set of mime metadata for a Microsoft Powerpoint file.

The base type for the form can be found at *file:mime:msppt*.

Properties:

:title / file:mime:msppt:title
The title extracted from Microsoft Office metadata.

The property type is *str*.

:author / file:mime:msppt:author
The author extracted from Microsoft Office metadata.

The property type is *str*.

:subject / file:mime:msppt:subject
The subject extracted from Microsoft Office metadata.

The property type is *str*.

:application / file:mime:msppt:application
The creating_application extracted from Microsoft Office metadata.

The property type is *str*.

:created / file:mime:msppt:created
The create_time extracted from Microsoft Office metadata.

The property type is *time*.

:lastsaved / file:mime:msppt:lastsaved
The last_saved_time extracted from Microsoft Office metadata.

The property type is *time*.

:file / file:mime:msppt:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:msppt:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:msppt:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:msxls

The GUID of a set of mime metadata for a Microsoft Excel file.

The base type for the form can be found at *file:mime:msxls*.

Properties:

:title / file:mime:msxls:title
The title extracted from Microsoft Office metadata.

The property type is *str*.

:author / file:mime:msxls:author
The author extracted from Microsoft Office metadata.

The property type is *str*.

:subject / file:mime:msxls:subject
The subject extracted from Microsoft Office metadata.

The property type is *str*.

:application / file:mime:msxls:application
The creating_application extracted from Microsoft Office metadata.

The property type is *str*.

:created / file:mime:msxls:created
The create_time extracted from Microsoft Office metadata.

The property type is *time*.

:lastsaved / file:mime:msxls:lastsaved
The last_saved_time extracted from Microsoft Office metadata.

The property type is *time*.

:file / file:mime:msxls:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:msxls:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:msxls:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:pe:export

The fused knowledge of a file:bytes node containing a pe named export.

The base type for the form can be found at *file:mime:pe:export*.

Properties:

:file / file:mime:pe:export:file
The file containing the export. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:name / file:mime:pe:export:name
The name of the export in the file. It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:mime:pe:resource

The fused knowledge of a file:bytes node containing a pe resource.

The base type for the form can be found at *file:mime:pe:resource*.

Properties:

:file / file:mime:pe:resource:file
The file containing the resource. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:type / file:mime:pe:resource:type
The typecode for the resource. It has the following property options set:

- Read Only: `True`

The property type is *pe:resource:type*.

:langid / file:mime:pe:resource:langid
The language code for the resource. It has the following property options set:

- Read Only: `True`

The property type is *pe:langid*.

:resource / file:mime:pe:resource:resource
The sha256 hash of the resource bytes. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

file:mime:pe:section

The fused knowledge a file:bytes node containing a pe section.

The base type for the form can be found at *file:mime:pe:section*.

Properties:

:file / file:mime:pe:section:file
The file containing the section. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:name / file:mime:pe:section:name
The textual name of the section. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:sha256 / file:mime:pe:section:sha256
The sha256 hash of the section. Relocations must be zeroed before hashing. It has the following property options set:

- Read Only: `True`

The property type is *hash:sha256*.

file:mime:pe:vsvers:info

knowledge of a file:bytes node containing vsvers info.

The base type for the form can be found at *file:mime:pe:vsvers:info*.

Properties:

:file / file:mime:pe:vsvers:info:file
The file containing the vsversion keyval pair. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:keyval / file:mime:pe:vsvers:info:keyval
The vsversion info keyval in this file:bytes node. It has the following property options set:

- Read Only: `True`

The property type is *file:mime:pe:vsvers:keyval*.

file:mime:pe:vsvers:keyval

A key value pair found in a PE vsversion info structure.

The base type for the form can be found at *file:mime:pe:vsvers:keyval*.

Properties:

:name / file:mime:pe:vsvers:keyval:name
The key for the vsversion keyval pair. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:value / file:mime:pe:vsvers:keyval:value
The value for the vsversion keyval pair. It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:mime:png

The GUID of a set of mime metadata for a .png file.

The base type for the form can be found at *file:mime:png*.

Properties:

:desc / file:mime:png:desc
MIME specific description field extracted from metadata.

The property type is *str*.

:comment / file:mime:png:comment
MIME specific comment field extracted from metadata.

The property type is *str*.

:created / file:mime:png:created
MIME specific creation timestamp extracted from metadata.

The property type is *time*.

:imageid / file:mime:png:imageid
MIME specific unique identifier extracted from metadata.

The property type is *str*.

:author / file:mime:png:author
MIME specific contact information extracted from metadata.

The property type is *ps:contact*.

:latlong / file:mime:png:latlong
MIME specific lat/long information extracted from metadata.

The property type is *geo:latlong*.

:altitude / file:mime:png:altitude
MIME specific altitude information extracted from metadata.

The property type is *geo:altitude*.

:file / file:mime:png:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:png:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:png:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:rtf

The GUID of a set of mime metadata for a .rtf file.

The base type for the form can be found at *file:mime:rtf*.

Properties:

:guid / file:mime:rtf:guid
The parsed GUID embedded in the .rtf file.

The property type is *guid*.

:file / file:mime:rtf:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:rtf:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:rtf:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:mime:tif

The GUID of a set of mime metadata for a .tif file.

The base type for the form can be found at *file:mime:tif*.

Properties:

:desc / file:mime:tif:desc
MIME specific description field extracted from metadata.

The property type is *str*.

:comment / file:mime:tif:comment
MIME specific comment field extracted from metadata.

The property type is *str*.

:created / file:mime:tif:created
MIME specific creation timestamp extracted from metadata.

The property type is *time*.

:imageid / file:mime:tif:imageid
MIME specific unique identifier extracted from metadata.

The property type is *str*.

:author / file:mime:tif:author
MIME specific contact information extracted from metadata.

The property type is *ps:contact*.

:latlong / file:mime:tif:latlong
MIME specific lat/long information extracted from metadata.

The property type is *geo:latlong*.

:altitude / file:mime:tif:altitude
MIME specific altitude information extracted from metadata.

The property type is *geo:altitude*.

:file / file:mime:tif:file
The file that the mime info was parsed from.

The property type is *file:bytes*.

:file:offs / file:mime:tif:file:offs
The optional offset where the mime info was parsed from.

The property type is *int*.

:file:data / file:mime:tif:file:data
A mime specific arbitrary data structure for non-indexed data.

The property type is *data*.

file:path

A normalized file path.

The base type for the form can be found at *file:path*.

An example of `file:path`:

- `c:/windows/system32/calc.exe`

Properties:

:dir / file:path:dir
The parent directory. It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:base / file:path:base
The file base name. It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:base:ext / file:path:base:ext
The file extension. It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:string

Deprecated. Please use the edge -(refs)> it:dev:str.

The base type for the form can be found at *file:string*.

Properties:

:file / file:string:file
The file containing the string. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:string / file:string:string
The string contained in this file:bytes node. It has the following property options set:

- Read Only: `True`

The property type is *str*.

file:subfile

A parent file that fully contains the specified child file.

The base type for the form can be found at *file:subfile*.

Properties:

:parent / file:subfile:parent
The parent file containing the child file. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:child / file:subfile:child
The child file contained in the parent file. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:name / file:subfile:name
Deprecated, please use the :path property. It has the following property options set:

- deprecated: `True`

The property type is *file:base*.

:path / file:subfile:path
The path that the parent uses to refer to the child file.

The property type is *file:path*.

geo:name

An unstructured place name or address.

The base type for the form can be found at *geo:name*.

Properties:

geo:nloc

Records a node latitude/longitude in space-time.

The base type for the form can be found at *geo:nloc*.

Properties:

:ndef / geo:nloc:ndef
The node with location in geospace and time. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:ndef:form / geo:nloc:ndef:form
The form of node referenced by the ndef. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:latlong / geo:nloc:latlong
The latitude/longitude the node was observed. It has the following property options set:

- Read Only: `True`

The property type is *geo:latlong*.

:time / geo:nloc:time
The time the node was observed at location. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:place / geo:nloc:place
The place corresponding to the latlong property.

The property type is *geo:place*.

:loc / geo:nloc:loc
The geo-political location string for the node.

The property type is *loc*.

geo:place

A GUID for a geographic place.

The base type for the form can be found at *geo:place*.

Properties:

:name / geo:place:name
The name of the place.

The property type is *geo:name*.

:type / geo:place:type
The type of place.

The property type is *geo:place:taxonomy*.

:names / geo:place:names
An array of alternative place names.

The property type is *array*. Its type has the following options set:

- type: `geo:name`
- sorted: `True`
- uniq: `True`

:parent / geo:place:parent
Deprecated. Please use a -(contains)> edge. It has the following property options set:

- deprecated: `True`

The property type is *geo:place*.

:desc / geo:place:desc
A long form description of the place.

The property type is *str*.

:loc / geo:place:loc
The geo-political location string for the node.

The property type is *loc*.

:address / geo:place:address
The street/mailing address for the place.

The property type is *geo:address*.

:geojson / geo:place:geojson
A GeoJSON representation of the place.

The property type is *geo:json*.

:latlong / geo:place:latlong
The lat/long position for the place.

The property type is *geo:latlong*.

:bbox / geo:place:bbox
A bounding box which encompasses the place.

The property type is *geo:bbox*.

:radius / geo:place:radius
An approximate radius to use for bounding box calculation.

The property type is *geo:dist*.

:photo / geo:place:photo
The image file to use as the primary image of the place.

The property type is *file:bytes*.

geo:place:taxonomy

A taxonomy of place types.

The base type for the form can be found at *geo:place:taxonomy*.

Properties:

geo:telem

A geospatial position of a node at a given time. The node should be linked via -(seenat)> edges.

The base type for the form can be found at *geo:telem*.

Properties:

:time / geo:telem:time
The time that the node was at the position.

The property type is *time*.

:desc / geo:telem:desc
A description of the telemetry sample.

The property type is *str*.

:latlong / geo:telem:latlong
The latitude/longitude reading at the time.

The property type is *geo:latlong*.

:accuracy / geo:telem:accuracy
The reported accuracy of the latlong telemetry reading.

The property type is *geo:dist*.

:place / geo:telem:place
The place which includes the latlong value.

The property type is *geo:place*.

:place:name / geo:telem:place:name
The purported place name. Used for entity resolution.

The property type is *geo:name*.

gov:cn:icp

A Chinese Internet Content Provider ID.

The base type for the form can be found at *gov:cn:icp*.

Properties:

:org / gov:cn:icp:org
The org with the Internet Content Provider ID.

The property type is *ou:org*.

gov:cn:mucd

A Chinese PLA MUCD.

The base type for the form can be found at *gov:cn:mucd*.

Properties:

gov:us:cage

A Commercial and Government Entity (CAGE) code.

The base type for the form can be found at *gov:us:cage*.

Properties:

:name0 / gov:us:cage:name0
The name of the organization.

The property type is *ou:name*.

:name1 / gov:us:cage:name1
Name Part 1.

The property type is *str*. Its type has the following options set:

- lower: `True`

:street / gov:us:cage:street
The base string type.

The property type is *str*. Its type has the following options set:

- lower: `True`

:city / gov:us:cage:city
The base string type.

The property type is *str*. Its type has the following options set:

- lower: `True`

:state / gov:us:cage:state
The base string type.

The property type is *str*. Its type has the following options set:

- lower: `True`

:zip / gov:us:cage:zip
A US Postal Zip Code.

The property type is *gov:us:zip*.

:cc / gov:us:cage:cc
The 2 digit ISO 3166 country code.

The property type is *pol:iso2*.

:country / gov:us:cage:country
The base string type.

The property type is *str*. Its type has the following options set:

- lower: `True`

:phone0 / gov:us:cage:phone0
A phone number.

The property type is *tel:phone*.

:phone1 / gov:us:cage:phone1
A phone number.

The property type is *tel:phone*.

gov:us:ssn

A US Social Security Number (SSN).

The base type for the form can be found at *gov:us:ssn*.

Properties:

gov:us:zip

A US Postal Zip Code.

The base type for the form can be found at *gov:us:zip*.

Properties:

graph:cluster

A generic node, used in conjunction with Edge types, to cluster arbitrary nodes to a single node in the model.

The base type for the form can be found at *graph:cluster*.

Properties:

:name / graph:cluster:name
A human friendly name for the cluster.

The property type is *str*. Its type has the following options set:

- lower: `True`

:desc / graph:cluster:desc
A human friendly long form description for the cluster.

The property type is *str*. Its type has the following options set:

- lower: `True`

:type / graph:cluster:type
An optional type field used to group clusters.

The property type is *str*. Its type has the following options set:

- lower: `True`

graph:edge

A generic digraph edge to show relationships outside the model.

The base type for the form can be found at *graph:edge*.

Properties:

:n1 / graph:edge:n1
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n1:form / graph:edge:n1:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:n2 / graph:edge:n2
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n2:form / graph:edge:n2:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

graph:event

A generic event node to represent events outside the model.

The base type for the form can be found at *graph:event*.

Properties:

:time / graph:event:time
The time of the event.

The property type is *time*.

:type / graph:event:type
A arbitrary type string for the event.

The property type is *str*.

:name / graph:event:name
A name for the event.

The property type is *str*.

:data / graph:event:data
Arbitrary non-indexed msgpack data attached to the event.

The property type is *data*.

graph:node

A generic node used to represent objects outside the model.

The base type for the form can be found at *graph:node*.

Properties:

:type / graph:node:type
The type name for the non-model node.

The property type is *str*.

:name / graph:node:name
A human readable name for this record.

The property type is *str*.

:data / graph:node:data
Arbitrary non-indexed msgpack data attached to the node.

The property type is *data*.

graph:timeedge

A generic digraph time edge to show relationships outside the model.

The base type for the form can be found at *graph:timeedge*.

Properties:

:time / graph:timeedge:time
A date/time value. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:n1 / graph:timeedge:n1
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n1:form / graph:timeedge:n1:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:n2 / graph:timeedge:n2
The node definition type for a (form,valu) compound field. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:n2:form / graph:timeedge:n2:form
The base string type. It has the following property options set:

- Read Only: `True`

The property type is *str*.

hash:md5

A hex encoded MD5 hash.

The base type for the form can be found at *hash:md5*.

An example of `hash:md5`:

- `d41d8cd98f00b204e9800998ecf8427e`

Properties:

hash:sha1

A hex encoded SHA1 hash.

The base type for the form can be found at *hash:sha1*.

An example of `hash:sha1`:

- `da39a3ee5e6b4b0d3255bfef95601890afd80709`

Properties:

hash:sha256

A hex encoded SHA256 hash.

The base type for the form can be found at *hash:sha256*.

An example of `hash:sha256`:

- `ad9f4fe922b61e674a09530831759843b1880381de686a43460a76864ca0340c`

Properties:

hash:sha384

A hex encoded SHA384 hash.

The base type for the form can be found at *hash:sha384*.

An example of `hash:sha384`:

- `d425f1394e418ce01ed1579069a8bfaa1da8f32cf823982113ccbef531fa36bda9987f389c5af05b5e28035242efab6c`

Properties:

hash:sha512

A hex encoded SHA512 hash.

The base type for the form can be found at *hash:sha512*.

An example of `hash:sha512`:

- `ca74fe2ff2d03b29339ad7d08ba21d192077fece1715291c7b43c20c9136cd132788239189f3441a87eb23ce2660aa243f3`

Properties:

inet:asn

An Autonomous System Number (ASN).

The base type for the form can be found at *inet:asn*.

Properties:

:name / inet:asn:name
The name of the organization currently responsible for the ASN.

The property type is *str*. Its type has the following options set:

- lower: `True`

:owner / inet:asn:owner
The guid of the organization currently responsible for the ASN.

The property type is *ou:org*.

inet:asnet4

An Autonomous System Number (ASN) and its associated IPv4 address range.

The base type for the form can be found at *inet:asnet4*.

An example of `inet:asnet4`:

- `(54959, (1.2.3.4, 1.2.3.20))`

Properties:

:asn / inet:asnet4:asn
The Autonomous System Number (ASN) of the netblock. It has the following property options set:

- Read Only: `True`

The property type is *inet:asn*.

:net4 / inet:asnet4:net4
The IPv4 address range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:net4*.

:net4:min / inet:asnet4:net4:min
The first IPv4 in the range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:net4:max / inet:asnet4:net4:max
The last IPv4 in the range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

inet:asnet6

An Autonomous System Number (ASN) and its associated IPv6 address range.

The base type for the form can be found at *inet:asnet6*.

An example of `inet:asnet6`:

- `(54959, (ff::00, ff::02))`

Properties:

:asn / inet:asnet6:asn
The Autonomous System Number (ASN) of the netblock. It has the following property options set:

- Read Only: `True`

The property type is *inet:asn*.

:net6 / inet:asnet6:net6
The IPv6 address range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:net6*.

:net6:min / inet:asnet6:net6:min
The first IPv6 in the range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:net6:max / inet:asnet6:net6:max
The last IPv6 in the range assigned to the ASN. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

inet:banner

A network protocol banner string presented by a server.

The base type for the form can be found at *inet:banner*.

Properties:

:server / inet:banner:server
The server which presented the banner string. It has the following property options set:

- Read Only: `True`

The property type is *inet:server*.

:server:ipv4 / inet:banner:server:ipv4
The IPv4 address of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:server:ipv6 / inet:banner:server:ipv6
The IPv6 address of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:server:port / inet:banner:server:port
The network port. It has the following property options set:

- Read Only: `True`

The property type is *inet:port*.

:text / inet:banner:text
The banner text. It has the following property options set:

- Read Only: `True`
- disp: `{'hint': 'text'}`

The property type is *it:dev:str*.

inet:cidr4

An IPv4 address block in Classless Inter-Domain Routing (CIDR) notation.

The base type for the form can be found at *inet:cidr4*.

An example of `inet:cidr4`:

- `1.2.3.0/24`

Properties:

:broadcast / inet:cidr4:broadcast
The broadcast IP address from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:mask / inet:cidr4:mask
The mask from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:network / inet:cidr4:network
The network IP address from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

inet:cidr6

An IPv6 address block in Classless Inter-Domain Routing (CIDR) notation.

The base type for the form can be found at *inet:cidr6*.

An example of `inet:cidr6`:

- `2001:db8::/101`

Properties:

:broadcast / inet:cidr6:broadcast
The broadcast IP address from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:mask / inet:cidr6:mask
The mask from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:network / inet:cidr6:network
The network IP address from the CIDR notation. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

inet:client

A network client address.

The base type for the form can be found at *inet:client*.

An example of `inet:client`:

- `tcp://1.2.3.4:80`

Properties:

:proto / inet:client:proto
The network protocol of the client. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:ipv4 / inet:client:ipv4
The IPv4 of the client. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:ipv6 / inet:client:ipv6
The IPv6 of the client. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:host / inet:client:host
The it:host node for the client. It has the following property options set:

- Read Only: `True`

The property type is *it:host*.

:port / inet:client:port
The client tcp/udp port.

The property type is *inet:port*.

inet:dns:a

The result of a DNS A record lookup.

The base type for the form can be found at *inet:dns:a*.

An example of `inet:dns:a`:

- `(vertex.link,1.2.3.4)`

Properties:

:fqdn / inet:dns:a:fqdn
The domain queried for its DNS A record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ipv4 / inet:dns:a:ipv4
The IPv4 address returned in the A record. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

inet:dns:aaaa

The result of a DNS AAAA record lookup.

The base type for the form can be found at *inet:dns:aaaa*.

An example of `inet:dns:aaaa`:

- `(vertex.link,2607:f8b0:4004:809::200e)`

Properties:

:fqdn / inet:dns:aaaa:fqdn
The domain queried for its DNS AAAA record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ipv6 / inet:dns:aaaa:ipv6
The IPv6 address returned in the AAAA record. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

inet:dns:answer

A single answer from within a DNS reply.

The base type for the form can be found at *inet:dns:answer*.

Properties:

:ttl / inet:dns:answer:ttl
The base 64 bit signed integer type.

The property type is *int*.

:request / inet:dns:answer:request
A single instance of a DNS resolver request and optional reply info.

The property type is *inet:dns:request*.

:a / inet:dns:answer:a
The DNS A record returned by the lookup.

The property type is *inet:dns:a*.

:ns / inet:dns:answer:ns
The DNS NS record returned by the lookup.

The property type is *inet:dns:ns*.

:rev / inet:dns:answer:rev
The DNS PTR record returned by the lookup.

The property type is *inet:dns:rev*.

:aaaa / inet:dns:answer:aaaa
The DNS AAAA record returned by the lookup.

The property type is *inet:dns:aaaa*.

:rev6 / inet:dns:answer:rev6
The DNS PTR record returned by the lookup of an IPv6 address.

The property type is *inet:dns:rev6*.

:cname / inet:dns:answer:cname
The DNS CNAME record returned by the lookup.

The property type is *inet:dns:cname*.

:mx / inet:dns:answer:mx
The DNS MX record returned by the lookup.

The property type is *inet:dns:mx*.

:mx:priority / inet:dns:answer:mx:priority
The DNS MX record priority.

The property type is *int*.

:soa / inet:dns:answer:soa
The domain queried for its SOA record.

The property type is *inet:dns:soa*.

:txt / inet:dns:answer:txt
The DNS TXT record returned by the lookup.

The property type is *inet:dns:txt*.

inet:dns:cname

The result of a DNS CNAME record lookup.

The base type for the form can be found at *inet:dns:cname*.

An example of `inet:dns:cname`:

- `(foo.vertex.link,vertex.link)`

Properties:

:fqdn / inet:dns:cname:fqdn
The domain queried for its CNAME record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:cname / inet:dns:cname:cname
The domain returned in the CNAME record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:dns:dynreg

A dynamic DNS registration.

The base type for the form can be found at *inet:dns:dynreg*.

Properties:

:fqdn / inet:dns:dynreg:fqdn
The FQDN registered within a dynamic DNS provider.

The property type is *inet:fqdn*.

:provider / inet:dns:dynreg:provider
The organization which provides the dynamic DNS FQDN.

The property type is *ou:org*.

:provider:name / inet:dns:dynreg:provider:name
The name of the organization which provides the dynamic DNS FQDN.

The property type is *ou:name*.

:provider:fqdn / inet:dns:dynreg:provider:fqdn
The FQDN of the organization which provides the dynamic DNS FQDN.

The property type is *inet:fqdn*.

:contact / inet:dns:dynreg:contact
The contact information of the registrant.

The property type is *ps:contact*.

:created / inet:dns:dynreg:created
The time that the dynamic DNS registration was first created.

The property type is *time*.

:client / inet:dns:dynreg:client
The network client address used to register the dynamic FQDN.

The property type is *inet:client*.

:client:ipv4 / inet:dns:dynreg:client:ipv4
The client IPv4 address used to register the dynamic FQDN.

The property type is *inet:ipv4*.

:client:ipv6 / inet:dns:dynreg:client:ipv6
The client IPv6 address used to register the dynamic FQDN.

The property type is *inet:ipv6*.

inet:dns:mx

The result of a DNS MX record lookup.

The base type for the form can be found at *inet:dns:mx*.

An example of `inet:dns:mx`:

- `(vertex.link,mail.vertex.link)`

Properties:

:fqdn / inet:dns:mx:fqdn
The domain queried for its MX record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:mx / inet:dns:mx:mx
The domain returned in the MX record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:dns:ns

The result of a DNS NS record lookup.

The base type for the form can be found at *inet:dns:ns*.

An example of `inet:dns:ns`:

- `(vertex.link,ns.dnshost.com)`

Properties:

:zone / inet:dns:ns:zone
The domain queried for its DNS NS record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ns / inet:dns:ns:ns
The domain returned in the NS record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:dns:query

A DNS query unique to a given client.

The base type for the form can be found at *inet:dns:query*.

An example of `inet:dns:query`:

- `(1.2.3.4, woot.com, 1)`

Properties:

:client / inet:dns:query:client
A network client address. It has the following property options set:

- Read Only: `True`

The property type is *inet:client*.

:name / inet:dns:query:name
A DNS query name string. Likely an FQDN but not always. It has the following property options set:

- Read Only: `True`

The property type is *inet:dns:name*.

:name:ipv4 / inet:dns:query:name:ipv4
An IPv4 address.

The property type is *inet:ipv4*.

:name:ipv6 / inet:dns:query:name:ipv6
An IPv6 address.

The property type is *inet:ipv6*.

:name:fqdn / inet:dns:query:name:fqdn
A Fully Qualified Domain Name (FQDN).

The property type is *inet:fqdn*.

:type / inet:dns:query:type
The base 64 bit signed integer type. It has the following property options set:

- Read Only: `True`

The property type is *int*.

inet:dns:request

A single instance of a DNS resolver request and optional reply info.

The base type for the form can be found at *inet:dns:request*.

Properties:

:time / inet:dns:request:time
A date/time value.

The property type is *time*.

:query / inet:dns:request:query
A DNS query unique to a given client.

The property type is *inet:dns:query*.

:query:name / inet:dns:request:query:name
A DNS query name string. Likely an FQDN but not always.

The property type is *inet:dns:name*.

:query:name:ipv4 / inet:dns:request:query:name:ipv4
An IPv4 address.

The property type is *inet:ipv4*.

:query:name:ipv6 / inet:dns:request:query:name:ipv6
An IPv6 address.

The property type is *inet:ipv6*.

:query:name:fqdn / inet:dns:request:query:name:fqdn
A Fully Qualified Domain Name (FQDN).

The property type is *inet:fqdn*.

:query:type / inet:dns:request:query:type
The base 64 bit signed integer type.

The property type is *int*.

:server / inet:dns:request:server
A network server address.

The property type is *inet:server*.

:reply:code / inet:dns:request:reply:code
The DNS server response code.

The property type is *int*.

:exe / inet:dns:request:exe
The file containing the code that attempted the DNS lookup.

The property type is *file:bytes*.

:proc / inet:dns:request:proc
The process that attempted the DNS lookup.

The property type is *it:exec:proc*.

:host / inet:dns:request:host
The host that attempted the DNS lookup.

The property type is *it:host*.

:sandbox:file / inet:dns:request:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

inet:dns:rev

The transformed result of a DNS PTR record lookup.

The base type for the form can be found at *inet:dns:rev*.

An example of `inet:dns:rev`:

- `(1.2.3.4,vertex.link)`

Properties:

:ipv4 / inet:dns:rev:ipv4
The IPv4 address queried for its DNS PTR record. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:fqdn / inet:dns:rev:fqdn
The domain returned in the PTR record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:dns:rev6

The transformed result of a DNS PTR record for an IPv6 address.

The base type for the form can be found at *inet:dns:rev6*.

An example of `inet:dns:rev6`:

- `(2607:f8b0:4004:809::200e,vertex.link)`

Properties:

:ipv6 / inet:dns:rev6:ipv6
The IPv6 address queried for its DNS PTR record. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:fqdn / inet:dns:rev6:fqdn
The domain returned in the PTR record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:dns:soa

The result of a DNS SOA record lookup.

The base type for the form can be found at *inet:dns:soa*.

Properties:

:fqdn / inet:dns:soa:fqdn
The domain queried for its SOA record.

The property type is *inet:fqdn*.

:ns / inet:dns:soa:ns
The domain (MNAME) returned in the SOA record.

The property type is *inet:fqdn*.

:email / inet:dns:soa:email
The email address (RNAME) returned in the SOA record.

The property type is *inet:email*.

inet:dns:txt

The result of a DNS MX record lookup.

The base type for the form can be found at *inet:dns:txt*.

An example of `inet:dns:txt`:

- `(hehe.vertex.link,"fancy TXT record")`

Properties:

:fqdn / inet:dns:txt:fqdn
The domain queried for its TXT record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:txt / inet:dns:txt:txt
The string returned in the TXT record. It has the following property options set:

- Read Only: `True`

The property type is *str*.

inet:dns:wild:a

A DNS A wild card record and the IPv4 it resolves to.

The base type for the form can be found at *inet:dns:wild:a*.

Properties:

:fqdn / inet:dns:wild:a:fqdn
The domain containing a wild card record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ipv4 / inet:dns:wild:a:ipv4
The IPv4 address returned by wild card resolutions. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

inet:dns:wild:aaaa

A DNS AAAA wild card record and the IPv6 it resolves to.

The base type for the form can be found at *inet:dns:wild:aaaa*.

Properties:

:fqdn / inet:dns:wild:aaaa:fqdn
The domain containing a wild card record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ipv6 / inet:dns:wild:aaaa:ipv6
The IPv6 address returned by wild card resolutions. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

inet:download

An instance of a file downloaded from a server.

The base type for the form can be found at *inet:download*.

Properties:

:time / inet:download:time
The time the file was downloaded.

The property type is *time*.

:fqdn / inet:download:fqdn
The FQDN used to resolve the server.

The property type is *inet:fqdn*.

:file / inet:download:file
The file that was downloaded.

The property type is *file:bytes*.

:server / inet:download:server
The inet:addr of the server.

The property type is *inet:server*.

:server:host / inet:download:server:host
The it:host node for the server.

The property type is *it:host*.

:server:ipv4 / inet:download:server:ipv4
The IPv4 of the server.

The property type is *inet:ipv4*.

:server:ipv6 / inet:download:server:ipv6
The IPv6 of the server.

The property type is *inet:ipv6*.

:server:port / inet:download:server:port
The server tcp/udp port.

The property type is *inet:port*.

:server:proto / inet:download:server:proto
The server network layer protocol.

The property type is *str*. Its type has the following options set:

- lower: `True`

:client / inet:download:client
The inet:addr of the client.

The property type is *inet:client*.

:client:host / inet:download:client:host
The it:host node for the client.

The property type is *it:host*.

:client:ipv4 / inet:download:client:ipv4
The IPv4 of the client.

The property type is *inet:ipv4*.

:client:ipv6 / inet:download:client:ipv6
The IPv6 of the client.

The property type is *inet:ipv6*.

:client:port / inet:download:client:port
The client tcp/udp port.

The property type is *inet:port*.

:client:proto / inet:download:client:proto
The client network layer protocol.

The property type is *str*. Its type has the following options set:

- lower: `True`

inet:egress

A host using a specific network egress client address.

The base type for the form can be found at *inet:egress*.

Properties:

:host / inet:egress:host
The host that used the network egress.

The property type is *it:host*.

:client / inet:egress:client
The client address the host used as a network egress.

The property type is *inet:client*.

:client:ipv4 / inet:egress:client:ipv4
The client IPv4 address the host used as a network egress.

The property type is *inet:ipv4*.

:client:ipv6 / inet:egress:client:ipv6
The client IPv6 address the host used as a network egress.

The property type is *inet:ipv6*.

inet:email

An e-mail address.

The base type for the form can be found at *inet:email*.

Properties:

:user / inet:email:user
The username of the email address. It has the following property options set:

- Read Only: `True`

The property type is *inet:user*.

:fqdn / inet:email:fqdn
The domain of the email address. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:email:header

A unique email message header.

The base type for the form can be found at *inet:email:header*.

Properties:

:name / inet:email:header:name
The name of the email header. It has the following property options set:

- Read Only: `True`

The property type is *inet:email:header:name*.

:value / inet:email:header:value
The value of the email header. It has the following property options set:

- Read Only: `True`

The property type is *str*.

inet:email:message

A unique email message.

The base type for the form can be found at *inet:email:message*.

Properties:

:to / inet:email:message:to
The email address of the recipient.

The property type is *inet:email*.

:from / inet:email:message:from
The email address of the sender.

The property type is *inet:email*.

:replyto / inet:email:message:replyto
The email address from the reply-to header.

The property type is *inet:email*.

:subject / inet:email:message:subject
The email message subject line.

The property type is *str*.

:body / inet:email:message:body
The body of the email message. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:date / inet:email:message:date
The time the email message was received.

The property type is *time*.

:bytes / inet:email:message:bytes
The file bytes which contain the email message.

The property type is *file:bytes*.

:headers / inet:email:message:headers
An array of email headers from the message.

The property type is *array*. Its type has the following options set:

- type: `inet:email:header`

inet:email:message:attachment

A file which was attached to an email message.

The base type for the form can be found at *inet:email:message:attachment*.

Properties:

:message / inet:email:message:attachment:message
The message containing the attached file. It has the following property options set:

- Read Only: `True`

The property type is *inet:email:message*.

:file / inet:email:message:attachment:file
The attached file. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:name / inet:email:message:attachment:name
The name of the attached file.

The property type is *file:base*.

inet:email:message:link

A url/link embedded in an email message.

The base type for the form can be found at *inet:email:message:link*.

Properties:

:message / inet:email:message:link:message
The message containing the embedded link. It has the following property options set:

- Read Only: `True`

The property type is *inet:email:message*.

:url / inet:email:message:link:url
The url contained within the email message. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

:text / inet:email:message:link:text
The displayed hyperlink text if it was not the raw URL.

The property type is *str*.

inet:flow

An individual network connection between a given source and destination.

The base type for the form can be found at *inet:flow*.

Properties:

:time / inet:flow:time
The time the network connection was initiated.

The property type is *time*.

:duration / inet:flow:duration
The duration of the flow in seconds.

The property type is *int*.

:from / inet:flow:from
The ingest source file/iden. Used for reparsing.

The property type is *guid*.

:dst / inet:flow:dst
The destination address / port for a connection.

The property type is *inet:server*.

:dst:ipv4 / inet:flow:dst:ipv4
The destination IPv4 address.

The property type is *inet:ipv4*.

:dst:ipv6 / inet:flow:dst:ipv6
The destination IPv6 address.

The property type is *inet:ipv6*.

:dst:port / inet:flow:dst:port
The destination port.

The property type is *inet:port*.

:dst:proto / inet:flow:dst:proto
The destination protocol.

The property type is *str*. Its type has the following options set:

- lower: `True`

:dst:host / inet:flow:dst:host
The guid of the destination host.

The property type is *it:host*.

:dst:proc / inet:flow:dst:proc
The guid of the destination process.

The property type is *it:exec:proc*.

:dst:exe / inet:flow:dst:exe
The file (executable) that received the connection.

The property type is *file:bytes*.

:dst:txcount / inet:flow:dst:txcount
The number of packets sent by the destination host.

The property type is *int*.

:dst:txbytes / inet:flow:dst:txbytes
The number of bytes sent by the destination host.

The property type is *int*.

:dst:handshake / inet:flow:dst:handshake
A text representation of the initial handshake sent by the server. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:src / inet:flow:src
The source address / port for a connection.

The property type is *inet:client*.

:src:ipv4 / inet:flow:src:ipv4
The source IPv4 address.

The property type is *inet:ipv4*.

:src:ipv6 / inet:flow:src:ipv6
The source IPv6 address.

The property type is *inet:ipv6*.

:src:port / inet:flow:src:port
The source port.

The property type is *inet:port*.

:src:proto / inet:flow:src:proto
The source protocol.

The property type is *str*. Its type has the following options set:

- lower: `True`

:src:host / inet:flow:src:host
The guid of the source host.

The property type is *it:host*.

:src:proc / inet:flow:src:proc
The guid of the source process.

The property type is *it:exec:proc*.

:src:exe / inet:flow:src:exe
The file (executable) that created the connection.

The property type is *file:bytes*.

:src:txcount / inet:flow:src:txcount
The number of packets sent by the source host.

The property type is *int*.

:src:txbytes / inet:flow:src:txbytes
The number of bytes sent by the source host.

The property type is *int*.

:tot:txcount / inet:flow:tot:txcount
The number of packets sent in both directions.

The property type is *int*.

:tot:txbytes / inet:flow:tot:txbytes
The number of bytes sent in both directions.

The property type is *int*.

:src:handshake / inet:flow:src:handshake
A text representation of the initial handshake sent by the client. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:dst:cpes / inet:flow:dst:cpes
An array of NIST CPEs identified on the destination host.

The property type is *array*. Its type has the following options set:

- type: `it:sec:cpe`
- uniq: `True`
- sorted: `True`

:dst:softnames / inet:flow:dst:softnames
An array of software names identified on the destination host.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`
- sorted: `True`

:src:cpes / inet:flow:src:cpes
An array of NIST CPEs identified on the source host.

The property type is *array*. Its type has the following options set:

- type: `it:sec:cpe`
- uniq: `True`
- sorted: `True`

:src:softnames / inet:flow:src:softnames
An array of software names identified on the source host.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`
- sorted: `True`

:ip:proto / inet:flow:ip:proto
The IP protocol number of the flow.

The property type is *int*. Its type has the following options set:

- min: `0`
- max: `255`

:ip:tcp:flags / inet:flow:ip:tcp:flags
An aggregation of observed TCP flags commonly provided by flow APIs.

The property type is *int*. Its type has the following options set:

- min: `0`
- max: `255`

:sandbox:file / inet:flow:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

:src:ssl:cert / inet:flow:src:ssl:cert
The x509 certificate sent by the client as part of an SSL/TLS negotiation.

The property type is *crypto:x509:cert*.

:dst:ssl:cert / inet:flow:dst:ssl:cert
The x509 certificate sent by the server as part of an SSL/TLS negotiation.

The property type is *crypto:x509:cert*.

:src:rdp:hostname / inet:flow:src:rdp:hostname
The hostname sent by the client as part of an RDP session setup.

The property type is *it:hostname*.

:src:rdp:keyboard:layout / inet:flow:src:rdp:keyboard:layout
The keyboard layout sent by the client as part of an RDP session setup.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:src:ssh:key / inet:flow:src:ssh:key
The key sent by the client as part of an SSH session setup.

The property type is *crypto:key*.

:dst:ssh:key / inet:flow:dst:ssh:key
The key sent by the server as part of an SSH session setup.

The property type is *crypto:key*.

:raw / inet:flow:raw
A raw record used to create the flow which may contain additional protocol details.

The property type is *data*.

inet:fqdn

A Fully Qualified Domain Name (FQDN).

The base type for the form can be found at *inet:fqdn*.

An example of `inet:fqdn`:

- `vertex.link`

Properties:

:domain / inet:fqdn:domain
The parent domain for the FQDN. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:host / inet:fqdn:host
The host part of the FQDN. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:issuffix / inet:fqdn:issuffix
True if the FQDN is considered a suffix.

The property type is *bool*.

:iszone / inet:fqdn:iszone
True if the FQDN is considered a zone.

The property type is *bool*.

:zone / inet:fqdn:zone
The zone level parent for this FQDN.

The property type is *inet:fqdn*.

inet:group

A group name string.

The base type for the form can be found at *inet:group*.

Properties:

inet:http:cookie

An individual HTTP cookie string.

The base type for the form can be found at *inet:http:cookie*.

An example of `inet:http:cookie`:

- `PHPSESSID=el4ukv0kqbvoirg7nkp4dncpk3`

Properties:

:name / inet:http:cookie:name
The name of the cookie preceding the equal sign.

The property type is *str*.

:value / inet:http:cookie:value
The value of the cookie after the equal sign if present.

The property type is *str*.

inet:http:param

An HTTP request path query parameter.

The base type for the form can be found at *inet:http:param*.

Properties:

:name / inet:http:param:name
The name of the HTTP query parameter. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:value / inet:http:param:value
The value of the HTTP query parameter. It has the following property options set:

- Read Only: `True`

The property type is *str*.

inet:http:request

A single HTTP request.

The base type for the form can be found at *inet:http:request*.

Properties:

:method / inet:http:request:method
The HTTP request method string.

The property type is *str*.

:path / inet:http:request:path
The requested HTTP path (without query parameters).

The property type is *str*.

:url / inet:http:request:url
The reconstructed URL for the request if known.

The property type is *inet:url*.

:query / inet:http:request:query
The HTTP query string which optionally follows the path.

The property type is *str*.

:headers / inet:http:request:headers
An array of HTTP headers from the request.

The property type is *array*. Its type has the following options set:

- type: `inet:http:request:header`

:body / inet:http:request:body
The body of the HTTP request.

The property type is *file:bytes*.

:referer / inet:http:request:referer
The referer URL parsed from the "Referer:" header in the request.

The property type is *inet:url*.

:cookies / inet:http:request:cookies
An array of HTTP cookie values parsed from the "Cookies:" header in the request.

The property type is *array*. Its type has the following options set:

- type: `inet:http:cookie`
- sorted: `True`
- uniq: `True`

:response:time / inet:http:request:response:time
A date/time value.

The property type is *time*.

:response:code / inet:http:request:response:code
The base 64 bit signed integer type.

The property type is *int*.

:response:reason / inet:http:request:response:reason
The base string type.

The property type is *str*.

:response:headers / inet:http:request:response:headers
An array of HTTP headers from the response.

The property type is *array*. Its type has the following options set:

- type: `inet:http:response:header`

:response:body / inet:http:request:response:body
The file bytes type with SHA256 based primary property.

The property type is *file:bytes*.

:session / inet:http:request:session
The HTTP session this request was part of.

The property type is *inet:http:session*.

:flow / inet:http:request:flow
The raw inet:flow containing the request.

The property type is *inet:flow*.

:client / inet:http:request:client
The inet:addr of the client.

The property type is *inet:client*.

:client:ipv4 / inet:http:request:client:ipv4
The server IPv4 address that the request was sent from.

The property type is *inet:ipv4*.

:client:ipv6 / inet:http:request:client:ipv6
The server IPv6 address that the request was sent from.

The property type is *inet:ipv6*.

:client:host / inet:http:request:client:host
The host that the request was sent from.

The property type is *it:host*.

:server / inet:http:request:server
The inet:addr of the server.

The property type is *inet:server*.

:server:ipv4 / inet:http:request:server:ipv4
The server IPv4 address that the request was sent to.

The property type is *inet:ipv4*.

:server:ipv6 / inet:http:request:server:ipv6
The server IPv6 address that the request was sent to.

The property type is *inet:ipv6*.

:server:port / inet:http:request:server:port
The server port that the request was sent to.

The property type is *inet:port*.

:server:host / inet:http:request:server:host
The host that the request was sent to.

The property type is *it:host*.

:exe / inet:http:request:exe
The executable file which caused the activity.

The property type is *file:bytes*.

:proc / inet:http:request:proc
The host process which caused the activity.

The property type is *it:exec:proc*.

:thread / inet:http:request:thread
The host thread which caused the activity.

The property type is *it:exec:thread*.

:host / inet:http:request:host
The host on which the activity occurred.

The property type is *it:host*.

:time / inet:http:request:time
The time that the activity started.

The property type is *time*.

:sandbox:file / inet:http:request:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

inet:http:request:header

An HTTP request header.

The base type for the form can be found at *inet:http:request:header*.

Properties:

:name / inet:http:request:header:name
The name of the HTTP request header. It has the following property options set:

- Read Only: `True`

The property type is *inet:http:header:name*.

:value / inet:http:request:header:value
The value of the HTTP request header. It has the following property options set:

- Read Only: `True`

The property type is *str*.

inet:http:response:header

An HTTP response header.

The base type for the form can be found at *inet:http:response:header*.

Properties:

:name / inet:http:response:header:name
The name of the HTTP response header. It has the following property options set:

- Read Only: `True`

The property type is *inet:http:header:name*.

:value / inet:http:response:header:value
The value of the HTTP response header. It has the following property options set:

- Read Only: `True`

The property type is *str*.

inet:http:session

An HTTP session.

The base type for the form can be found at *inet:http:session*.

Properties:

:contact / inet:http:session:contact
The ps:contact which owns the session.

The property type is *ps:contact*.

:cookies / inet:http:session:cookies
An array of cookies used to identify this specific session.

The property type is *array*. Its type has the following options set:

- type: `inet:http:cookie`
- sorted: `True`
- uniq: `True`

inet:iface

A network interface with a set of associated protocol addresses.

The base type for the form can be found at *inet:iface*.

Properties:

:host / inet:iface:host
The guid of the host the interface is associated with.

The property type is *it:host*.

:network / inet:iface:network
The guid of the it:network the interface connected to.

The property type is *it:network*.

:type / inet:iface:type
The free-form interface type.

The property type is *str*. Its type has the following options set:

- lower: `True`

:mac / inet:iface:mac
The ethernet (MAC) address of the interface.

The property type is *inet:mac*.

:ipv4 / inet:iface:ipv4
The IPv4 address of the interface.

The property type is *inet:ipv4*.

:ipv6 / inet:iface:ipv6
The IPv6 address of the interface.

The property type is *inet:ipv6*.

:phone / inet:iface:phone
The telephone number of the interface.

The property type is *tel:phone*.

:wifi:ssid / inet:iface:wifi:ssid
The wifi SSID of the interface.

The property type is *inet:wifi:ssid*.

:wifi:bssid / inet:iface:wifi:bssid
The wifi BSSID of the interface.

The property type is *inet:mac*.

:adid / inet:iface:adid
An advertising ID associated with the interface.

The property type is *it:adid*.

:mob:imei / inet:iface:mob:imei
The IMEI of the interface.

The property type is *tel:mob:imei*.

:mob:imsi / inet:iface:mob:imsi
The IMSI of the interface.

The property type is *tel:mob:imsi*.

inet:ipv4

An IPv4 address.

The base type for the form can be found at *inet:ipv4*.

An example of `inet:ipv4`:

- `1.2.3.4`

Properties:

:asn / inet:ipv4:asn
The ASN to which the IPv4 address is currently assigned.

The property type is *inet:asn*.

:latlong / inet:ipv4:latlong
The best known latitude/longitude for the node.

The property type is *geo:latlong*.

:loc / inet:ipv4:loc
The geo-political location string for the IPv4.

The property type is *loc*.

:place / inet:ipv4:place
The geo:place associated with the latlong property.

The property type is *geo:place*.

:type / inet:ipv4:type
The type of IP address (e.g., private, multicast, etc.).

The property type is *str*.

:dns:rev / inet:ipv4:dns:rev
The most current DNS reverse lookup for the IPv4.

The property type is *inet:fqdn*.

inet:ipv6

An IPv6 address.

The base type for the form can be found at *inet:ipv6*.

An example of `inet:ipv6`:

- `2607:f8b0:4004:809::200e`

Properties:

:asn / inet:ipv6:asn
The ASN to which the IPv6 address is currently assigned.

The property type is *inet:asn*.

:ipv4 / inet:ipv6:ipv4
The mapped ipv4.

The property type is *inet:ipv4*.

:latlong / inet:ipv6:latlong
The last known latitude/longitude for the node.

The property type is *geo:latlong*.

:place / inet:ipv6:place
The geo:place associated with the latlong property.

The property type is *geo:place*.

:dns:rev / inet:ipv6:dns:rev
The most current DNS reverse lookup for the IPv6.

The property type is *inet:fqdn*.

:loc / inet:ipv6:loc
The geo-political location string for the IPv6.

The property type is *loc*.

inet:mac

A 48-bit Media Access Control (MAC) address.

The base type for the form can be found at *inet:mac*.

An example of `inet:mac`:

- `aa:bb:cc:dd:ee:ff`

Properties:

:vendor / inet:mac:vendor
The vendor associated with the 24-bit prefix of a MAC address.

The property type is *str*.

inet:passwd

A password string.

The base type for the form can be found at *inet:passwd*.

Properties:

:md5 / inet:passwd:md5
The MD5 hash of the password. It has the following property options set:

- Read Only: `True`

The property type is *hash:md5*.

:sha1 / inet:passwd:sha1
The SHA1 hash of the password. It has the following property options set:

- Read Only: `True`

The property type is *hash:sha1*.

:sha256 / inet:passwd:sha256
The SHA256 hash of the password. It has the following property options set:

- Read Only: `True`

The property type is *hash:sha256*.

inet:proto

A network protocol name.

The base type for the form can be found at *inet:proto*.

Properties:

:port / inet:proto:port
The default port this protocol typically uses if applicable.

The property type is *inet:port*.

inet:rfc2822:addr

An RFC 2822 Address field.

The base type for the form can be found at *inet:rfc2822:addr*.

An example of `inet:rfc2822:addr`:

- `"Visi Kenshoto" <visi@vertex.link>`

Properties:

:name / inet:rfc2822:addr:name
The name field parsed from an RFC 2822 address string. It has the following property options set:

- Read Only: `True`

The property type is *ps:name*.

:email / inet:rfc2822:addr:email
The email field parsed from an RFC 2822 address string. It has the following property options set:

- Read Only: `True`

The property type is *inet:email*.

inet:search:query

An instance of a search query issued to a search engine.

The base type for the form can be found at *inet:search:query*.

Properties:

:text / inet:search:query:text
The search query text. It has the following property options set:

- disp: `{'hint':  'text'}`

The property type is *str*.

:time / inet:search:query:time
The time the web search was issued.

The property type is *time*.

:acct / inet:search:query:acct
The account that the query was issued as.

The property type is *inet:web:acct*.

:host / inet:search:query:host
The host that issued the query.

The property type is *it:host*.

:engine / inet:search:query:engine
A simple name for the search engine used. It has the following property options set:

- Example: `google`

The property type is *str*. Its type has the following options set:

- lower: `True`

:request / inet:search:query:request
The HTTP request used to issue the query.

The property type is *inet:http:request*.

inet:search:result

A single result from a web search.

The base type for the form can be found at *inet:search:result*.

Properties:

:query / inet:search:result:query
The search query that produced the result.

The property type is *inet:search:query*.

:title / inet:search:result:title
The title of the matching web page.

The property type is *str*. Its type has the following options set:

- lower: `True`

:rank / inet:search:result:rank
The rank/order of the query result.

The property type is *int*.

:url / inet:search:result:url
The URL hosting the matching content.

The property type is *inet:url*.

:text / inet:search:result:text
Extracted/matched text from the matched content.

The property type is *str*. Its type has the following options set:

- lower: `True`

inet:server

A network server address.

The base type for the form can be found at *inet:server*.

An example of `inet:server`:

- `tcp://1.2.3.4:80`

Properties:

:proto / inet:server:proto
The network protocol of the server. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:ipv4 / inet:server:ipv4
The IPv4 of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:ipv6 / inet:server:ipv6
The IPv6 of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:host / inet:server:host
The it:host node for the server. It has the following property options set:

- Read Only: `True`

The property type is *it:host*.

:port / inet:server:port
The server tcp/udp port.

The property type is *inet:port*.

inet:servfile

A file hosted on a server for access over a network protocol.

The base type for the form can be found at *inet:servfile*.

Properties:

:file / inet:servfile:file
The file hosted by the server. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:server / inet:servfile:server
The inet:addr of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:server*.

:server:proto / inet:servfile:server:proto
The network protocol of the server. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:server:ipv4 / inet:servfile:server:ipv4
The IPv4 of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:server:ipv6 / inet:servfile:server:ipv6
The IPv6 of the server. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:server:host / inet:servfile:server:host
The it:host node for the server. It has the following property options set:

- Read Only: `True`

The property type is *it:host*.

:server:port / inet:servfile:server:port
The server tcp/udp port.

The property type is *inet:port*.

inet:ssl:cert

An SSL certificate file served by a server.

The base type for the form can be found at *inet:ssl:cert*.

An example of `inet:ssl:cert`:

- `(1.2.3.4:443, guid:d41d8cd98f00b204e9800998ecf8427e)`

Properties:

:file / inet:ssl:cert:file
The file bytes for the SSL certificate. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:server / inet:ssl:cert:server
The server that presented the SSL certificate. It has the following property options set:

- Read Only: `True`

The property type is *inet:server*.

:server:ipv4 / inet:ssl:cert:server:ipv4
The SSL server IPv4 address. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:server:ipv6 / inet:ssl:cert:server:ipv6
The SSL server IPv6 address. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:server:port / inet:ssl:cert:server:port
The SSL server listening port. It has the following property options set:

- Read Only: `True`

The property type is *inet:port*.

inet:ssl:jarmhash

A TLS JARM fingerprint hash.

The base type for the form can be found at *inet:ssl:jarmhash*.

Properties:

:ciphers / inet:ssl:jarmhash:ciphers
The encoded cipher and TLS version of the server. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`
- regex: `^[0-9a-f]{30}$`

:extensions / inet:ssl:jarmhash:extensions
The truncated SHA256 of the TLS server extensions. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`
- regex: `^[0-9a-f]{32}$`

inet:ssl:jarmsample

A JARM hash sample taken from a server.

The base type for the form can be found at *inet:ssl:jarmsample*.

Properties:

:jarmhash / inet:ssl:jarmsample:jarmhash
The JARM hash computed from the server responses. It has the following property options set:

- Read Only: `True`

The property type is *inet:ssl:jarmhash*.

:server / inet:ssl:jarmsample:server
The server that was sampled to compute the JARM hash. It has the following property options set:

- Read Only: `True`

The property type is *inet:server*.

inet:tunnel

A specific sequence of hosts forwarding connections such as a VPN or proxy.

The base type for the form can be found at *inet:tunnel*.

Properties:

:anon / inet:tunnel:anon
Indicates that this tunnel provides anonymization.

The property type is *bool*.

:type / inet:tunnel:type
The type of tunnel such as vpn or proxy.

The property type is *inet:tunnel:type:taxonomy*.

:ingress / inet:tunnel:ingress
The server where client traffic enters the tunnel.

The property type is *inet:server*.

:egress / inet:tunnel:egress
The server where client traffic leaves the tunnel.

The property type is *inet:server*.

:operator / inet:tunnel:operator
The contact information for the tunnel operator.

The property type is *ps:contact*.

inet:tunnel:type:taxonomy

A taxonomy of network tunnel types.

The base type for the form can be found at *inet:tunnel:type:taxonomy*.

Properties:

:title / inet:tunnel:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / inet:tunnel:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / inet:tunnel:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / inet:tunnel:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / inet:tunnel:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / inet:tunnel:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *inet:tunnel:type:taxonomy*.

inet:url

A Universal Resource Locator (URL).

The base type for the form can be found at *inet:url*.

An example of `inet:url`:

- `http://www.woot.com/files/index.html`

Properties:

:fqdn / inet:url:fqdn
The fqdn used in the URL (e.g., http://www.woot.com/page.html). It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:ipv4 / inet:url:ipv4
The IPv4 address used in the URL (e.g., http://1.2.3.4/page.html). It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv4*.

:ipv6 / inet:url:ipv6
The IPv6 address used in the URL. It has the following property options set:

- Read Only: `True`

The property type is *inet:ipv6*.

:passwd / inet:url:passwd
The optional password used to access the URL. It has the following property options set:

- Read Only: `True`

The property type is *inet:passwd*.

:base / inet:url:base
The base scheme, user/pass, fqdn, port and path w/o parameters. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:path / inet:url:path
The path in the URL w/o parameters. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:params / inet:url:params
The URL parameter string. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:port / inet:url:port
The port of the URL. URLs prefixed with http will be set to port 80 and URLs prefixed with https will be set to port 443 unless otherwise specified. It has the following property options set:

- Read Only: `True`

The property type is *inet:port*.

:proto / inet:url:proto
The protocol in the URL. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:user / inet:url:user
The optional username used to access the URL. It has the following property options set:

- Read Only: `True`

The property type is *inet:user*.

inet:url:mirror

A URL mirror site.

The base type for the form can be found at *inet:url:mirror*.

Properties:

:of / inet:url:mirror:of
The URL being mirrored. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

:at / inet:url:mirror:at
The URL of the mirror. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

inet:urlfile

A file hosted at a specific Universal Resource Locator (URL).

The base type for the form can be found at *inet:urlfile*.

Properties:

:url / inet:urlfile:url
The URL where the file was hosted. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

:file / inet:urlfile:file
The file that was hosted at the URL. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

inet:urlredir

A URL that redirects to another URL, such as via a URL shortening service or an HTTP 302 response.

The base type for the form can be found at *inet:urlredir*.

An example of `inet:urlredir`:

- `(http://foo.com/,http://bar.com/)`

Properties:

:src / inet:urlredir:src
The original/source URL before redirect. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

:src:fqdn / inet:urlredir:src:fqdn
The FQDN within the src URL (if present). It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:dst / inet:urlredir:dst
The redirected/destination URL. It has the following property options set:

- Read Only: `True`

The property type is *inet:url*.

:dst:fqdn / inet:urlredir:dst:fqdn
The FQDN within the dst URL (if present). It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

inet:user

A username string.

The base type for the form can be found at *inet:user*.

Properties:

inet:web:acct

An account with a given Internet-based site or service.

The base type for the form can be found at *inet:web:acct*.

An example of `inet:web:acct`:

- `twitter.com/invisig0th`

Properties:

:avatar / inet:web:acct:avatar
The file representing the avatar (e.g., profile picture) for the account.

The property type is *file:bytes*.

:banner / inet:web:acct:banner
The file representing the banner for the account.

The property type is *file:bytes*.

:dob / inet:web:acct:dob
A self-declared date of birth for the account (if the account belongs to a person).

The property type is *time*.

:email / inet:web:acct:email
The email address associated with the account.

The property type is *inet:email*.

:linked:accts / inet:web:acct:linked:accts
Linked accounts specified in the account profile.

The property type is *array*. Its type has the following options set:

- type: `inet:web:acct`
- uniq: `True`
- sorted: `True`

:latlong / inet:web:acct:latlong
The last known latitude/longitude for the node.

The property type is *geo:latlong*.

:place / inet:web:acct:place
The geo:place associated with the latlong property.

The property type is *geo:place*.

:loc / inet:web:acct:loc
A self-declared location for the account.

The property type is *loc*.

:name / inet:web:acct:name
The localized name associated with the account (may be different from the account identifier, e.g., a display name).

The property type is *inet:user*.

:name:en / inet:web:acct:name:en
The English version of the name associated with the (may be different from the account identifier, e.g., a display name).

The property type is *inet:user*.

:aliases / inet:web:acct:aliases
An array of alternate names for the user.

The property type is *array*. Its type has the following options set:

- type: `inet:user`
- uniq: `True`
- sorted: `True`

:occupation / inet:web:acct:occupation
A self-declared occupation for the account.

The property type is *str*. Its type has the following options set:

- lower: `True`

:passwd / inet:web:acct:passwd
The current password for the account.

The property type is *inet:passwd*.

:phone / inet:web:acct:phone
The phone number associated with the account.

The property type is *tel:phone*.

:realname / inet:web:acct:realname
The localized version of the real name of the account owner / registrant.

The property type is *ps:name*.

:realname:en / inet:web:acct:realname:en
The English version of the real name of the account owner / registrant.

The property type is *ps:name*.

:signup / inet:web:acct:signup
The date and time the account was registered.

The property type is *time*.

:signup:client / inet:web:acct:signup:client
The client address used to sign up for the account.

The property type is *inet:client*.

:signup:client:ipv4 / inet:web:acct:signup:client:ipv4
The IPv4 address used to sign up for the account.

The property type is *inet:ipv4*.

:signup:client:ipv6 / inet:web:acct:signup:client:ipv6
The IPv6 address used to sign up for the account.

The property type is *inet:ipv6*.

:site / inet:web:acct:site
The site or service associated with the account. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:tagline / inet:web:acct:tagline
The text of the account status or tag line.

The property type is *str*.

:url / inet:web:acct:url
The service provider URL where the account is hosted.

The property type is *inet:url*.

:user / inet:web:acct:user
The unique identifier for the account (may be different from the common name or display name). It has the following property options set:

- Read Only: `True`

The property type is *inet:user*.

:webpage / inet:web:acct:webpage
A related URL specified by the account (e.g., a personal or company web page, blog, etc.).

The property type is *inet:url*.

:recovery:email / inet:web:acct:recovery:email
An email address registered as a recovery email address for the account.

The property type is *inet:email*.

inet:web:action

An instance of an account performing an action at an Internet-based site or service.

The base type for the form can be found at *inet:web:action*.

Properties:

:act / inet:web:action:act
The action performed by the account.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:acct / inet:web:action:acct
The web account associated with the action.

The property type is *inet:web:acct*.

:acct:site / inet:web:action:acct:site
The site or service associated with the account.

The property type is *inet:fqdn*.

:acct:user / inet:web:action:acct:user
The unique identifier for the account.

The property type is *inet:user*.

:time / inet:web:action:time
The date and time the account performed the action.

The property type is *time*.

:client / inet:web:action:client
The source client address of the action.

The property type is *inet:client*.

:client:ipv4 / inet:web:action:client:ipv4
The source IPv4 address of the action.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:action:client:ipv6
The source IPv6 address of the action.

The property type is *inet:ipv6*.

:loc / inet:web:action:loc
The location of the user executing the web action.

The property type is *loc*.

:latlong / inet:web:action:latlong
The latlong of the user when executing the web action.

The property type is *geo:latlong*.

:place / inet:web:action:place
The geo:place of the user when executing the web action.

The property type is *geo:place*.

inet:web:attachment

An instance of a file being sent to a web service by an account.

The base type for the form can be found at *inet:web:attachment*.

Properties:

:acct / inet:web:attachment:acct
The account that uploaded the file.

The property type is *inet:web:acct*.

:post / inet:web:attachment:post
The optional web post that the file was attached to.

The property type is *inet:web:post*.

:mesg / inet:web:attachment:mesg
The optional web message that the file was attached to.

The property type is *inet:web:mesg*.

:proto / inet:web:attachment:proto
The protocol used to transmit the file to the web service. It has the following property options set:

- Example: `https`

The property type is *inet:proto*.

:interactive / inet:web:attachment:interactive
Set to true if the upload was interactive. False if automated.

The property type is *bool*.

:file / inet:web:attachment:file
The file that was sent.

The property type is *file:bytes*.

:name / inet:web:attachment:name
The name of the file at the time it was sent.

The property type is *file:path*.

:time / inet:web:attachment:time
The time the file was sent.

The property type is *time*.

:client / inet:web:attachment:client
The client address which initiated the upload.

The property type is *inet:client*.

:client:ipv4 / inet:web:attachment:client:ipv4
The IPv4 address of the client that initiated the upload.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:attachment:client:ipv6
The IPv6 address of the client that initiated the upload.

The property type is *inet:ipv6*.

:place / inet:web:attachment:place
The place the file was sent from.

The property type is *geo:place*.

:place:loc / inet:web:attachment:place:loc
The geopolitical location that the file was sent from.

The property type is *loc*.

:place:name / inet:web:attachment:place:name
The reported name of the place that the file was sent from.

The property type is *geo:name*.

inet:web:channel

A channel within a web service or instance such as slack or discord.

The base type for the form can be found at *inet:web:channel*.

Properties:

:url / inet:web:channel:url
The primary URL used to identify the channel. It has the following property options set:

- Example: `https://app.slack.com/client/T2XK1223Y/C2XHHNDS7`

The property type is *inet:url*.

:id / inet:web:channel:id
The operator specified ID of this channel. It has the following property options set:

- Example: `C2XHHNDS7`

The property type is *str*. Its type has the following options set:

- strip: `True`

:instance / inet:web:channel:instance
The instance which contains the channel.

The property type is *inet:web:instance*.

:name / inet:web:channel:name
The visible name of the channel. It has the following property options set:

- Example: `general`

The property type is *str*. Its type has the following options set:

- strip: `True`

:topic / inet:web:channel:topic
The visible topic of the channel. It has the following property options set:

- Example: `Synapse Discussion - Feel free to invite others!`

The property type is *str*. Its type has the following options set:

- strip: `True`

:created / inet:web:channel:created
The time the channel was created.

The property type is *time*.

:creator / inet:web:channel:creator
The account which created the channel.

The property type is *inet:web:acct*.

inet:web:chprofile

A change to a web account. Used to capture historical properties associated with an account, as opposed to current data in the inet:web:acct node.

The base type for the form can be found at *inet:web:chprofile*.

Properties:

:acct / inet:web:chprofile:acct
The web account associated with the change.

The property type is *inet:web:acct*.

:acct:site / inet:web:chprofile:acct:site
The site or service associated with the account.

The property type is *inet:fqdn*.

:acct:user / inet:web:chprofile:acct:user
The unique identifier for the account.

The property type is *inet:user*.

:client / inet:web:chprofile:client
The source address used to make the account change.

The property type is *inet:client*.

:client:ipv4 / inet:web:chprofile:client:ipv4
The source IPv4 address used to make the account change.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:chprofile:client:ipv6
The source IPv6 address used to make the account change.

The property type is *inet:ipv6*.

:time / inet:web:chprofile:time
The date and time when the account change occurred.

The property type is *time*.

:pv / inet:web:chprofile:pv
The prop=valu of the account property that was changed. Valu should be the old / original value, while the new value should be updated on the inet:web:acct form.

The property type is *nodeprop*.

:pv:prop / inet:web:chprofile:pv:prop
The property that was changed.

The property type is *str*.

inet:web:file

A file posted by a web account.

The base type for the form can be found at *inet:web:file*.

Properties:

:acct / inet:web:file:acct
The account that owns or is associated with the file. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

:acct:site / inet:web:file:acct:site
The site or service associated with the account. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:acct:user / inet:web:file:acct:user
The unique identifier for the account. It has the following property options set:

- Read Only: `True`

The property type is *inet:user*.

:file / inet:web:file:file
The file owned by or associated with the account. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:name / inet:web:file:name
The name of the file owned by or associated with the account.

The property type is *file:base*.

:posted / inet:web:file:posted
Deprecated. Instance data belongs on inet:web:attachment. It has the following property options set:

- deprecated: `True`

The property type is *time*.

:client / inet:web:file:client
Deprecated. Instance data belongs on inet:web:attachment. It has the following property options set:

- deprecated: `True`

The property type is *inet:client*.

:client:ipv4 / inet:web:file:client:ipv4
Deprecated. Instance data belongs on inet:web:attachment. It has the following property options set:

- deprecated: `True`

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:file:client:ipv6
Deprecated. Instance data belongs on inet:web:attachment. It has the following property options set:

- deprecated: `True`

The property type is *inet:ipv6*.

inet:web:follows

A web account follows or is connected to another web account.

The base type for the form can be found at *inet:web:follows*.

Properties:

:follower / inet:web:follows:follower
The account following an account. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

:followee / inet:web:follows:followee
The account followed by an account. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

inet:web:group

A group hosted within or registered with a given Internet-based site or service.

The base type for the form can be found at *inet:web:group*.

An example of `inet:web:group`:

- `somesite.com/mycoolgroup`

Properties:

:site / inet:web:group:site
The site or service associated with the group. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:id / inet:web:group:id
The site-specific unique identifier for the group (may be different from the common name or display name). It has the following property options set:

- Read Only: `True`

The property type is *inet:group*.

:name / inet:web:group:name
The localized name associated with the group (may be different from the account identifier, e.g., a display name).

The property type is *inet:group*.

:aliases / inet:web:group:aliases
An array of alternate names for the group.

The property type is *array*. Its type has the following options set:

- type: `inet:group`
- uniq: `True`
- sorted: `True`

:name:en / inet:web:group:name:en
The English version of the name associated with the group (may be different from the localized name).

The property type is *inet:group*.

:url / inet:web:group:url
The service provider URL where the group is hosted.

The property type is *inet:url*.

:avatar / inet:web:group:avatar
The file representing the avatar (e.g., profile picture) for the group.

The property type is *file:bytes*.

:desc / inet:web:group:desc
The text of the description of the group.

The property type is *str*.

:webpage / inet:web:group:webpage
A related URL specified by the group (e.g., primary web site, etc.).

The property type is *inet:url*.

:loc / inet:web:group:loc
A self-declared location for the group.

The property type is *str*. Its type has the following options set:

- lower: `True`

:latlong / inet:web:group:latlong
The last known latitude/longitude for the node.

The property type is *geo:latlong*.

:place / inet:web:group:place
The geo:place associated with the latlong property.

The property type is *geo:place*.

:signup / inet:web:group:signup
The date and time the group was created on the site.

The property type is *time*.

:signup:client / inet:web:group:signup:client
The client address used to create the group.

The property type is *inet:client*.

:signup:client:ipv4 / inet:web:group:signup:client:ipv4
The IPv4 address used to create the group.

The property type is *inet:ipv4*.

:signup:client:ipv6 / inet:web:group:signup:client:ipv6
The IPv6 address used to create the group.

The property type is *inet:ipv6*.

inet:web:hashtag

A hashtag used in a web post.

The base type for the form can be found at *inet:web:hashtag*.

Properties:

inet:web:instance

An instance of a web service such as slack or discord.

The base type for the form can be found at *inet:web:instance*.

Properties:

:url / inet:web:instance:url
The primary URL used to identify the instance. It has the following property options set:

- Example: `https://app.slack.com/client/T2XK1223Y`

The property type is *inet:url*.

:id / inet:web:instance:id
The operator specified ID of this instance. It has the following property options set:

- Example: `T2XK1223Y`

The property type is *str*. Its type has the following options set:

- strip: `True`

:name / inet:web:instance:name
The visible name of the instance. It has the following property options set:

- Example: `vertex synapse`

The property type is *str*. Its type has the following options set:

- strip: `True`

:created / inet:web:instance:created
The time the instance was created.

The property type is *time*.

:creator / inet:web:instance:creator
The account which created the instance.

The property type is *inet:web:acct*.

:owner / inet:web:instance:owner
The organization which created the instance.

The property type is *ou:org*.

:owner:fqdn / inet:web:instance:owner:fqdn
The FQDN of the organization which created the instance. Used for entity resolution. It has the following property options set:

- Example: `vertex.link`

The property type is *inet:fqdn*.

:owner:name / inet:web:instance:owner:name
The name of the organization which created the instance. Used for entity resolution. It has the following property options set:

- Example: `the vertex project, llc.`

The property type is *ou:name*.

:operator / inet:web:instance:operator
The organization which operates the instance.

The property type is *ou:org*.

:operator:name / inet:web:instance:operator:name
The name of the organization which operates the instance. Used for entity resolution. It has the following property options set:

- Example: `slack`

The property type is *ou:name*.

:operator:fqdn / inet:web:instance:operator:fqdn
The FQDN of the organization which operates the instance. Used for entity resolution. It has the following property options set:

- Example: `slack.com`

The property type is *inet:fqdn*.

inet:web:logon

An instance of an account authenticating to an Internet-based site or service.

The base type for the form can be found at *inet:web:logon*.

Properties:

:acct / inet:web:logon:acct
The web account associated with the logon event.

The property type is *inet:web:acct*.

:acct:site / inet:web:logon:acct:site
The site or service associated with the account.

The property type is *inet:fqdn*.

:acct:user / inet:web:logon:acct:user
The unique identifier for the account.

The property type is *inet:user*.

:time / inet:web:logon:time
The date and time the account logged into the service.

The property type is *time*.

:client / inet:web:logon:client
The source address of the logon.

The property type is *inet:client*.

:client:ipv4 / inet:web:logon:client:ipv4
The source IPv4 address of the logon.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:logon:client:ipv6
The source IPv6 address of the logon.

The property type is *inet:ipv6*.

:logout / inet:web:logon:logout
The date and time the account logged out of the service.

The property type is *time*.

:loc / inet:web:logon:loc
The location of the user executing the logon.

The property type is *loc*.

:latlong / inet:web:logon:latlong
The latlong of the user executing the logon.

The property type is *geo:latlong*.

:place / inet:web:logon:place
The geo:place of the user executing the logon.

The property type is *geo:place*.

inet:web:memb

Deprecated. Please use inet:web:member.

The base type for the form can be found at *inet:web:memb*.

Properties:

:acct / inet:web:memb:acct
The account that is a member of the group. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

:group / inet:web:memb:group
The group that the account is a member of. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:group*.

:title / inet:web:memb:title
The title or status of the member (e.g., admin, new member, etc.).

The property type is *str*. Its type has the following options set:

- lower: `True`

:joined / inet:web:memb:joined
The date / time the account joined the group.

The property type is *time*.

inet:web:member

Represents a web account membership in a channel or group.

The base type for the form can be found at *inet:web:member*.

Properties:

:acct / inet:web:member:acct
The account that is a member of the group or channel.

The property type is *inet:web:acct*.

:group / inet:web:member:group
The group that the account is a member of.

The property type is *inet:web:group*.

:channel / inet:web:member:channel
The channel that the account is a member of.

The property type is *inet:web:channel*.

:added / inet:web:member:added
The date / time the account was added to the group or channel.

The property type is *time*.

:removed / inet:web:member:removed
The date / time the account was removed from the group or channel.

The property type is *time*.

inet:web:mesg

A message sent from one web account to another web account or channel.

The base type for the form can be found at *inet:web:mesg*.

An example of `inet:web:mesg`:

- `((twitter.com, invisig0th), (twitter.com, gobbles), 20041012130220)`

Properties:

:from / inet:web:mesg:from
The web account that sent the message. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

:to / inet:web:mesg:to
The web account that received the message. It has the following property options set:

- Read Only: `True`

The property type is *inet:web:acct*.

:client / inet:web:mesg:client
The source address of the message.

The property type is *inet:client*.

:client:ipv4 / inet:web:mesg:client:ipv4
The source IPv4 address of the message.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:mesg:client:ipv6
The source IPv6 address of the message.

The property type is *inet:ipv6*.

:time / inet:web:mesg:time
The date and time at which the message was sent. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:url / inet:web:mesg:url
The URL where the message is posted / visible.

The property type is *inet:url*.

:text / inet:web:mesg:text
The text of the message. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:deleted / inet:web:mesg:deleted
The message was deleted.

The property type is *bool*.

:file / inet:web:mesg:file
The file attached to or sent with the message.

The property type is *file:bytes*.

:place / inet:web:mesg:place
The place that the message was reportedly sent from.

The property type is *geo:place*.

:place:name / inet:web:mesg:place:name
The name of the place that the message was reportedly sent from. Used for entity resolution.

The property type is *geo:name*.

:instance / inet:web:mesg:instance
The instance where the message was sent.

The property type is *inet:web:instance*.

inet:web:post

A post made by a web account.

The base type for the form can be found at *inet:web:post*.

Properties:

:acct / inet:web:post:acct
The web account that made the post.

The property type is *inet:web:acct*.

:acct:site / inet:web:post:acct:site
The site or service associated with the account.

The property type is *inet:fqdn*.

:client / inet:web:post:client
The source address of the post.

The property type is *inet:client*.

:client:ipv4 / inet:web:post:client:ipv4
The source IPv4 address of the post.

The property type is *inet:ipv4*.

:client:ipv6 / inet:web:post:client:ipv6
The source IPv6 address of the post.

The property type is *inet:ipv6*.

:acct:user / inet:web:post:acct:user
The unique identifier for the account.

The property type is *inet:user*.

:text / inet:web:post:text
The text of the post. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:time / inet:web:post:time
The date and time that the post was made.

The property type is *time*.

:deleted / inet:web:post:deleted
The message was deleted by the poster.

The property type is *bool*.

:url / inet:web:post:url
The URL where the post is published / visible.

The property type is *inet:url*.

:file / inet:web:post:file
The file that was attached to the post.

The property type is *file:bytes*.

:replyto / inet:web:post:replyto
The post that this post is in reply to.

The property type is *inet:web:post*.

:repost / inet:web:post:repost
The original post that this is a repost of.

The property type is *inet:web:post*.

:hashtags / inet:web:post:hashtags
Hashtags mentioned within the post.

The property type is *array*. Its type has the following options set:

- type: `inet:web:hashtag`
- uniq: `True`
- sorted: `True`
- split: `,`

:mentions:users / inet:web:post:mentions:users
Accounts mentioned within the post.

The property type is *array*. Its type has the following options set:

- type: `inet:web:acct`
- uniq: `True`
- sorted: `True`
- split: `,`

:mentions:groups / inet:web:post:mentions:groups
Groups mentioned within the post.

The property type is *array*. Its type has the following options set:

- type: `inet:web:group`
- uniq: `True`
- sorted: `True`
- split: `,`

:loc / inet:web:post:loc
The location that the post was reportedly sent from.

The property type is *loc*.

:place / inet:web:post:place
The place that the post was reportedly sent from.

The property type is *geo:place*.

:place:name / inet:web:post:place:name
The name of the place that the post was reportedly sent from. Used for entity resolution.

The property type is *geo:name*.

:latlong / inet:web:post:latlong
The place that the post was reportedly sent from.

The property type is *geo:latlong*.

:channel / inet:web:post:channel
The channel where the post was made.

The property type is *inet:web:channel*.

inet:web:post:link

A link contained within post text.

The base type for the form can be found at *inet:web:post:link*.

Properties:

:post / inet:web:post:link:post
The post containing the embedded link.

The property type is *inet:web:post*.

:url / inet:web:post:link:url
The url that the link forwards to.

The property type is *inet:url*.

:text / inet:web:post:link:text
The displayed hyperlink text if it was not the raw URL.

The property type is *str*.

inet:whois:contact

An individual contact from a domain whois record.

The base type for the form can be found at *inet:whois:contact*.

Properties:

:rec / inet:whois:contact:rec
The whois record containing the contact data. It has the following property options set:

- Read Only: `True`

The property type is *inet:whois:rec*.

:rec:fqdn / inet:whois:contact:rec:fqdn
The domain associated with the whois record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:rec:asof / inet:whois:contact:rec:asof
The date of the whois record. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:type / inet:whois:contact:type
The contact type (e.g., registrar, registrant, admin, billing, tech, etc.). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`

:id / inet:whois:contact:id
The ID associated with the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:name / inet:whois:contact:name
The name of the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:email / inet:whois:contact:email
The email address of the contact.

The property type is *inet:email*.

:orgname / inet:whois:contact:orgname
The name of the contact organization.

The property type is *ou:name*.

:address / inet:whois:contact:address
The content of the street address field(s) of the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:city / inet:whois:contact:city
The content of the city field of the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:state / inet:whois:contact:state
The content of the state field of the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:country / inet:whois:contact:country
The two-letter country code of the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:phone / inet:whois:contact:phone
The content of the phone field of the contact.

The property type is *tel:phone*.

:fax / inet:whois:contact:fax
The content of the fax field of the contact.

The property type is *tel:phone*.

:url / inet:whois:contact:url
The URL specified for the contact.

The property type is *inet:url*.

:whois:fqdn / inet:whois:contact:whois:fqdn
The whois server FQDN for the given contact (most likely a registrar).

The property type is *inet:fqdn*.

inet:whois:email

An email address associated with an FQDN via whois registration text.

The base type for the form can be found at *inet:whois:email*.

Properties:

:fqdn / inet:whois:email:fqdn
The domain with a whois record containing the email address. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:email / inet:whois:email:email
The email address associated with the domain whois record. It has the following property options set:

- Read Only: `True`

The property type is *inet:email*.

inet:whois:ipcontact

An individual contact from an IP block record.

The base type for the form can be found at *inet:whois:ipcontact*.

Properties:

:contact / inet:whois:ipcontact:contact
Contact information associated with a registration.

The property type is *ps:contact*.

:asof / inet:whois:ipcontact:asof
The date of the record.

The property type is *time*.

:created / inet:whois:ipcontact:created
The "created" time from the record.

The property type is *time*.

:updated / inet:whois:ipcontact:updated
The "last updated" time from the record.

The property type is *time*.

:role / inet:whois:ipcontact:role
The primary role for the contact.

The property type is *str*. Its type has the following options set:

- lower: `True`

:roles / inet:whois:ipcontact:roles
Additional roles assigned to the contact.

The property type is *array*. Its type has the following options set:

- type: `str`
- uniq: `True`
- sorted: `True`

:asn / inet:whois:ipcontact:asn
The associated Autonomous System Number (ASN).

The property type is *inet:asn*.

:id / inet:whois:ipcontact:id
The registry unique identifier (e.g. NET-74-0-0-0-1).

The property type is *inet:whois:regid*.

:links / inet:whois:ipcontact:links
URLs provided with the record.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

:status / inet:whois:ipcontact:status
The state of the registered contact (e.g. validated, obscured).

The property type is *str*. Its type has the following options set:

- lower: `True`

:contacts / inet:whois:ipcontact:contacts
Additional contacts referenced by this contact.

The property type is *array*. Its type has the following options set:

- type: `inet:whois:ipcontact`
- uniq: `True`
- sorted: `True`

inet:whois:ipquery

Query details used to retrieve an IP record.

The base type for the form can be found at *inet:whois:ipquery*.

Properties:

:time / inet:whois:ipquery:time
The time the request was made.

The property type is *time*.

:url / inet:whois:ipquery:url
The query URL when using the HTTP RDAP Protocol.

The property type is *inet:url*.

:fqdn / inet:whois:ipquery:fqdn
The FQDN of the host server when using the legacy WHOIS Protocol.

The property type is *inet:fqdn*.

:ipv4 / inet:whois:ipquery:ipv4
The IPv4 address queried.

The property type is *inet:ipv4*.

:ipv6 / inet:whois:ipquery:ipv6
The IPv6 address queried.

The property type is *inet:ipv6*.

:success / inet:whois:ipquery:success
Whether the host returned a valid response for the query.

The property type is *bool*.

:rec / inet:whois:ipquery:rec
The resulting record from the query.

The property type is *inet:whois:iprec*.

inet:whois:iprec

An IPv4/IPv6 block registration record.

The base type for the form can be found at *inet:whois:iprec*.

Properties:

:net4 / inet:whois:iprec:net4
The IPv4 address range assigned.

The property type is *inet:net4*.

:net4:min / inet:whois:iprec:net4:min
The first IPv4 in the range assigned.

The property type is *inet:ipv4*.

:net4:max / inet:whois:iprec:net4:max
The last IPv4 in the range assigned.

The property type is *inet:ipv4*.

:net6 / inet:whois:iprec:net6
The IPv6 address range assigned.

The property type is *inet:net6*.

:net6:min / inet:whois:iprec:net6:min
The first IPv6 in the range assigned.

The property type is *inet:ipv6*.

:net6:max / inet:whois:iprec:net6:max
The last IPv6 in the range assigned.

The property type is *inet:ipv6*.

:asof / inet:whois:iprec:asof
The date of the record.

The property type is *time*.

:created / inet:whois:iprec:created
The "created" time from the record.

The property type is *time*.

:updated / inet:whois:iprec:updated
The "last updated" time from the record.

The property type is *time*.

:text / inet:whois:iprec:text
The full text of the record. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:desc / inet:whois:iprec:desc
Notes concerning the record. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:asn / inet:whois:iprec:asn
The associated Autonomous System Number (ASN).

The property type is *inet:asn*.

:id / inet:whois:iprec:id
The registry unique identifier (e.g. NET-74-0-0-0-1).

The property type is *inet:whois:regid*.

:name / inet:whois:iprec:name
The name assigned to the network by the registrant.

The property type is *str*.

:parentid / inet:whois:iprec:parentid
The registry unique identifier of the parent whois record (e.g. NET-74-0-0-0-0).

The property type is *inet:whois:regid*.

:registrant / inet:whois:iprec:registrant
The registrant contact from the record.

The property type is *inet:whois:ipcontact*.

:contacts / inet:whois:iprec:contacts
Additional contacts from the record.

The property type is *array*. Its type has the following options set:

- type: `inet:whois:ipcontact`
- uniq: `True`
- sorted: `True`

:country / inet:whois:iprec:country
The two-letter ISO 3166 country code.

The property type is *str*. Its type has the following options set:

- lower: `True`
- regex: `^[a-z]{2}$`

:status / inet:whois:iprec:status
The state of the registered network.

The property type is *str*. Its type has the following options set:

- lower: `True`

:type / inet:whois:iprec:type
The classification of the registered network (e.g. direct allocation).

The property type is *str*. Its type has the following options set:

- lower: `True`

:links / inet:whois:iprec:links
URLs provided with the record.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

inet:whois:rar

A domain registrar.

The base type for the form can be found at *inet:whois:rar*.

An example of `inet:whois:rar`:

- `godaddy, inc.`

Properties:

inet:whois:rec

A domain whois record.

The base type for the form can be found at *inet:whois:rec*.

Properties:

:fqdn / inet:whois:rec:fqdn
The domain associated with the whois record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:asof / inet:whois:rec:asof
The date of the whois record. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:text / inet:whois:rec:text
The full text of the whois record. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:created / inet:whois:rec:created
The "created" time from the whois record.

The property type is *time*.

:updated / inet:whois:rec:updated
The "last updated" time from the whois record.

The property type is *time*.

:expires / inet:whois:rec:expires
The "expires" time from the whois record.

The property type is *time*.

:registrar / inet:whois:rec:registrar
The registrar name from the whois record.

The property type is *inet:whois:rar*.

:registrant / inet:whois:rec:registrant
The registrant name from the whois record.

The property type is *inet:whois:reg*.

inet:whois:recns

A nameserver associated with a domain whois record.

The base type for the form can be found at *inet:whois:recns*.

Properties:

:ns / inet:whois:recns:ns
A nameserver for a domain as listed in the domain whois record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:rec / inet:whois:recns:rec
The whois record containing the nameserver data. It has the following property options set:

- Read Only: `True`

The property type is *inet:whois:rec*.

:rec:fqdn / inet:whois:recns:rec:fqdn
The domain associated with the whois record. It has the following property options set:

- Read Only: `True`

The property type is *inet:fqdn*.

:rec:asof / inet:whois:recns:rec:asof
The date of the whois record. It has the following property options set:

- Read Only: `True`

The property type is *time*.

inet:whois:reg

A domain registrant.

The base type for the form can be found at *inet:whois:reg*.

An example of `inet:whois:reg`:

- `woot hostmaster`

Properties:

inet:whois:regid

The registry unique identifier of the registration record.

The base type for the form can be found at *inet:whois:regid*.

An example of `inet:whois:regid`:

- `NET-10-0-0-0-1`

Properties:

inet:wifi:ap

An SSID/MAC address combination for a wireless access point.

The base type for the form can be found at *inet:wifi:ap*.

Properties:

:ssid / inet:wifi:ap:ssid
The SSID for the wireless access point. It has the following property options set:

- Read Only: `True`

The property type is *inet:wifi:ssid*.

:bssid / inet:wifi:ap:bssid
The MAC address for the wireless access point. It has the following property options set:

- Read Only: `True`

The property type is *inet:mac*.

:latlong / inet:wifi:ap:latlong
The best known latitude/longitude for the wireless access point.

The property type is *geo:latlong*.

:accuracy / inet:wifi:ap:accuracy
The reported accuracy of the latlong telemetry reading.

The property type is *geo:dist*.

:channel / inet:wifi:ap:channel
The WIFI channel that the AP was last observed operating on.

The property type is *int*.

:encryption / inet:wifi:ap:encryption
The type of encryption used by the WIFI AP such as "wpa2".

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:place / inet:wifi:ap:place
The geo:place associated with the latlong property.

The property type is *geo:place*.

:loc / inet:wifi:ap:loc
The geo-political location string for the wireless access point.

The property type is *loc*.

:org / inet:wifi:ap:org
The organization that owns/operates the access point.

The property type is *ou:org*.

inet:wifi:ssid

A WiFi service set identifier (SSID) name.

The base type for the form can be found at *inet:wifi:ssid*.

An example of `inet:wifi:ssid`:

- `The Vertex Project`

Properties:

iso:oid

An ISO Object Identifier string.

The base type for the form can be found at *iso:oid*.

Properties:

:descr / iso:oid:descr
A description of the value or meaning of the OID.

The property type is *str*.

:identifier / iso:oid:identifier
The string identifier for the deepest tree element.

The property type is *str*.

it:account

A GUID that represents an account on a host or network.

The base type for the form can be found at *it:account*.

Properties:

:user / it:account:user
The username associated with the account.

The property type is *inet:user*.

:contact / it:account:contact
Additional contact information associated with this account.

The property type is *ps:contact*.

:host / it:account:host
The host where the account is registered.

The property type is *it:host*.

:domain / it:account:domain
The authentication domain where the account is registered.

The property type is *it:domain*.

:posix:uid / it:account:posix:uid
The user ID of the account. It has the following property options set:

- Example: `1001`

The property type is *int*.

:posix:gid / it:account:posix:gid
The primary group ID of the account. It has the following property options set:

- Example: `1001`

The property type is *int*.

:posix:gecos / it:account:posix:gecos
The GECOS field for the POSIX account.

The property type is *int*.

:posix:home / it:account:posix:home
The path to the POSIX account's home directory. It has the following property options set:

- Example: `/home/visi`

The property type is *file:path*.

:posix:shell / it:account:posix:shell
The path to the POSIX account's default shell. It has the following property options set:

- Example: `/bin/bash`

The property type is *file:path*.

:windows:sid / it:account:windows:sid
The Microsoft Windows Security Identifier of the account.

The property type is *it:os:windows:sid*.

:groups / it:account:groups
An array of groups that the account is a member of.

The property type is *array*. Its type has the following options set:

- type: `it:group`
- uniq: `True`
- sorted: `True`

it:adid

An advertising identification string.

The base type for the form can be found at *it:adid*.

Properties:

it:app:snort:hit

An instance of a snort rule hit.

The base type for the form can be found at *it:app:snort:hit*.

Properties:

:rule / it:app:snort:hit:rule
The snort rule that matched the file.

The property type is *it:app:snort:rule*.

:flow / it:app:snort:hit:flow
The inet:flow that matched the snort rule.

The property type is *inet:flow*.

:src / it:app:snort:hit:src
The source address of flow that caused the hit.

The property type is *inet:addr*.

:src:ipv4 / it:app:snort:hit:src:ipv4
The source IPv4 address of the flow that caused the hit.

The property type is *inet:ipv4*.

:src:ipv6 / it:app:snort:hit:src:ipv6
The source IPv6 address of the flow that caused the hit.

The property type is *inet:ipv6*.

:src:port / it:app:snort:hit:src:port
The source port of the flow that caused the hit.

The property type is *inet:port*.

:dst / it:app:snort:hit:dst
The destination address of the trigger.

The property type is *inet:addr*.

:dst:ipv4 / it:app:snort:hit:dst:ipv4
The destination IPv4 address of the flow that caused the hit.

The property type is *inet:ipv4*.

:dst:ipv6 / it:app:snort:hit:dst:ipv6
The destination IPv4 address of the flow that caused the hit.

The property type is *inet:ipv6*.

:dst:port / it:app:snort:hit:dst:port
The destination port of the flow that caused the hit.

The property type is *inet:port*.

:time / it:app:snort:hit:time
The time of the network flow that caused the hit.

The property type is *time*.

:sensor / it:app:snort:hit:sensor
The sensor host node that produced the hit.

The property type is *it:host*.

:version / it:app:snort:hit:version
The version of the rule at the time of match.

The property type is *it:semver*.

it:app:snort:rule

A snort rule.

The base type for the form can be found at *it:app:snort:rule*.

Properties:

:id / it:app:snort:rule:id
The snort rule id.

The property type is *str*.

:text / it:app:snort:rule:text
The snort rule text. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:name / it:app:snort:rule:name
The name of the snort rule.

The property type is *str*.

:desc / it:app:snort:rule:desc
A brief description of the snort rule. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:engine / it:app:snort:rule:engine
The snort engine ID which can parse and evaluate the rule text.

The property type is *int*.

:version / it:app:snort:rule:version
The current version of the rule.

The property type is *it:semver*.

:author / it:app:snort:rule:author
Contact info for the author of the rule.

The property type is *ps:contact*.

:created / it:app:snort:rule:created
The time the rule was initially created.

The property type is *time*.

:updated / it:app:snort:rule:updated
The time the rule was most recently modified.

The property type is *time*.

:enabled / it:app:snort:rule:enabled
The rule enabled status to be used for snort evaluation engines.

The property type is *bool*.

:family / it:app:snort:rule:family
The name of the software family the rule is designed to detect.

The property type is *it:prod:softname*.

it:app:yara:match

A YARA rule match to a file.

The base type for the form can be found at *it:app:yara:match*.

Properties:

:rule / it:app:yara:match:rule
The YARA rule that matched the file. It has the following property options set:

- Read Only: `True`

The property type is *it:app:yara:rule*.

:file / it:app:yara:match:file
The file that matched the YARA rule. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:version / it:app:yara:match:version
The most recent version of the rule evaluated as a match.

The property type is *it:semver*.

it:app:yara:procmatch

An instance of a YARA rule match to a process.

The base type for the form can be found at *it:app:yara:procmatch*.

Properties:

:rule / it:app:yara:procmatch:rule
The YARA rule that matched the file.

The property type is *it:app:yara:rule*.

:proc / it:app:yara:procmatch:proc
The process that matched the YARA rule.

The property type is *it:exec:proc*.

:time / it:app:yara:procmatch:time
The time that the YARA engine matched the process to the rule.

The property type is *time*.

:version / it:app:yara:procmatch:version
The most recent version of the rule evaluated as a match.

The property type is *it:semver*.

it:app:yara:rule

A YARA rule unique identifier.

The base type for the form can be found at *it:app:yara:rule*.

Properties:

:text / it:app:yara:rule:text
The YARA rule text. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:ext:id / it:app:yara:rule:ext:id
The YARA rule ID from an external system.

The property type is *str*.

:url / it:app:yara:rule:url
A URL which documents the YARA rule.

The property type is *inet:url*.

:name / it:app:yara:rule:name
The name of the YARA rule.

The property type is *str*.

:author / it:app:yara:rule:author
Contact info for the author of the YARA rule.

The property type is *ps:contact*.

:version / it:app:yara:rule:version
The current version of the rule.

The property type is *it:semver*.

:created / it:app:yara:rule:created
The time the YARA rule was initially created.

The property type is *time*.

:updated / it:app:yara:rule:updated
The time the YARA rule was most recently modified.

The property type is *time*.

:enabled / it:app:yara:rule:enabled
The rule enabled status to be used for YARA evaluation engines.

The property type is *bool*.

:family / it:app:yara:rule:family
The name of the software family the rule is designed to detect.

The property type is *it:prod:softname*.

it:auth:passwdhash

An instance of a password hash.

The base type for the form can be found at *it:auth:passwdhash*.

Properties:

:salt / it:auth:passwdhash:salt
The (optional) hex encoded salt value used to calculate the password hash.

The property type is *hex*.

:hash:md5 / it:auth:passwdhash:hash:md5
The MD5 password hash value.

The property type is *hash:md5*.

:hash:sha1 / it:auth:passwdhash:hash:sha1
The SHA1 password hash value.

The property type is *hash:sha1*.

:hash:sha256 / it:auth:passwdhash:hash:sha256
The SHA256 password hash value.

The property type is *hash:sha256*.

:hash:sha512 / it:auth:passwdhash:hash:sha512
The SHA512 password hash value.

The property type is *hash:sha512*.

:hash:lm / it:auth:passwdhash:hash:lm
The LM password hash value.

The property type is *hash:lm*.

:hash:ntlm / it:auth:passwdhash:hash:ntlm
The NTLM password hash value.

The property type is *hash:ntlm*.

:passwd / it:auth:passwdhash:passwd
The (optional) clear text password for this password hash.

The property type is *inet:passwd*.

it:av:filehit

A file that triggered an alert on a specific antivirus signature.

The base type for the form can be found at *it:av:filehit*.

Properties:

:file / it:av:filehit:file
The file that triggered the signature hit. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:sig / it:av:filehit:sig
The signature that the file triggered on. It has the following property options set:

- Read Only: `True`

The property type is *it:av:sig*.

:sig:name / it:av:filehit:sig:name
The signature name. It has the following property options set:

- Read Only: `True`

The property type is *it:av:signame*.

:sig:soft / it:av:filehit:sig:soft
The anti-virus product which contains the signature. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:soft*.

it:av:prochit

An instance of a process triggering an alert on a specific antivirus signature.

The base type for the form can be found at *it:av:prochit*.

Properties:

:proc / it:av:prochit:proc
The file that triggered the signature hit.

The property type is *it:exec:proc*.

:sig / it:av:prochit:sig
The signature that the file triggered on.

The property type is *it:av:sig*.

:time / it:av:prochit:time
The time that the AV engine detected the signature.

The property type is *time*.

it:av:sig

A signature name within the namespace of an antivirus engine name.

The base type for the form can be found at *it:av:sig*.

Properties:

:soft / it:av:sig:soft
The anti-virus product which contains the signature. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:soft*.

:name / it:av:sig:name
The signature name. It has the following property options set:

- Read Only: `True`

The property type is *it:av:signame*.

:desc / it:av:sig:desc
A free-form description of the signature. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:url / it:av:sig:url
A reference URL for information about the signature.

The property type is *inet:url*.

it:av:signame

An antivirus signature name.

The base type for the form can be found at *it:av:signame*.

Properties:

it:cmd

A unique command-line string.

The base type for the form can be found at *it:cmd*.

An example of `it:cmd`:

- `foo.exe --dostuff bar`

Properties:

it:dev:int

A developer selected integer constant.

The base type for the form can be found at *it:dev:int*.

Properties:

it:dev:mutex

A string representing a mutex.

The base type for the form can be found at *it:dev:mutex*.

Properties:

it:dev:pipe

A string representing a named pipe.

The base type for the form can be found at *it:dev:pipe*.

Properties:

it:dev:regkey

A Windows registry key.

The base type for the form can be found at *it:dev:regkey*.

An example of `it:dev:regkey`:

- `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run`

Properties:

it:dev:regval

A Windows registry key/value pair.

The base type for the form can be found at *it:dev:regval*.

Properties:

:key / it:dev:regval:key
: The Windows registry key.

  The property type is *it:dev:regkey*.

:str / it:dev:regval:str
: The value of the registry key, if the value is a string.

  The property type is *it:dev:str*.

:int / it:dev:regval:int
: The value of the registry key, if the value is an integer.

  The property type is *it:dev:int*.

:bytes / it:dev:regval:bytes
The file representing the value of the registry key, if the value is binary data.

The property type is *file:bytes*.

it:dev:str

A developer-selected string.

The base type for the form can be found at *it:dev:str*.

Properties:

:norm / it:dev:str:norm
Lower case normalized version of the it:dev:str.

The property type is *str*. Its type has the following options set:

- lower: `True`

it:domain

A logical boundary of authentication and configuration such as a windows domain.

The base type for the form can be found at *it:domain*.

Properties:

:name / it:domain:name
The name of the domain.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / it:domain:desc
A brief description of the domain.

The property type is *str*.

:org / it:domain:org
The org that operates the given domain.

The property type is *ou:org*.

it:exec:bind

An instance of a host binding a listening port.

The base type for the form can be found at *it:exec:bind*.

Properties:

:proc / it:exec:bind:proc
The main process executing code that bound the listening port.

The property type is *it:exec:proc*.

:host / it:exec:bind:host
The host running the process that bound the listening port. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:bind:exe
The specific file containing code that bound the listening port. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:bind:time
The time the port was bound.

The property type is *time*.

:server / it:exec:bind:server
The inet:addr of the server when binding the port.

The property type is *inet:server*.

:server:ipv4 / it:exec:bind:server:ipv4
The IPv4 address specified to bind().

The property type is *inet:ipv4*.

:server:ipv6 / it:exec:bind:server:ipv6
The IPv6 address specified to bind().

The property type is *inet:ipv6*.

:server:port / it:exec:bind:server:port
The bound (listening) TCP port.

The property type is *inet:port*.

:sandbox:file / it:exec:bind:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:file:add

An instance of a host adding a file to a filesystem.

The base type for the form can be found at *it:exec:file:add*.

Properties:

:proc / it:exec:file:add:proc
The main process executing code that created the new file.

The property type is *it:exec:proc*.

:host / it:exec:file:add:host
The host running the process that created the new file. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:file:add:exe
The specific file containing code that created the new file. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:file:add:time
The time the file was created.

The property type is *time*.

:path / it:exec:file:add:path
The path where the file was created.

The property type is *file:path*.

:path:dir / it:exec:file:add:path:dir
The parent directory of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:ext / it:exec:file:add:path:ext
The file extension of the file name (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:path:base / it:exec:file:add:path:base
The final component of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:file / it:exec:file:add:file
The file that was created.

The property type is *file:bytes*.

:sandbox:file / it:exec:file:add:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:file:del

An instance of a host deleting a file from a filesystem.

The base type for the form can be found at *it:exec:file:del*.

Properties:

:proc / it:exec:file:del:proc
The main process executing code that deleted the file.

The property type is *it:exec:proc*.

:host / it:exec:file:del:host
The host running the process that deleted the file. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:file:del:exe
The specific file containing code that deleted the file. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:file:del:time
The time the file was deleted.

The property type is *time*.

:path / it:exec:file:del:path
The path where the file was deleted.

The property type is *file:path*.

:path:dir / it:exec:file:del:path:dir
The parent directory of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:ext / it:exec:file:del:path:ext
The file extension of the file name (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:path:base / it:exec:file:del:path:base
The final component of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:file / it:exec:file:del:file
The file that was deleted.

The property type is *file:bytes*.

:sandbox:file / it:exec:file:del:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:file:read

An instance of a host reading a file from a filesystem.

The base type for the form can be found at *it:exec:file:read*.

Properties:

:proc / it:exec:file:read:proc
The main process executing code that read the file.

The property type is *it:exec:proc*.

:host / it:exec:file:read:host
The host running the process that read the file. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:file:read:exe
The specific file containing code that read the file. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:file:read:time
The time the file was read.

The property type is *time*.

:path / it:exec:file:read:path
The path where the file was read.

The property type is *file:path*.

:path:dir / it:exec:file:read:path:dir
The parent directory of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:ext / it:exec:file:read:path:ext
The file extension of the file name (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:path:base / it:exec:file:read:path:base
The final component of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:file / it:exec:file:read:file
The file that was read.

The property type is *file:bytes*.

:sandbox:file / it:exec:file:read:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:file:write

An instance of a host writing a file to a filesystem.

The base type for the form can be found at *it:exec:file:write*.

Properties:

:proc / it:exec:file:write:proc
The main process executing code that wrote to / modified the existing file.

The property type is *it:exec:proc*.

:host / it:exec:file:write:host
The host running the process that wrote to the file. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:file:write:exe
The specific file containing code that wrote to the file. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:file:write:time
The time the file was written to/modified.

The property type is *time*.

:path / it:exec:file:write:path
The path where the file was written to/modified.

The property type is *file:path*.

:path:dir / it:exec:file:write:path:dir
The parent directory of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:ext / it:exec:file:write:path:ext
The file extension of the file name (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:path:base / it:exec:file:write:path:base
The final component of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:file / it:exec:file:write:file
The file that was modified.

The property type is *file:bytes*.

:sandbox:file / it:exec:file:write:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:loadlib

A library load event in a process.

The base type for the form can be found at *it:exec:loadlib*.

Properties:

:proc / it:exec:loadlib:proc
The process where the library was loaded.

The property type is *it:exec:proc*.

:va / it:exec:loadlib:va
The base memory address where the library was loaded in the process.

The property type is *int*.

:loaded / it:exec:loadlib:loaded
The time the library was loaded.

The property type is *time*.

:unloaded / it:exec:loadlib:unloaded
The time the library was unloaded.

The property type is *time*.

:path / it:exec:loadlib:path
The path that the library was loaded from.

The property type is *file:path*.

:file / it:exec:loadlib:file
The library file that was loaded.

The property type is *file:bytes*.

:sandbox:file / it:exec:loadlib:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:mmap

A memory mapped segment located in a process.

The base type for the form can be found at *it:exec:mmap*.

Properties:

:proc / it:exec:mmap:proc
The process where the memory was mapped.

The property type is *it:exec:proc*.

:va / it:exec:mmap:va
The base memory address where the map was created in the process.

The property type is *int*.

:size / it:exec:mmap:size
The size of the memory map in bytes.

The property type is *int*.

:perms:read / it:exec:mmap:perms:read
True if the mmap is mapped with read permissions.

The property type is *bool*.

:perms:write / it:exec:mmap:perms:write
True if the mmap is mapped with write permissions.

The property type is *bool*.

:perms:execute / it:exec:mmap:perms:execute
True if the mmap is mapped with execute permissions.

The property type is *bool*.

:created / it:exec:mmap:created
The time the memory map was created.

The property type is *time*.

:deleted / it:exec:mmap:deleted
The time the memory map was deleted.

The property type is *time*.

:path / it:exec:mmap:path
The file path if the mmap is a mapped view of a file.

The property type is *file:path*.

:hash:sha256 / it:exec:mmap:hash:sha256
A SHA256 hash of the memory map. Bytes may optionally be present in the axon.

The property type is *hash:sha256*.

:sandbox:file / it:exec:mmap:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:mutex

A mutex created by a process at runtime.

The base type for the form can be found at *it:exec:mutex*.

Properties:

:proc / it:exec:mutex:proc
The main process executing code that created the mutex.

The property type is *it:exec:proc*.

:host / it:exec:mutex:host
The host running the process that created the mutex. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:mutex:exe
The specific file containing code that created the mutex. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:mutex:time
The time the mutex was created.

The property type is *time*.

:name / it:exec:mutex:name
The mutex string.

The property type is *it:dev:mutex*.

:sandbox:file / it:exec:mutex:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:pipe

A named pipe created by a process at runtime.

The base type for the form can be found at *it:exec:pipe*.

Properties:

:proc / it:exec:pipe:proc
The main process executing code that created the named pipe.

The property type is *it:exec:proc*.

:host / it:exec:pipe:host
The host running the process that created the named pipe. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:pipe:exe
The specific file containing code that created the named pipe. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:pipe:time
The time the named pipe was created.

The property type is *time*.

:name / it:exec:pipe:name
The named pipe string.

The property type is *it:dev:pipe*.

:sandbox:file / it:exec:pipe:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:proc

A process executing on a host. May be an actual (e.g., endpoint) or virtual (e.g., malware sandbox) host.

The base type for the form can be found at *it:exec:proc*.

Properties:

:host / it:exec:proc:host
The host that executed the process. May be an actual or a virtual / notional host.

The property type is *it:host*.

:exe / it:exec:proc:exe
The file considered the "main" executable for the process. For example, rundll32.exe may be considered the "main" executable for DLLs loaded by that program.

The property type is *file:bytes*.

:cmd / it:exec:proc:cmd
The command string used to launch the process, including any command line parameters. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *it:cmd*.

:pid / it:exec:proc:pid
The process ID.

The property type is *int*.

:time / it:exec:proc:time
The start time for the process.

The property type is *time*.

:name / it:exec:proc:name
The display name specified by the process.

The property type is *str*.

:exited / it:exec:proc:exited
The time the process exited.

The property type is *time*.

:exitcode / it:exec:proc:exitcode
The exit code for the process.

The property type is *int*.

:user / it:exec:proc:user
The user name of the process owner. It has the following property options set:

- deprecated: `True`

The property type is *inet:user*.

:account / it:exec:proc:account
The account of the process owner.

The property type is *it:account*.

:path / it:exec:proc:path
The path to the executable of the process.

The property type is *file:path*.

:path:base / it:exec:proc:path:base
The file basename of the executable of the process.

The property type is *file:base*.

:src:exe / it:exec:proc:src:exe
The path to the executable which started the process.

The property type is *file:path*.

:src:proc / it:exec:proc:src:proc
The process which created the process.

The property type is *it:exec:proc*.

:killedby / it:exec:proc:killedby
The process which killed this process.

The property type is *it:exec:proc*.

:sandbox:file / it:exec:proc:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:query

An instance of an executed query.

The base type for the form can be found at *it:exec:query*.

Properties:

:text / it:exec:query:text
The query string that was executed.

The property type is *it:query*.

:opts / it:exec:query:opts
An opaque JSON object containing query parameters and options.

The property type is *data*.

:api:url / it:exec:query:api:url
The URL of the API endpoint the query was sent to.

The property type is *inet:url*.

:language / it:exec:query:language
The name of the language that the query is expressed in.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:exe / it:exec:query:exe
The executable file which caused the activity.

The property type is *file:bytes*.

:proc / it:exec:query:proc
The host process which caused the activity.

The property type is *it:exec:proc*.

:thread / it:exec:query:thread
The host thread which caused the activity.

The property type is *it:exec:thread*.

:host / it:exec:query:host
The host on which the activity occurred.

The property type is *it:host*.

:time / it:exec:query:time
The time that the activity started.

The property type is *time*.

:sandbox:file / it:exec:query:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:reg:del

An instance of a host deleting a registry key.

The base type for the form can be found at *it:exec:reg:del*.

Properties:

:proc / it:exec:reg:del:proc
The main process executing code that deleted data from the registry.

The property type is *it:exec:proc*.

:host / it:exec:reg:del:host
The host running the process that deleted data from the registry. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:reg:del:exe
The specific file containing code that deleted data from the registry. May or may not be the same :exe referenced in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:reg:del:time
The time the data from the registry was deleted.

The property type is *time*.

:reg / it:exec:reg:del:reg
The registry key or value that was deleted.

The property type is *it:dev:regval*.

:sandbox:file / it:exec:reg:del:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:reg:get

An instance of a host getting a registry key.

The base type for the form can be found at *it:exec:reg:get*.

Properties:

:proc / it:exec:reg:get:proc
The main process executing code that read the registry.

The property type is *it:exec:proc*.

:host / it:exec:reg:get:host
The host running the process that read the registry. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:reg:get:exe
The specific file containing code that read the registry. May or may not be the same :exe referenced in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:reg:get:time
The time the registry was read.

The property type is *time*.

:reg / it:exec:reg:get:reg
The registry key or value that was read.

The property type is *it:dev:regval*.

:sandbox:file / it:exec:reg:get:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:reg:set

An instance of a host creating or setting a registry key.

The base type for the form can be found at *it:exec:reg:set*.

Properties:

:proc / it:exec:reg:set:proc
The main process executing code that wrote to the registry.

The property type is *it:exec:proc*.

:host / it:exec:reg:set:host
The host running the process that wrote to the registry. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:reg:set:exe
The specific file containing code that wrote to the registry. May or may not be the same :exe referenced in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:reg:set:time
The time the registry was written to.

The property type is *time*.

:reg / it:exec:reg:set:reg
The registry key or value that was written to.

The property type is *it:dev:regval*.

:sandbox:file / it:exec:reg:set:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:thread

A thread executing in a process.

The base type for the form can be found at *it:exec:thread*.

Properties:

:proc / it:exec:thread:proc
The process which contains the thread.

The property type is *it:exec:proc*.

:created / it:exec:thread:created
The time the thread was created.

The property type is *time*.

:exited / it:exec:thread:exited
The time the thread exited.

The property type is *time*.

:exitcode / it:exec:thread:exitcode
The exit code or return value for the thread.

The property type is *int*.

:src:proc / it:exec:thread:src:proc
An external process which created the thread.

The property type is *it:exec:proc*.

:src:thread / it:exec:thread:src:thread
The thread which created this thread.

The property type is *it:exec:thread*.

:sandbox:file / it:exec:thread:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:exec:url

An instance of a host requesting a URL.

The base type for the form can be found at *it:exec:url*.

Properties:

:proc / it:exec:url:proc
The main process executing code that requested the URL.

The property type is *it:exec:proc*.

:browser / it:exec:url:browser
The software version of the browser.

The property type is *it:prod:softver*.

:host / it:exec:url:host
The host running the process that requested the URL. Typically the same host referenced in :proc, if present.

The property type is *it:host*.

:exe / it:exec:url:exe
The specific file containing code that requested the URL. May or may not be the same :exe specified in :proc, if present.

The property type is *file:bytes*.

:time / it:exec:url:time
The time the URL was requested.

The property type is *time*.

:url / it:exec:url:url
The URL that was requested.

The property type is *inet:url*.

:page:pdf / it:exec:url:page:pdf
The rendered DOM saved as a PDF file.

The property type is *file:bytes*.

:page:html / it:exec:url:page:html
The rendered DOM saved as an HTML file.

The property type is *file:bytes*.

:page:image / it:exec:url:page:image
The rendered DOM saved as an image.

The property type is *file:bytes*.

:http:request / it:exec:url:http:request
The HTTP request made to retrieve the initial URL contents.

The property type is *inet:http:request*.

:client / it:exec:url:client
The address of the client during the URL retrieval.

The property type is *inet:client*.

:client:ipv4 / it:exec:url:client:ipv4
The IPv4 of the client during the URL retrieval..

The property type is *inet:ipv4*.

:client:ipv6 / it:exec:url:client:ipv6
The IPv6 of the client during the URL retrieval..

The property type is *inet:ipv6*.

:client:port / it:exec:url:client:port
The client port during the URL retrieval..

The property type is *inet:port*.

:sandbox:file / it:exec:url:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:fs:file

A file on a host.

The base type for the form can be found at *it:fs:file*.

Properties:

:host / it:fs:file:host
The host containing the file.

The property type is *it:host*.

:path / it:fs:file:path
The path for the file.

The property type is *file:path*.

:path:dir / it:fs:file:path:dir
The parent directory of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:path*.

:path:ext / it:fs:file:path:ext
The file extension of the file name (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:path:base / it:fs:file:path:base
The final component of the file path (parsed from :path). It has the following property options set:

- Read Only: `True`

The property type is *file:base*.

:file / it:fs:file:file
The file on the host.

The property type is *file:bytes*.

:ctime / it:fs:file:ctime
The file creation time.

The property type is *time*.

:mtime / it:fs:file:mtime
The file modification time.

The property type is *time*.

:atime / it:fs:file:atime
The file access time.

The property type is *time*.

:user / it:fs:file:user
The owner of the file.

The property type is *inet:user*.

:group / it:fs:file:group
The group owner of the file.

The property type is *inet:user*.

it:group

A GUID that represents a group on a host or network.

The base type for the form can be found at *it:group*.

Properties:

:name / it:group:name
The name of the group.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / it:group:desc
A brief description of the group.

The property type is *str*.

:host / it:group:host
The host where the group is registered.

The property type is *it:host*.

:domain / it:group:domain
The authentication domain where the group is registered.

The property type is *it:domain*.

:groups / it:group:groups
Groups that are a member of this group.

The property type is *array*. Its type has the following options set:

- type: `it:group`
- uniq: `True`
- sorted: `True`

:posix:gid / it:group:posix:gid
The primary group ID of the account. It has the following property options set:

- Example: `1001`

The property type is *int*.

:windows:sid / it:group:windows:sid
The Microsoft Windows Security Identifier of the group.

The property type is *it:os:windows:sid*.

it:host

A GUID that represents a host or system.

The base type for the form can be found at *it:host*.

Properties:

:name / it:host:name
The name of the host or system.

The property type is *it:hostname*.

:desc / it:host:desc
A free-form description of the host.

The property type is *str*.

:domain / it:host:domain
The authentication domain that the host is a member of.

The property type is *it:domain*.

:ipv4 / it:host:ipv4
The last known ipv4 address for the host.

The property type is *inet:ipv4*.

:latlong / it:host:latlong
The last known location for the host.

The property type is *geo:latlong*.

:place / it:host:place
The place where the host resides.

The property type is *geo:place*.

:loc / it:host:loc
The geo-political location string for the node.

The property type is *loc*.

:os / it:host:os
The operating system of the host.

The property type is *it:prod:softver*.

:os:name / it:host:os:name
A software product name for the host operating system. Used for entity resolution.

The property type is *it:prod:softname*.

:hardware / it:host:hardware
The hardware specification for this host.

The property type is *it:prod:hardware*.

:manu / it:host:manu
Please use :hardware:make. It has the following property options set:

- deprecated: `True`

The property type is *str*.

:model / it:host:model
Please use :hardware:model. It has the following property options set:

- deprecated: `True`

The property type is *str*.

:serial / it:host:serial
The serial number of the host.

The property type is *str*.

:operator / it:host:operator
The operator of the host.

The property type is *ps:contact*.

:org / it:host:org
The org that operates the given host.

The property type is *ou:org*.

:ext:id / it:host:ext:id
An external identifier for the host.

The property type is *str*.

:keyboard:layout / it:host:keyboard:layout
The primary keyboard layout configured on the host.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:keyboard:language / it:host:keyboard:language
The primary keyboard input language configured on the host.

The property type is *lang:language*.

it:hostname

The name of a host or system.

The base type for the form can be found at *it:hostname*.

Properties:

it:hostsoft

A version of a software product which is present on a given host.

The base type for the form can be found at *it:hostsoft*.

Properties:

:host / it:hostsoft:host
: Host with the software. It has the following property options set:

  - Read Only: `True`

  The property type is *it:host*.

:softver / it:hostsoft:softver
: Software on the host. It has the following property options set:

  - Read Only: `True`

  The property type is *it:prod:softver*.

it:hosturl

A url hosted on or served by a host or system.

The base type for the form can be found at *it:hosturl*.

Properties:

:host / it:hosturl:host
: Host serving a url. It has the following property options set:

  - Read Only: `True`

  The property type is *it:host*.

:url / it:hosturl:url
: URL available on the host. It has the following property options set:

  - Read Only: `True`

  The property type is *inet:url*.

it:log:event

A GUID representing an individual log event.

The base type for the form can be found at *it:log:event*.

Properties:

:mesg / it:log:event:mesg
The log message text.

The property type is *str*.

:type / it:log:event:type
A taxonometric type for the log event. It has the following property options set:

- Example: `windows.eventlog.securitylog`

The property type is *it:log:event:type:taxonomy*.

:severity / it:log:event:severity
A log level integer that increases with severity.

The property type is *int*. Its type has the following options set:

- enums: `((10, 'debug'), (20, 'info'), (30, 'notice'), (40, 'warning'), (50, 'err'), (60, 'crit'), (70, 'alert'), (80, 'emerg'))`

:data / it:log:event:data
A raw JSON record of the log event.

The property type is *data*.

:ext:id / it:log:event:ext:id
An external id that uniquely identifies this log entry.

The property type is *str*.

:product / it:log:event:product
The software which produced the log entry.

The property type is *it:prod:softver*.

:exe / it:log:event:exe
The executable file which caused the activity.

The property type is *file:bytes*.

:proc / it:log:event:proc
The host process which caused the activity.

The property type is *it:exec:proc*.

:thread / it:log:event:thread
The host thread which caused the activity.

The property type is *it:exec:thread*.

:host / it:log:event:host
The host on which the activity occurred.

The property type is *it:host*.

:time / it:log:event:time
The time that the activity started.

The property type is *time*.

:sandbox:file / it:log:event:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:log:event:type:taxonomy

A taxonomy of log event types.

The base type for the form can be found at *it:log:event:type:taxonomy*.

Properties:

it:logon

A GUID that represents an individual logon/logoff event.

The base type for the form can be found at *it:logon*.

Properties:

:time / it:logon:time
The time the logon occurred.

The property type is *time*.

:success / it:logon:success
Set to false to indicate an unsuccessful logon attempt.

The property type is *bool*.

:logoff:time / it:logon:logoff:time
The time the logon session ended.

The property type is *time*.

:host / it:logon:host
The host that the account logged in to.

The property type is *it:host*.

:account / it:logon:account
The account that logged in.

The property type is *it:account*.

:creds / it:logon:creds
The credentials that were used for the logon.

The property type is *auth:creds*.

:duration / it:logon:duration
The duration of the logon session.

The property type is *duration*.

:client:host / it:logon:client:host
The host where the logon originated.

The property type is *it:host*.

:client:ipv4 / it:logon:client:ipv4
The IPv4 where the logon originated.

The property type is *inet:ipv4*.

:client:ipv6 / it:logon:client:ipv6
The IPv6 where the logon originated.

The property type is *inet:ipv6*.

it:mitre:attack:group

A Mitre ATT&CK Group ID.

The base type for the form can be found at *it:mitre:attack:group*.

An example of `it:mitre:attack:group`:

- `G0100`

Properties:

:org / it:mitre:attack:group:org
Used to map an ATT&CK group to a synapse ou:org.

The property type is *ou:org*.

:name / it:mitre:attack:group:name
The primary name for the ATT&CK group.

The property type is *ou:name*.

:names / it:mitre:attack:group:names
An array of alternate names for the ATT&CK group.

The property type is *array*. Its type has the following options set:

- type: `ou:name`
- uniq: `True`
- sorted: `True`

:desc / it:mitre:attack:group:desc
A description of the ATT&CK group. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:isnow / it:mitre:attack:group:isnow
If deprecated, this field may contain the current value for the group.

The property type is *it:mitre:attack:group*.

:url / it:mitre:attack:group:url
The URL that documents the ATT&CK group.

The property type is *inet:url*.

:tag / it:mitre:attack:group:tag
The synapse tag used to annotate nodes included in this ATT&CK group ID. It has the following property options set:

- Example: `cno.mitre.g0100`

The property type is *syn:tag*.

:references / it:mitre:attack:group:references
An array of URLs that document the ATT&CK group.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`

:techniques / it:mitre:attack:group:techniques
An array of ATT&CK technique IDs used by the group.

The property type is *array*. Its type has the following options set:

- type: `it:mitre:attack:technique`
- uniq: `True`
- sorted: `True`
- split: `,`

:software / it:mitre:attack:group:software
An array of ATT&CK software IDs used by the group.

The property type is *array*. Its type has the following options set:

- type: `it:mitre:attack:software`
- uniq: `True`
- sorted: `True`
- split: `,`

it:mitre:attack:mitigation

A Mitre ATT&CK Mitigation ID.

The base type for the form can be found at *it:mitre:attack:mitigation*.

An example of `it:mitre:attack:mitigation`:

- `M1036`

Properties:

:name / it:mitre:attack:mitigation:name
The primary name for the ATT&CK mitigation.

The property type is *str*. Its type has the following options set:

- strip: `True`

:matrix / it:mitre:attack:mitigation:matrix
The ATT&CK matrix which defines the mitigation.

The property type is *it:mitre:attack:matrix*.

:desc / it:mitre:attack:mitigation:desc
A description of the ATT&CK mitigation. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- strip: `True`

:url / it:mitre:attack:mitigation:url
The URL that documents the ATT&CK mitigation.

The property type is *inet:url*.

:tag / it:mitre:attack:mitigation:tag
The synapse tag used to annotate nodes included in this ATT&CK mitigation. It has the following property options set:

- Example: `cno.mitre.m0100`

The property type is *syn:tag*.

:references / it:mitre:attack:mitigation:references
An array of URLs that document the ATT&CK mitigation.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`

:addresses / it:mitre:attack:mitigation:addresses
An array of ATT&CK technique IDs addressed by the mitigation.

The property type is *array*. Its type has the following options set:

- type: `it:mitre:attack:technique`
- uniq: `True`
- sorted: `True`
- split: `,`

it:mitre:attack:software

A Mitre ATT&CK Software ID.

The base type for the form can be found at *it:mitre:attack:software*.

An example of `it:mitre:attack:software`:

- `S0154`

Properties:

:software / it:mitre:attack:software:software
Used to map an ATT&CK software to a synapse it:prod:soft.

The property type is *it:prod:soft*.

:name / it:mitre:attack:software:name
The primary name for the ATT&CK software.

The property type is *it:prod:softname*.

:names / it:mitre:attack:software:names
Associated names for the ATT&CK software.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`

- sorted: `True`

:desc / it:mitre:attack:software:desc
A description of the ATT&CK software. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- strip: `True`

:isnow / it:mitre:attack:software:isnow
If deprecated, this field may contain the current value for the software.

The property type is *it:mitre:attack:software*.

:url / it:mitre:attack:software:url
The URL that documents the ATT&CK software.

The property type is *inet:url*.

:tag / it:mitre:attack:software:tag
The synapse tag used to annotate nodes included in this ATT&CK software. It has the following property options set:

- Example: `cno.mitre.s0100`

The property type is *syn:tag*.

:references / it:mitre:attack:software:references
An array of URLs that document the ATT&CK software.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`

:techniques / it:mitre:attack:software:techniques
An array of techniques used by the software.

The property type is *array*. Its type has the following options set:

- type: `it:mitre:attack:technique`
- uniq: `True`
- sorted: `True`
- split: `,`

it:mitre:attack:tactic

A Mitre ATT&CK Tactic ID.

The base type for the form can be found at *it:mitre:attack:tactic*.

An example of `it:mitre:attack:tactic`:

- `TA0040`

Properties:

:name / it:mitre:attack:tactic:name
The primary name for the ATT&CK tactic.

The property type is *str*. Its type has the following options set:

- strip: `True`

:matrix / it:mitre:attack:tactic:matrix
The ATT&CK matrix which defines the tactic.

The property type is *it:mitre:attack:matrix*.

:desc / it:mitre:attack:tactic:desc
A description of the ATT&CK tactic. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:url / it:mitre:attack:tactic:url
The URL that documents the ATT&CK tactic.

The property type is *inet:url*.

:tag / it:mitre:attack:tactic:tag
The synapse tag used to annotate nodes included in this ATT&CK tactic. It has the following property options set:

- Example: `cno.mitre.ta0100`

The property type is *syn:tag*.

:references / it:mitre:attack:tactic:references
An array of URLs that document the ATT&CK tactic.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`

it:mitre:attack:technique

A Mitre ATT&CK Technique ID.

The base type for the form can be found at *it:mitre:attack:technique*.

An example of `it:mitre:attack:technique`:

- `T1548`

Properties:

:name / it:mitre:attack:technique:name
The primary name for the ATT&CK technique.

The property type is *str*. Its type has the following options set:

- strip: `True`

:matrix / it:mitre:attack:technique:matrix
The ATT&CK matrix which defines the technique.

The property type is *it:mitre:attack:matrix*.

:status / it:mitre:attack:technique:status
The status of this ATT&CK technique.

The property type is *it:mitre:attack:status*.

:isnow / it:mitre:attack:technique:isnow
If deprecated, this field may contain the current value for the technique.

The property type is *it:mitre:attack:technique*.

:desc / it:mitre:attack:technique:desc
A description of the ATT&CK technique. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- strip: `True`

:url / it:mitre:attack:technique:url
The URL that documents the ATT&CK technique.

The property type is *inet:url*.

:tag / it:mitre:attack:technique:tag
The synapse tag used to annotate nodes included in this ATT&CK technique. It has the following property options set:

- Example: `cno.mitre.t0100`

The property type is *syn:tag*.

:references / it:mitre:attack:technique:references
An array of URLs that document the ATT&CK technique.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`

:parent / it:mitre:attack:technique:parent
The parent ATT&CK technique on this sub-technique.

The property type is *it:mitre:attack:technique*.

:tactics / it:mitre:attack:technique:tactics
An array of ATT&CK tactics that include this technique.

The property type is *array*. Its type has the following options set:

- type: `it:mitre:attack:tactic`
- uniq: `True`
- sorted: `True`
- split: `,`

it:network

A GUID that represents a logical network.

The base type for the form can be found at *it:network*.

Properties:

:name / it:network:name
The name of the network.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / it:network:desc
A brief description of the network.

The property type is *str*.

:org / it:network:org
The org that owns/operates the network.

The property type is *ou:org*.

:net4 / it:network:net4
The optional contiguous IPv4 address range of this network.

The property type is *inet:net4*.

:net6 / it:network:net6
The optional contiguous IPv6 address range of this network.

The property type is *inet:net6*.

it:os:android:aaid

An android advertising identification string.

The base type for the form can be found at *it:os:android:aaid*.

Properties:

it:os:android:ibroadcast

The given software broadcasts the given Android intent.

The base type for the form can be found at *it:os:android:ibroadcast*.

Properties:

:app / it:os:android:ibroadcast:app
The app software which broadcasts the android intent. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:intent / it:os:android:ibroadcast:intent
The android intent which is broadcast by the app. It has the following property options set:

- Read Only: `True`

The property type is *it:os:android:intent*.

it:os:android:ilisten

The given software listens for an android intent.

The base type for the form can be found at *it:os:android:ilisten*.

Properties:

:app / it:os:android:ilisten:app
The app software which listens for the android intent. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:intent / it:os:android:ilisten:intent
The android intent which is listened for by the app. It has the following property options set:

- Read Only: `True`

The property type is *it:os:android:intent*.

it:os:android:intent

An android intent string.

The base type for the form can be found at *it:os:android:intent*.

Properties:

it:os:android:perm

An android permission string.

The base type for the form can be found at *it:os:android:perm*.

Properties:

it:os:android:reqperm

The given software requests the android permission.

The base type for the form can be found at *it:os:android:reqperm*.

Properties:

:app / it:os:android:reqperm:app
The android app which requests the permission. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:perm / it:os:android:reqperm:perm
The android permission requested by the app. It has the following property options set:

- Read Only: `True`

The property type is *it:os:android:perm*.

it:os:ios:idfa

An iOS advertising identification string.

The base type for the form can be found at *it:os:ios:idfa*.

Properties:

it:prod:component

A specific instance of an it:prod:hardware most often as part of an it:host.

The base type for the form can be found at *it:prod:component*.

Properties:

:hardware / it:prod:component:hardware
The hardware specification of this component.

The property type is *it:prod:hardware*.

:serial / it:prod:component:serial
The serial number of this component.

The property type is *str*.

:host / it:prod:component:host
The it:host which has this component installed.

The property type is *it:host*.

it:prod:hardware

A specification for a piece of IT hardware.

The base type for the form can be found at *it:prod:hardware*.

Properties:

:name / it:prod:hardware:name
The display name for this hardware specification.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / it:prod:hardware:type
The type of hardware.

The property type is *it:prod:hardwaretype*.

:desc / it:prod:hardware:desc
A brief description of the hardware. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:cpe / it:prod:hardware:cpe
The NIST CPE 2.3 string specifying this hardware.

The property type is *it:sec:cpe*.

:make / it:prod:hardware:make
The name of the organization which manufactures this hardware.

The property type is *ou:name*.

:model / it:prod:hardware:model
The model name or number for this hardware specification.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:version / it:prod:hardware:version
Version string associated with this hardware specification.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:released / it:prod:hardware:released
The initial release date for this hardware.

The property type is *time*.

:parts / it:prod:hardware:parts
An array of it:prod:hadware parts included in this hardware specification.

The property type is *array*. Its type has the following options set:

- type: `it:prod:hardware`
- uniq: `True`
- sorted: `True`

it:prod:hardwaretype

An IT hardware type taxonomy.

The base type for the form can be found at *it:prod:hardwaretype*.

Properties:

:title / it:prod:hardwaretype:title
A brief title of the definition.

The property type is *str*.

:summary / it:prod:hardwaretype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / it:prod:hardwaretype:sort
A display sort order for siblings.

The property type is *int*.

:base / it:prod:hardwaretype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / it:prod:hardwaretype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / it:prod:hardwaretype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:hardwaretype*.

it:prod:soft

A software product.

The base type for the form can be found at *it:prod:soft*.

Properties:

:name / it:prod:soft:name
Name of the software.

The property type is *it:prod:softname*.

:type / it:prod:soft:type
The software type.

The property type is *it:prod:soft:taxonomy*.

:names / it:prod:soft:names
Observed/variant names for this software.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`
- sorted: `True`

:desc / it:prod:soft:desc
A description of the software. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:desc:short / it:prod:soft:desc:short
A short description of the software.

The property type is *str*. Its type has the following options set:

- lower: `True`

:cpe / it:prod:soft:cpe
The NIST CPE 2.3 string specifying this software.

The property type is *it:sec:cpe*.

:author / it:prod:soft:author
The contact information of the org or person who authored the software.

The property type is *ps:contact*.

:author:org / it:prod:soft:author:org
Deprecated. Please use :author to link to a ps:contact. It has the following property options set:

- deprecated: `True`

The property type is *ou:org*.

:author:acct / it:prod:soft:author:acct
Deprecated. Please use :author to link to a ps:contact. It has the following property options set:

- deprecated: `True`

The property type is *inet:web:acct*.

:author:email / it:prod:soft:author:email
Deprecated. Please use :author to link to a ps:contact. It has the following property options set:

- deprecated: `True`

The property type is *inet:email*.

:author:person / it:prod:soft:author:person
Deprecated. Please use :author to link to a ps:contact. It has the following property options set:

- deprecated: `True`

The property type is *ps:person*.

:url / it:prod:soft:url
URL relevant for the software.

The property type is *inet:url*.

:isos / it:prod:soft:isos
Set to True if the software is an operating system.

The property type is *bool*.

:islib / it:prod:soft:islib
Set to True if the software is a library.

The property type is *bool*.

:techniques / it:prod:soft:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

it:prod:soft:taxonomy

A software type taxonomy.

The base type for the form can be found at *it:prod:soft:taxonomy*.

Properties:

it:prod:softfile

A file is distributed by a specific software version.

The base type for the form can be found at *it:prod:softfile*.

Properties:

:soft / it:prod:softfile:soft
The software which distributes the file. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:file / it:prod:softfile:file
The file distributed by the software. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:path / it:prod:softfile:path
The default installation path of the file.

The property type is *file:path*.

it:prod:softid

An identifier issued to a given host by a specific software application.

The base type for the form can be found at *it:prod:softid*.

Properties:

:id / it:prod:softid:id
The ID issued by the software to the host.

The property type is *str*.

:host / it:prod:softid:host
The host which was issued the ID by the software.

The property type is *it:host*.

:soft / it:prod:softid:soft
The software which issued the ID to the host.

The property type is *it:prod:softver*.

:soft:name / it:prod:softid:soft:name
The name of the software which issued the ID to the host.

The property type is *it:prod:softname*.

it:prod:softlib

A software version contains a library software version.

The base type for the form can be found at *it:prod:softlib*.

Properties:

:soft / it:prod:softlib:soft
The software version that contains the library. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:lib / it:prod:softlib:lib
The library software version. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

it:prod:softname

A software product name.

The base type for the form can be found at *it:prod:softname*.

Properties:

it:prod:softos

The software version is known to be compatible with the given os software version.

The base type for the form can be found at *it:prod:softos*.

Properties:

:soft / it:prod:softos:soft
The software which can run on the operating system. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:os / it:prod:softos:os
The operating system which the software can run on. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

it:prod:softreg

A registry entry is created by a specific software version.

The base type for the form can be found at *it:prod:softreg*.

Properties:

:softver / it:prod:softreg:softver
The software which creates the registry entry. It has the following property options set:

- Read Only: `True`

The property type is *it:prod:softver*.

:regval / it:prod:softreg:regval
The registry entry created by the software. It has the following property options set:

- Read Only: `True`

The property type is *it:dev:regval*.

it:prod:softver

A specific version of a software product.

The base type for the form can be found at *it:prod:softver*.

Properties:

:software / it:prod:softver:software
Software associated with this version instance.

The property type is *it:prod:soft*.

:software:name / it:prod:softver:software:name
Deprecated. Please use it:prod:softver:name. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:name / it:prod:softver:name
Name of the software version.

The property type is *it:prod:softname*.

:names / it:prod:softver:names
Observed/variant names for this software version.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`
- sorted: `True`

:desc / it:prod:softver:desc
A description of the software. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:cpe / it:prod:softver:cpe
The NIST CPE 2.3 string specifying this software version.

The property type is *it:sec:cpe*.

:cves / it:prod:softver:cves
A list of CVEs that apply to this software version.

The property type is *array*. Its type has the following options set:

- type: `it:sec:cve`
- uniq: `True`
- sorted: `True`

:vers / it:prod:softver:vers
Version string associated with this version instance.

The property type is *it:dev:str*.

:vers:norm / it:prod:softver:vers:norm
Normalized version of the version string.

The property type is *str*. Its type has the following options set:

- lower: `True`

:arch / it:prod:softver:arch
Software architecture.

The property type is *it:dev:str*.

:released / it:prod:softver:released
Timestamp for when this version of the software was released.

The property type is *time*.

:semver / it:prod:softver:semver
System normalized semantic version number.

The property type is *it:semver*.

:semver:major / it:prod:softver:semver:major
Version major number.

The property type is *int*.

:semver:minor / it:prod:softver:semver:minor
Version minor number.

The property type is *int*.

:semver:patch / it:prod:softver:semver:patch
Version patch number.

The property type is *int*.

:semver:pre / it:prod:softver:semver:pre
Semver prerelease string.

The property type is *str*.

:semver:build / it:prod:softver:semver:build
Semver build string.

The property type is *str*.

:url / it:prod:softver:url
URL where a specific version of the software is available from.

The property type is *inet:url*.

it:query

A unique query string.

The base type for the form can be found at *it:query*.

Properties:

it:reveng:filefunc

An instance of a function in an executable.

The base type for the form can be found at *it:reveng:filefunc*.

Properties:

:function / it:reveng:filefunc:function
The guid matching the function. It has the following property options set:

- Read Only: `True`

The property type is *it:reveng:function*.

:file / it:reveng:filefunc:file
The file that contains the function. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

:va / it:reveng:filefunc:va
The virtual address of the first codeblock of the function.

The property type is *int*.

:rank / it:reveng:filefunc:rank
The function rank score used to evaluate if it exhibits interesting behavior.

The property type is *int*.

:complexity / it:reveng:filefunc:complexity
The complexity of the function.

The property type is *int*.

:funccalls / it:reveng:filefunc:funccalls
Other function calls within the scope of the function.

The property type is *array*. Its type has the following options set:

- type: `it:reveng:filefunc`
- uniq: `True`
- sorted: `True`

it:reveng:funcstr

A reference to a string inside a function.

The base type for the form can be found at *it:reveng:funcstr*.

Properties:

:function / it:reveng:funcstr:function
The guid matching the function. It has the following property options set:

- Read Only: `True`

The property type is *it:reveng:function*.

:string / it:reveng:funcstr:string
The string that the function references. It has the following property options set:

- Read Only: `True`

The property type is *str*.

it:reveng:function

A function inside an executable.

The base type for the form can be found at *it:reveng:function*.

Properties:

:name / it:reveng:function:name
The name of the function.

The property type is *str*.

:description / it:reveng:function:description
Notes concerning the function.

The property type is *str*.

:impcalls / it:reveng:function:impcalls
Calls to imported library functions within the scope of the function.

The property type is *array*. Its type has the following options set:

- type: `it:reveng:impfunc`
- uniq: `True`
- sorted: `True`

:strings / it:reveng:function:strings
An array of strings referenced within the function.

The property type is *array*. Its type has the following options set:

- type: `it:dev:str`
- uniq: `True`

it:reveng:impfunc

A function from an imported library.

The base type for the form can be found at *it:reveng:impfunc*.

Properties:

it:screenshot

A screenshot of a host.

The base type for the form can be found at *it:screenshot*.

Properties:

:image / it:screenshot:image
The image file.

The property type is *file:bytes*.

:desc / it:screenshot:desc
A brief description of the screenshot. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:exe / it:screenshot:exe
The executable file which caused the activity.

The property type is *file:bytes*.

:proc / it:screenshot:proc
The host process which caused the activity.

The property type is *it:exec:proc*.

:thread / it:screenshot:thread
The host thread which caused the activity.

The property type is *it:exec:thread*.

:host / it:screenshot:host
The host on which the activity occurred.

The property type is *it:host*.

:time / it:screenshot:time
The time that the activity started.

The property type is *time*.

:sandbox:file / it:screenshot:sandbox:file
The initial sample given to a sandbox environment to analyze.

The property type is *file:bytes*.

it:sec:c2:config

An extracted C2 config from an executable.

The base type for the form can be found at *it:sec:c2:config*.

Properties:

:family / it:sec:c2:config:family
The name of the software family which uses the config.

The property type is *it:prod:softname*.

:file / it:sec:c2:config:file
The file that the C2 config was extracted from.

The property type is *file:bytes*.

:decoys / it:sec:c2:config:decoys
An array of URLs used as decoy connections to obfuscate the C2 servers.

The property type is *array*. Its type has the following options set:

- type: `inet:url`

:servers / it:sec:c2:config:servers
An array of connection URLs built from host/port/passwd combinations.

The property type is *array*. Its type has the following options set:

- type: `inet:url`

:proxies / it:sec:c2:config:proxies
An array of proxy URLs used to communicate with the C2 server.

The property type is *array*. Its type has the following options set:

- type: `inet:url`

:listens / it:sec:c2:config:listens
An array of listen URLs that the software should bind.

The property type is *array*. Its type has the following options set:

- type: `inet:url`

:dns:resolvers / it:sec:c2:config:dns:resolvers
An array of inet:servers to use when resolving DNS names.

The property type is *array*. Its type has the following options set:

- type: `inet:server`

:mutex / it:sec:c2:config:mutex
The mutex that the software uses to prevent multiple-installations.

The property type is *it:dev:mutex*.

:campaigncode / it:sec:c2:config:campaigncode
The operator selected string used to identify the campaign or group of targets.

The property type is *it:dev:str*.

:crypto:key / it:sec:c2:config:crypto:key
Static key material used to encrypt C2 communications.

The property type is *crypto:key*.

:connect:delay / it:sec:c2:config:connect:delay
The time delay from first execution to connecting to the C2 server.

The property type is *duration*.

:connect:interval / it:sec:c2:config:connect:interval
The configured duration to sleep between connections to the C2 server.

The property type is *duration*.

:raw / it:sec:c2:config:raw
A JSON blob containing the raw config extracted from the binary.

The property type is *data*.

:http:headers / it:sec:c2:config:http:headers
An array of HTTP headers that the sample should transmit to the C2 server.

The property type is *array*. Its type has the following options set:

- type: `inet:http:header`

it:sec:cpe

A NIST CPE 2.3 Formatted String.

The base type for the form can be found at *it:sec:cpe*.

Properties:

:v2_2 / it:sec:cpe:v2_2
The CPE 2.2 string which is equivalent to the primary property.

The property type is *it:sec:cpe:v2_2*.

:part / it:sec:cpe:part
The "part" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:vendor / it:sec:cpe:vendor
The "vendor" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *ou:name*.

:product / it:sec:cpe:product
The "product" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:version / it:sec:cpe:version
The "version" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:update / it:sec:cpe:update
The "update" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:edition / it:sec:cpe:edition
The "edition" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:language / it:sec:cpe:language
The "language" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:sw_edition / it:sec:cpe:sw_edition
The "sw_edition" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:target_sw / it:sec:cpe:target_sw
The "target_sw" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:target_hw / it:sec:cpe:target_hw
The "target_hw" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:other / it:sec:cpe:other
The "other" field from the CPE 2.3 string. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

it:sec:cve

A vulnerability as designated by a Common Vulnerabilities and Exposures (CVE) number.

The base type for the form can be found at *it:sec:cve*.

An example of `it:sec:cve`:

- `cve-2012-0158`

Properties:

:desc / it:sec:cve:desc
Deprecated. Please use risk:vuln:cve:desc. It has the following property options set:

- deprecated: `True`

The property type is *str*.

:url / it:sec:cve:url
Deprecated. Please use risk:vuln:cve:url. It has the following property options set:

- deprecated: `True`

The property type is *inet:url*.

:references / it:sec:cve:references
Deprecated. Please use risk:vuln:cve:references. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

it:sec:cwe

NIST NVD Common Weaknesses Enumeration Specification.

The base type for the form can be found at *it:sec:cwe*.

An example of `it:sec:cwe`:

- `CWE-120`

Properties:

:name / it:sec:cwe:name
The CWE description field. It has the following property options set:

- Example: `Buffer Copy without Checking Size of Input (Classic Buffer Overflow)`

The property type is *str*.

:desc / it:sec:cwe:desc
The CWE description field. It has the following property options set:

- disp: `{'hint':  'text'}`

The property type is *str*.

:url / it:sec:cwe:url
A URL linking this CWE to a full description.

The property type is *inet:url*.

:parents / it:sec:cwe:parents
An array of ChildOf CWE Relationships.

The property type is *array*. Its type has the following options set:

- type: `it:sec:cwe`
- uniq: `True`
- sorted: `True`
- split: `,`

it:sec:stix:bundle

A STIX bundle.

The base type for the form can be found at *it:sec:stix:bundle*.

Properties:

:id / it:sec:stix:bundle:id
The id field from the STIX bundle.

The property type is *str*.

it:sec:stix:indicator

A STIX indicator pattern.

The base type for the form can be found at *it:sec:stix:indicator*.

Properties:

:id / it:sec:stix:indicator:id
The STIX id field from the indicator pattern.

The property type is *str*.

:name / it:sec:stix:indicator:name
The name of the STIX indicator pattern.

The property type is *str*.

:pattern / it:sec:stix:indicator:pattern
The STIX indicator pattern text.

The property type is *str*.

:created / it:sec:stix:indicator:created
The time that the indicator pattern was first created.

The property type is *time*.

:updated / it:sec:stix:indicator:updated
The time that the indicator pattern was last modified.

The property type is *time*.

:labels / it:sec:stix:indicator:labels
The label strings embedded in the STIX indicator pattern.

The property type is *array*. Its type has the following options set:

- type: `str`
- uniq: `True`
- sorted: `True`

lang:idiom

Deprecated. Please use lang:translation.

The base type for the form can be found at *lang:idiom*.

Properties:

:url / lang:idiom:url
Authoritative URL for the idiom.

The property type is *inet:url*.

:desc:en / lang:idiom:desc:en
English description. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

lang:language

A specific written or spoken language.

The base type for the form can be found at *lang:language*.

Properties:

:code / lang:language:code
: The language code for this language.

  The property type is *lang:code*.

:name / lang:language:name
: The primary name of the language.

  The property type is *lang:name*.

:names / lang:language:names
: An array of alternative names for the language.

  The property type is *array*. Its type has the following options set:

  - type: `lang:name`
  - sorted: `True`
  - uniq: `True`

:skill / lang:language:skill
: The skill used to annotate proficiency in the language.

  The property type is *ps:skill*.

lang:name

A name used to refer to a language.

The base type for the form can be found at *lang:name*.

Properties:

lang:trans

Deprecated. Please use lang:translation.

The base type for the form can be found at *lang:trans*.

Properties:

:text:en / lang:trans:text:en
: English translation. It has the following property options set:

  - disp: `{'hint': 'text'}`

  The property type is *str*.

:desc:en / lang:trans:desc:en
: English description. It has the following property options set:

  - disp: `{'hint': 'text'}`

  The property type is *str*.

lang:translation

A translation of text from one language to another.

The base type for the form can be found at *lang:translation*.

Properties:

:input / lang:translation:input
The input text. It has the following property options set:

- Example: `hola`

The property type is *str*.

:input:lang / lang:translation:input:lang
The input language code.

The property type is *lang:code*.

:output / lang:translation:output
The output text. It has the following property options set:

- Example: `hi`

The property type is *str*.

:output:lang / lang:translation:output:lang
The output language code.

The property type is *lang:code*.

:desc / lang:translation:desc
A description of the meaning of the output. It has the following property options set:

- Example: `A standard greeting`

The property type is *str*.

:engine / lang:translation:engine
The translation engine version used.

The property type is *it:prod:softver*.

mat:item

A GUID assigned to a material object.

The base type for the form can be found at *mat:item*.

Properties:

:name / mat:item:name
The name of the material item.

The property type is *str*. Its type has the following options set:

- lower: `True`

:type / mat:item:type
The taxonomy type of the item.

The property type is *mat:type*.

:spec / mat:item:spec
The specification which defines this item.

The property type is *mat:spec*.

:place / mat:item:place
The most recent place the item is known to reside.

The property type is *geo:place*.

:latlong / mat:item:latlong
The last known lat/long location of the node.

The property type is *geo:latlong*.

:loc / mat:item:loc
The geo-political location string for the node.

The property type is *loc*.

mat:itemimage

The base type for compound node fields.

The base type for the form can be found at *mat:itemimage*.

Properties:

:item / mat:itemimage:item
The item contained within the image file. It has the following property options set:

- Read Only: `True`

The property type is *mat:item*.

:file / mat:itemimage:file
The file containing an image of the item. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

mat:spec

A GUID assigned to a material specification.

The base type for the form can be found at *mat:spec*.

Properties:

:name / mat:spec:name
The name of the material specification.

The property type is *str*. Its type has the following options set:

- lower: `True`

:type / mat:spec:type
The taxonomy type for the specification.

The property type is *mat:type*.

mat:specimage

The base type for compound node fields.

The base type for the form can be found at *mat:specimage*.

Properties:

:spec / mat:specimage:spec
The spec contained within the image file. It has the following property options set:

- Read Only: `True`

The property type is *mat:spec*.

:file / mat:specimage:file
The file containing an image of the spec. It has the following property options set:

- Read Only: `True`

The property type is *file:bytes*.

media:news

A GUID for a news article or report.

The base type for the form can be found at *media:news*.

Properties:

:url / media:news:url
The (optional) URL where the news was published. It has the following property options set:

- Example: `http://cnn.com/news/mars-lander.html`

The property type is *inet:url*.

:url:fqdn / media:news:url:fqdn
The FQDN within the news URL. It has the following property options set:

- Example: `cnn.com`

The property type is *inet:fqdn*.

:type / media:news:type
A taxonomy for the type of reporting or news.

The property type is *media:news:taxonomy*.

:file / media:news:file
The (optional) file blob containing or published as the news.

The property type is *file:bytes*.

:title / media:news:title
Title/Headline for the news. It has the following property options set:

- Example: `mars lander reaches mars`
- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:summary / media:news:summary
A brief summary of the news item. It has the following property options set:

- Example: `lorum ipsum`
- disp: `{'hint': 'text'}`

The property type is *str*.

:publisher / media:news:publisher
The organization which published the news.

The property type is *ou:org*.

:publisher:name / media:news:publisher:name
The name of the publishing org used to publish the news.

The property type is *ou:name*.

:published / media:news:published
The date the news item was published. It has the following property options set:

- Example: `20161201180433`

The property type is *time*.

:updated / media:news:updated
The last time the news item was updated. It has the following property options set:

- Example: `20161201180433`

The property type is *time*. Its type has the following options set:

- ismax: `True`

:org / media:news:org
Deprecated. Please use :publisher:name. It has the following property options set:

- deprecated: `True`

The property type is *ou:alias*.

:author / media:news:author
Deprecated. Please use :authors array of ps:contact nodes. It has the following property options set:

- deprecated: `True`

The property type is *ps:name*.

:authors / media:news:authors
An array of authors of the news item.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- split: `,`
- uniq: `True`
- sorted: `True`

:rss:feed / media:news:rss:feed
The RSS feed that published the news.

The property type is *inet:url*.

:ext:id / media:news:ext:id
An external identifier specified by the publisher.

The property type is *str*.

:topics / media:news:topics
An array of relevant topics discussed in the report.

The property type is *array*. Its type has the following options set:

- type: `media:topic`
- uniq: `True`
- sorted: `True`

media:news:taxonomy

A taxonomy of types or sources of news.

The base type for the form can be found at *media:news:taxonomy*.

Properties:

media:topic

A topic string.

The base type for the form can be found at *media:topic*.

Properties:

:desc / media:topic:desc
A brief description of the topic.

The property type is *str*.

meta:event

An analytically relevant event in a curated timeline.

The base type for the form can be found at *meta:event*.

Properties:

:timeline / meta:event:timeline
The timeline containing the event.

The property type is *meta:timeline*.

:title / meta:event:title
A title for the event.

The property type is *str*.

:summary / meta:event:summary
A prose summary of the event. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:time / meta:event:time
The time that the event occurred.

The property type is *time*.

:duration / meta:event:duration
The duration of the event.

The property type is *duration*.

:type / meta:event:type
Type of event.

The property type is *meta:event:taxonomy*.

meta:event:taxonomy

A taxonomy of event types for meta:event nodes.

The base type for the form can be found at *meta:event:taxonomy*.

Properties:

:title / meta:event:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / meta:event:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / meta:event:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / meta:event:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / meta:event:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / meta:event:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *meta:event:taxonomy*.

meta:note

An analyst note about nodes linked with -(about)> edges.

The base type for the form can be found at *meta:note*.

Properties:

:type / meta:note:type
The note type.

The property type is *meta:note:type:taxonomy*.

:text / meta:note:text
The analyst authored note text. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:author / meta:note:author
The contact information of the author.

The property type is *ps:contact*.

:creator / meta:note:creator
The synapse user who authored the note.

The property type is *syn:user*.

:created / meta:note:created
The time the note was created.

The property type is *time*.

meta:note:type:taxonomy

An analyst note type taxonomy.

The base type for the form can be found at *meta:note:type:taxonomy*.

Properties:

:title / meta:note:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / meta:note:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / meta:note:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / meta:note:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / meta:note:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / meta:note:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *meta:note:type:taxonomy*.

meta:rule

A generic rule linked to matches with -(matches)> edges.

The base type for the form can be found at *meta:rule*.

Properties:

:name / meta:rule:name
A name for the rule.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / meta:rule:desc
A description of the rule. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:text / meta:rule:text
The text of the rule logic. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:author / meta:rule:author
The contact information of the rule author.

The property type is *ps:contact*.

:created / meta:rule:created
The time the rule was initially created.

The property type is *time*.

:updated / meta:rule:updated
The time the rule was most recently modified.

The property type is *time*.

:url / meta:rule:url
A URL which documents the rule.

The property type is *inet:url*.

:ext:id / meta:rule:ext:id
An external identifier for the rule.

The property type is *str*.

meta:ruleset

A set of rules linked with -(has)> edges.

The base type for the form can be found at *meta:ruleset*.

Properties:

:name / meta:ruleset:name
A name for the ruleset.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / meta:ruleset:desc
A description of the ruleset. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:author / meta:ruleset:author
The contact information of the ruleset author.

The property type is *ps:contact*.

:created / meta:ruleset:created
The time the ruleset was initially created.

The property type is *time*.

:updated / meta:ruleset:updated
The time the ruleset was most recently modified.

The property type is *time*.

meta:seen

Annotates that the data in a node was obtained from or observed by a given source.

The base type for the form can be found at *meta:seen*.

Properties:

:source / meta:seen:source
The source which observed or provided the node. It has the following property options set:

- Read Only: `True`

The property type is *meta:source*.

:node / meta:seen:node
The node which was observed by or received from the source. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

meta:source

A data source unique identifier.

The base type for the form can be found at *meta:source*.

Properties:

:name / meta:source:name
A human friendly name for the source.

The property type is *str*. Its type has the following options set:

- lower: `True`

:type / meta:source:type
An optional type field used to group sources.

The property type is *str*. Its type has the following options set:

- lower: `True`

meta:timeline

A curated timeline of analytically relevant events.

The base type for the form can be found at *meta:timeline*.

Properties:

:title / meta:timeline:title
A title for the timeline. It has the following property options set:

- Example: `The history of the Vertex Project`

The property type is *str*.

:summary / meta:timeline:summary
A prose summary of the timeline. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:type / meta:timeline:type
The type of timeline.

The property type is *meta:timeline:taxonomy*.

meta:timeline:taxonomy

A taxonomy of timeline types for meta:timeline nodes.

The base type for the form can be found at *meta:timeline:taxonomy*.

Properties:

:title / meta:timeline:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / meta:timeline:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / meta:timeline:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / meta:timeline:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / meta:timeline:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / meta:timeline:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *meta:timeline:taxonomy*.

ou:attendee

A node representing a person attending a meeting, conference, or event.

The base type for the form can be found at *ou:attendee*.

Properties:

:person / ou:attendee:person
The contact information for the person who attended the event.

The property type is *ps:contact*.

:arrived / ou:attendee:arrived
The time when the person arrived.

The property type is *time*.

:departed / ou:attendee:departed
The time when the person departed.

The property type is *time*.

:roles / ou:attendee:roles
List of the roles the person had at the event.

The property type is *array*. Its type has the following options set:

- type: `ou:role`
- split: `,`
- uniq: `True`
- sorted: `True`

:meet / ou:attendee:meet
The meeting that the person attended.

The property type is *ou:meet*.

:conference / ou:attendee:conference
The conference that the person attended.

The property type is *ou:conference*.

:conference:event / ou:attendee:conference:event
The conference event that the person attended.

The property type is *ou:conference:event*.

:contest / ou:attendee:contest
The contest that the person attended.

The property type is *ou:contest*.

:preso / ou:attendee:preso
The presentation that the person attended.

The property type is *ou:preso*.

ou:award

An award issued by an organization.

The base type for the form can be found at *ou:award*.

Properties:

:name / ou:award:name
The name of the award. It has the following property options set:

- Example: `Bachelors of Science`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / ou:award:type
The type of award. It has the following property options set:

- Example: `certification`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:org / ou:award:org
The organization which issues the award.

The property type is *ou:org*.

ou:campaign

Represents an org's activity in pursuit of a goal.

The base type for the form can be found at *ou:campaign*.

Properties:

:org / ou:campaign:org
The org carrying out the campaign.

The property type is *ou:org*.

:org:name / ou:campaign:org:name
The name of the org responsible for the campaign. Used for entity resolution.

The property type is *ou:name*.

:org:fqdn / ou:campaign:org:fqdn
The FQDN of the org responsible for the campaign. Used for entity resolution.

The property type is *inet:fqdn*.

:goal / ou:campaign:goal
The assessed primary goal of the campaign.

The property type is *ou:goal*.

:actors / ou:campaign:actors
Actors who participated in the campaign.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- split: `,`
- uniq: `True`
- sorted: `True`

:goals / ou:campaign:goals
Additional assessed goals of the campaign.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- split: `,`
- uniq: `True`
- sorted: `True`

:success / ou:campaign:success
Records the success/failure status of the campaign if known.

The property type is *bool*.

:name / ou:campaign:name
A terse name of the campaign. It has the following property options set:

- Example: `operation overlord`

The property type is *ou:campname*.

:names / ou:campaign:names
An array of alternate names for the campaign.

The property type is *array*. Its type has the following options set:

- type: `ou:campname`
- sorted: `True`
- uniq: `True`

:reporter / ou:campaign:reporter
The organization reporting on the campaign.

The property type is *ou:org*.

:reporter:name / ou:campaign:reporter:name
The name of the organization reporting on the campaign.

The property type is *ou:name*.

:type / ou:campaign:type
Deprecated. Use the :camptype taxonomy. It has the following property options set:

- deprecated: `True`

The property type is *str*.

:sophistication / ou:campaign:sophistication
The assessed sophistication of the campaign.

The property type is *meta:sophistication*.

:camptype / ou:campaign:camptype
The campaign type taxonomy. It has the following property options set:

- disp: `{'hint': 'taxonomy'}`

The property type is *ou:camptype*.

:desc / ou:campaign:desc
A description of the campaign. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:period / ou:campaign:period
The time interval when the organization was running the campaign.

The property type is *ival*.

:cost / ou:campaign:cost
The actual cost to the organization.

The property type is *econ:price*.

:budget / ou:campaign:budget
The budget allocated by the organization to execute the campaign.

The property type is *econ:price*.

:currency / ou:campaign:currency
The currency used to record econ:price properties.

The property type is *econ:currency*.

:goal:revenue / ou:campaign:goal:revenue
A goal for revenue resulting from the campaign.

The property type is *econ:price*.

:result:revenue / ou:campaign:result:revenue
The revenue resulting from the campaign.

The property type is *econ:price*.

:goal:pop / ou:campaign:goal:pop
A goal for the number of people affected by the campaign.

The property type is *int*.

:result:pop / ou:campaign:result:pop
The count of people affected by the campaign.

The property type is *int*.

:team / ou:campaign:team
The org team responsible for carrying out the campaign.

The property type is *ou:team*.

:conflict / ou:campaign:conflict
The conflict in which this campaign is a primary participant.

The property type is *ou:conflict*.

:techniques / ou:campaign:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

:tag / ou:campaign:tag
The tag used to annotate nodes that are associated with the campaign.

The property type is *syn:tag*.

ou:campname

A campaign name.

The base type for the form can be found at *ou:campname*.

Properties:

ou:camptype

An campaign type taxonomy.

The base type for the form can be found at *ou:camptype*.

Properties:

:title / ou:camptype:title
A brief title of the definition.

The property type is *str*.

:summary / ou:camptype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:camptype:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:camptype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:camptype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:camptype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:camptype*.

ou:conference

A conference with a name and sponsoring org.

The base type for the form can be found at *ou:conference*.

Properties:

:org / ou:conference:org
The org which created/managed the conference.

The property type is *ou:org*.

:organizer / ou:conference:organizer
Contact information for the primary organizer of the conference.

The property type is *ps:contact*.

:sponsors / ou:conference:sponsors
An array of contacts which sponsored the conference.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:name / ou:conference:name
The full name of the conference. It has the following property options set:

- Example: `decfon 2017`

The property type is *str*. Its type has the following options set:

- lower: `True`

:desc / ou:conference:desc
A description of the conference. It has the following property options set:

- Example: `annual cybersecurity conference`
- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:base / ou:conference:base
The base name which is shared by all conference instances. It has the following property options set:

- Example: `defcon`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:start / ou:conference:start
The conference start date / time.

The property type is *time*.

:end / ou:conference:end
The conference end date / time.

The property type is *time*.

:place / ou:conference:place
The geo:place node where the conference was held.

The property type is *geo:place*.

:url / ou:conference:url
The inet:url node for the conference website.

The property type is *inet:url*.

ou:conference:attendee

Deprecated. Please use ou:attendee.

The base type for the form can be found at *ou:conference:attendee*.

Properties:

:conference / ou:conference:attendee:conference
The conference which was attended. It has the following property options set:

- Read Only: `True`

The property type is *ou:conference*.

:person / ou:conference:attendee:person
The person who attended the conference. It has the following property options set:

- Read Only: `True`

The property type is *ps:person*.

:arrived / ou:conference:attendee:arrived
The time when a person arrived to the conference.

The property type is *time*.

:departed / ou:conference:attendee:departed
The time when a person departed from the conference.

The property type is *time*.

:role:staff / ou:conference:attendee:role:staff
The person worked as staff at the conference.

The property type is *bool*.

:role:speaker / ou:conference:attendee:role:speaker
The person was a speaker or presenter at the conference.

The property type is *bool*.

:roles / ou:conference:attendee:roles
List of the roles the person had at the conference.

The property type is *array*. Its type has the following options set:

- type: `str`
- uniq: `True`
- sorted: `True`

ou:conference:event

A conference event with a name and associated conference.

The base type for the form can be found at *ou:conference:event*.

Properties:

:conference / ou:conference:event:conference
The conference to which the event is associated. It has the following property options set:

- Read Only: `True`

The property type is *ou:conference*.

:organizer / ou:conference:event:organizer
Contact information for the primary organizer of the event.

The property type is *ps:contact*.

:sponsors / ou:conference:event:sponsors
An array of contacts which sponsored the event.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:place / ou:conference:event:place
The geo:place where the event occurred.

The property type is *geo:place*.

:name / ou:conference:event:name
The name of the conference event. It has the following property options set:

- Example: `foobar conference dinner`

The property type is *str*. Its type has the following options set:

- lower: `True`

:desc / ou:conference:event:desc
A description of the conference event. It has the following property options set:

- Example: `foobar conference networking dinner at ridge hotel`
- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:url / ou:conference:event:url
The inet:url node for the conference event website.

The property type is *inet:url*.

:contact / ou:conference:event:contact
Contact info for the event.

The property type is *ps:contact*.

:start / ou:conference:event:start
The event start date / time.

The property type is *time*.

:end / ou:conference:event:end
The event end date / time.

The property type is *time*.

ou:conference:event:attendee

Deprecated. Please use ou:attendee.

The base type for the form can be found at *ou:conference:event:attendee*.

Properties:

:event / ou:conference:event:attendee:event
The conference event which was attended. It has the following property options set:

- Read Only: `True`

The property type is *ou:conference:event*.

:person / ou:conference:event:attendee:person
The person who attended the conference event. It has the following property options set:

- Read Only: `True`

The property type is *ps:person*.

:arrived / ou:conference:event:attendee:arrived
The time when a person arrived to the conference event.

The property type is *time*.

:departed / ou:conference:event:attendee:departed
The time when a person departed from the conference event.

The property type is *time*.

:roles / ou:conference:event:attendee:roles
List of the roles the person had at the conference event.

The property type is *array*. Its type has the following options set:

- type: `str`
- uniq: `True`
- sorted: `True`

ou:conflict

Represents a conflict where two or more campaigns have mutually exclusive goals.

The base type for the form can be found at *ou:conflict*.

Properties:

:name / ou:conflict:name
The name of the conflict.

The property type is *str*. Its type has the following options set:

- onespace: `True`

:started / ou:conflict:started
The time the conflict began.

The property type is *time*.

:ended / ou:conflict:ended
The time the conflict ended.

The property type is *time*.

:timeline / ou:conflict:timeline
A timeline of significant events related to the conflict.

The property type is *meta:timeline*.

ou:contest

A competitive event resulting in a ranked set of participants.

The base type for the form can be found at *ou:contest*.

Properties:

:name / ou:contest:name
The name of the contest. It has the following property options set:

- Example: `defcon ctf 2020`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / ou:contest:type
The type of contest. It has the following property options set:

- Example: `cyber ctf`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:family / ou:contest:family
A name for a series of recurring contests. It has the following property options set:

- Example: `defcon ctf`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / ou:contest:desc
A description of the contest. It has the following property options set:

- Example: `the capture-the-flag event hosted at defcon 2020`
- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:url / ou:contest:url
The contest website URL.

The property type is *inet:url*.

:start / ou:contest:start
The contest start date / time.

The property type is *time*.

:end / ou:contest:end
The contest end date / time.

The property type is *time*.

:loc / ou:contest:loc
The geopolitical affiliation of the contest.

The property type is *loc*.

:place / ou:contest:place
The geo:place where the contest was held.

The property type is *geo:place*.

:latlong / ou:contest:latlong
The latlong where the contest was held.

The property type is *geo:latlong*.

:conference / ou:contest:conference
The conference that the contest is associated with.

The property type is *ou:conference*.

:contests / ou:contest:contests
An array of sub-contests that contributed to the rankings.

The property type is *array*. Its type has the following options set:

- type: `ou:contest`
- split: `,`
- uniq: `True`
- sorted: `True`

:sponsors / ou:contest:sponsors
Contact information for contest sponsors.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- split: `,`
- uniq: `True`
- sorted: `True`

:organizers / ou:contest:organizers
Contact information for contest organizers.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- split: `,`
- uniq: `True`
- sorted: `True`

:participants / ou:contest:participants
Contact information for contest participants.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- split: `,`
- uniq: `True`
- sorted: `True`

ou:contest:result

The results from a single contest participant.

The base type for the form can be found at *ou:contest:result*.

Properties:

:contest / ou:contest:result:contest
The contest. It has the following property options set:

- Read Only: `True`

The property type is *ou:contest*.

:participant / ou:contest:result:participant
The participant. It has the following property options set:

- Read Only: `True`

The property type is *ps:contact*.

:rank / ou:contest:result:rank
The rank order of the participant.

The property type is *int*.

:score / ou:contest:result:score
The score of the participant.

The property type is *int*.

:url / ou:contest:result:url
The contest result website URL.

The property type is *inet:url*.

ou:contract

An contract between multiple entities.

The base type for the form can be found at *ou:contract*.

Properties:

:title / ou:contract:title
A terse title for the contract.

The property type is *str*.

:type / ou:contract:type
The type of contract.

The property type is *ou:conttype*.

:sponsor / ou:contract:sponsor
The contract sponsor.

The property type is *ps:contact*.

:parties / ou:contract:parties
The non-sponsor entities bound by the contract.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:document / ou:contract:document
The best/current contract document.

The property type is *file:bytes*.

:signed / ou:contract:signed
The date that the contract signing was complete.

The property type is *time*.

:begins / ou:contract:begins
The date that the contract goes into effect.

The property type is *time*.

:expires / ou:contract:expires
The date that the contract expires.

The property type is *time*.

:completed / ou:contract:completed
The date that the contract was completed.

The property type is *time*.

:terminated / ou:contract:terminated
The date that the contract was terminated.

The property type is *time*.

:award:price / ou:contract:award:price
The value of the contract at time of award.

The property type is *econ:price*.

:budget:price / ou:contract:budget:price
The amount of money budgeted for the contract.

The property type is *econ:price*.

:currency / ou:contract:currency
The currency of the econ:price values.

The property type is *econ:currency*.

:purchase / ou:contract:purchase
Purchase details of the contract.

The property type is *econ:purchase*.

:requirements / ou:contract:requirements
The requirements levied upon the parties.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- uniq: `True`
- sorted: `True`

:types / ou:contract:types
A list of types that apply to the contract. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:contract:type`
- split: `,`
- uniq: `True`
- sorted: `True`

ou:contribution

Represents a specific instance of contributing material support to a campaign.

The base type for the form can be found at *ou:contribution*.

Properties:

:from / ou:contribution:from
The contact information of the contributor.

The property type is *ps:contact*.

:campaign / ou:contribution:campaign
The campaign receiving the contribution.

The property type is *ou:campaign*.

:value / ou:contribution:value
The assessed value of the contribution.

The property type is *econ:price*.

:currency / ou:contribution:currency
The currency used for the assessed value.

The property type is *econ:currency*.

:time / ou:contribution:time
The time the contribution occurred.

The property type is *time*.

:material:spec / ou:contribution:material:spec
The specification of material items contributed.

The property type is *mat:spec*.

:material:count / ou:contribution:material:count
The number of material items contributed.

The property type is *int*.

:monetary:payment / ou:contribution:monetary:payment
Payment details for a monetary contribution.

The property type is *econ:acct:payment*.

:personnel:count / ou:contribution:personnel:count
Number of personnel contributed to the campaign.

The property type is *int*.

:personnel:jobtitle / ou:contribution:personnel:jobtitle
Title or designation for the contributed personnel.

The property type is *ou:jobtitle*.

ou:conttype

A contract type taxonomy.

The base type for the form can be found at *ou:conttype*.

Properties:

:title / ou:conttype:title
A brief title of the definition.

The property type is *str*.

:summary / ou:conttype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:conttype:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:conttype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:conttype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:conttype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:conttype*.

ou:employment

An employment type taxonomy.

The base type for the form can be found at *ou:employment*.

An example of `ou:employment`:

- `fulltime.salary`

Properties:

:title / ou:employment:title
A brief title of the definition.

The property type is *str*.

:summary / ou:employment:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:employment:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:employment:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:employment:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:employment:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:employment*.

ou:goal

An assessed or stated goal which may be abstract or org specific.

The base type for the form can be found at *ou:goal*.

Properties:

:name / ou:goal:name
A terse name for the goal.

The property type is *ou:goalname*.

:names / ou:goal:names
An array of alternate names for the goal. Used to merge/resolve goals.

The property type is *array*. Its type has the following options set:

- type: `ou:goalname`
- sorted: `True`
- uniq: `True`

:type / ou:goal:type
A type taxonomy entry for the goal.

The property type is *ou:goal:type:taxonomy*.

:desc / ou:goal:desc
A description of the goal. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:prev / ou:goal:prev
Deprecated. Please use ou:goal:type taxonomy. It has the following property options set:

- deprecated: `True`

The property type is *ou:goal*.

ou:goal:type:taxonomy

A taxonomy of goal types.

The base type for the form can be found at *ou:goal:type:taxonomy*.

Properties:

:title / ou:goal:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / ou:goal:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:goal:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:goal:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:goal:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:goal:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:goal:type:taxonomy*.

ou:goalname

A goal name.

The base type for the form can be found at *ou:goalname*.

Properties:

ou:hasalias

The knowledge that an organization has an alias.

The base type for the form can be found at *ou:hasalias*.

Properties:

:org / ou:hasalias:org
The org guid which has the alias. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:alias / ou:hasalias:alias
Alias for the organization. It has the following property options set:

- Read Only: `True`

The property type is *ou:alias*.

ou:hasgoal

Deprecated. Please use ou:org:goals.

The base type for the form can be found at *ou:hasgoal*.

Properties:

:org / ou:hasgoal:org
The org which has the goal. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:goal / ou:hasgoal:goal
The goal which the org has. It has the following property options set:

- Read Only: `True`

The property type is *ou:goal*.

:stated / ou:hasgoal:stated
Set to true/false if the goal is known to be self stated.

The property type is *bool*.

:window / ou:hasgoal:window
Set if a goal has a limited time window.

The property type is *ival*.

ou:id:number

A unique id number issued by a specific organization.

The base type for the form can be found at *ou:id:number*.

Properties:

:type / ou:id:number:type
The type of org id. It has the following property options set:

- Read Only: `True`

The property type is *ou:id:type*.

:value / ou:id:number:value
The value of org id. It has the following property options set:

- Read Only: `True`

The property type is *ou:id:value*.

:status / ou:id:number:status
A freeform status such as valid, suspended, expired.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:issued / ou:id:number:issued
The time at which the org issued the ID number.

The property type is *time*.

:expires / ou:id:number:expires
The time at which the ID number expires.

The property type is *time*.

ou:id:type

A type of id number issued by an org.

The base type for the form can be found at *ou:id:type*.

Properties:

:org / ou:id:type:org
The org which issues id numbers of this type.

The property type is *ou:org*.

:name / ou:id:type:name
The friendly name of the id number type.

The property type is *str*.

ou:id:update

A status update to an org:id:number.

The base type for the form can be found at *ou:id:update*.

Properties:

:number / ou:id:update:number
The id number that was updated.

The property type is *ou:id:number*.

:status / ou:id:update:status
The updated status of the id number.

The property type is *str*. Its type has the following options set:

- strip: `True`
- lower: `True`

:time / ou:id:update:time
The date/time that the id number was updated.

The property type is *time*.

ou:industry

An industry classification type.

The base type for the form can be found at *ou:industry*.

Properties:

:name / ou:industry:name
The name of the industry.

The property type is *ou:industryname*.

:type / ou:industry:type
An taxonomy entry for the industry.

The property type is *ou:industry:type:taxonomy*.

:names / ou:industry:names
An array of alternative names for the industry.

The property type is *array*. Its type has the following options set:

- type: `ou:industryname`
- uniq: `True`
- sorted: `True`

:subs / ou:industry:subs
Deprecated. Please use ou:industry:type taxonomy.

The property type is *array*. Its type has the following options set:

- type: `ou:industry`
- split: `,`
- uniq: `True`
- sorted: `True`

:sic / ou:industry:sic
An array of SIC codes that map to the industry.

The property type is *array*. Its type has the following options set:

- type: `ou:sic`
- split: `,`
- uniq: `True`
- sorted: `True`

:naics / ou:industry:naics
An array of NAICS codes that map to the industry.

The property type is *array*. Its type has the following options set:

- type: `ou:naics`
- split: `,`
- uniq: `True`
- sorted: `True`

:isic / ou:industry:isic
An array of ISIC codes that map to the industry.

The property type is *array*. Its type has the following options set:

- type: `ou:isic`
- split: `,`
- uniq: `True`
- sorted: `True`

:desc / ou:industry:desc
A description of the industry. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

ou:industryname

The name of an industry.

The base type for the form can be found at *ou:industryname*.

Properties:

ou:jobtitle

A title for a position within an org.

The base type for the form can be found at *ou:jobtitle*.

Properties:

ou:jobtype

A title for a position within an org.

The base type for the form can be found at *ou:jobtype*.

An example of `ou:jobtype`:

- `it.dev.python`

Properties:

:title / ou:jobtype:title
A brief title of the definition.

The property type is *str*.

:summary / ou:jobtype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:jobtype:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:jobtype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:jobtype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:jobtype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:jobtype*.

ou:meet

An informal meeting of people which has no title or sponsor. See also: ou:conference.

The base type for the form can be found at *ou:meet*.

Properties:

:name / ou:meet:name
A human friendly name for the meeting.

The property type is *str*. Its type has the following options set:

- lower: `True`

:start / ou:meet:start
The date / time the meet starts.

The property type is *time*.

:end / ou:meet:end
The date / time the meet ends.

The property type is *time*.

:place / ou:meet:place
The geo:place node where the meet was held.

The property type is *geo:place*.

ou:meet:attendee

Deprecated. Please use ou:attendee.

The base type for the form can be found at *ou:meet:attendee*.

Properties:

:meet / ou:meet:attendee:meet
The meeting which was attended. It has the following property options set:

- Read Only: `True`

The property type is *ou:meet*.

:person / ou:meet:attendee:person
The person who attended the meeting. It has the following property options set:

- Read Only: `True`

The property type is *ps:person*.

:arrived / ou:meet:attendee:arrived
The time when a person arrived to the meeting.

The property type is *time*.

:departed / ou:meet:attendee:departed
The time when a person departed from the meeting.

The property type is *time*.

ou:member

Deprecated. Please use ou:position.

The base type for the form can be found at *ou:member*.

Properties:

:org / ou:member:org
The GUID of the org the person is a member of. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:person / ou:member:person
The GUID of the person that is a member of an org. It has the following property options set:

- Read Only: `True`

The property type is *ps:person*.

:title / ou:member:title
The persons normalized title.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:start / ou:member:start
Earliest known association of the person with the org.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:end / ou:member:end
Most recent known association of the person with the org.

The property type is *time*. Its type has the following options set:

- ismax: `True`

ou:name

The name of an organization. This may be a formal name or informal name of the organization.

The base type for the form can be found at *ou:name*.

An example of `ou:name`:

- `acme corporation`

Properties:

ou:opening

A job/work opening within an org.

The base type for the form can be found at *ou:opening*.

Properties:

:org / ou:opening:org
The org which has the opening.

The property type is *ou:org*.

:orgname / ou:opening:orgname
The name of the organization as listed in the opening.

The property type is *ou:name*.

:orgfqdn / ou:opening:orgfqdn
The FQDN of the organization as listed in the opening.

The property type is *inet:fqdn*.

:posted / ou:opening:posted
The date/time that the job opening was posted.

The property type is *time*.

:removed / ou:opening:removed
The date/time that the job opening was removed.

The property type is *time*.

:postings / ou:opening:postings
URLs where the opening is listed.

The property type is *array*. Its type has the following options set:

- type: `inet:url`

- uniq: `True`
- sorted: `True`

:contact / ou:opening:contact
The contact details to inquire about the opening.

The property type is *ps:contact*.

:loc / ou:opening:loc
The geopolitical boundary of the opening.

The property type is *loc*.

:jobtype / ou:opening:jobtype
The job type taxonomy.

The property type is *ou:jobtype*.

:employment / ou:opening:employment
The type of employment.

The property type is *ou:employment*.

:jobtitle / ou:opening:jobtitle
The title of the opening.

The property type is *ou:jobtitle*.

:remote / ou:opening:remote
Set to true if the opening will allow a fully remote worker.

The property type is *bool*.

:yearlypay / ou:opening:yearlypay
The yearly income associated with the opening.

The property type is *econ:price*.

:paycurrency / ou:opening:paycurrency
The currency that the yearly pay was delivered in.

The property type is *econ:currency*.

ou:org

A GUID for a human organization such as a company or military unit.

The base type for the form can be found at *ou:org*.

Properties:

:loc / ou:org:loc
Location for an organization.

The property type is *loc*.

:name / ou:org:name
The localized name of an organization.

The property type is *ou:name*.

:type / ou:org:type
The type of organization. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:orgtype / ou:org:orgtype
The type of organization. It has the following property options set:

- disp: `{'hint': 'taxonomy'}`

The property type is *ou:orgtype*.

:vitals / ou:org:vitals
The most recent/accurate ou:vitals for the org.

The property type is *ou:vitals*.

:desc / ou:org:desc
A description of the org. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:logo / ou:org:logo
An image file representing the logo for the organization.

The property type is *file:bytes*.

:names / ou:org:names
A list of alternate names for the organization.

The property type is *array*. Its type has the following options set:

- type: `ou:name`
- uniq: `True`
- sorted: `True`

:alias / ou:org:alias
The default alias for an organization.

The property type is *ou:alias*.

:phone / ou:org:phone
The primary phone number for the organization.

The property type is *tel:phone*.

:sic / ou:org:sic
The Standard Industrial Classification code for the organization. It has the following property options set:

- deprecated: `True`

The property type is *ou:sic*.

:naics / ou:org:naics
The North American Industry Classification System code for the organization. It has the following property options set:

- deprecated: `True`

The property type is *ou:naics*.

:industries / ou:org:industries
The industries associated with the org.

The property type is *array*. Its type has the following options set:

- type: `ou:industry`
- uniq: `True`
- sorted: `True`

:us:cage / ou:org:us:cage
The Commercial and Government Entity (CAGE) code for the organization.

The property type is *gov:us:cage*.

:founded / ou:org:founded
The date on which the org was founded.

The property type is *time*.

:dissolved / ou:org:dissolved
The date on which the org was dissolved.

The property type is *time*.

:url / ou:org:url
The primary url for the organization.

The property type is *inet:url*.

:subs / ou:org:subs
An set of sub-organizations.

The property type is *array*. Its type has the following options set:

- type: `ou:org`
- uniq: `True`
- sorted: `True`

:orgchart / ou:org:orgchart
The root node for an orgchart made up ou:position nodes.

The property type is *ou:position*.

:hq / ou:org:hq
A collection of contact information for the “main office” of an org.

The property type is *ps:contact*.

:locations / ou:org:locations
An array of contacts for facilities operated by the org.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:country / ou:org:country
The organization’s country of origin.

The property type is *pol:country*.

:country:code / ou:org:country:code
The 2 digit ISO 3166 country code for the organization's country of origin.

The property type is *pol:iso2*.

:dns:mx / ou:org:dns:mx
An array of MX domains used by email addresses issued by the org.

The property type is *array*. Its type has the following options set:

- type: `inet:fqdn`
- uniq: `True`
- sorted: `True`

:techniques / ou:org:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

:goals / ou:org:goals
The assessed goals of the organization.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- sorted: `True`
- uniq: `True`

ou:org:has

An org owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time.

The base type for the form can be found at *ou:org:has*.

Properties:

:org / ou:org:has:org
The org who owns or controls the object or resource. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:node / ou:org:has:node
The object or resource that is owned or controlled by the org. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:node:form / ou:org:has:node:form
The form of the object or resource that is owned or controlled by the org. It has the following property options set:

- Read Only: `True`

The property type is *str*.

ou:orgnet4

An organization's IPv4 netblock.

The base type for the form can be found at *ou:orgnet4*.

Properties:

:org / ou:orgnet4:org
The org guid which owns the netblock. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:net / ou:orgnet4:net
Netblock owned by the organization. It has the following property options set:

- Read Only: `True`

The property type is *inet:net4*.

:name / ou:orgnet4:name
The name that the organization assigns to this netblock.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

ou:orgnet6

An organization's IPv6 netblock.

The base type for the form can be found at *ou:orgnet6*.

Properties:

:org / ou:orgnet6:org
The org guid which owns the netblock. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:net / ou:orgnet6:net
Netblock owned by the organization. It has the following property options set:

- Read Only: `True`

The property type is *inet:net6*.

:name / ou:orgnet6:name
The name that the organization assigns to this netblock.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

ou:orgtype

An org type taxonomy.

The base type for the form can be found at *ou:orgtype*.

Properties:

:title / ou:orgtype:title
A brief title of the definition.

The property type is *str*.

:summary / ou:orgtype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:orgtype:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:orgtype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:orgtype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:orgtype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:orgtype*.

ou:position

A position within an org. May be organized into an org chart.

The base type for the form can be found at *ou:position*.

Properties:

:org / ou:position:org
The org which has the position.

The property type is *ou:org*.

:team / ou:position:team
The team that the position is a member of.

The property type is *ou:team*.

:contact / ou:position:contact
The contact info for the person who holds the position.

The property type is *ps:contact*.

:title / ou:position:title
The title of the position.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:reports / ou:position:reports
An array of positions which report to this position.

The property type is *array*. Its type has the following options set:

- type: `ou:position`
- uniq: `True`
- sorted: `True`

ou:preso

A webinar, conference talk, or other type of presentation.

The base type for the form can be found at *ou:preso*.

Properties:

:organizer / ou:preso:organizer
Contact information for the primary organizer of the presentation.

The property type is *ps:contact*.

:sponsors / ou:preso:sponsors
A set of contacts which sponsored the presentation.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:presenters / ou:preso:presenters
A set of contacts which gave the presentation.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- sorted: `True`

:title / ou:preso:title
The full name of the presentation. It has the following property options set:

- Example: `Synapse 101 - 2021/06/22`

The property type is *str*. Its type has the following options set:

- lower: `True`

:desc / ou:preso:desc
A description of the presentation. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- lower: `True`

:time / ou:preso:time
The scheduled presentation start time.

The property type is *time*.

:duration / ou:preso:duration
The scheduled duration of the presentation.

The property type is *duration*.

:loc / ou:preso:loc
The geopolitical location string for where the presentation was given.

The property type is *loc*.

:place / ou:preso:place
The geo:place node where the presentation was held.

The property type is *geo:place*.

:deck:url / ou:preso:deck:url
The URL hosting a copy of the presentation materials.

The property type is *inet:url*.

:deck:file / ou:preso:deck:file
A file containing the presentation materials.

The property type is *file:bytes*.

:attendee:url / ou:preso:attendee:url
The URL visited by live attendees of the presentation.

The property type is *inet:url*.

:recording:url / ou:preso:recording:url
The URL hosting a recording of the presentation.

The property type is *inet:url*.

:recording:file / ou:preso:recording:file
A file containing a recording of the presentation.

The property type is *file:bytes*.

:conference / ou:preso:conference
The conference which hosted the presentation.

The property type is *ou:conference*.

ou:suborg

Any parent/child relationship between two orgs. May represent ownership, organizational structure, etc.

The base type for the form can be found at *ou:suborg*.

Properties:

:org / ou:suborg:org
The org which owns the sub organization. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:sub / ou:suborg:sub
The sub org which owned by the org. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:perc / ou:suborg:perc
The optional percentage of sub which is owned by org.

The property type is *int*. Its type has the following options set:

- min: `0`
- max: `100`

:founded / ou:suborg:founded
The date on which the suborg relationship was founded.

The property type is *time*.

:dissolved / ou:suborg:dissolved
The date on which the suborg relationship was dissolved.

The property type is *time*.

:current / ou:suborg:current
Bool indicating if the suborg relationship still current.

The property type is *bool*.

ou:team

A GUID for a team within an organization.

The base type for the form can be found at *ou:team*.

Properties:

:org / ou:team:org
A GUID for a human organization such as a company or military unit.

The property type is *ou:org*.

:name / ou:team:name
The name of an organization. This may be a formal name or informal name of the organization.

The property type is *ou:name*.

ou:technique

A specific technique used to achieve a goal.

The base type for the form can be found at *ou:technique*.

Properties:

:name / ou:technique:name
The normalized name of the technique.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / ou:technique:type
The taxonomy classification of the technique.

The property type is *ou:technique:taxonomy*.

:sophistication / ou:technique:sophistication
The assessed sophistication of the technique.

The property type is *meta:sophistication*.

:desc / ou:technique:desc
A description of the technique. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:tag / ou:technique:tag
The tag used to annotate nodes where the technique was employed.

The property type is *syn:tag*.

:mitre:attack:technique / ou:technique:mitre:attack:technique
A mapping to a Mitre ATT&CK technique if applicable.

The property type is *it:mitre:attack:technique*.

:reporter / ou:technique:reporter
The organization reporting on the technique.

The property type is *ou:org*.

:reporter:name / ou:technique:reporter:name
The name of the organization reporting on the technique.

The property type is *ou:name*.

ou:technique:taxonomy

An analyst defined taxonomy to classify techniques in different disciplines.

The base type for the form can be found at *ou:technique:taxonomy*.

Properties:

:title / ou:technique:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / ou:technique:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ou:technique:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / ou:technique:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ou:technique:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ou:technique:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ou:technique:taxonomy*.

ou:user

A user name within an organization.

The base type for the form can be found at *ou:user*.

Properties:

:org / ou:user:org
The org guid which owns the netblock. It has the following property options set:

- Read Only: `True`

The property type is *ou:org*.

:user / ou:user:user
The username associated with the organization. It has the following property options set:

- Read Only: `True`

The property type is *inet:user*.

ou:vitals

Vital statistics about an org for a given time period.

The base type for the form can be found at *ou:vitals*.

Properties:

:asof / ou:vitals:asof
The time that the vitals represent.

The property type is *time*.

:org / ou:vitals:org
The resolved org.

The property type is *ou:org*.

:orgname / ou:vitals:orgname
The org name as reported by the source of the vitals.

The property type is *ou:name*.

:orgfqdn / ou:vitals:orgfqdn
The org FQDN as reported by the source of the vitals.

The property type is *inet:fqdn*.

:currency / ou:vitals:currency
The currency of the econ:price values.

The property type is *econ:currency*.

:costs / ou:vitals:costs
The costs/expenditures over the period.

The property type is *econ:price*.

:revenue / ou:vitals:revenue
The gross revenue over the period.

The property type is *econ:price*.

:profit / ou:vitals:profit
The net profit over the period.

The property type is *econ:price*.

:valuation / ou:vitals:valuation
The assessed value of the org.

The property type is *econ:price*.

:shares / ou:vitals:shares
The number of shares outstanding.

The property type is *int*.

:population / ou:vitals:population
The population of the org.

The property type is *int*.

:delta:costs / ou:vitals:delta:costs
The change in costs over last period.

The property type is *econ:price*.

:delta:revenue / ou:vitals:delta:revenue
The change in revenue over last period.

The property type is *econ:price*.

:delta:profit / ou:vitals:delta:profit
The change in profit over last period.

The property type is *econ:price*.

:delta:valuation / ou:vitals:delta:valuation
The change in valuation over last period.

The property type is *econ:price*.

:delta:population / ou:vitals:delta:population
The change in population over last period.

The property type is *int*.

pol:candidate

A candidate for office in a specific race.

The base type for the form can be found at *pol:candidate*.

Properties:

:contact / pol:candidate:contact
The contact information of the candidate.

The property type is *ps:contact*.

:race / pol:candidate:race
The race the candidate is participating in.

The property type is *pol:race*.

:campaign / pol:candidate:campaign
The official campaign to elect the candidate.

The property type is *ou:campaign*.

:winner / pol:candidate:winner
Records the outcome of the race.

The property type is *bool*.

:party / pol:candidate:party
The declared political party of the candidate.

The property type is *ou:org*.

:incumbent / pol:candidate:incumbent
Set to true if the candidate is an incumbent in this race.

The property type is *bool*.

pol:country

A GUID for a country.

The base type for the form can be found at *pol:country*.

Properties:

:flag / pol:country:flag
A thumbnail image of the flag of the country.

The property type is *file:bytes*.

:iso2 / pol:country:iso2
The 2 digit ISO 3166 country code.

The property type is *pol:iso2*.

:iso3 / pol:country:iso3
The 3 digit ISO 3166 country code.

The property type is *pol:iso3*.

:isonum / pol:country:isonum
The ISO integer country code.

The property type is *pol:isonum*.

:pop / pol:country:pop
Deprecated. Please use :vitals::population. It has the following property options set:

- deprecated: `True`

The property type is *int*.

:tld / pol:country:tld
A Fully Qualified Domain Name (FQDN).

The property type is *inet:fqdn*.

:name / pol:country:name
The name of the country.

The property type is *geo:name*.

:names / pol:country:names
An array of alternate or localized names for the country.

The property type is *array*. Its type has the following options set:

- type: `geo:name`
- uniq: `True`
- sorted: `True`

:government / pol:country:government
The ou:org node which represents the government of the country.

The property type is *ou:org*.

:place / pol:country:place
A geo:place node representing the geospatial properties of the country.

The property type is *geo:place*.

:founded / pol:country:founded
The date that the country was founded.

The property type is *time*.

:dissolved / pol:country:dissolved
The date that the country was dissolved.

The property type is *time*.

:vitals / pol:country:vitals
The most recent known vitals for the country.

The property type is *pol:vitals*.

pol:election

An election involving one or more races for office.

The base type for the form can be found at *pol:election*.

Properties:

:name / pol:election:name
The name of the election. It has the following property options set:

- Example: `2022 united states congressional midterm election`

The property type is *str*. Its type has the following options set:

- onespace: `True`
- lower: `True`

:time / pol:election:time
The date of the election.

The property type is *time*.

pol:immigration:status

A node which tracks the immigration status of a contact.

The base type for the form can be found at *pol:immigration:status*.

Properties:

:contact / pol:immigration:status:contact
The contact information for the immigration status record.

The property type is *ps:contact*.

:country / pol:immigration:status:country
The country that the contact is/has immigrated to.

The property type is *pol:country*.

:type / pol:immigration:status:type
A taxonomy entry for the immigration status type. It has the following property options set:

- Example: `citizen.naturalized`

The property type is *pol:immigration:status:type:taxonomy*.

:state / pol:immigration:status:state
The state of the immigration status.

The property type is *str*. Its type has the following options set:

- enums: `requested,active,rejected,revoked,renounced`

:began / pol:immigration:status:began
The time when the status was granted to the contact.

The property type is *time*.

:ended / pol:immigration:status:ended
The time when the status no longer applied to the contact.

The property type is *time*.

pol:immigration:status:type:taxonomy

A taxonomy of immigration types.

The base type for the form can be found at *pol:immigration:status:type:taxonomy*.

Properties:

:title / pol:immigration:status:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / pol:immigration:status:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / pol:immigration:status:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / pol:immigration:status:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / pol:immigration:status:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / pol:immigration:status:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *pol:immigration:status:type:taxonomy*.

pol:office

An elected or appointed office.

The base type for the form can be found at *pol:office*.

Properties:

:title / pol:office:title
The title of the political office. It has the following property options set:

- Example: `united states senator`

The property type is *ou:jobtitle*.

:position / pol:office:position
The position this office holds in the org chart for the governing body.

The property type is *ou:position*.

:termlimit / pol:office:termlimit
The maximum number of times a single person may hold the office.

The property type is *int*.

:govbody / pol:office:govbody
The governmental body which contains the office.

The property type is *ou:org*.

pol:pollingplace

An official place where ballots may be cast for a specific election.

The base type for the form can be found at *pol:pollingplace*.

Properties:

:election / pol:pollingplace:election
The election that the polling place is designated for.

The property type is *pol:election*.

:name / pol:pollingplace:name
The name of the polling place at the time of the election. This may differ from the official place name.

The property type is *geo:name*.

:place / pol:pollingplace:place
The place where votes were cast.

The property type is *geo:place*.

:opens / pol:pollingplace:opens
The time that the polling place is scheduled to open.

The property type is *time*.

:closes / pol:pollingplace:closes
The time that the polling place is scheduled to close.

The property type is *time*.

:opened / pol:pollingplace:opened
The time that the polling place opened.

The property type is *time*.

:closed / pol:pollingplace:closed
The time that the polling place closed.

The property type is *time*.

pol:race

An individual race for office.

The base type for the form can be found at *pol:race*.

Properties:

:election / pol:race:election
The election that includes the race.

The property type is *pol:election*.

:office / pol:race:office
The political office that the candidates in the race are running for.

The property type is *pol:office*.

:voters / pol:race:voters
The number of eligible voters for this race.

The property type is *int*.

:turnout / pol:race:turnout
The number of individuals who voted in this race.

The property type is *int*.

pol:term

A term in office held by a specific individual.

The base type for the form can be found at *pol:term*.

Properties:

:office / pol:term:office
The office held for the term.

The property type is *pol:office*.

:start / pol:term:start
The start of the term of office.

The property type is *time*.

:end / pol:term:end
The end of the term of office.

The property type is *time*.

:race / pol:term:race
The race that determined who held office during the term.

The property type is *pol:race*.

:contact / pol:term:contact
The contact information of the person who held office during the term.

The property type is *ps:contact*.

:party / pol:term:party
The political party of the person who held office during the term.

The property type is *ou:org*.

pol:vitals

A set of vital statistics about a country.

The base type for the form can be found at *pol:vitals*.

Properties:

:country / pol:vitals:country
The country that the statistics are about.

The property type is *pol:country*.

:asof / pol:vitals:asof
The time that the vitals were measured.

The property type is *time*.

:area / pol:vitals:area
The area of the country.

The property type is *geo:area*.

:population / pol:vitals:population
The total number of people living in the country.

The property type is *int*.

:currency / pol:vitals:currency
The national currency.

The property type is *econ:currency*.

:econ:currency / pol:vitals:econ:currency
The currency used to record price properties.

The property type is *econ:currency*.

:econ:gdp / pol:vitals:econ:gdp
The gross domestic product of the country.

The property type is *econ:price*.

proj:attachment

A file attachment added to a ticket or comment.

The base type for the form can be found at *proj:attachment*.

Properties:

:name / proj:attachment:name
: The name of the file that was attached.

  The property type is *file:base*.

:file / proj:attachment:file
: The file that was attached.

  The property type is *file:bytes*.

:creator / proj:attachment:creator
: The synapse user who added the attachment.

  The property type is *syn:user*.

:created / proj:attachment:created
: The time the attachment was added.

  The property type is *time*.

:ticket / proj:attachment:ticket
: The ticket the attachment was added to.

  The property type is *proj:ticket*.

:comment / proj:attachment:comment
: The comment the attachment was added to.

  The property type is *proj:comment*.

proj:comment

A user comment on a ticket.

The base type for the form can be found at *proj:comment*.

Properties:

:creator / proj:comment:creator
: The synapse user who added the comment.

  The property type is *syn:user*.

:created / proj:comment:created
: The time the comment was added.

  The property type is *time*.

:updated / proj:comment:updated
: The last time the comment was updated.

  The property type is *time*. Its type has the following options set:

  - ismax: `True`

:ticket / proj:comment:ticket
The ticket the comment was added to.

The property type is *proj:ticket*.

:text / proj:comment:text
The text of the comment.

The property type is *str*.

proj:epic

A collection of tickets related to a topic.

The base type for the form can be found at *proj:epic*.

Properties:

:name / proj:epic:name
The name of the epic.

The property type is *str*. Its type has the following options set:

- onespace: `True`

:project / proj:epic:project
The project containing the epic.

The property type is *proj:project*.

:creator / proj:epic:creator
The synapse user who created the epic.

The property type is *syn:user*.

:created / proj:epic:created
The time the epic was created.

The property type is *time*.

:updated / proj:epic:updated
The last time the epic was updated.

The property type is *time*. Its type has the following options set:

- ismax: `True`

proj:project

A project in a ticketing system.

The base type for the form can be found at *proj:project*.

Properties:

:name / proj:project:name
The project name.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / proj:project:desc
The project description. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:creator / proj:project:creator
The synapse user who created the project.

The property type is *syn:user*.

:created / proj:project:created
The time the project was created.

The property type is *time*.

proj:sprint

A timeboxed period to complete a set amount of work.

The base type for the form can be found at *proj:sprint*.

Properties:

:name / proj:sprint:name
The name of the sprint.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:status / proj:sprint:status
The sprint status.

The property type is *str*. Its type has the following options set:

- enums: `planned,current,completed`

:project / proj:sprint:project
The project containing the sprint.

The property type is *proj:project*.

:creator / proj:sprint:creator
The synapse user who created the sprint.

The property type is *syn:user*.

:created / proj:sprint:created
The date the sprint was created.

The property type is *time*.

:period / proj:sprint:period
The interval for the sprint.

The property type is *ival*.

:desc / proj:sprint:desc
A description of the sprint.

The property type is *str*.

proj:ticket

A ticket in a ticketing system.

The base type for the form can be found at *proj:ticket*.

Properties:

:project / proj:ticket:project
The project containing the ticket.

The property type is *proj:project*.

:ext:id / proj:ticket:ext:id
A ticket ID from an external system.

The property type is *str*. Its type has the following options set:

- strip: `True`

:ext:url / proj:ticket:ext:url
A URL to the ticket in an external system.

The property type is *inet:url*.

:ext:creator / proj:ticket:ext:creator
Ticket creator contact information from an external system.

The property type is *ps:contact*.

:epic / proj:ticket:epic
The epic that includes the ticket.

The property type is *proj:epic*.

:created / proj:ticket:created
The time the ticket was created.

The property type is *time*.

:updated / proj:ticket:updated
The last time the ticket was updated.

The property type is *time*. Its type has the following options set:

- ismax: `True`

:name / proj:ticket:name
The name of the ticket.

The property type is *str*. Its type has the following options set:

- onespace: `True`

:desc / proj:ticket:desc
A description of the ticket.

The property type is *str*.

:points / proj:ticket:points
Optional SCRUM style story points value.

The property type is *int*.

:status / proj:ticket:status
The ticket completion status.

The property type is *int*. Its type has the following options set:

- enums: `((0, 'new'), (10, 'in validation'), (20, 'in backlog'), (30, 'in sprint'), (40, 'in progress'), (50, 'in review'), (60, 'completed'), (70, 'done'), (80, 'blocked'))`

:sprint / proj:ticket:sprint
The sprint that contains the ticket.

The property type is *proj:sprint*.

:priority / proj:ticket:priority
The priority of the ticket.

The property type is *int*. Its type has the following options set:

- enums: `((0, 'none'), (10, 'lowest'), (20, 'low'), (30, 'medium'), (40, 'high'), (50, 'highest'))`

:type / proj:ticket:type
The type of ticket. (eg story / bug).

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:creator / proj:ticket:creator
The synapse user who created the ticket.

The property type is *syn:user*.

:assignee / proj:ticket:assignee
The synapse user who the ticket is assigned to.

The property type is *syn:user*.

ps:achievement

An instance of an individual receiving an award.

The base type for the form can be found at *ps:achievement*.

Properties:

:awardee / ps:achievement:awardee
The recipient of the award.

The property type is *ps:contact*.

:award / ps:achievement:award
The award bestowed on the awardee.

The property type is *ou:award*.

:awarded / ps:achievement:awarded
The date the award was granted to the awardee.

The property type is *time*.

:expires / ps:achievement:expires
The date the award or certification expires.

The property type is *time*.

:revoked / ps:achievement:revoked
The date the award was revoked by the org.

The property type is *time*.

ps:contact

A GUID for a contact info record.

The base type for the form can be found at *ps:contact*.

Properties:

:org / ps:contact:org
The org which this contact represents.

The property type is *ou:org*.

:type / ps:contact:type
The type of contact which may be used for entity resolution.

The property type is *ps:contact:type:taxonomy*.

:asof / ps:contact:asof
A date/time value. It has the following property options set:

- date: `The time this contact was created or modified.`

The property type is *time*.

:person / ps:contact:person
The ps:person GUID which owns this contact.

The property type is *ps:person*.

:vitals / ps:contact:vitals
The most recent known vitals for the contact.

The property type is *ps:vitals*.

:name / ps:contact:name
The person name listed for the contact.

The property type is *ps:name*.

:desc / ps:contact:desc
A description of this contact.

The property type is *str*.

:title / ps:contact:title
The job/org title listed for this contact.

The property type is *ou:jobtitle*.

:photo / ps:contact:photo
The photo listed for this contact.

The property type is *file:bytes*.

:orgname / ps:contact:orgname
The listed org/company name for this contact.

The property type is *ou:name*.

:orgfqdn / ps:contact:orgfqdn
The listed org/company FQDN for this contact.

The property type is *inet:fqdn*.

:user / ps:contact:user
The username or handle for this contact.

The property type is *inet:user*.

:web:acct / ps:contact:web:acct
The social media account for this contact.

The property type is *inet:web:acct*.

:web:group / ps:contact:web:group
A web group representing this contact.

The property type is *inet:web:group*.

:birth:place / ps:contact:birth:place
A fully resolved place of birth for this contact.

The property type is *geo:place*.

:birth:place:loc / ps:contact:birth:place:loc
The loc of the place of birth of this contact.

The property type is *loc*.

:birth:place:name / ps:contact:birth:place:name
The name of the place of birth of this contact.

The property type is *geo:name*.

:death:place / ps:contact:death:place
A fully resolved place of death for this contact.

The property type is *geo:place*.

:death:place:loc / ps:contact:death:place:loc
The loc of the place of death of this contact.

The property type is *loc*.

:death:place:name / ps:contact:death:place:name
The name of the place of death of this contact.

The property type is *geo:name*.

:dob / ps:contact:dob
The date of birth for this contact.

The property type is *time*.

:dod / ps:contact:dod
The date of death for this contact.

The property type is *time*.

:url / ps:contact:url
The home or main site for this contact.

The property type is *inet:url*.

:email / ps:contact:email
The main email address for this contact.

The property type is *inet:email*.

:email:work / ps:contact:email:work
The work email address for this contact.

The property type is *inet:email*.

:loc / ps:contact:loc
Best known contact geopolitical location.

The property type is *loc*.

:address / ps:contact:address
The street address listed for the contact. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *geo:address*.

:place / ps:contact:place
The place associated with this contact.

The property type is *geo:place*.

:place:name / ps:contact:place:name
The reported name of the place associated with this contact.

The property type is *geo:name*.

:phone / ps:contact:phone
The main phone number for this contact.

The property type is *tel:phone*.

:phone:fax / ps:contact:phone:fax
The fax number for this contact.

The property type is *tel:phone*.

:phone:work / ps:contact:phone:work
The work phone number for this contact.

The property type is *tel:phone*.

:id:number / ps:contact:id:number
An ID number issued by an org and associated with this contact.

The property type is *ou:id:number*.

:adid / ps:contact:adid
A Advertising ID associated with this contact.

The property type is *it:adid*.

:imid / ps:contact:imid
An IMID associated with the contact.

The property type is *tel:mob:imid*.

:imid:imei / ps:contact:imid:imei
An IMEI associated with the contact.

The property type is *tel:mob:imei*.

:imid:imsi / ps:contact:imid:imsi
An IMSI associated with the contact.

The property type is *tel:mob:imsi*.

:names / ps:contact:names
An array of associated names/aliases for the person.

The property type is *array*. Its type has the following options set:

- type: `ps:name`
- uniq: `True`
- sorted: `True`

:orgnames / ps:contact:orgnames
An array of associated names/aliases for the organization.

The property type is *array*. Its type has the following options set:

- type: `ou:name`
- uniq: `True`
- sorted: `True`

:emails / ps:contact:emails
An array of secondary/associated email addresses.

The property type is *array*. Its type has the following options set:

- type: `inet:email`
- uniq: `True`
- sorted: `True`

:web:accts / ps:contact:web:accts
An array of secondary/associated web accounts.

The property type is *array*. Its type has the following options set:

- type: `inet:web:acct`
- uniq: `True`
- sorted: `True`

:id:numbers / ps:contact:id:numbers
An array of secondary/associated IDs.

The property type is *array*. Its type has the following options set:

- type: `ou:id:number`
- uniq: `True`
- sorted: `True`

:users / ps:contact:users
An array of secondary/associated user names.

The property type is *array*. Its type has the following options set:

- type: `inet:user`
- uniq: `True`

- sorted: `True`

:crypto:address / ps:contact:crypto:address
A crypto currency address associated with the contact.

The property type is *crypto:currency:address*.

:lang / ps:contact:lang
The language specified for the contact.

The property type is *lang:language*.

:langs / ps:contact:langs
An array of alternative languages specified for the contact.

The property type is *array*. Its type has the following options set:

- type: `lang:language`

ps:contact:type:taxonomy

A taxonomy of contact types.

The base type for the form can be found at *ps:contact:type:taxonomy*.

Properties:

:title / ps:contact:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / ps:contact:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ps:contact:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / ps:contact:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ps:contact:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ps:contact:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ps:contact:type:taxonomy*.

ps:contactlist

A GUID for a list of associated contacts.

The base type for the form can be found at *ps:contactlist*.

Properties:

:contacts / ps:contactlist:contacts
The array of contacts contained in the list.

The property type is *array*. Its type has the following options set:

- type: `ps:contact`
- uniq: `True`
- split: `,`
- sorted: `True`

:source:host / ps:contactlist:source:host
The host from which the contact list was extracted.

The property type is *it:host*.

:source:file / ps:contactlist:source:file
The file from which the contact list was extracted.

The property type is *file:bytes*.

:source:acct / ps:contactlist:source:acct
The web account from which the contact list was extracted.

The property type is *inet:web:acct*.

ps:education

A period of education for an individual.

The base type for the form can be found at *ps:education*.

Properties:

:student / ps:education:student
The contact of the person being educated.

The property type is *ps:contact*.

:institution / ps:education:institution
The contact info for the org providing educational services.

The property type is *ps:contact*.

:attended:first / ps:education:attended:first
The first date the student attended a class.

The property type is *time*.

:attended:last / ps:education:attended:last
The last date the student attended a class.

The property type is *time*.

:classes / ps:education:classes
The classes attended by the student.

The property type is *array*. Its type has the following options set:

- type: `edu:class`
- uniq: `True`
- sorted: `True`

:achievement / ps:education:achievement
The achievement awarded to the individual.

The property type is *ps:achievement*.

ps:name

An arbitrary, lower spaced string with normalized whitespace.

The base type for the form can be found at *ps:name*.

An example of `ps:name`:

- `robert grey`

Properties:

:sur / ps:name:sur
The surname part of the name.

The property type is *ps:tokn*.

:middle / ps:name:middle
The middle name part of the name.

The property type is *ps:tokn*.

:given / ps:name:given
The given name part of the name.

The property type is *ps:tokn*.

ps:person

A GUID for a person.

The base type for the form can be found at *ps:person*.

Properties:

:dob / ps:person:dob
The date on which the person was born.

The property type is *time*.

:dod / ps:person:dod
The date on which the person died.

The property type is *time*.

:img / ps:person:img
Deprecated: use ps:person:photo. It has the following property options set:

- deprecated: `True`

The property type is *file:bytes*.

:photo / ps:person:photo
The primary image of a person.

The property type is *file:bytes*.

:nick / ps:person:nick
A username commonly used by the person.

The property type is *inet:user*.

:vitals / ps:person:vitals
The most recent known vitals for the person.

The property type is *ps:vitals*.

:name / ps:person:name
The localized name for the person.

The property type is *ps:name*.

:name:sur / ps:person:name:sur
The surname of the person.

The property type is *ps:tokn*.

:name:middle / ps:person:name:middle
The middle name of the person.

The property type is *ps:tokn*.

:name:given / ps:person:name:given
The given name of the person.

The property type is *ps:tokn*.

:names / ps:person:names
Variations of the name for the person.

The property type is *array*. Its type has the following options set:

- type: `ps:name`
- uniq: `True`
- sorted: `True`

:nicks / ps:person:nicks
Usernames used by the person.

The property type is *array*. Its type has the following options set:

- type: `inet:user`
- uniq: `True`
- sorted: `True`

ps:person:has

A person owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time.

The base type for the form can be found at *ps:person:has*.

Properties:

:person / ps:person:has:person
The person who owns or controls the object or resource. It has the following property options set:

- Read Only: `True`

The property type is *ps:person*.

:node / ps:person:has:node
The object or resource that is owned or controlled by the person. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:node:form / ps:person:has:node:form
The form of the object or resource that is owned or controlled by the person. It has the following property options set:

- Read Only: `True`

The property type is *str*.

ps:persona

A GUID for a suspected person.

The base type for the form can be found at *ps:persona*.

Properties:

:person / ps:persona:person
The real person behind the persona.

The property type is *ps:person*.

:dob / ps:persona:dob
The Date of Birth (DOB) if known.

The property type is *time*.

:img / ps:persona:img
The primary image of a suspected person.

The property type is *file:bytes*.

:nick / ps:persona:nick
A username commonly used by the suspected person.

The property type is *inet:user*.

:name / ps:persona:name
The localized name for the suspected person.

The property type is *ps:name*.

:name:sur / ps:persona:name:sur
The surname of the suspected person.

The property type is *ps:tokn*.

:name:middle / ps:persona:name:middle
The middle name of the suspected person.

The property type is *ps:tokn*.

:name:given / ps:persona:name:given
The given name of the suspected person.

The property type is *ps:tokn*.

:names / ps:persona:names
Variations of the name for a persona.

The property type is *array*. Its type has the following options set:

- type: `ps:name`
- uniq: `True`
- sorted: `True`

:nicks / ps:persona:nicks
Usernames used by the persona.

The property type is *array*. Its type has the following options set:

- type: `inet:user`
- uniq: `True`
- sorted: `True`

ps:persona:has

A persona owns, controls, or has exclusive use of an object or resource, potentially during a specific period of time.

The base type for the form can be found at *ps:persona:has*.

Properties:

:persona / ps:persona:has:persona
The persona who owns or controls the object or resource. It has the following property options set:

- Read Only: `True`

The property type is *ps:persona*.

:node / ps:persona:has:node
The object or resource that is owned or controlled by the persona. It has the following property options set:

- Read Only: `True`

The property type is *ndef*.

:node:form / ps:persona:has:node:form
The form of the object or resource that is owned or controlled by the persona. It has the following property options set:

- Read Only: `True`

The property type is *str*.

ps:proficiency

The assessment that a given contact possesses a specific skill.

The base type for the form can be found at *ps:proficiency*.

Properties:

:skill / ps:proficiency:skill
The skill in which the contact is proficient.

The property type is *ps:skill*.

:contact / ps:proficiency:contact
The contact which is proficient in the skill.

The property type is *ps:contact*.

ps:skill

A specific skill which a person or organization may have.

The base type for the form can be found at *ps:skill*.

Properties:

:name / ps:skill:name
The name of the skill.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / ps:skill:type
The type of skill as a taxonomy.

The property type is *ps:skill:type:taxonomy*.

ps:skill:type:taxonomy

A taxonomy of skill types.

The base type for the form can be found at *ps:skill:type:taxonomy*.

Properties:

:title / ps:skill:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / ps:skill:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / ps:skill:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / ps:skill:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / ps:skill:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / ps:skill:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *ps:skill:type:taxonomy*.

ps:tokn

A single name element (potentially given or sur).

The base type for the form can be found at *ps:tokn*.

An example of `ps:tokn`:

- `robert`

Properties:

ps:vitals

Statistics and demographic data about a person or contact.

The base type for the form can be found at *ps:vitals*.

Properties:

:asof / ps:vitals:asof
The time the vitals were gathered or computed.

The property type is *time*.

:contact / ps:vitals:contact
The contact that the vitals are about.

The property type is *ps:contact*.

:person / ps:vitals:person
The person that the vitals are about.

The property type is *ps:person*.

:height / ps:vitals:height
The height of the person or contact.

The property type is *geo:dist*.

:weight / ps:vitals:weight
The weight of the person or contact.

The property type is *mass*.

:econ:currency / ps:vitals:econ:currency
The currency that the price values are recorded using.

The property type is *econ:currency*.

:econ:net:worth / ps:vitals:econ:net:worth
The net worth of the contact.

The property type is *econ:price*.

:econ:annual:income / ps:vitals:econ:annual:income
The yearly income of the contact.

The property type is *econ:price*.

ps:workhist

A GUID representing entry in a contact's work history.

The base type for the form can be found at *ps:workhist*.

Properties:

:contact / ps:workhist:contact
The contact which has the work history.

The property type is *ps:contact*.

:org / ps:workhist:org
The org that this work history orgname refers to.

The property type is *ou:org*.

:orgname / ps:workhist:orgname
The reported name of the org the contact worked for.

The property type is *ou:name*.

:orgfqdn / ps:workhist:orgfqdn
The reported fqdn of the org the contact worked for.

The property type is *inet:fqdn*.

:jobtype / ps:workhist:jobtype
The type of job.

The property type is *ou:jobtype*.

:employment / ps:workhist:employment
The type of employment.

The property type is *ou:employment*.

:jobtitle / ps:workhist:jobtitle
The job title.

The property type is *ou:jobtitle*.

:started / ps:workhist:started
The date that the contact began working.

The property type is *time*.

:ended / ps:workhist:ended
The date that the contact stopped working.

The property type is *time*.

:duration / ps:workhist:duration
The duration of the period of work.

The property type is *duration*.

:pay / ps:workhist:pay
The estimated/average yearly pay for the work.

The property type is *econ:price*.

:currency / ps:workhist:currency
The currency that the yearly pay was delivered in.

The property type is *econ:currency*.

risk:alert

An instance of an alert which indicates the presence of a risk.

The base type for the form can be found at *risk:alert*.

Properties:

:type / risk:alert:type
A type for the alert, as a taxonomy entry.

The property type is *risk:alert:taxonomy*.

:name / risk:alert:name
A brief name for the alert.

The property type is *str*.

:desc / risk:alert:desc
A free-form description / overview of the alert. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:benign / risk:alert:benign
Set to true if the alert has been confirmed benign. Set to false if malicious.

The property type is *bool*.

:priority / risk:alert:priority
A numeric value used to rank alerts by priority.

The property type is *int*.

:verdict / risk:alert:verdict
A verdict about why the alert is malicious or benign, as a taxonomy entry. It has the following property options set:

- Example: `benign.false_positive`

The property type is *risk:alert:verdict:taxonomy*.

:engine / risk:alert:engine
The software that generated the alert.

The property type is *it:prod:softver*.

:detected / risk:alert:detected
The time the alerted condition was detected.

The property type is *time*.

:vuln / risk:alert:vuln
The optional vulnerability that the alert indicates.

The property type is *risk:vuln*.

:attack / risk:alert:attack
A confirmed attack that this alert indicates.

The property type is *risk:attack*.

:url / risk:alert:url
A URL which documents the alert.

The property type is *inet:url*.

:ext:id / risk:alert:ext:id
An external identifier for the alert.

The property type is *str*.

risk:alert:taxonomy

A taxonomy of alert types.

The base type for the form can be found at *risk:alert:taxonomy*.

Properties:

risk:alert:verdict:taxonomy

A taxonomy of verdicts for the origin and validity of the alert.

The base type for the form can be found at *risk:alert:verdict:taxonomy*.

Properties:

risk:attack

An instance of an actor attacking a target.

The base type for the form can be found at *risk:attack*.

Properties:

:desc / risk:attack:desc
A description of the attack. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:type / risk:attack:type
A type for the attack, as a taxonomy entry. It has the following property options set:

- Example: `cno.phishing`

The property type is *risk:attacktype*.

:reporter / risk:attack:reporter
The organization reporting on the attack.

The property type is *ou:org*.

:reporter:name / risk:attack:reporter:name
The name of the organization reporting on the attack.

The property type is *ou:name*.

:time / risk:attack:time
Set if the time of the attack is known.

The property type is *time*.

:detected / risk:attack:detected
The first confirmed detection time of the attack.

The property type is *time*.

:success / risk:attack:success
Set if the attack was known to have succeeded or not.

The property type is *bool*.

:targeted / risk:attack:targeted
Set if the attack was assessed to be targeted or not.

The property type is *bool*.

:goal / risk:attack:goal
The tactical goal of this specific attack.

The property type is *ou:goal*.

:campaign / risk:attack:campaign
Set if the attack was part of a larger campaign.

The property type is *ou:campaign*.

:compromise / risk:attack:compromise
A compromise that this attack contributed to.

The property type is *risk:compromise*.

:severity / risk:attack:severity
An integer based relative severity score for the attack.

The property type is *int*.

:sophistication / risk:attack:sophistication
The assessed sophistication of the attack.

The property type is *meta:sophistication*.

:prev / risk:attack:prev
The previous/parent attack in a list or hierarchy.

The property type is *risk:attack*.

:actor:org / risk:attack:actor:org
Deprecated. Please use :attacker to allow entity resolution. It has the following property options set:

- deprecated: `True`

The property type is *ou:org*.

:actor:person / risk:attack:actor:person
Deprecated. Please use :attacker to allow entity resolution. It has the following property options set:

- deprecated: `True`

The property type is *ps:person*.

:attacker / risk:attack:attacker
Contact information representing the attacker.

The property type is *ps:contact*.

:target / risk:attack:target
Deprecated. Please use -(targets)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *ps:contact*.

:target:org / risk:attack:target:org
Deprecated. Please use -(targets)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *ou:org*.

:target:host / risk:attack:target:host
Deprecated. Please use -(targets)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *it:host*.

:target:person / risk:attack:target:person
Deprecated. Please use -(targets)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *ps:person*.

:target:place / risk:attack:target:place
Deprecated. Please use -(targets)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *geo:place*.

:via:ipv4 / risk:attack:via:ipv4
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:ipv4*.

:via:ipv6 / risk:attack:via:ipv6
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:ipv6*.

:via:email / risk:attack:via:email
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:email*.

:via:phone / risk:attack:via:phone
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *tel:phone*.

:used:vuln / risk:attack:used:vuln
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *risk:vuln*.

:used:url / risk:attack:used:url
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:url*.

:used:host / risk:attack:used:host
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *it:host*.

:used:email / risk:attack:used:email
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:email*.

:used:file / risk:attack:used:file
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *file:bytes*.

:used:server / risk:attack:used:server
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *inet:server*.

:used:software / risk:attack:used:software
Deprecated. Please use -(uses)> light weight edges. It has the following property options set:

- deprecated: `True`

The property type is *it:prod:softver*.

:techniques / risk:attack:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

:url / risk:attack:url
A URL which documents the attack.

The property type is *inet:url*.

:ext:id / risk:attack:ext:id
An external unique ID for the attack.

The property type is *str*.

risk:attacktype

A taxonomy of attack types.

The base type for the form can be found at *risk:attacktype*.

Properties:

:title / risk:attacktype:title
A brief title of the definition.

The property type is *str*.

:summary / risk:attacktype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / risk:attacktype:sort
A display sort order for siblings.

The property type is *int*.

:base / risk:attacktype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / risk:attacktype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / risk:attacktype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *risk:attacktype*.

risk:availability

A taxonomy of availability status values.

The base type for the form can be found at *risk:availability*.

Properties:

:title / risk:availability:title
A brief title of the definition.

The property type is *str*.

:summary / risk:availability:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / risk:availability:sort
A display sort order for siblings.

The property type is *int*.

:base / risk:availability:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / risk:availability:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / risk:availability:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *risk:availability*.

risk:compromise

An instance of a compromise and its aggregate impact.

The base type for the form can be found at *risk:compromise*.

Properties:

:name / risk:compromise:name
A brief name for the compromise event.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:desc / risk:compromise:desc
A prose description of the compromise event. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:reporter / risk:compromise:reporter
The organization reporting on the compromise.

The property type is *ou:org*.

:reporter:name / risk:compromise:reporter:name
The name of the organization reporting on the compromise.

The property type is *ou:name*.

:type / risk:compromise:type
A type for the compromise, as a taxonomy entry. It has the following property options set:

- Example: `cno.breach`

The property type is *risk:compromisetype*.

:vector / risk:compromise:vector
The attack assessed to be the initial compromise vector.

The property type is *risk:attack*.

:target / risk:compromise:target
Contact information representing the target.

The property type is *ps:contact*.

:attacker / risk:compromise:attacker
Contact information representing the attacker.

The property type is *ps:contact*.

:campaign / risk:compromise:campaign
The campaign that this compromise is part of.

The property type is *ou:campaign*.

:time / risk:compromise:time
Earliest known evidence of compromise.

The property type is *time*.

:lasttime / risk:compromise:lasttime
Last known evidence of compromise.

The property type is *time*.

:duration / risk:compromise:duration
The duration of the compromise.

The property type is *duration*.

:detected / risk:compromise:detected
The first confirmed detection time of the compromise.

The property type is *time*.

:loss:pii / risk:compromise:loss:pii
The number of records compromised which contain PII.

The property type is *int*.

:loss:econ / risk:compromise:loss:econ
The total economic cost of the compromise.

The property type is *econ:price*.

:loss:life / risk:compromise:loss:life
The total loss of life due to the compromise.

The property type is *int*.

:loss:bytes / risk:compromise:loss:bytes
An estimate of the volume of data compromised.

The property type is *int*.

:ransom:paid / risk:compromise:ransom:paid
The value of the ransom paid by the target.

The property type is *econ:price*.

:ransom:price / risk:compromise:ransom:price
The value of the ransom demanded by the attacker.

The property type is *econ:price*.

:response:cost / risk:compromise:response:cost
The economic cost of the response and mitigation efforts.

The property type is *econ:price*.

:theft:price / risk:compromise:theft:price
The total value of the theft of assets.

The property type is *econ:price*.

:econ:currency / risk:compromise:econ:currency
The currency type for the econ:price fields.

The property type is *econ:currency*.

:severity / risk:compromise:severity
An integer based relative severity score for the compromise.

The property type is *int*.

:goal / risk:compromise:goal
The assessed primary goal of the attacker for the compromise.

The property type is *ou:goal*.

:goals / risk:compromise:goals
An array of assessed attacker goals for the compromise.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- sorted: `True`
- uniq: `True`

:techniques / risk:compromise:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

risk:compromisetype

A taxonomy of compromise types.

The base type for the form can be found at *risk:compromisetype*.

An example of `risk:compromisetype`:

- `cno.breach`

Properties:

:title / risk:compromisetype:title
A brief title of the definition.

The property type is *str*.

:summary / risk:compromisetype:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / risk:compromisetype:sort
A display sort order for siblings.

The property type is *int*.

:base / risk:compromisetype:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / risk:compromisetype:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / risk:compromisetype:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *risk:compromisetype*.

risk:hasvuln

An instance of a vulnerability present in a target.

The base type for the form can be found at *risk:hasvuln*.

Properties:

:vuln / risk:hasvuln:vuln
The vulnerability present in the target.

The property type is *risk:vuln*.

:person / risk:hasvuln:person
The vulnerable person.

The property type is *ps:person*.

:org / risk:hasvuln:org
The vulnerable org.

The property type is *ou:org*.

:place / risk:hasvuln:place
The vulnerable place.

The property type is *geo:place*.

:software / risk:hasvuln:software
The vulnerable software.

The property type is *it:prod:softver*.

:hardware / risk:hasvuln:hardware
The vulnerable hardware.

The property type is *it:prod:hardware*.

:spec / risk:hasvuln:spec
The vulnerable material specification.

The property type is *mat:spec*.

:item / risk:hasvuln:item
The vulnerable material item.

The property type is *mat:item*.

:host / risk:hasvuln:host
The vulnerable host.

The property type is *it:host*.

risk:mitigation

A mitigation for a specific risk:vuln.

The base type for the form can be found at *risk:mitigation*.

Properties:

:vuln / risk:mitigation:vuln
The vulnerability that this mitigation addresses.

The property type is *risk:vuln*.

:name / risk:mitigation:name
A brief name for this risk mitigation.

The property type is *str*.

:desc / risk:mitigation:desc
A description of the mitigation approach for the vulnerability. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:software / risk:mitigation:software
A software version which implements a fix for the vulnerability.

The property type is *it:prod:softver*.

:hardware / risk:mitigation:hardware
A hardware version which implements a fix for the vulnerability.

The property type is *it:prod:hardware*.

risk:threat

A threat cluster or subgraph of threat activity, as reported by a specific organization.

The base type for the form can be found at *risk:threat*.

Properties:

:name / risk:threat:name
A brief descriptive name for the threat cluster. It has the following property options set:

- Example: `apt1 (mandiant)`

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:type / risk:threat:type
A type for the threat, as a taxonomy entry.

The property type is *risk:threat:type:taxonomy*.

:desc / risk:threat:desc
A description of the threat cluster.

The property type is *str*.

:tag / risk:threat:tag
The tag used to annotate nodes that are associated with the threat cluster.

The property type is *syn:tag*.

:active / risk:threat:active
An interval for when the threat cluster is assessed to have been active.

The property type is *ival*.

:reporter / risk:threat:reporter
The organization reporting on the threat cluster.

The property type is *ou:org*.

:reporter:name / risk:threat:reporter:name
The name of the organization reporting on the threat cluster.

The property type is *ou:name*.

:reporter:discovered / risk:threat:reporter:discovered
The time that the reporting organization first discovered the threat cluster.

The property type is *time*.

:reporter:published / risk:threat:reporter:published
The time that the reporting organization first publicly disclosed the threat cluster.

The property type is *time*.

:org / risk:threat:org
The authoritative organization for the threat cluster.

The property type is *ou:org*.

:org:loc / risk:threat:org:loc
The reporting organization's assessed location of the threat cluster.

The property type is *loc*.

:org:name / risk:threat:org:name
The reporting organization's name for the threat cluster. It has the following property options set:

- Example: `apt1`

The property type is *ou:name*.

:org:names / risk:threat:org:names
An array of alternate names for the threat cluster, according to the reporting organization.

The property type is *array*. Its type has the following options set:

- type: `ou:name`
- sorted: `True`
- uniq: `True`

:country / risk:threat:country
The reporting organization's assessed country of origin of the threat cluster.

The property type is *pol:country*.

:country:code / risk:threat:country:code
The 2 digit ISO 3166 country code for the threat cluster's assessed country of origin.

The property type is *pol:iso2*.

:goals / risk:threat:goals
The reporting organization's assessed goals of the threat cluster.

The property type is *array*. Its type has the following options set:

- type: `ou:goal`
- sorted: `True`
- uniq: `True`

:sophistication / risk:threat:sophistication
The reporting organization's assessed sophistication of the threat cluster.

The property type is *meta:sophistication*.

:techniques / risk:threat:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- sorted: `True`
- uniq: `True`

:merged:time / risk:threat:merged:time
The time that the reporting organization merged this threat cluster into another.

The property type is *time*.

:merged:isnow / risk:threat:merged:isnow
The threat cluster that the reporting organization merged this cluster into.

The property type is *risk:threat*.

risk:threat:type:taxonomy

A taxonomy of threat types.

The base type for the form can be found at *risk:threat:type:taxonomy*.

Properties:

risk:tool:software

A software tool used in threat activity, as reported by a specific organization.

The base type for the form can be found at *risk:tool:software*.

Properties:

:tag / risk:tool:software:tag
The tag used to annotate nodes that are associated with the tool. It has the following property options set:

- Example: `rep.mandiant.tabcteng`

The property type is *syn:tag*.

:desc / risk:tool:software:desc
A description of the tool.

The property type is *str*.

:type / risk:tool:software:type
A type for the tool, as a taxonomy entry.

The property type is *risk:tool:software:taxonomy*.

:used / risk:tool:software:used
An interval for when the tool is assessed to have been deployed.

The property type is *ival*.

:availability / risk:tool:software:availability
The reporting organization's assessed availability of the tool.

The property type is *risk:availability*.

:sophistication / risk:tool:software:sophistication
The reporting organization's assessed sophistication of the tool.

The property type is *meta:sophistication*.

:reporter / risk:tool:software:reporter
The organization reporting on the tool.

The property type is *ou:org*.

:reporter:name / risk:tool:software:reporter:name
The name of the organization reporting on the tool.

The property type is *ou:name*.

:reporter:discovered / risk:tool:software:reporter:discovered
The time that the reporting organization first discovered the tool.

The property type is *time*.

:reporter:published / risk:tool:software:reporter:published
The time that the reporting organization first publicly disclosed the tool.

The property type is *time*.

:soft / risk:tool:software:soft
The authoritative software family for the tool.

The property type is *it:prod:soft*.

:soft:name / risk:tool:software:soft:name
The reporting organization's name for the tool.

The property type is *it:prod:softname*.

:soft:names / risk:tool:software:soft:names
An array of alternate names for the tool, according to the reporting organization.

The property type is *array*. Its type has the following options set:

- type: `it:prod:softname`
- uniq: `True`
- sorted: `True`

:techniques / risk:tool:software:techniques
Deprecated for scalability. Please use -(uses)> ou:technique. It has the following property options set:

- deprecated: `True`

The property type is *array*. Its type has the following options set:

- type: `ou:technique`
- uniq: `True`
- sorted: `True`

risk:tool:software:taxonomy

A taxonomy of software / tool types.

The base type for the form can be found at *risk:tool:software:taxonomy*.

Properties:

:title / risk:tool:software:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / risk:tool:software:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / risk:tool:software:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / risk:tool:software:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / risk:tool:software:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / risk:tool:software:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *risk:tool:software:taxonomy*.

risk:vuln

A unique vulnerability.

The base type for the form can be found at *risk:vuln*.

Properties:

:name / risk:vuln:name
A user specified name for the vulnerability.

The property type is *risk:vulnname*.

:names / risk:vuln:names
An array of alternate names for the vulnerability.

The property type is *array*. Its type has the following options set:

- type: `risk:vulnname`

- sorted: `True`
- uniq: `True`

:type / risk:vuln:type
A taxonomy type entry for the vulnerability.

The property type is *risk:vuln:type:taxonomy*.

:desc / risk:vuln:desc
A description of the vulnerability. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:reporter / risk:vuln:reporter
The organization reporting on the vulnerability.

The property type is *ou:org*.

:reporter:name / risk:vuln:reporter:name
The name of the organization reporting on the vulnerability.

The property type is *ou:name*.

:mitigated / risk:vuln:mitigated
Set to true if a mitigation/fix is available for the vulnerability.

The property type is *bool*.

:exploited / risk:vuln:exploited
Set to true if the vulnerability has been exploited in the wild.

The property type is *bool*.

:timeline:discovered / risk:vuln:timeline:discovered
The earliest known discovery time for the vulnerability.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:timeline:published / risk:vuln:timeline:published
The earliest known time the vulnerability was published.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:timeline:vendor:notified / risk:vuln:timeline:vendor:notified
The earliest known vendor notification time for the vulnerability.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:timeline:vendor:fixed / risk:vuln:timeline:vendor:fixed
The earliest known time the vendor issued a fix for the vulnerability.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:timeline:exploited / risk:vuln:timeline:exploited
The earliest known time when the vulnerability was exploited in the wild.

The property type is *time*. Its type has the following options set:

- ismin: `True`

:cve / risk:vuln:cve
The CVE ID of the vulnerability.

The property type is *it:sec:cve*.

:cve:desc / risk:vuln:cve:desc
The description of the vulnerability according to the CVE database. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:cve:url / risk:vuln:cve:url
A URL linking this vulnerability to the CVE description.

The property type is *inet:url*.

:cve:references / risk:vuln:cve:references
An array of documentation URLs provided by the CVE database.

The property type is *array*. Its type has the following options set:

- type: `inet:url`
- uniq: `True`
- sorted: `True`

:nist:nvd:source / risk:vuln:nist:nvd:source
The name of the organization which reported the vulnerability to NIST.

The property type is *ou:name*.

:nist:nvd:published / risk:vuln:nist:nvd:published
The date the vulnerability was first published in the NVD.

The property type is *time*.

:nist:nvd:modified / risk:vuln:nist:nvd:modified
The date the vulnerability was last modified in the NVD.

The property type is *time*. Its type has the following options set:

- ismax: `True`

:cisa:kev:name / risk:vuln:cisa:kev:name
The name of the vulnerability according to the CISA KEV database.

The property type is *str*.

:cisa:kev:desc / risk:vuln:cisa:kev:desc
The description of the vulnerability according to the CISA KEV database.

The property type is *str*.

:cisa:kev:action / risk:vuln:cisa:kev:action
The action to mitigate the vulnerability according to the CISA KEV database.

The property type is *str*.

:cisa:kev:vendor / risk:vuln:cisa:kev:vendor
The vendor name listed in the CISA KEV database.

The property type is *ou:name*.

:cisa:kev:product / risk:vuln:cisa:kev:product
The product name listed in the CISA KEV database.

The property type is *it:prod:softname*.

:cisa:kev:added / risk:vuln:cisa:kev:added
The date the vulnerability was added to the CISA KEV database.

The property type is *time*.

:cisa:kev:duedate / risk:vuln:cisa:kev:duedate
The date the action is due according to the CISA KEV database.

The property type is *time*.

:cvss:v2 / risk:vuln:cvss:v2
The CVSS v2 vector for the vulnerability.

The property type is *cvss:v2*.

:cvss:v2_0:score / risk:vuln:cvss:v2_0:score
The CVSS v2.0 overall score for the vulnerability.

The property type is *float*.

:cvss:v2_0:score:base / risk:vuln:cvss:v2_0:score:base
The CVSS v2.0 base score for the vulnerability.

The property type is *float*.

:cvss:v2_0:score:temporal / risk:vuln:cvss:v2_0:score:temporal
The CVSS v2.0 temporal score for the vulnerability.

The property type is *float*.

:cvss:v2_0:score:environmental / risk:vuln:cvss:v2_0:score:environmental
The CVSS v2.0 environmental score for the vulnerability.

The property type is *float*.

:cvss:v3 / risk:vuln:cvss:v3
The CVSS v3 vector for the vulnerability.

The property type is *cvss:v3*.

:cvss:v3_0:score / risk:vuln:cvss:v3_0:score
The CVSS v3.0 overall score for the vulnerability.

The property type is *float*.

:cvss:v3_0:score:base / risk:vuln:cvss:v3_0:score:base
The CVSS v3.0 base score for the vulnerability.

The property type is *float*.

:cvss:v3_0:score:temporal / risk:vuln:cvss:v3_0:score:temporal
The CVSS v3.0 temporal score for the vulnerability.

The property type is *float*.

:cvss:v3_0:score:environmental / risk:vuln:cvss:v3_0:score:environmental
The CVSS v3.0 environmental score for the vulnerability.

The property type is *float*.

:cvss:v3_1:score / risk:vuln:cvss:v3_1:score
The CVSS v3.1 overall score for the vulnerability.

The property type is *float*.

:cvss:v3_1:score:base / risk:vuln:cvss:v3_1:score:base
The CVSS v3.1 base score for the vulnerability.

The property type is *float*.

:cvss:v3_1:score:temporal / risk:vuln:cvss:v3_1:score:temporal
The CVSS v3.1 temporal score for the vulnerability.

The property type is *float*.

:cvss:v3_1:score:environmental / risk:vuln:cvss:v3_1:score:environmental
The CVSS v3.1 environmental score for the vulnerability.

The property type is *float*.

:cvss:av / risk:vuln:cvss:av
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,A,P,L`

:cvss:ac / risk:vuln:cvss:ac
Deprecated. Please use :cvss:v3. It has the following property options set:

- disp: `{'enums': (('Low', 'L'), ('High', 'H'))}`
- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `L,H`

:cvss:pr / risk:vuln:cvss:pr
Deprecated. Please use :cvss:v3. It has the following property options set:

- disp: `{'enums': ({'title': 'None', 'value': 'N', 'doc': 'FIXME privs stuff'}, {'title': 'Low', 'value': 'L', 'doc': 'FIXME privs stuff'}, {'title': 'High', 'value': 'H', 'doc': 'FIXME privs stuff'})}`
- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,L,H`

:cvss:ui / risk:vuln:cvss:ui
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,R`

:cvss:s / risk:vuln:cvss:s
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `U,C`

:cvss:c / risk:vuln:cvss:c
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,L,H`

:cvss:i / risk:vuln:cvss:i
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,L,H`

:cvss:a / risk:vuln:cvss:a
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `N,L,H`

:cvss:e / risk:vuln:cvss:e
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,U,P,F,H`

:cvss:rl / risk:vuln:cvss:rl
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,O,T,W,U`

:cvss:rc / risk:vuln:cvss:rc
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,U,R,C`

:cvss:mav / risk:vuln:cvss:mav
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,A,L,P`

:cvss:mac / risk:vuln:cvss:mac
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,L,H`

:cvss:mpr / risk:vuln:cvss:mpr
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,L,H`

:cvss:mui / risk:vuln:cvss:mui
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,R`

:cvss:ms / risk:vuln:cvss:ms
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,U,C`

:cvss:mc / risk:vuln:cvss:mc
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,L,H`

:cvss:mi / risk:vuln:cvss:mi
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,L,H`

:cvss:ma / risk:vuln:cvss:ma
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,N,L,H`

:cvss:cr / risk:vuln:cvss:cr
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,L,M,H`

:cvss:ir / risk:vuln:cvss:ir
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,L,M,H`

:cvss:ar / risk:vuln:cvss:ar
Deprecated. Please use :cvss:v3. It has the following property options set:

- deprecated: `True`

The property type is *str*. Its type has the following options set:

- enums: `X,L,M,H`

:cvss:score / risk:vuln:cvss:score
Deprecated. Please use version specific score properties. It has the following property options set:

- deprecated: `True`

The property type is *float*.

:cvss:score:base / risk:vuln:cvss:score:base
Deprecated. Please use version specific score properties. It has the following property options set:

- deprecated: `True`

The property type is *float*.

:cvss:score:temporal / risk:vuln:cvss:score:temporal
Deprecated. Please use version specific score properties. It has the following property options set:

- deprecated: `True`

The property type is *float*.

:cvss:score:environmental / risk:vuln:cvss:score:environmental
Deprecated. Please use version specific score properties. It has the following property options set:

- deprecated: `True`

The property type is *float*.

:cwes / risk:vuln:cwes
An array of MITRE CWE values that apply to the vulnerability.

The property type is *array*. Its type has the following options set:

- type: `it:sec:cwe`
- uniq: `True`
- sorted: `True`

risk:vuln:soft:range

A contiguous range of software versions which contain a vulnerability.

The base type for the form can be found at *risk:vuln:soft:range*.

Properties:

:vuln / risk:vuln:soft:range:vuln
The vulnerability present in this software version range.

The property type is *risk:vuln*.

:version:min / risk:vuln:soft:range:version:min
The minimum version which is vulnerable in this range.

The property type is *it:prod:softver*.

:version:max / risk:vuln:soft:range:version:max
The maximum version which is vulnerable in this range.

The property type is *it:prod:softver*.

risk:vuln:type:taxonomy

A taxonomy of vulnerability types.

The base type for the form can be found at *risk:vuln:type:taxonomy*.

Properties:

:title / risk:vuln:type:taxonomy:title
A brief title of the definition.

The property type is *str*.

:summary / risk:vuln:type:taxonomy:summary
A summary of the definition. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:sort / risk:vuln:type:taxonomy:sort
A display sort order for siblings.

The property type is *int*.

:base / risk:vuln:type:taxonomy:base
The base taxon. It has the following property options set:

- Read Only: `True`

The property type is *taxon*.

:depth / risk:vuln:type:taxonomy:depth
The depth indexed from 0. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:parent / risk:vuln:type:taxonomy:parent
The taxonomy parent. It has the following property options set:

- Read Only: `True`

The property type is *risk:vuln:type:taxonomy*.

risk:vulnname

A vulnerability name such as log4j or rowhammer.

The base type for the form can be found at *risk:vulnname*.

Properties:

rsa:key

An RSA keypair modulus and public exponent.

The base type for the form can be found at *rsa:key*.

Properties:

:mod / rsa:key:mod
The RSA key modulus. It has the following property options set:

- Read Only: `True`

The property type is *hex*.

:pub:exp / rsa:key:pub:exp
The public exponent of the key. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:bits / rsa:key:bits
The length of the modulus in bits.

The property type is *int*.

:priv:exp / rsa:key:priv:exp
The private exponent of the key.

The property type is *hex*.

:priv:p / rsa:key:priv:p
One of the two private primes.

The property type is *hex*.

:priv:q / rsa:key:priv:q
One of the two private primes.

The property type is *hex*.

syn:cmd

A Synapse storm command.

The base type for the form can be found at *syn:cmd*.

Properties:

:doc / syn:cmd:doc
Description of the command. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*. Its type has the following options set:

- strip: `True`

:package / syn:cmd:package
Storm package which provided the command.

The property type is *str*. Its type has the following options set:

- strip: `True`

:svciden / syn:cmd:svciden
Storm service iden which provided the package.

The property type is *guid*. Its type has the following options set:

- strip: `True`

:input / syn:cmd:input
The list of forms accepted by the command as input. It has the following property options set:

- uniq: `True`
- sorted: `True`
- Read Only: `True`

The property type is *array*. Its type has the following options set:

- type: `syn:form`

:output / syn:cmd:output
The list of forms produced by the command as output. It has the following property options set:

- uniq: `True`
- sorted: `True`
- Read Only: `True`

The property type is *array*. Its type has the following options set:

- type: `syn:form`

:nodedata / syn:cmd:nodedata
The list of nodedata that may be added by the command. It has the following property options set:

- uniq: `True`
- sorted: `True`
- Read Only: `True`

The property type is *array*. Its type has the following options set:

- type: `syn:nodedata`

syn:cron

A Cortex cron job.

The base type for the form can be found at *syn:cron*.

Properties:

:doc / syn:cron:doc
A description of the cron job. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:name / syn:cron:name
A user friendly name/alias for the cron job.

The property type is *str*.

:storm / syn:cron:storm
The storm query executed by the cron job. It has the following property options set:

- Read Only: `True`
- disp: `{'hint': 'text'}`

The property type is *str*.

syn:form

A Synapse form used for representing nodes in the graph.

The base type for the form can be found at *syn:form*.

Properties:

:doc / syn:form:doc
The docstring for the form. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:type / syn:form:type
Synapse type for this form. It has the following property options set:

- Read Only: `True`

The property type is *syn:type*.

:runt / syn:form:runt
Whether or not the form is runtime only. It has the following property options set:

- Read Only: `True`

The property type is *bool*.

syn:prop

A Synapse property.

The base type for the form can be found at *syn:prop*.

Properties:

:doc / syn:prop:doc
Description of the property definition.

The property type is *str*. Its type has the following options set:

- strip: `True`

:form / syn:prop:form
The form of the property. It has the following property options set:

- Read Only: `True`

The property type is *syn:form*.

:type / syn:prop:type
The synapse type for this property. It has the following property options set:

- Read Only: `True`

The property type is *syn:type*.

:relname / syn:prop:relname
Relative property name. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:univ / syn:prop:univ
Specifies if a prop is universal. It has the following property options set:

- Read Only: `True`

The property type is *bool*.

:base / syn:prop:base
Base name of the property. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:ro / syn:prop:ro
If the property is read-only after being set. It has the following property options set:

- Read Only: `True`

The property type is *bool*.

:extmodel / syn:prop:extmodel
If the property is an extended model property or not. It has the following property options set:

- Read Only: `True`

The property type is *bool*.

syn:splice

A splice from a layer.

The base type for the form can be found at *syn:splice*.

Properties:

:type / syn:splice:type
Type of splice. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:iden / syn:splice:iden
The iden of the node involved in the splice. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:form / syn:splice:form
The form involved in the splice. It has the following property options set:

- Read Only: `True`

The property type is *syn:form*. Its type has the following options set:

- strip: `True`

:prop / syn:splice:prop
Property modified in the splice. It has the following property options set:

- Read Only: `True`

The property type is *syn:prop*. Its type has the following options set:

- strip: `True`

:tag / syn:splice:tag
Tag modified in the splice. It has the following property options set:

- Read Only: `True`

The property type is *syn:tag*. Its type has the following options set:

- strip: `True`

:valu / syn:splice:valu
The value being set in the splice. It has the following property options set:

- Read Only: `True`

The property type is *data*.

:oldv / syn:splice:oldv
The value before the splice. It has the following property options set:

- Read Only: `True`

The property type is *data*.

:user / syn:splice:user
The user who caused the splice. It has the following property options set:

- Read Only: `True`

The property type is *guid*.

:prov / syn:splice:prov
The provenance stack of the splice. It has the following property options set:

- Read Only: `True`

The property type is *guid*.

:time / syn:splice:time
The time the splice occurred. It has the following property options set:

- Read Only: `True`

The property type is *time*.

:splice / syn:splice:splice
The splice. It has the following property options set:

- Read Only: `True`

The property type is *data*.

syn:tag

The base type for a synapse tag.

The base type for the form can be found at *syn:tag*.

Properties:

:up / syn:tag:up
The parent tag for the tag. It has the following property options set:

- Read Only: `True`

The property type is *syn:tag*.

:isnow / syn:tag:isnow
Set to an updated tag if the tag has been renamed.

The property type is *syn:tag*.

:doc / syn:tag:doc
A short definition for the tag. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:doc:url / syn:tag:doc:url
A URL link to additional documentation about the tag.

The property type is *inet:url*.

:depth / syn:tag:depth
How deep the tag is in the hierarchy. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:title / syn:tag:title
A display title for the tag.

The property type is *str*.

:base / syn:tag:base
The tag base name. Eg baz for foo.bar.baz . It has the following property options set:

- Read Only: `True`

The property type is *str*.

syn:tagprop

A user defined tag property.

The base type for the form can be found at *syn:tagprop*.

Properties:

:doc / syn:tagprop:doc
Description of the tagprop definition.

The property type is *str*. Its type has the following options set:

- strip: `True`

:type / syn:tagprop:type
The synapse type for this tagprop. It has the following property options set:

- Read Only: `True`

The property type is *syn:type*.

syn:trigger

A Cortex trigger.

The base type for the form can be found at *syn:trigger*.

Properties:

:vers / syn:trigger:vers
Trigger version. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:doc / syn:trigger:doc
A documentation string describing the trigger. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:name / syn:trigger:name
A user friendly name/alias for the trigger.

The property type is *str*.

:cond / syn:trigger:cond
The trigger condition. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`
- lower: `True`

:user / syn:trigger:user
User who owns the trigger. It has the following property options set:

- Read Only: `True`

The property type is *str*.

:storm / syn:trigger:storm
The Storm query for the trigger. It has the following property options set:

- Read Only: `True`
- disp: `{'hint': 'text'}`

The property type is *str*.

:enabled / syn:trigger:enabled
Trigger enabled status. It has the following property options set:

- Read Only: `True`

The property type is *bool*.

:form / syn:trigger:form
Form the trigger is watching for.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:prop / syn:trigger:prop
Property the trigger is watching for.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:tag / syn:trigger:tag
Tag the trigger is watching for.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

syn:type

A Synapse type used for normalizing nodes and properties.

The base type for the form can be found at *syn:type*.

Properties:

:doc / syn:type:doc
The docstring for the type. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:ctor / syn:type:ctor
The python ctor path for the type object. It has the following property options set:

- Read Only: `True`

The property type is *str*. Its type has the following options set:

- strip: `True`

:subof / syn:type:subof
Type which this inherits from. It has the following property options set:

- Read Only: `True`

The property type is *syn:type*.

:opts / syn:type:opts
Arbitrary type options. It has the following property options set:

- Read Only: `True`

The property type is *data*.

tel:call

A guid for a telephone call record.

The base type for the form can be found at *tel:call*.

Properties:

:src / tel:call:src
The source phone number for a call.

The property type is *tel:phone*.

:dst / tel:call:dst
The destination phone number for a call.

The property type is *tel:phone*.

:time / tel:call:time
The time the call was initiated.

The property type is *time*.

:duration / tel:call:duration
The duration of the call in seconds.

The property type is *int*.

:connected / tel:call:connected
Indicator of whether the call was connected.

The property type is *bool*.

:text / tel:call:text
The text transcription of the call. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:file / tel:call:file
A file containing related media.

The property type is *file:bytes*.

tel:mob:carrier

The fusion of a MCC/MNC.

The base type for the form can be found at *tel:mob:carrier*.

Properties:

:mcc / tel:mob:carrier:mcc
ITU Mobile Country Code. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:mcc*.

:mnc / tel:mob:carrier:mnc
ITU Mobile Network Code. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:mnc*.

:org / tel:mob:carrier:org
Organization operating the carrier.

The property type is *ou:org*.

:loc / tel:mob:carrier:loc
Location the carrier operates from.

The property type is *loc*.

tel:mob:cell

A mobile cell site which a phone may connect to.

The base type for the form can be found at *tel:mob:cell*.

Properties:

:carrier / tel:mob:cell:carrier
Mobile carrier. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:carrier*.

:carrier:mcc / tel:mob:cell:carrier:mcc
Mobile Country Code. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:mcc*.

:carrier:mnc / tel:mob:cell:carrier:mnc
Mobile Network Code. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:mnc*.

:lac / tel:mob:cell:lac
Location Area Code. LTE networks may call this a TAC. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:cid / tel:mob:cell:cid
The Cell ID. It has the following property options set:

- Read Only: `True`

The property type is *int*.

:radio / tel:mob:cell:radio
Cell radio type.

The property type is *str*. Its type has the following options set:

- lower: `1`
- onespace: `1`

:latlong / tel:mob:cell:latlong
Last known location of the cell site.

The property type is *geo:latlong*.

:loc / tel:mob:cell:loc
Location at which the cell is operated.

The property type is *loc*.

:place / tel:mob:cell:place
The place associated with the latlong property.

The property type is *geo:place*.

tel:mob:imei

An International Mobile Equipment Id.

The base type for the form can be found at *tel:mob:imei*.

An example of `tel:mob:imei`:

- `490154203237518`

Properties:

:tac / tel:mob:imei:tac
The Type Allocate Code within the IMEI. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:tac*.

:serial / tel:mob:imei:serial
The serial number within the IMEI. It has the following property options set:

- Read Only: `True`

The property type is *int*.

tel:mob:imid

Fused knowledge of an IMEI/IMSI used together.

The base type for the form can be found at *tel:mob:imid*.

An example of `tel:mob:imid`:

- `(490154203237518, 310150123456789)`

Properties:

:imei / tel:mob:imid:imei
: The IMEI for the phone hardware. It has the following property options set:

  - Read Only: `True`

  The property type is *tel:mob:imei*.

:imsi / tel:mob:imid:imsi
: The IMSI for the phone subscriber. It has the following property options set:

  - Read Only: `True`

  The property type is *tel:mob:imsi*.

tel:mob:imsi

An International Mobile Subscriber Id.

The base type for the form can be found at *tel:mob:imsi*.

An example of `tel:mob:imsi`:

- `310150123456789`

Properties:

:mcc / tel:mob:imsi:mcc
: The Mobile Country Code. It has the following property options set:

  - Read Only: `True`

  The property type is *tel:mob:mcc*.

tel:mob:imsiphone

Fused knowledge of an IMSI assigned phone number.

The base type for the form can be found at *tel:mob:imsiphone*.

An example of `tel:mob:imsiphone`:

- `(310150123456789, "+7(495) 124-59-83")`

Properties:

:phone / tel:mob:imsiphone:phone
: The phone number assigned to the IMSI. It has the following property options set:

  - Read Only: `True`

  The property type is *tel:phone*.

:imsi / tel:mob:imsiphone:imsi
The IMSI with the assigned phone number. It has the following property options set:

- Read Only: `True`

The property type is *tel:mob:imsi*.

tel:mob:mcc

ITU Mobile Country Code.

The base type for the form can be found at *tel:mob:mcc*.

Properties:

:loc / tel:mob:mcc:loc
Location assigned to the MCC.

The property type is *loc*.

tel:mob:tac

A mobile Type Allocation Code.

The base type for the form can be found at *tel:mob:tac*.

An example of `tel:mob:tac`:

- `49015420`

Properties:

:org / tel:mob:tac:org
The org guid for the manufacturer.

The property type is *ou:org*.

:manu / tel:mob:tac:manu
The TAC manufacturer name.

The property type is *str*. Its type has the following options set:

- lower: `1`

:model / tel:mob:tac:model
The TAC model name.

The property type is *str*. Its type has the following options set:

- lower: `1`

:internal / tel:mob:tac:internal
The TAC internal model name.

The property type is *str*. Its type has the following options set:

- lower: `1`

tel:mob:telem

A single mobile telemetry measurement.

The base type for the form can be found at *tel:mob:telem*.

Properties:

:time / tel:mob:telem:time
A date/time value.

The property type is *time*.

:latlong / tel:mob:telem:latlong
A Lat/Long string specifying a point on Earth.

The property type is *geo:latlong*.

:http:request / tel:mob:telem:http:request
The HTTP request that the telemetry was extracted from.

The property type is *inet:http:request*.

:host / tel:mob:telem:host
The host that generated the mobile telemetry data.

The property type is *it:host*.

:place / tel:mob:telem:place
The place representing the location of the mobile telemetry sample.

The property type is *geo:place*.

:loc / tel:mob:telem:loc
The geo-political location of the mobile telemetry sample.

The property type is *loc*.

:accuracy / tel:mob:telem:accuracy
The reported accuracy of the latlong telemetry reading.

The property type is *geo:dist*.

:cell / tel:mob:telem:cell
A mobile cell site which a phone may connect to.

The property type is *tel:mob:cell*.

:cell:carrier / tel:mob:telem:cell:carrier
The fusion of a MCC/MNC.

The property type is *tel:mob:carrier*.

:imsi / tel:mob:telem:imsi
An International Mobile Subscriber Id.

The property type is *tel:mob:imsi*.

:imei / tel:mob:telem:imei
An International Mobile Equipment Id.

The property type is *tel:mob:imei*.

:phone / tel:mob:telem:phone
A phone number.

The property type is *tel:phone*.

:mac / tel:mob:telem:mac
A 48-bit Media Access Control (MAC) address.

The property type is *inet:mac*.

:ipv4 / tel:mob:telem:ipv4
An IPv4 address.

The property type is *inet:ipv4*.

:ipv6 / tel:mob:telem:ipv6
An IPv6 address.

The property type is *inet:ipv6*.

:wifi / tel:mob:telem:wifi
An SSID/MAC address combination for a wireless access point.

The property type is *inet:wifi:ap*.

:wifi:ssid / tel:mob:telem:wifi:ssid
A WiFi service set identifier (SSID) name.

The property type is *inet:wifi:ssid*.

:wifi:bssid / tel:mob:telem:wifi:bssid
A 48-bit Media Access Control (MAC) address.

The property type is *inet:mac*.

:adid / tel:mob:telem:adid
An advertising identification string.

The property type is *it:adid*.

:aaid / tel:mob:telem:aaid
An android advertising identification string.

The property type is *it:os:android:aaid*.

:idfa / tel:mob:telem:idfa
An iOS advertising identification string.

The property type is *it:os:ios:idfa*.

:name / tel:mob:telem:name
An arbitrary, lower spaced string with normalized whitespace.

The property type is *ps:name*.

:email / tel:mob:telem:email
An e-mail address.

The property type is *inet:email*.

:acct / tel:mob:telem:acct
An account with a given Internet-based site or service.

The property type is *inet:web:acct*.

:app / tel:mob:telem:app
A specific version of a software product.

The property type is *it:prod:softver*.

:data / tel:mob:telem:data
Arbitrary json compatible data.

The property type is *data*.

tel:phone

A phone number.

The base type for the form can be found at *tel:phone*.

An example of `tel:phone`:

- `+15558675309`

Properties:

:loc / tel:phone:loc
The location associated with the number.

The property type is *loc*.

tel:txtmesg

A guid for an individual text message.

The base type for the form can be found at *tel:txtmesg*.

Properties:

:from / tel:txtmesg:from
The phone number assigned to the sender.

The property type is *tel:phone*.

:to / tel:txtmesg:to
The phone number assigned to the primary recipient.

The property type is *tel:phone*.

:recipients / tel:txtmesg:recipients
An array of phone numbers for additional recipients of the message.

The property type is *array*. Its type has the following options set:

- type: `tel:phone`
- uniq: `True`
- sorted: `True`

:svctype / tel:txtmesg:svctype
The message service type (sms, mms, rcs).

The property type is *str*. Its type has the following options set:

- enums: `sms,mms,rcs`
- strip: 1
- lower: 1

:time / tel:txtmesg:time
The time the message was sent.

The property type is *time*.

:text / tel:txtmesg:text
The text of the message. It has the following property options set:

- disp: `{'hint': 'text'}`

The property type is *str*.

:file / tel:txtmesg:file
A file containing related media.

The property type is *file:bytes*.

transport:air:craft

An individual aircraft.

The base type for the form can be found at *transport:air:craft*.

Properties:

:tailnum / transport:air:craft:tailnum
The aircraft tail number.

The property type is *transport:air:tailnum*.

:type / transport:air:craft:type
The type of aircraft.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:built / transport:air:craft:built
The date the aircraft was constructed.

The property type is *time*.

:make / transport:air:craft:make
The make of the aircraft.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:model / transport:air:craft:model
The model of the aircraft.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:serial / transport:air:craft:serial
The serial number of the aircraft.

The property type is *str*. Its type has the following options set:

- strip: `True`

:operator / transport:air:craft:operator
Contact info representing the person or org that operates the aircraft.

The property type is *ps:contact*.

transport:air:flight

An individual instance of a flight.

The base type for the form can be found at *transport:air:flight*.

Properties:

:num / transport:air:flight:num
The flight number of this flight.

The property type is *transport:air:flightnum*.

:scheduled:departure / transport:air:flight:scheduled:departure
The time this flight was originally scheduled to depart.

The property type is *time*.

:scheduled:arrival / transport:air:flight:scheduled:arrival
The time this flight was originally scheduled to arrive.

The property type is *time*.

:departed / transport:air:flight:departed
The time this flight departed.

The property type is *time*.

:arrived / transport:air:flight:arrived
The time this flight arrived.

The property type is *time*.

:carrier / transport:air:flight:carrier
The org which operates the given flight number.

The property type is *ou:org*.

:craft / transport:air:flight:craft
The aircraft that flew this flight.

The property type is *transport:air:craft*.

:tailnum / transport:air:flight:tailnum
The tail/registration number at the time the aircraft flew this flight.

The property type is *transport:air:tailnum*.

:to:port / transport:air:flight:to:port
The destination airport of this flight.

The property type is *transport:air:port*.

:from:port / transport:air:flight:from:port
The origin airport of this flight.

The property type is *transport:air:port*.

:stops / transport:air:flight:stops
An ordered list of airport codes for stops which occurred during this flight.

The property type is *array*. Its type has the following options set:

- type: `transport:air:port`

:cancelled / transport:air:flight:cancelled
Set to true for cancelled flights.

The property type is *bool*.

transport:air:flightnum

A commercial flight designator including airline and serial.

The base type for the form can be found at *transport:air:flightnum*.

An example of `transport:air:flightnum`:

- `ua2437`

Properties:

:carrier / transport:air:flightnum:carrier
The org which operates the given flight number.

The property type is *ou:org*.

:to:port / transport:air:flightnum:to:port
The most recently registered destination for the flight number.

The property type is *transport:air:port*.

:from:port / transport:air:flightnum:from:port
The most recently registered origin for the flight number.

The property type is *transport:air:port*.

:stops / transport:air:flightnum:stops
An ordered list of aiport codes for the flight segments.

The property type is *array*. Its type has the following options set:

- type: `transport:air:port`

transport:air:occupant

An occupant of a specific flight.

The base type for the form can be found at *transport:air:occupant*.

Properties:

:type / transport:air:occupant:type
The type of occupant such as pilot, crew or passenger.

The property type is *str*. Its type has the following options set:

- lower: `True`

:flight / transport:air:occupant:flight
The flight that the occupant was aboard.

The property type is *transport:air:flight*.

:seat / transport:air:occupant:seat
The seat assigned to the occupant.

The property type is *str*. Its type has the following options set:

- lower: `True`

:contact / transport:air:occupant:contact
The contact information of the occupant.

The property type is *ps:contact*.

transport:air:port

An IATA assigned airport code.

The base type for the form can be found at *transport:air:port*.

Properties:

:name / transport:air:port:name
The name of the airport.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:place / transport:air:port:place
The place where the IATA airport code is assigned.

The property type is *geo:place*.

transport:air:tailnum

An aircraft registration number or military aircraft serial number.

The base type for the form can be found at *transport:air:tailnum*.

An example of `transport:air:tailnum`:

- `ff023`

Properties:

:loc / transport:air:tailnum:loc
The geopolitical location that the tailnumber is allocated to.

The property type is *loc*.

:type / transport:air:tailnum:type
A type which may be specific to the country prefix.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

transport:air:telem

A telemetry sample from an aircraft in transit.

The base type for the form can be found at *transport:air:telem*.

Properties:

:flight / transport:air:telem:flight
The flight being measured.

The property type is *transport:air:flight*.

:latlong / transport:air:telem:latlong
The lat/lon of the aircraft at the time.

The property type is *geo:latlong*.

:loc / transport:air:telem:loc
The location of the aircraft at the time.

The property type is *loc*.

:place / transport:air:telem:place
The place that the lat/lon geocodes to.

The property type is *geo:place*.

:accuracy / transport:air:telem:accuracy
The horizontal accuracy of the latlong sample.

The property type is *geo:dist*.

:course / transport:air:telem:course
The direction, in degrees from true North, that the aircraft is traveling.

The property type is *transport:direction*.

:heading / transport:air:telem:heading
The direction, in degrees from true North, that the nose of the aircraft is pointed.

The property type is *transport:direction*.

:speed / transport:air:telem:speed
The ground speed of the aircraft at the time.

The property type is *velocity*.

:airspeed / transport:air:telem:airspeed
The air speed of the aircraft at the time.

The property type is *velocity*.

:verticalspeed / transport:air:telem:verticalspeed
The relative vertical speed of the aircraft at the time.

The property type is *velocity*. Its type has the following options set:

- relative: `True`

:altitude / transport:air:telem:altitude
The altitude of the aircraft at the time.

The property type is *geo:altitude*.

:altitude:accuracy / transport:air:telem:altitude:accuracy
The vertical accuracy of the altitude measurement.

The property type is *geo:dist*.

:time / transport:air:telem:time
The time the telemetry sample was taken.

The property type is *time*.

transport:land:license

A license to operate a land vehicle issued to a contact.

The base type for the form can be found at *transport:land:license*.

Properties:

:id / transport:land:license:id
The license ID.

The property type is *str*. Its type has the following options set:

- strip: `True`

:contact / transport:land:license:contact
The contact info of the registrant.

The property type is *ps:contact*.

:issued / transport:land:license:issued
The time the license was issued.

The property type is *time*.

:expires / transport:land:license:expires
The time the license expires.

The property type is *time*.

:issuer / transport:land:license:issuer
The org which issued the license.

The property type is *ou:org*.

:issuer:name / transport:land:license:issuer:name
The name of the org which issued the license.

The property type is *ou:name*.

transport:land:registration

Registration issued to a contact for a land vehicle.

The base type for the form can be found at *transport:land:registration*.

Properties:

:id / transport:land:registration:id
The vehicle registration ID or license plate.

The property type is *str*. Its type has the following options set:

- strip: `True`

:contact / transport:land:registration:contact
The contact info of the registrant.

The property type is *ps:contact*.

:license / transport:land:registration:license
The license used to register the vehicle.

The property type is *transport:land:license*.

:issued / transport:land:registration:issued
The time the vehicle registration was issued.

The property type is *time*.

:expires / transport:land:registration:expires
The time the vehicle registration expires.

The property type is *time*.

:vehicle / transport:land:registration:vehicle
The vehicle being registered.

The property type is *transport:land:vehicle*.

:issuer / transport:land:registration:issuer
The org which issued the registration.

The property type is *ou:org*.

:issuer:name / transport:land:registration:issuer:name
The name of the org which issued the registration.

The property type is *ou:name*.

transport:land:vehicle

An individual vehicle.

The base type for the form can be found at *transport:land:vehicle*.

Properties:

:serial / transport:land:vehicle:serial
The serial number or VIN of the vehicle.

The property type is *str*. Its type has the following options set:

- strip: `True`

:built / transport:land:vehicle:built
The date the vehicle was constructed.

The property type is *time*.

:make / transport:land:vehicle:make
The make of the vehicle.

The property type is *ou:name*.

:model / transport:land:vehicle:model
The model of the vehicle.

The property type is *str*. Its type has the following options set:

- lower: `True`

- onespace: `True`

:registration / transport:land:vehicle:registration
The current vehicle registration information.

The property type is *transport:land:registration*.

:owner / transport:land:vehicle:owner
The contact info of the owner of the vehicle.

The property type is *ps:contact*.

transport:sea:telem

A telemetry sample from a vessel in transit.

The base type for the form can be found at *transport:sea:telem*.

Properties:

:vessel / transport:sea:telem:vessel
The vessel being measured.

The property type is *transport:sea:vessel*.

:time / transport:sea:telem:time
The time the telemetry was sampled.

The property type is *time*.

:latlong / transport:sea:telem:latlong
The lat/lon of the vessel at the time.

The property type is *geo:latlong*.

:loc / transport:sea:telem:loc
The location of the vessel at the time.

The property type is *loc*.

:place / transport:sea:telem:place
The place that the lat/lon geocodes to.

The property type is *geo:place*.

:accuracy / transport:sea:telem:accuracy
The horizontal accuracy of the latlong sample.

The property type is *geo:dist*.

:course / transport:sea:telem:course
The direction, in degrees from true North, that the vessel is traveling.

The property type is *transport:direction*.

:heading / transport:sea:telem:heading
The direction, in degrees from true North, that the bow of the vessel is pointed.

The property type is *transport:direction*.

:speed / transport:sea:telem:speed
The speed of the vessel at the time.

The property type is *velocity*.

:draft / transport:sea:telem:draft
The keel depth at the time.

The property type is *geo:dist*.

:airdraft / transport:sea:telem:airdraft
The maximum height of the ship from the waterline.

The property type is *geo:dist*.

:destination / transport:sea:telem:destination
The fully resolved destination that the vessel has declared.

The property type is *geo:place*.

:destination:name / transport:sea:telem:destination:name
The name of the destination that the vessel has declared.

The property type is *geo:name*.

:destination:eta / transport:sea:telem:destination:eta
The estimated time of arrival that the vessel has declared.

The property type is *time*.

transport:sea:vessel

An individual sea vessel.

The base type for the form can be found at *transport:sea:vessel*.

Properties:

:imo / transport:sea:vessel:imo
The International Maritime Organization number for the vessel.

The property type is *transport:sea:imo*.

:name / transport:sea:vessel:name
The name of the vessel.

The property type is *str*. Its type has the following options set:

- lower: `True`
- onespace: `True`

:length / transport:sea:vessel:length
The official overall vessel length.

The property type is *geo:dist*.

:beam / transport:sea:vessel:beam
The official overall vessel beam.

The property type is *geo:dist*.

:flag / transport:sea:vessel:flag
The country the vessel is flagged to.

The property type is *iso:3166:cc*.

:mmsi / transport:sea:vessel:mmsi
The Maritime Mobile Service Identifier assigned to the vessel.

The property type is *transport:sea:mmsi*.

:built / transport:sea:vessel:built
The year the vessel was constructed.

The property type is *time*.

:make / transport:sea:vessel:make
The make of the vessel.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:model / transport:sea:vessel:model
The model of the vessel.

The property type is *str*. Its type has the following options set:

- lower: `True`
- strip: `True`

:operator / transport:sea:vessel:operator
The contact information of the operator.

The property type is *ps:contact*.

12.2.2 Universal Properties

Universal props are system level properties which may be present on every node.

These properties are not specific to a particular form and exist outside of a particular namespace.

.created

The time the node was created in the cortex. It has the following property options set:

- Read Only: `True`

The universal property type is *time*. Its type has the following options set:

- ismin: `True`

.seen

The time interval for first/last observation of the node.

The universal property type is *ival*.

12.3 Datamodel Deprecation Policy

As the Synapse Data Model has grown and evolved over time, Vertex has found the need to deprecate model elements which are no longer useful. These elements may represent relationships which are better captured with newer elements; concepts which are better represented by convention; or other issues. As such, model elements (types, forms, and properties) which are deprecated should no longer be used for new data modeling. Deprecated model elements will be removed in a future Synapse release, no earlier than `v3.0.0`.

For deprecated model elements, suggested alternatives will be provided and example Storm queries which can be used to migrate data in such a fashion.

12.3.1 Using Deprecated Model Elements

When Deprecated model elements are used in a Cortex, the following log events will be made:

- One startup, if a extended property definition uses a deprecated type to define it, a warning message will be logged.
- If a extended property is added which uses a deprecated type to define it, a warning message will be logged.
- Any Types or Forms, from a datamodel loaded by a custom CoreModule, which use a deprecated model component will cause a warning message to be logged. This includes any Array or Comp type model elements which utilize a deprecated Type.
- If a property or tag property is set on a node which is deprecated or using a deprecated type, that will cause a warning message to be logged and a `warn` message to be sent over the Storm runtime. This only occurs once per given runtime.
- If a node is made using deprecated form or using a deprecated type, that will cause a warning message to be logged and a `warn` message to be sent over the Storm runtime. This only occurs once per given runtime.

Deleting nodes which use deprecated model elements does not trigger warnings, since that would normally be done after an associated data migration and would be excessive in the event of a large migration.

12.3.2 Deprecated Model Elements

The following elements are deprecated.

Types

- ***file:string***
  - -(refs)> it:dev:str
- ***it:reveng:funcstr***
  - Please use the *:strings* array property on the *it:reveng:function* form.
- ***lang:idiom***
  - Please use *lang:translation* instead.
- ***lang:trans***
  - Please use *lang:translation* instead.
- ***ou:hasalias***
  - *ou:hasalias* is deprecated in favor of the *:alias* property on *ou:org* nodes.

- ***ou:meet:attendee***
  - *ou:meet:attendee* has been superseded by *ou:attendee*. *ou:attendee* has the *:meet* property to denote what meeting the attendee attended.
- ***ou:conference:attendee***
  - *ou:conference:attendee* has been superseded by *ou:attendee*. *ou:attendee* has the *:conference* property to denote what conference the attendee attended.
- ***ou:conference:event:attendee***
  - *ou:conference:attendee* has been superseded by *ou:attendee*. *ou:attendee* has the *:conference* property to denote what conference event the attendee attended.
- ***ou:member***
  - *ou:member* has been superseded by *ou:position*.
- ***ps:persona***
  - Please use the *ps:person* or *ps:contact* types.
- ***ps:person:has***
  - Please use *edge:has* or a light edge.
- ***ps:persona:has***
  - Please use *ps:person* or *ps:context* in combination with an *edge:has* or a light edge.

Forms

Consistent with the deprecated types, the following forms are deprecated: - *file:string* - *it:reveng:funcstr* - *lang:idiom* - *lang:trans* - *ou:hasalias* - *ou:meet:attendee* - *ou:conference:attendee* - *ou:conference:event:attendee* - *ou:member* - *ps:person:has* - *ps:persona* - *ps:persona:has*

Properties

- ***ps:person***
  - ***:img***
    - *ps:person:img* has been renamed to *ps:person:photo*.
- ***it:prod:soft***
  - ***author:org*, *author:acct*, *author:email*, and *author:person***
    - These properties have been collected into the *it:prod:soft:author* property, which is typed as a *ps:contact*.
- ***media:news***
  - ***:author***
    - The *media:news:author* property has been superseded by the array property of *media:news:authors*, which is an array of type *ps:contact*.
- ***file:subfile***
  - ***:name***
    - The *file:subfile:name* property has been superseded by the property *file:subfile:path*, which is typed as *file:path*.

- ***ou:org***
  - ***:naics* and *:sic***
    - The *ou:org:naics* and *ou:org:sic* properties has been collected into the *ou:org:industries* property, which is an array of type *ou:industry*.
  - ***:has***
    - Please use an *edge:has* node or a light edge.
- ***risk:attack***
  - ***:actor:org***
    - Please use the *:attacker ps:contact* property to allow entity resolution.
  - ***:actor:person***
    - Please use the *:attacker ps:contact* property to allow entity resolution.
  - ***:target:org***
    - Please use the *:target ps:contact* property to allow entity resolution.
  - ***:target:person***
    - Please use the *:target ps:contact* property to allow entity resolution.
- ***ou:campaign***
  - ***:type***
    - Please use the *:camptype taxonomy* property.
- ***it:host***
  - ***:manu***
    - This property has been superseded by the *it:prod:hardware:make* property, which is typed as *ou:name*.
  - ***:model***
    - This property has been superseded by the *it:prod:hardware:model* property, which is typed as string.
- ***it:exec:proc***
  - ***:user***
    - Please use the *:account it:exec:proc* property to link processes to users.

CHAPTER

THIRTEEN

STORM LIBRARY DOCUMENTATION

This contains API documentation for Storm Libraries and Storm Types.

Storm Types (also called Storm Objects) are objects in the Storm Runtime that can represent values such as nodes in the runtime or objects in the Cortex. Storm Types encompass objects from strings of characters (*str*), to objects representing Cron Jobs in the Cortex (stormprims-storm-cronjob-f527), to nodes in the Cortex (stormprims-storm-node-f527). These objects each have their own properties and methods defined on them that can be used to inspect or edit that object. For instance, String Storm Types all have the *upper* method defined on them that returns a new instance of that String, except with every letter turned uppercase (*upper()*). Storm Types help form the basis for programmatic manipulation of objects and data in the Cortex.

Storm Libraries are ready-made tools in the Storm query language for creating, updating, or fetching data using Storm Types. Storm libraries include functionality for making HTTP requests (via *$lib.inet.http*), scraping nodes from text (*$lib.scrape*), manipulating Cortex objects such as Queues (*$lib.queue*) and StormDmons (*$lib.dmon*), creating new Cron Jobs (*$lib.cron*), and more. Many of these libraries accept or return Storm Types as part of their usage. For instance, there is a library in Storm for interacting with OAuthv1 servers (*$lib.inet.http.oauth.v1.client(ckey, csecret, atoken, asecret, sigtype=QUERY)*), and it accepts several String Storm Types as parameters and returns an OAuthV1 client object for later usage (stormprims-storm-oauth-v1-client-f527). Storm Libraries form a powerful bench of tools for usage within the Storm query language.

The current sections are:

13.1 Storm Libraries

Storm Libraries represent powerful tools available inside of the Storm query language.

13.1.1 $lib

The Base Storm Library. This mainly contains utility functionality.

$lib.cast(name, valu)

Normalize a value as a Synapse Data Model Type.

Args:

name (str): The name of the model type to normalize the value as.

valu (any): The value to normalize.

Returns:

The normalized value. The return type is `prim`.

$lib.copy(item)

Create and return a deep copy of the given storm object.

Note:
This is currently limited to msgpack compatible primitives.

Examples:
Make a copy of a list or dict:

```
$copy = $lib.copy($item)
```

Args:
item (prim): The item to make a copy of.

Returns:
A deep copy of the primitive object. The return type is `prim`.

$lib.debug

True if the current runtime has debugging enabled.

Note:
The debug state is inherited by sub-runtimes at instantiation time. Any changes to a runtime's debug state do not percolate automatically.

Examples:
Check if the runtime is in debug and print a message:

```
if $lib.debug {
    $lib.print('Doing stuff!")
}
```

Update the current runtime to enable debugging:

```
$lib.debug = $lib.true
```

Returns:
The return type is *boolean*. When this is used to set the value, it does not have a return type.

$lib.dict(**kwargs)

Get a Storm Dict object.

Args:
**kwargs (any): Initial set of keyword argumetns to place into the dict.

Returns:
A dictionary object. The return type is *dict*.

$lib.exit(mesg=None, **kwargs)

Cause a Storm Runtime to stop running.

Args:
mesg (str): Optional string to warn.

**kwargs (any): Keyword arguments to substitute into the mesg.

Returns:
The return type is `null`.

$lib.false

This constant represents a value of False that can be used in Storm.

Examples:
Conditionally print a statement based on the constant value:

```
cli> storm if $lib.false { $lib.print('Is True') } else { $lib.print('Is False') }
Is False
```

Returns:
The type is *boolean*.

$lib.fire(name, **info)

Fire an event onto the runtime.

Notes:
This fires events as `storm:fire` event types. The name of the event is placed into a `type` key, and any additional keyword arguments are added to a dictionary under the `data` key.

Examples:
Fire an event called `demo` with some data:

```
cli> storm $foo='bar' $lib.fire('demo', foo=$foo, knight='ni')
...
('storm:fire', {'type': 'demo', 'data': {'foo': 'bar', 'knight': 'ni'}})
...
```

Args:
name (str): The name of the event to fire.

**info (any): Additional keyword arguments containing data to add to the event.

Returns:
The return type is `null`.

$lib.guid(*args)

Get a random guid, or generate a guid from the arguments.

Args:
*args (prim): Arguments which are hashed to create a guid.

Returns:
A guid. The return type is *str*.

$lib.import(name, debug=False, reqvers=None)

Import a Storm module.

Args:
name (str): Name of the module to import.

debug (boolean): Enable debugging in the module.

reqvers (str): Version requirement for the imported module.

Returns:
A `lib` instance representing the imported package. The return type is `lib`.

$lib.len(item)

Get the length of a item.

This could represent the size of a string, or the number of keys in a dictionary, or the number of elements in an array. It may also be used to iterate an emitter or yield function and count the total.

Args:
item (prim): The item to get the length of.

Returns:
The length of the item. The return type is `int`.

$lib.list(*vals)

Get a Storm List object.

Args:
*vals (any): Initial values to place in the list.

Returns:
A new list object. The return type is *list*.

$lib.max(*args)

Get the maximum value in a list of arguments.

Args:
*args (any): List of arguments to evaluate.

Returns:
The largest argument. The return type is `int`.

$lib.min(*args)

Get the minimum value in a list of arguments.

Args:
*args (any): List of arguments to evaluate.

Returns:
The smallest argument. The return type is `int`.

$lib.null

This constant represents a value of None that can be used in Storm.

Examples:
Create a dictionary object with a key whose value is null, and call `$lib.fire()` with it:

```
cli> storm $d=$lib.dict(key=$lib.null) $lib.fire('demo', d=$d)
('storm:fire', {'type': 'demo', 'data': {'d': {'key': None}}})
```

Returns:
The type is `null`.

$lib.pprint(item, prefix=, clamp=None)

The pprint API should not be considered a stable interface.

Args:
item (any): Item to pprint

prefix (str): Line prefix.

clamp (int): Line clamping length.

Returns:
The return type is `null`.

$lib.print(mesg, **kwargs)

Print a message to the runtime.

Examples:

Print a simple string:

```
cli> storm $lib.print("Hello world!")
Hello world!
```

Format and print string based on variables:

```
cli> storm $d=$lib.dict(key1=(1), key2="two")
     for ($key, $value) in $d { $lib.print('{k} => {v}', k=$key, v=$value) }
key1 => 1
key2 => two
```

Use values off of a node to format and print string:

```
cli> storm inet:ipv4:asn
     $lib.print("node: {ndef}, asn: {asn}", ndef=$node.ndef(), asn=:asn) | spin
node: ('inet:ipv4', 16909060), asn: 1138
```

Notes:

Arbitrary objects can be printed as well. They will have their Python __repr()__ printed.

Args:

mesg (str): String to print.

**kwargs (any): Keyword arguments to substitute into the mesg.

Returns:

The return type is `null`.

$lib.raise(name, mesg, **info)

Raise an exception in the storm runtime.

Args:

name (str): The name of the error condition to raise.

mesg (str): A friendly description of the specific error.

**info (any): Additional metadata to include in the exception.

Returns:

This function does not return. The return type is `null`.

$lib.range(stop, start=None, step=None)

Generate a range of integers.

Examples:

Generate a sequence of integers based on the size of an array:

```
cli> storm $a=(foo,bar,(2)) for $i in $lib.range($lib.len($a)) {$lib.fire('test',␣
↪indx=$i, valu=$a.$i)}
Executing query at 2021/03/22 19:25:48.835
('storm:fire', {'type': 'test', 'data': {'index': 0, 'valu': 'foo'}})
('storm:fire', {'type': 'test', 'data': {'index': 1, 'valu': 'bar'}})
('storm:fire', {'type': 'test', 'data': {'index': 2, 'valu': 2}})
```

Notes:

The range behavior is the same as the Python3 `range()` builtin Sequence type.

Args:

stop (int): The value to stop at.

start (int): The value to start at.

step (int): The range step size.

Yields:

The sequence of integers. The return type is `int`.

$lib.set(*vals)

Get a Storm Set object.

Args:

*vals (any): Initial values to place in the set.

Returns:

The new set. The return type is *set*.

$lib.sorted(valu, reverse=False)

Yield sorted values.

Args:

valu (any): An iterable object to sort.

reverse (boolean): Reverse the sort order.

Yields:

Yields the sorted output. The return type is `any`.

$lib.text(*args)

Get a Storm Text object.

Args:
*args (str): An initial set of values to place in the Text. These values are joined together with an empty string.

Returns:
The new Text object. The return type is *text*.

$lib.true

This constant represents a value of True that can be used in Storm.

Examples:
Conditionally print a statement based on the constant value:

```
cli> storm if $lib.true { $lib.print('Is True') } else { $lib.print('Is False') }
Is True
```

Returns:
The type is *boolean*.

$lib.trycast(name, valu)

Attempt to normalize a value and return status and the normalized value.

Examples:
Do something if the value is a valid IPV4:

```
($ok, $ipv4) = $lib.trycast(inet:ipv4, 1.2.3.4)
if $ok { $dostuff($ipv4) }
```

Args:
name (str): The name of the model type to normalize the value as.

valu (any): The value to normalize.

Returns:
A list of (<bool>, <prim>) for status and normalized value. The return type is *list*.

$lib.undef

This constant can be used to unset variables and derefs.

Examples:
Unset the variable $foo:

```
$foo = $lib.undef
```

Remove a dictionary key bar:

```
$foo.bar = $lib.undef
```

Remove a list index of 0:

```
$foo.0 = $lib.undef
```

Returns:
The type is `undef`.

$lib.warn(mesg, **kwargs)

Print a warning message to the runtime.

Notes:
Arbitrary objects can be warned as well. They will have their Python __repr()__ printed.

Args:
mesg (str): String to warn.

**kwargs (any): Keyword arguments to substitute into the mesg.

Returns:
The return type is `null`.

13.1.2 $lib.auth

A Storm Library for interacting with Auth in the Cortex.

$lib.auth.getPermDef(perm)

Return a single permission definition.

Args:
perm (list): A permission tuple.

Returns:
A permission definition or null. The return type is *dict*.

$lib.auth.getPermDefs()

Return a list of permission definitions.

Returns:
The list of permission definitions. The return type is *list*.

$lib.auth.ruleFromText(text)

Get a rule tuple from a text string.

Args:
text (str): The string to process.

Returns:
A tuple containing a bool and a list of permission parts. The return type is *list*.

$lib.auth.textFromRule(rule)

Return a text string from a rule tuple.

Args:
rule (list): A rule tuple.

Returns:
The rule text. The return type is *str*.

13.1.3 $lib.auth.easyperm

A Storm Library for interacting with easy perm dictionaries.

$lib.auth.easyperm.allowed(edef, level)

Check if the current user has a permission level in an easy perm dictionary.

Args:
edef (dict): The easy perm dictionary to check.

level (str): The required permission level number.

Returns:
True if the user meets the requirement, false otherwise. The return type is *boolean*.

$lib.auth.easyperm.confirm(edef, level)

Require that the current user has a permission level in an easy perm dictionary.

Args:
edef (dict): The easy perm dictionary to check.

level (str): The required permission level number.

Returns:
The return type is `null`.

$lib.auth.easyperm.init(edef=None)

Add the easy perm structure to a new or existing dictionary.

Note:
The current user will be given admin permission in the new easy perm structure.

Args:
edef (dict): A dictionary to add easy perms to.

Returns:
Dictionary with the easy perm structure. The return type is *dict*.

$lib.auth.easyperm.set(edef, scope, iden, level)

Set the permission level for a user or role in an easy perm dictionary.

Args:

edef (dict): The easy perm dictionary to modify.

scope (str): The scope, either "users" or "roles".

iden (str): The user/role iden depending on scope.

level (int): The permission level number, or None to remove the permission.

Returns:

Dictionary with the updated easy perm structure. The return type is *dict*.

13.1.4 $lib.auth.gates

A Storm Library for interacting with Auth Gates in the Cortex.

$lib.auth.gates.get(iden)

Get a specific Gate by iden.

Args:

iden (str): The iden of the gate to retrieve.

Returns:

The `auth:gate` if it exists, otherwise null. The return type may be one of the following: `null`, *auth:gate*.

$lib.auth.gates.list()

Get a list of Gates in the Cortex.

Returns:

A list of `auth:gate` objects. The return type is *list*.

13.1.5 $lib.auth.roles

A Storm Library for interacting with Auth Roles in the Cortex.

$lib.auth.roles.add(name)

Add a Role to the Cortex.

Args:

name (str): The name of the role.

Returns:

The new role object. The return type is *auth:role*.

$lib.auth.roles.byname(name)

Get a specific Role by name.

Args:
name (str): The name of the role to retrieve.

Returns:
The role by name, or null if it does not exist. The return type may be one of the following: `null`, *auth:role*.

$lib.auth.roles.del(iden)

Delete a Role from the Cortex.

Args:
iden (str): The iden of the role to delete.

Returns:
The return type is `null`.

$lib.auth.roles.get(iden)

Get a specific Role by iden.

Args:
iden (str): The iden of the role to retrieve.

Returns:
The `auth:role` object; or null if the role does not exist. The return type may be one of the following: `null`, *auth:role*.

$lib.auth.roles.list()

Get a list of Roles in the Cortex.

Returns:
A list of `auth:role` objects. The return type is *list*.

13.1.6 $lib.auth.users

A Storm Library for interacting with Auth Users in the Cortex.

$lib.auth.users.add(name, passwd=None, email=None, iden=None)

Add a User to the Cortex.

Args:
name (str): The name of the user.

passwd (str): The user's password.

email (str): The user's email address.

iden (str): The iden to use to create the user.

Returns:
The `auth:user` object for the new user. The return type is *auth:user*.

$lib.auth.users.byname(name)

Get a specific user by name.

Args:
name (str): The name of the user to retrieve.

Returns:
The `auth:user` object, or none if the user does not exist. The return type may be one of the following: `null`, *auth:user*.

$lib.auth.users.del(iden)

Delete a User from the Cortex.

Args:
iden (str): The iden of the user to delete.

Returns:
The return type is `null`.

$lib.auth.users.get(iden)

Get a specific User by iden.

Args:
iden (str): The iden of the user to retrieve.

Returns:
The `auth:user` object, or none if the user does not exist. The return type may be one of the following: `null`, *auth:user*.

$lib.auth.users.list()

Get a list of Users in the Cortex.

Returns:
A list of `auth:user` objects. The return type is *list*.

13.1.7 $lib.axon

A Storm library for interacting with the Cortex's Axon.

$lib.axon.csvrows(sha256, dialect=excel, **fmtparams)

Yields CSV rows from a CSV file stored in the Axon.

Notes:
The dialect and fmtparams expose the Python csv.reader() parameters.

Example:
Get the rows from a given csv file:

```
for $row in $lib.axon.csvrows($sha256) {
    $dostuff($row)
}
```

Get the rows from a given tab separated file:

```
for $row in $lib.axon.csvrows($sha256, delimiter="\t") {
    $dostuff($row)
}
```

Args:
sha256 (str): The SHA256 hash of the file.

dialect (str): The default CSV dialect to use.

**fmtparams (any): Format arguments.

yields:
A list of strings from the CSV file. The return type is *list*.

$lib.axon.del(sha256)

Remove the bytes from the Cortex's Axon by sha256.

Example:
Delete files from the axon based on a tag:

```
file:bytes#foo +:sha256 $lib.axon.del(:sha256)
```

Args:
sha256 (hash:sha256): The sha256 of the bytes to remove from the Axon.

Returns:
True if the bytes were found and removed. The return type is *boolean*.

$lib.axon.dels(sha256s)

Remove multiple byte blobs from the Cortex's Axon by a list of sha256 hashes.

Example:
Delete a list of files (by hash) from the Axon:

```
$list = ($hash0, $hash1, $hash2)
$lib.axon.dels($list)
```

Args:
sha256s (list): A list of sha256 hashes to remove from the Axon.

Returns:
A list of boolean values that are True if the bytes were found. The return type is *list*.

$lib.axon.jsonlines(sha256)

Yields JSON objects from a JSON-lines file stored in the Axon.

Example:
Get the JSON objects from a given JSONL file:

```
for $item in $lib.axon.jsonlines($sha256) {
    $dostuff($item)
}
```

Args:
sha256 (str): The SHA256 hash of the file.

yields:
A JSON object parsed from a line of text. The return type is any.

$lib.axon.list(offs=0, wait=False, timeout=None)

List (offset, sha256, size) tuples for files in the Axon in added order.

Example:
List files:

```
for ($offs, $sha256, $size) in $lib.axon.list() {
    $lib.print($sha256)
}
```

Start list from offset 10:

```
for ($offs, $sha256, $size) in $lib.axon.list(10) {
    $lib.print($sha256)
}
```

Args:
offs (int): The offset to start from.

wait (boolean): Wait for new results and yield them in realtime.

timeout (int): The maximum time to wait for a new result before returning.

yields:
Tuple of (offset, sha256, size) in added order. The return type is *list*.

$lib.axon.metrics()

Get runtime metrics of the Axon.

Example:

Print the total number of files stored in the Axon:

```
$data = $lib.axon.metrics()
$lib.print("The Axon has {n} files", n=$data."file:count")
```

Returns:

A dictionary containing runtime data about the Axon. The return type is *dict*.

$lib.axon.readlines(sha256)

Yields lines of text from a plain-text file stored in the Axon.

Example:

Get the lines for a given file:

```
for $line in $lib.axon.readlines($sha256) {
    $dostuff($line)
}
```

Args:

sha256 (str): The SHA256 hash of the file.

yields:

A line of text from the file. The return type is *str*.

$lib.axon.urlfile(*args, **kwargs)

Retrive the target URL using the wget() function and construct an inet:urlfile node from the response.

Notes:

This accepts the same arguments as `$lib.axon.wget()`.

Args:

*args (any): Args from `$lib.axon.wget()`.

**kwargs (any): Args from `$lib.axon.wget()`.

Returns:

The `inet:urlfile` node on success, `null` on error. The return type may be one of the following: *node*, `null`.

$lib.axon.wget(url, headers=None, params=None, method=GET, json=None, body=None, ssl=True, timeout=None, proxy=None)

A method to download an HTTP(S) resource into the Cortex's Axon.

Notes:

The response body will be stored regardless of the status code. See the `Axon.wget()` API documentation to see the complete structure of the response dictionary.

Example:

Get the Vertex Project website:

```
$headers = $lib.dict()
$headers."User-Agent" = Foo/Bar

$resp = $lib.axon.wget("http://vertex.link", method=GET, headers=$headers)
if $resp.ok { $lib.print("Downloaded: {size} bytes", size=$resp.size) }
```

Args:

url (str): The URL to download

headers (dict): An optional dictionary of HTTP headers to send.

params (dict): An optional dictionary of URL parameters to add.

method (str): The HTTP method to use.

json (dict): A JSON object to send as the body.

body (bytes): Bytes to send as the body.

ssl (boolean): Set to False to disable SSL/TLS certificate verification.

timeout (int): Timeout for the download operation.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:

A status dictionary of metadata. The return type is *dict*.

$lib.axon.wput(sha256, url, headers=None, params=None, method=PUT, ssl=True, timeout=None, proxy=None)

A method to upload a blob from the axon to an HTTP(S) endpoint.

Args:

sha256 (str): The sha256 of the file blob to upload.

url (str): The URL to upload the file to.

headers (dict): An optional dictionary of HTTP headers to send.

params (dict): An optional dictionary of URL parameters to add.

method (str): The HTTP method to use.

ssl (boolean): Set to False to disable SSL/TLS certificate verification.

timeout (int): Timeout for the download operation.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:

A status dictionary of metadata. The return type is *dict*.

13.1.8 $lib.backup

A Storm Library for interacting with the backup APIs in the Cortex.

$lib.backup.del(name)

Remove a backup by name.

Args:
name (str): The name of the backup to remove.

Returns:
The return type is `null`.

$lib.backup.list()

Get a list of backup names.

Returns:
A list of backup names. The return type is *list*.

$lib.backup.run(name=None, wait=True)

Run a Cortex backup.

Args:
name (str): The name of the backup to generate.

wait (boolean): If true, wait for the backup to complete before returning.

Returns:
The name of the newly created backup. The return type is *str*.

13.1.9 $lib.base64

A Storm Library for encoding and decoding base64 data.

$lib.base64.decode(valu, urlsafe=True)

Decode a base64 string into a bytes object.

Args:
valu (str): The string to decode.

urlsafe (boolean): Perform the decoding in a urlsafe manner if true.

Returns:
A bytes object for the decoded data. The return type is *bytes*.

$lib.base64.encode(valu, urlsafe=True)

Encode a bytes object to a base64 encoded string.

Args:
valu (bytes): The object to encode.

urlsafe (boolean): Perform the encoding in a urlsafe manner if true.

Returns:
A base64 encoded string. The return type is *str*.

13.1.10 $lib.basex

A Storm library which implements helpers for encoding and decoding strings using an arbitrary charset.

$lib.basex.decode(text, charset)

Decode a baseX string into bytes.

Args:
text (str): The hex string to be decoded into bytes.

charset (str): The charset used to decode the string.

Returns:
The decoded bytes. The return type is *bytes*.

$lib.basex.encode(byts, charset)

Encode bytes into a baseX string.

Args:
byts (bytes): The bytes to be encoded into a string.

charset (str): The charset used to encode the bytes.

Returns:
The encoded string. The return type is *str*.

13.1.11 $lib.bytes

A Storm Library for interacting with bytes storage.

$lib.bytes.has(sha256)

Check if the Axon the Cortex is configured to use has a given sha256 value.

Examples:
Check if the Axon has a given file:

```
# This example assumes the Axon does have the bytes
cli> storm if $lib.bytes.
↪has(9f86d081884c7d659a2feaa0c55ad015a3bf4f1b2b0b822cd15d6c15b0f00a08) {
        $lib.print("Has bytes")
    } else {
        $lib.print("Does not have bytes")
    }

Has bytes
```

Args:
sha256 (str): The sha256 value to check.

Returns:
True if the Axon has the file, false if it does not. The return type is *boolean*.

$lib.bytes.hashset(sha256)

Return additional hashes of the bytes stored in the Axon for the given sha256.

Examples:
Get the md5 hash for a file given a variable named `$sha256`:

```
$hashset = $lib.bytes.hashset($sha256)
$md5 = $hashset.md5
```

Args:
sha256 (str): The sha256 value to calculate hashes for.

Returns:
A dictionary of additional hashes. The return type is *dict*.

$lib.bytes.put(byts)

Save the given bytes variable to the Axon the Cortex is configured to use.

Examples:
Save a base64 encoded buffer to the Axon:

```
cli> storm $s='dGVzdA==' $buf=$lib.base64.decode($s) ($size, $sha256)=$lib.bytes.
↪put($buf)
     $lib.print('size={size} sha256={sha256}', size=$size, sha256=$sha256)

size=4 sha256=9f86d081884c7d659a2feaa0c55ad015a3bf4f1b2b0b822cd15d6c15b0f00a08
```

Args:
byts (bytes): The bytes to save.

Returns:
A tuple of the file size and sha256 value. The return type is *list*.

$lib.bytes.size(sha256)

Return the size of the bytes stored in the Axon for the given sha256.

Examples:

Get the size for a file given a variable named `$sha256`:

```
$size = $lib.bytes.size($sha256)
```

Args:

sha256 (str): The sha256 value to check.

Returns:

The size of the file or `null` if the file is not found. The return type may be one of the following: `int`, `null`.

$lib.bytes.upload(genr)

Upload a stream of bytes to the Axon as a file.

Examples:

Upload bytes from a generator:

```
($size, $sha256) = $lib.bytes.upload($getBytesChunks())
```

Args:

genr (generator): A generator which yields bytes.

Returns:

A tuple of the file size and sha256 value. The return type is *list*.

13.1.12 $lib.cell

A Storm Library for interacting with the Cortex.

$lib.cell.getBackupInfo()

Get information about recent backup activity.

Returns:

A dictionary containing backup information. The return type is *dict*.

$lib.cell.getCellInfo()

Return metadata specific for the Cortex.

Returns:

A dictionary containing metadata. The return type is *dict*.

$lib.cell.getHealthCheck()

Get healthcheck information about the Cortex.

Returns:
A dictionary containing healthcheck information. The return type is *dict*.

$lib.cell.getMirrorUrls(name=None)

Get mirror Telepath URLs for an AHA configured service.

Args:
name (str): The name, or iden, of the service to get mirror URLs for (defaults to the Cortex if not provided).

Returns:
A list of Telepath URLs. The return type is *list*.

$lib.cell.getSystemInfo()

Get info about the system in which the Cortex is running.

Returns:
A dictionary containing system information. The return type is *dict*.

$lib.cell.hotFixesApply()

Apply known data migrations and fixes via storm.

Returns:
Tuple containing the current version after applying the fixes. The return type is *list*.

$lib.cell.hotFixesCheck()

Check to see if there are known hot fixes to apply.

Returns:
Bool indicating if there are hot fixes to apply or not. The return type is *boolean*.

$lib.cell.trimNexsLog(consumers=None, timeout=30)

Rotate and cull the Nexus log (and any consumers) at the current offset.

If the consumers argument is provided they will first be checked if online before rotating and raise otherwise. After rotation, all consumers provided must catch-up to the offset to cull at within the specified timeout before executing the cull, and will raise otherwise.

Args:
consumers (array): List of Telepath URLs for consumers of the Nexus log.

timeout (int): Time (in seconds) to wait for consumers to catch-up before culling.

Returns:
The offset that was culled (up to and including). The return type is `int`.

$lib.cell.uptime(name=None)

Get update data for the Cortex or a connected Service.

Args:
name (str): The name, or iden, of the service to get uptime data for (defaults to the Cortex if not provided).

Returns:
A dictionary containing uptime data. The return type is *dict*.

13.1.13 $lib.compression.bzip2

A Storm library which implements helpers for bzip2 compression.

$lib.compression.bzip2.en(valu)

Compress bytes using bzip2 and return them.

Example:
Compress bytes with bzip2:

```
$foo = $lib.compression.bzip2.en($mybytez)
```

Args:
valu (bytes): The bytes to be compressed.

Returns:
The bzip2 compressed bytes. The return type is *bytes*.

$lib.compression.bzip2.un(valu)

Decompress bytes using bzip2 and return them.

Example:
Decompress bytes with bzip2:

```
$foo = $lib.compression.bzip2.un($mybytez)
```

Args:
valu (bytes): The bytes to be decompressed.

Returns:
Decompressed bytes. The return type is *bytes*.

13.1.14 $lib.compression.gzip

A Storm library which implements helpers for gzip compression.

$lib.compression.gzip.en(valu)

Compress bytes using gzip and return them.

Example:
Compress bytes with gzip:

```
$foo = $lib.compression.gzip.en($mybytez)
```

Args:
valu (bytes): The bytes to be compressed.

Returns:
The gzip compressed bytes. The return type is *bytes*.

$lib.compression.gzip.un(valu)

Decompress bytes using gzip and return them.

Example:
Decompress bytes with gzip:

```
$foo = $lib.compression.gzip.un($mybytez)
```

Args:
valu (bytes): The bytes to be decompressed.

Returns:
Decompressed bytes. The return type is *bytes*.

13.1.15 $lib.compression.zlib

A Storm library which implements helpers for zlib compression.

$lib.compression.zlib.en(valu)

Compress bytes using zlib and return them.

Example:
Compress bytes with zlib:

```
$foo = $lib.compression.zlib.en($mybytez)
```

Args:
valu (bytes): The bytes to be compressed.

Returns:
The zlib compressed bytes. The return type is *bytes*.

$lib.compression.zlib.un(valu)

Decompress bytes using zlib and return them.

Example:
Decompress bytes with zlib:

```
$foo = $lib.compression.zlib.un($mybytez)
```

Args:
valu (bytes): The bytes to be decompressed.

Returns:
Decompressed bytes. The return type is *bytes*.

13.1.16 $lib.cron

A Storm Library for interacting with Cron Jobs in the Cortex.

$lib.cron.add(**kwargs)

Add a recurring Cron Job to the Cortex.

Args:
**kwargs (any): Key-value parameters used to add the cron job.

Returns:
The new Cron Job. The return type is *cronjob*.

$lib.cron.at(**kwargs)

Add a non-recurring Cron Job to the Cortex.

Args:
**kwargs (any): Key-value parameters used to add the cron job.

Returns:
The new Cron Job. The return type is *cronjob*.

$lib.cron.del(prefix)

Delete a CronJob from the Cortex.

Args:
prefix (str): A prefix to match in order to identify a cron job to delete. Only a single matching prefix will be deleted.

Returns:
The return type is `null`.

$lib.cron.disable(prefix)

Disable a CronJob in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a cron job to disable. Only a single matching prefix will be disabled.

Returns:

The iden of the CronJob which was disabled. The return type is *str*.

$lib.cron.enable(prefix)

Enable a CronJob in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a cron job to enable. Only a single matching prefix will be enabled.

Returns:

The iden of the CronJob which was enabled. The return type is *str*.

$lib.cron.get(prefix)

Get a CronJob in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a cron job to get. Only a single matching prefix will be retrieved.

Returns:

The requested cron job. The return type is *cronjob*.

$lib.cron.list()

List CronJobs in the Cortex.

Returns:

A list of `cronjob` objects.. The return type is *list*.

$lib.cron.mod(prefix, query)

Modify the Storm query for a CronJob in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a cron job to modify. Only a single matching prefix will be modified.

query: The new Storm query for the Cron Job. The input type may one one of the following: `str`, `query`.

Returns:

The iden of the CronJob which was modified. The return type is *str*.

$lib.cron.move(prefix, view)

Move a cron job to a new view.

Args:

prefix (str): A prefix to match in order to identify a cron job to move. Only a single matching prefix will be modified.

view (str): The iden of the view to move the CrobJob to

Returns:

The iden of the CronJob which was moved. The return type is *str*.

13.1.17 $lib.crypto.coin.ethereum

A Storm library which implements helpers for Ethereum.

$lib.crypto.coin.ethereum.eip55(addr)

Convert an Ethereum address to a checksummed address.

Args:

addr (str): The Ethereum address to be converted.

Returns:

A list of (<bool>, <addr>) for status and checksummed address. The return type is *list*.

13.1.18 $lib.crypto.hashes

A Storm Library for hashing bytes

$lib.crypto.hashes.md5(byts)

Retrieve an MD5 hash of a byte string.

Args:

byts (bytes): The bytes to hash.

Returns:

The hex digest of the MD5 hash of the input bytes. The return type is *str*.

$lib.crypto.hashes.sha1(byts)

Retrieve a SHA1 hash of a byte string.

Args:

byts (bytes): The bytes to hash.

Returns:

The hex digest of the SHA1 hash of the input bytes. The return type is *str*.

$lib.crypto.hashes.sha256(byts)

Retrieve a SHA256 hash of a byte string.

Args:
byts (bytes): The bytes to hash.

Returns:
The hex digest of the SHA256 hash of the input bytes. The return type is *str*.

$lib.crypto.hashes.sha512(byts)

Retrieve a SHA512 hash of a byte string.

Args:
byts (bytes): The bytes to hash.

Returns:
The hex digest of the SHA512 hash of the input bytes. The return type is *str*.

13.1.19 $lib.crypto.hmac

A Storm library for computing RFC2104 HMAC values.

$lib.crypto.hmac.digest(key, mesg, alg=sha256)

Compute the digest value of a message using RFC2104 HMAC.

Examples:
Compute the HMAC-SHA256 digest for a message with a secret key:

```
$digest = $lib.crypto.hmac.digest(key=$secretKey.encode(), mesg=$mesg.encode())
```

Args:
key (bytes): The key to use for the HMAC calculation.

mesg (bytes): The message to use for the HMAC calculation.

alg (str): The digest algorithm to use.

Returns:
The binary digest of the HMAC value. The return type is *bytes*.

13.1.20 $lib.csv

A Storm Library for interacting with csvtool.

$lib.csv.emit(*args, table=None)

Emit a `csv:row` event to the Storm runtime for the given args.

Args:

*args (any): Items which are emitted as a `csv:row` event.

table (str): The name of the table to emit data too. Optional.

Returns:

The return type is `null`.

13.1.21 $lib.dmon

A Storm Library for interacting with StormDmons.

$lib.dmon.add(text, name=noname, ddef=None)

Add a Storm Dmon to the Cortex.

Examples:

Add a dmon that executes a query:

```
$lib.dmon.add(${ myquery }, name='example dmon')
```

Args:

text: The Storm query to execute in the Dmon loop. The input type may one one of the following: `str`, `storm:query`.

name (str): The name of the Dmon.

ddef (dict): Additional daemon definition fields.

Returns:

The iden of the newly created Storm Dmon. The return type is *str*.

$lib.dmon.bump(iden)

Restart the Dmon.

Args:

iden (str): The GUID of the dmon to restart.

Returns:

True if the Dmon is restarted; False if the iden does not exist. The return type is *boolean*.

$lib.dmon.del(iden)

Delete a Storm Dmon by iden.

Args:
iden (str): The iden of the Storm Dmon to delete.

Returns:
The return type is `null`.

$lib.dmon.get(iden)

Get a Storm Dmon definition by iden.

Args:
iden (str): The iden of the Storm Dmon to get.

Returns:
A Storm Dmon definition dict. The return type is *dict*.

$lib.dmon.list()

Get a list of Storm Dmons.

Returns:
A list of Storm Dmon definitions. The return type is *list*.

$lib.dmon.log(iden)

Get the messages from a Storm Dmon.

Args:
iden (str): The iden of the Storm Dmon to get logs for.

Returns:
A list of messages from the StormDmon. The return type is *list*.

$lib.dmon.start(iden)

Start a storm dmon.

Args:
iden (str): The GUID of the dmon to start.

Returns:
$lib.true unless the dmon does not exist or was already started. The return type is *boolean*.

$lib.dmon.stop(iden)

Stop a Storm Dmon.

Args:
iden (str): The GUID of the Dmon to stop.

Returns:
$lib.true unless the dmon does not exist or was already stopped. The return type is *boolean*.

13.1.22 $lib.export

A Storm Library for exporting data.

$lib.export.toaxon(query, opts=None)

Run a query as an export (fully resolving relationships between nodes in the output set) and save the resulting stream of packed nodes to the axon.

Args:
query (str): A query to run as an export.

opts (dict): Storm runtime query option params.

Returns:
Returns a tuple of (size, sha256). The return type is *list*.

13.1.23 $lib.feed

A Storm Library for interacting with Cortex feed functions.

$lib.feed.genr(name, data)

Yield nodes being added to the graph by adding data with a given ingest type.

Notes:
This is using the Runtimes's Snap to call addFeedNodes(). This only yields nodes if the feed function yields nodes. If the generator is not entirely consumed there is no guarantee that all of the nodes which should be made by the feed function will be made.

Args:
name (str): Name of the ingest function to send data too.

data (prim): Data to send to the ingest function.

Yields:
Yields Nodes as they are created by the ingest function. The return type is *node*.

$lib.feed.ingest(name, data)

Add nodes to the graph with a given ingest type.

Notes:

This is using the Runtimes's Snap to call addFeedData(), after setting the snap.strict mode to False. This will cause node creation and property setting to produce warning messages, instead of causing the Storm Runtime to be torn down.

Args:

name (str): Name of the ingest function to send data too.

data (prim): Data to send to the ingest function.

Returns:

The return type is `null`.

$lib.feed.list()

Get a list of feed functions.

Returns:

A list of feed functions. The return type is *list*.

13.1.24 $lib.gen

A Storm Library for secondary property based deconfliction.

$lib.gen.industryByName(name)

Returns an ou:industry by name, adding the node if it does not exist.

Args:

name (str): The name of the industry.

Returns:

An ou:industry node with the given name. The return type is *node*.

$lib.gen.langByCode(name, try=False)

Returns a lang:language node by language code, adding the node if it does not exist.

Args:

name (str): The language code for the language.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:

A lang:language node with the given code. The return type is *node*.

$lib.gen.langByName(name)

Returns a lang:language node by name, adding the node if it does not exist.

Args:
name (str): The name of the language.

Returns:
A lang:language node with the given name. The return type is *node*.

$lib.gen.newsByUrl(url, try=False)

Returns a media:news node by URL, adding the node if it does not exist.

Args:
url (inet:url): The URL where the news is published.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:
A media:news node with the given URL. The return type is *node*.

$lib.gen.orgByFqdn(fqdn, try=False)

Returns an ou:org node by FQDN, adding the node if it does not exist.

Args:
fqdn (str): The FQDN of the org.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:
An ou:org node with the given FQDN. The return type is *node*.

$lib.gen.orgByName(name)

Returns an ou:org by name, adding the node if it does not exist.

Args:
name (str): The name of the org.

Returns:
An ou:org node with the given name. The return type is *node*.

$lib.gen.orgHqByName(name)

Returns a ps:contact node for the ou:org, adding the node if it does not exist.

Args:
name (str): The name of the org.

Returns:
A ps:contact node for the ou:org with the given name. The return type is *node*.

$lib.gen.polCountryByIso2(iso2, try=False)

Returns a pol:country node by deconflicting the :iso2 property.

Args:
iso2 (str): The pol:country:iso2 property.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:
A pol:country node. The return type is *node*.

$lib.gen.psContactByEmail(type, email, try=False)

Returns a ps:contact by deconflicting the type and email address.

Args:
type (str): The ps:contact:type property.

email (str): The ps:contact:email property.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:
A ps:contact node. The return type is *node*.

$lib.gen.riskThreat(name, reporter)

Returns a risk:threat node based on the threat and reporter names, adding the node if it does not exist.

Args:
name (str): The reported name of the threat cluster.

reporter (str): The name of the organization which reported the threat cluster.

Returns:
A risk:threat node. The return type is *node*.

$lib.gen.riskToolSoftware(name, reporter)

Returns a risk:tool:software node based on the tool and reporter names, adding the node if it does not exist.

Args:
name (str): The reported name of the tool.

reporter (str): The name of the organization which reported the tool.

Returns:
A risk:tool:software node. The return type is *node*.

$lib.gen.softByName(name)

Returns it:prod:soft node by name, adding the node if it does not exist.

Args:
name (str): The name of the software.

Returns:
An it:prod:soft node with the given name. The return type is *node*.

$lib.gen.vulnByCve(cve, try=False)

Returns risk:vuln node by CVE, adding the node if it does not exist.

Args:
cve (str): The CVE id.

try (boolean): Type normalization will fail silently instead of raising an exception.

Returns:
A risk:vuln node with the given CVE. The return type is *node*.

13.1.25 $lib.globals

A Storm Library for interacting with global variables which are persistent across the Cortex.

$lib.globals.get(name, default=None)

Get a Cortex global variables.

Args:
name (str): Name of the variable.

default (prim): Default value to return if the variable is not set.

Returns:
The variable value. The return type is `prim`.

$lib.globals.list()

Get a list of variable names and values.

Returns:
A list of tuples with variable names and values that the user can access. The return type is *list*.

$lib.globals.pop(name, default=None)

Delete a variable value from the Cortex.

Args:
name (str): Name of the variable.

default (prim): Default value to return if the variable is not set.

Returns:
The variable value. The return type is `prim`.

$lib.globals.set(name, valu)

Set a variable value in the Cortex.

Args:
name (str): The name of the variable to set.

valu (prim): The value to set.

Returns:
The variable value. The return type is `prim`.

13.1.26 $lib.graph

A Storm Library for interacting with graph projections in the Cortex.

$lib.graph.activate(iden)

Set the graph projection to use for the top level Storm Runtime.

Args:
iden (str): The iden of the graph projection to use.

Returns:
The return type is `null`.

$lib.graph.add(gdef)

Add a graph projection to the Cortex.

Example:
Add a graph projection named "Test Projection":

```
$rules = ({
    "name": "Test Projection",
    "desc": "My test projection",
    "degrees": 2,
    "pivots": ["<- meta:seen <- meta:source"],
    "filters": ["-#nope"],
    "forms": {
        "inet:fqdn": {
            "pivots": ["<- *", "-> *"],
            "filters": ["-inet:fqdn:issuffix=1"]
        },
        "*": {
            "pivots": ["-> #"],
        }
    }
})
$lib.graph.add($rules)
```

Args:
gdef (dict): A graph projection definition.

Returns:
The return type is `null`.

$lib.graph.del(iden)

Delete a graph projection from the Cortex.

Args:
iden (str): The iden of the graph projection to delete.

Returns:
The return type is `null`.

$lib.graph.get(iden=None)

Get a graph projection definition from the Cortex.

Args:
iden (str): The iden of the graph projection to get. If not specified, returns the current graph projection.

Returns:
A graph projection definition, or None if no iden was specified and there is currently no graph projection set. The return type is *dict*.

$lib.graph.grant(gden, scope, iden, level)

Modify permissions granted to users/roles on a graph projection.

Args:
gden (str): Iden of the graph projection to modify.

scope (str): The scope, either "users" or "roles".

iden (str): The user/role iden depending on scope.

level (int): The permission level number.

Returns:
The return type is `null`.

$lib.graph.list()

List the graph projections available in the Cortex.

Returns:
A list of graph projection definitions. The return type is *list*.

$lib.graph.mod(iden, info)

Modify user editable properties of a graph projection.

Args:
iden (str): The iden of the graph projection to modify.

info (dict): A dictionary of the properties to edit.

Returns:
The return type is `null`.

13.1.27 $lib.hex

A Storm library which implements helpers for hexadecimal encoded strings.

$lib.hex.decode(valu)

Decode a hexadecimal string into bytes.

Args:
valu (str): The hex string to be decoded into bytes.

Returns:
The decoded bytes. The return type is *bytes*.

$lib.hex.encode(valu)

Encode bytes into a hexadecimal string.

Args:
valu (bytes): The bytes to be encoded into a hex string.

Returns:
The hex encoded string. The return type is *str*.

$lib.hex.fromint(valu, length, signed=False)

Convert an integer to a big endian hexadecimal string.

Args:
valu (int): The integer to be converted.

length (int): The number of bytes to use to represent the integer.

signed (bool): If true, convert as a signed value.

Returns:
The resulting hex string. The return type is *str*.

$lib.hex.signext(valu, length)

Sign extension pad a hexadecimal encoded signed integer.

Args:
valu (str): The hex string to pad.

length (int): The number of characters to pad the string to.

Returns:
The sign extended hex string. The return type is *str*.

$lib.hex.toint(valu, signed=False)

Convert a big endian hexadecimal string to an integer.

Args:
valu (str): The hex string to be converted.

signed (bool): If true, convert to a signed integer.

Returns:
The resulting integer. The return type is `int`.

$lib.hex.trimext(valu)

Trim sign extension bytes from a hexadecimal encoded signed integer.

Args:
valu (str): The hex string to trim.

Returns:
The trimmed hex string. The return type is *str*.

13.1.28 $lib.inet.http

A Storm Library exposing an HTTP client API.

$lib.inet.http.codereason(code)

Get the reason phrase for an HTTP status code.

Examples:
Get the reason for a 404 status code:

```
$str=$lib.inet.http.codereason(404)
```

Args:
code (int): The HTTP status code.

Returns:
The reason phrase for the status code. The return type is *str*.

$lib.inet.http.connect(url, headers=None, ssl_verify=True, timeout=300, params=None, proxy=None)

Connect a web socket to tx/rx JSON messages.

Args:

url (str): The URL to retrieve.

headers (dict): HTTP headers to send with the request.

ssl_verify (boolean): Perform SSL/TLS verification.

timeout (int): Total timeout for the request in seconds.

params (dict): Optional parameters which may be passed to the connection request.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:

A websocket object. The return type is *inet:http:socket*.

$lib.inet.http.get(url, headers=None, ssl_verify=True, params=None, timeout=300, allow_redirects=True, proxy=None)

Get the contents of a given URL.

Args:

url (str): The URL to retrieve.

headers (dict): HTTP headers to send with the request.

ssl_verify (boolean): Perform SSL/TLS verification.

params (dict): Optional parameters which may be passed to the request.

timeout (int): Total timeout for the request in seconds.

allow_redirects (bool): If set to false, do not follow redirects.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:

The response object. The return type is *inet:http:resp*.

$lib.inet.http.head(url, headers=None, ssl_verify=True, params=None, timeout=300, allow_redirects=False, proxy=None)

Get the HEAD response for a URL.

Args:

url (str): The URL to retrieve.

headers (dict): HTTP headers to send with the request.

ssl_verify (boolean): Perform SSL/TLS verification.

params (dict): Optional parameters which may be passed to the request.

timeout (int): Total timeout for the request in seconds.

allow_redirects (bool): If set to true, follow redirects.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:
The response object. The return type is *inet:http:resp*.

$lib.inet.http.post(url, headers=None, json=None, body=None, ssl_verify=True, params=None, timeout=300, allow_redirects=True, fields=None, proxy=None)

Post data to a given URL.

Args:
url (str): The URL to post to.

headers (dict): HTTP headers to send with the request.

json (prim): The data to post, as JSON object.

body (bytes): The data to post, as binary object.

ssl_verify (boolean): Perform SSL/TLS verification.

params (dict): Optional parameters which may be passed to the request.

timeout (int): Total timeout for the request in seconds.

allow_redirects (bool): If set to false, do not follow redirects.

fields (list): A list of info dictionaries containing the name, value or sha256, and additional parameters for fields to post, as multipart/form-data. If a sha256 is specified, the request will be sent from the axon and the corresponding file will be uploaded as the value for the field.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:
The response object. The return type is *inet:http:resp*.

$lib.inet.http.request(meth, url, headers=None, json=None, body=None, ssl_verify=True, params=None, timeout=300, allow_redirects=True, fields=None, proxy=None)

Make an HTTP request using the given HTTP method to the url.

Args:
meth (str): The HTTP method. (ex. PUT)

url (str): The URL to send the request to.

headers (dict): HTTP headers to send with the request.

json (prim): The data to include in the body, as JSON object.

body (bytes): The data to include in the body, as binary object.

ssl_verify (boolean): Perform SSL/TLS verification.

params (dict): Optional parameters which may be passed to the request.

timeout (int): Total timeout for the request in seconds.

allow_redirects (bool): If set to false, do not follow redirects.

fields (list): A list of info dictionaries containing the name, value or sha256, and additional parameters for fields to post, as multipart/form-data. If a sha256 is specified, the request will be sent from the axon and the corresponding file will be uploaded as the value for the field.

proxy: Set to a proxy URL string or $lib.false to disable proxy use. The input type may one one of the following: `bool`, `null`, `str`.

Returns:
The response object. The return type is *inet:http:resp*.

$lib.inet.http.urldecode(text)

Urldecode a text string.

This will replace %xx escape characters with the special characters they represent and replace plus signs with spaces.

Examples:
Urlencode a string:

```
$str=$lib.inet.http.urldecode("http%3A%2F%2Fgo+ogle.com")
```

Args:
text (str): The text string.

Returns:
The urldecoded string. The return type is *str*.

$lib.inet.http.urlencode(text)

Urlencode a text string.

This will replace special characters in a string using the %xx escape and replace spaces with plus signs.

Examples:
Urlencode a string:

```
$str=$lib.inet.http.urlencode("http://go ogle.com")
```

Args:
text (str): The text string.

Returns:
The urlencoded string. The return type is *str*.

13.1.29 $lib.inet.http.oauth.v1

A Storm library to handle OAuth v1 authentication.

$lib.inet.http.oauth.v1.client(ckey, csecret, atoken, asecret, sigtype=QUERY)

Initialize an OAuthV1 Client to use for signing/authentication.

Args:

ckey (str): The OAuthV1 Consumer Key to store and use for signing requests.

csecret (str): The OAuthV1 Consumer Secret used to sign requests.

atoken (str): The OAuthV1 Access Token (or resource owner key) to use to sign requests.)

asecret (str): The OAuthV1 Access Token Secret (or resource owner secret) to use to sign requests.

sigtype (str): Where to populate the signature (in the HTTP body, in the query parameters, or in the header)

Returns:

An OAuthV1 client to be used to sign requests. The return type is *inet:http:oauth:v1:client*.

13.1.30 $lib.inet.http.oauth.v2

A Storm library for managing OAuth V2 clients.

$lib.inet.http.oauth.v2.addProvider(conf)

Add a new provider configuration.

Example:

Add a new provider which uses the authorization code flow:

```
$iden = $lib.guid(example, provider, oauth)
$conf = ({
    "iden": $iden,
    "name": "example_provider",
    "client_id": "yourclientid",
    "client_secret": "yourclientsecret",
    "scope": "first_scope second_scope",
    "auth_uri": "https://provider.com/auth",
    "token_uri": "https://provider.com/token",
    "redirect_uri": "https://local.redirect.com/oauth",
})

// Optionally enable PKCE
$conf.extensions = ({"pkce": $lib.true})

// Optionally disable SSL verification
$conf.ssl_verify = $lib.false

// Optionally provide additional key-val parameters
// to include when calling the auth URI
$conf.extra_auth_params = ({"customparam": "foo"})

$lib.inet.http.oauth.v2.addProvider($conf)
```

Args:

conf (dict): A provider configuration.

Returns:
The return type is `null`.

$lib.inet.http.oauth.v2.clearUserAccessToken(iden)

Clear the stored refresh data for the current user's provider access token.

Args:
iden (str): The provider iden.

Returns:
The existing token state data or None if it did not exist. The return type is *dict*.

$lib.inet.http.oauth.v2.delProvider(iden)

Delete a provider configuration.

Args:
iden (str): The provider iden.

Returns:
The deleted provider configuration or None if it does not exist. The return type is *dict*.

$lib.inet.http.oauth.v2.getProvider(iden)

Get a provider configuration

Args:
iden (str): The provider iden.

Returns:
The provider configuration or None if it does not exist. The return type is *dict*.

$lib.inet.http.oauth.v2.getUserAccessToken(iden)

Get the provider access token for the current user.

Example:

Retrieve the token and handle needing an auth code:

```
$provideriden = $lib.globals.get("oauth:myprovider")

($ok, $data) = $lib.inet.http.oauth.v2.getUserAccessToken($provideriden)

if $ok {
    // $data is the token to be used in a request
else {
    // $data is a message stating why the token is not available
    // caller should now handle retrieving a new auth code for the user
}
```

Args:
iden (str): The provider iden.

Returns:
List of (<bool>, <token/mesg>) for status and data. The return type is *list*.

$lib.inet.http.oauth.v2.listProviders()

List provider configurations

Returns:
List of (iden, conf) tuples. The return type is *list*.

$lib.inet.http.oauth.v2.setUserAuthCode(iden, authcode, code_verifier=None)

Set the auth code for the current user.

Args:
iden (str): The provider iden.

authcode (str): The auth code for the user.

code_verifier (str): Optional PKCE code verifier.

Returns:
The return type is `null`.

13.1.31 $lib.inet.imap

A Storm library to connect to an IMAP server.

$lib.inet.imap.connect(host, port=993, timeout=30, ssl=True)

Open a connection to an IMAP server.

This method will wait for a "hello" response from the server before returning the `inet:imap:server` instance.

Args:
host (str): The IMAP hostname.

port (int): The IMAP server port.

timeout (int): The time to wait for all commands on the server to execute.

ssl (bool): Use SSL to connect to the IMAP server.

Returns:
A new `inet:imap:server` instance. The return type is *inet:imap:server*.

13.1.32 $lib.inet.ipv6

A Storm Library for providing ipv6 helpers.

$lib.inet.ipv6.expand(valu)

Convert a IPv6 address to its expanded form.'

Notes:
The expanded form is also sometimes called the "long form" address.

Examples:
Expand a ipv6 address to its long form:

```
$expandedvalu = $lib.inet.ipv6.expand('2001:4860:4860::8888')
```

Args:
valu (str): IPv6 Address to expand

Returns:
The expanded form. The return type is *str*.

13.1.33 $lib.inet.smtp

A Storm Library for sending email messages via SMTP.

$lib.inet.smtp.message()

Construct a new email message.

Returns:
The newly constructed inet:smtp:message. The return type is *inet:smtp:message*.

13.1.34 $lib.inet.whois

A Storm Library for providing a consistent way to generate guids for WHOIS / Registration Data in Storm.

$lib.inet.whois.guid(props, form)

Provides standard patterns for creating guids for certain inet:whois forms.

Raises:
StormRuntimeError: If form is not supported in this method.

Args:
props (dict): Dictionary of properties used to create the form.

form (str): The `inet:whois` form to create the guid for.

Returns:
A guid for creating a the node for. The return type is *str*.

13.1.35 $lib.infosec.cvss

A Storm library which implements CVSS score calculations.

$lib.infosec.cvss.calculate(node, save=True, vers=3.1)

Calculate the CVSS score values for an input risk:vuln node.

Args:

node (node): A risk:vuln node from the Storm runtime.

save (boolean): If true, save the computed scores to the node properties.

vers (str): The version of CVSS calculations to execute.

Returns:

A dictionary containing the computed score and subscores. The return type is *dict*.

$lib.infosec.cvss.calculateFromProps(props, vers=3.1)

Calculate the CVSS score values from a props dict.

Args:

props (dict): A props dictionary.

vers (str): The version of CVSS calculations to execute.

Returns:

A dictionary containing the computed score and subscores. The return type is *dict*.

$lib.infosec.cvss.saveVectToNode(node, text)

Parse a CVSS v3.1 vector and record properties on a risk:vuln node.

Args:

node (node): A risk:vuln node to record the CVSS properties on.

text (str): A CVSS vector string.

Returns:

The return type is `null`.

$lib.infosec.cvss.vectToProps(text)

Parse a CVSS v3.1 vector and return a dictionary of risk:vuln props.

Args:

text (str): A CVSS vector string.

Returns:

A dictionary of risk:vuln secondary props. The return type is *dict*.

$lib.infosec.cvss.vectToScore(vect, vers=None)

Compute CVSS scores from a vector string.

Takes a CVSS vector string, attempts to automatically detect the version (defaults to CVSS3.1 if it cannot), and calculates the base, temporal, and environmental scores.

Raises:

- BadArg: An invalid *vers* string is provided
- BadDataValu: The vector string is invalid in some way. Possible reasons are malformed string, duplicated metrics, missing mandatory metrics, and invalid metric values.

Args:

vect (str):
A valid CVSS vector string.

The following examples are valid formats:

- CVSS 2 with version: *CVSS2#AV:L/AC:L/Au:M/C:P/I:C/A:N*
- CVSS 2 with parentheses: *(AV:L/AC:L/Au:M/C:P/I:C/A:N)*
- CVSS 2 without parentheses: *AV:L/AC:L/Au:M/C:P/I:C/A:N*
- CVSS 3.0 with version: *CVSS:3.0/AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L*
- CVSS 3.1 with version: *CVSS:3.1/AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L*
- CVSS 3.0/3.1 with parentheses: *(AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L)*
- CVSS 3.0/3.1 without parentheses: *AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L*

vers (str):
A valid version string or None to autodetect the version from the vector string. Accepted values are: 2, 3.0, 3.1, None.

Returns:

A dictionary with the detected version, base score, temporal score, environmental score, overall score, and normalized vector string. The normalized vector string will have metrics ordered in specification order and metrics with undefined values will be removed. Example:

```
{
    'version': '3.1', 'score': 4.3, 'base': 5.0, 'temporal': 4.4, 'environmental': 4.3,
    'normalized': 'AV:N/AC:H/PR:L/UI:R/S:U/C:L/I:L/A:L'

}
```

The return type is *dict*.

13.1.36 $lib.iters

A Storm library for providing iterator helpers.

$lib.iters.enum(genr)

Yield (<indx>, <item>) tuples from an iterable or generator.

Args:
genr (iter): An iterable or generator.

yields:
Yields (<indx>, <item>) tuples. The return type is *list*.

13.1.37 $lib.json

A Storm Library for interacting with Json data.

$lib.json.load(text)

Parse a JSON string and return the deserialized data.

Args:
text (str): The string to be deserialized.

Returns:
The JSON deserialized object. The return type is `prim`.

$lib.json.save(item)

Save an object as a JSON string.

Args:
item (any): The item to be serialized as a JSON string.

Returns:
The JSON serialized object. The return type is *str*.

$lib.json.schema(schema, use_default=True)

Get a JS schema validation object.

Args:
schema (dict): The JsonSchema to use.

use_default (boolean): Whether to insert default schema values into the validated data structure.

Returns:
A validation object that can be used to validate data structures. The return type is *json:schema*.

13.1.38 $lib.jsonstor

Implements cortex JSON storage.

$lib.jsonstor.cacheget(path, key, asof=now, envl=False)

Retrieve data stored with cacheset() if it was stored more recently than the asof argument.

Args:

path (str|list): The base path to use for the cache key.

key (prim): The value to use for the GUID cache key.

asof (time): The max cache age.

envl (boolean): Return the full cache envelope.

Returns:

The cached value (or envelope) or null. The return type is `prim`.

$lib.jsonstor.cacheset(path, key, valu)

Set cache data with an envelope that tracks time for cacheget() use.

Args:

path (str|list): The base path to use for the cache key.

key (prim): The value to use for the GUID cache key.

valu (prim): The data to store.

Returns:

The cached asof time and path. The return type is *dict*.

$lib.jsonstor.del(path, prop=None)

Delete a stored JSON object or object.

Args:

path (str|list): A path string or list of path parts.

prop (str|list): A property name or list of name parts.

Returns:

True if the del operation was successful. The return type is *boolean*.

$lib.jsonstor.get(path, prop=None)

Return a stored JSON object or object property.

Args:

path (str|list): A path string or list of path parts.

prop (str|list): A property name or list of name parts.

Returns:

The previously stored value or $lib.null The return type is `prim`.

$lib.jsonstor.iter(path=None)

Yield (<path>, <valu>) tuples for the JSON objects.

Args:
path (str|list): A path string or list of path parts.

Yields:
(<path>, <item>) tuples. The return type is *list*.

$lib.jsonstor.set(path, valu, prop=None)

Set a JSON object or object property.

Args:
path (str|list): A path string or list of path elements.

valu (prim): The value to set as the JSON object or object property.

prop (str|list): A property name or list of name parts.

Returns:
True if the set operation was successful. The return type is *boolean*.

13.1.39 $lib.layer

A Storm Library for interacting with Layers in the Cortex.

$lib.layer.add(ldef=None)

Add a layer to the Cortex.

Args:
ldef (dict): The layer definition dictionary.

Returns:
A `layer` object representing the new layer. The return type is *layer*.

$lib.layer.del(iden)

Delete a layer from the Cortex.

Args:
iden (str): The iden of the layer to delete.

Returns:
The return type is `null`.

$lib.layer.get(iden=None)

Get a Layer from the Cortex.

Args:
iden (str): The iden of the layer to get. If not set, this defaults to the top layer of the current View.

Returns:
The storm layer object. The return type is *layer*.

$lib.layer.list()

List the layers in a Cortex

Returns:
List of `layer` objects. The return type is *list*.

13.1.40 $lib.lift

A Storm Library for interacting with lift helpers.

$lib.lift.byNodeData(name)

Lift nodes which have a given nodedata name set on them.

Args:
name (str): The name to of the nodedata key to lift by.

Yields:
Yields nodes to the pipeline. This must be used in conjunction with the `yield` keyword. The return type is *node*.

13.1.41 $lib.log

A Storm library which implements server side logging. These messages are logged to the `synapse.storm.log` logger.

$lib.log.debug(mesg, extra=None)

Log a message to the Cortex at the debug log level.

Notes:
This requires the `storm.lib.log.debug` permission to use.

Examples:
Log a debug message:

```
$lib.log.debug('I am a debug message!')
```

Log a debug message with extra information:

```
$lib.log.debug('Extra information included here.', extra={"key": $valu})
```

Args:
mesg (str): The message to log.

extra (dict): Extra key / value pairs to include when structured logging is enabled on the Cortex.

Returns:
The return type is `null`.

$lib.log.error(mesg, extra=None)

Log a message to the Cortex at the error log level.

Notes:
This requires the `storm.lib.log.error` permission to use.

Examples:
Log an error message:

```
$lib.log.error('I am a error message!')
```

Log an error message with extra information:

```
$lib.log.error('Extra information included here.', extra={"key": $valu})
```

Args:
mesg (str): The message to log.

extra (dict): Extra key / value pairs to include when structured logging is enabled on the Cortex.

Returns:
The return type is `null`.

$lib.log.info(mesg, extra=None)

Log a message to the Cortex at the info log level.

Notes:
This requires the `storm.lib.log.info` permission to use.

Examples:
Log an info message:

```
$lib.log.info('I am a info message!')
```

Log an info message with extra information:

```
$lib.log.info('Extra information included here.', extra={"key": $valu})
```

Args:
mesg (str): The message to log.

extra (dict): Extra key / value pairs to include when structured logging is enabled on the Cortex.

Returns:
The return type is `null`.

$lib.log.warning(mesg, extra=None)

Log a message to the Cortex at the warning log level.

Notes:
This requires the `storm.lib.log.warning` permission to use.

Examples:
Log a warning message:

```
$lib.log.warning('I am a warning message!')
```

Log a warning message with extra information:

```
$lib.log.warning('Extra information included here.', extra={"key": $valu})
```

Args:
mesg (str): The message to log.

extra (dict): Extra key / value pairs to include when structured logging is enabled on the Cortex.

Returns:
The return type is `null`.

13.1.42 $lib.macro

A Storm Library for interacting with the Storm Macros in the Cortex.

$lib.macro.del(name)

Delete a Storm Macro by name from the Cortex.

Args:
name (str): The name of the macro to delete.

Returns:
The return type is `null`.

$lib.macro.get(name)

Get a Storm Macro definition by name from the Cortex.

Args:
name (str): The name of the macro to get.

Returns:
A macro definition. The return type is *dict*.

$lib.macro.grant(name, scope, iden, level)

Modify permissions granted to users/roles on a Storm Macro.

Args:
name (str): Name of the Storm Macro to modify.

scope (str): The scope, either "users" or "roles".

iden (str): The user/role iden depending on scope.

level (int): The permission level number.

Returns:
The return type is `null`.

$lib.macro.list()

Get a list of Storm Macros in the Cortex.

Returns:
A list of `dict` objects containing Macro definitions. The return type is *list*.

$lib.macro.mod(name, info)

Modify user editable properties of a Storm Macro.

Args:
name (str): Name of the Storm Macro to modify.

info (dict): A dictionary of the properties to edit.

Returns:
The return type is `null`.

$lib.macro.set(name, storm)

Add or modify an existing Storm Macro in the Cortex.

Args:
name (str): Name of the Storm Macro to add or modify.

storm: The Storm query to add to the macro. The input type may one one of the following: `str`, `storm:query`.

Returns:
The return type is `null`.

13.1.43 $lib.math

A Storm library for performing math operations.

$lib.math.number(value)

Convert a value to a Storm Number object.

Storm Numbers are high precision fixed point decimals corresponding to the the hugenum storage type.

This is not to be used for converting a string to an integer.

Args:
value (any): Value to convert.

Returns:
A Number object. The return type is *number*.

13.1.44 $lib.mime.html

A Storm library for manipulating HTML text.

$lib.mime.html.totext(html)

Return inner text from all tags within an HTML document.

Args:
html (str): The HTML text to be parsed.

Returns:
The newline-joined inner HTML text. The return type is *str*.

13.1.45 $lib.model

A Storm Library for interacting with the Data Model in the Cortex.

$lib.model.form(name)

Get a form object by name.

Args:
name (str): The name of the form to retrieve.

Returns:
The `model:form` instance if the form is present or null. The return type may be one of the following: *model:form*, `null`.

$lib.model.prop(name)

Get a prop object by name.

Args:
name (str): The name of the prop to retrieve.

Returns:
The `model:property` instance if the type if present or null. The return type may be one of the following: *model:property*, `null`.

$lib.model.tagprop(name)

Get a tag property object by name.

Args:
name (str): The name of the tag prop to retrieve.

Returns:
The `model:tagprop` instance if the tag prop if present or null. The return type may be one of the following: *model:tagprop*, `null`.

$lib.model.type(name)

Get a type object by name.

Args:
name (str): The name of the type to retrieve.

Returns:
The `model:type` instance if the type if present on the form or null. The return type may be one of the following: *model:type*, `null`.

13.1.46 $lib.model.deprecated

A storm library for interacting with the model deprecation mechanism.

$lib.model.deprecated.lock(name, locked)

Set the locked property for a deprecated model element.

Args:
name (str): The full path of the model element to lock.

locked (boolean): The lock status.

Returns:
The return type is `null`.

$lib.model.deprecated.locks()

Get a dictionary of the data model elements which are deprecated and their lock status in the Cortex.

Returns:
A dictionary of named elements to their boolean lock values. The return type is *dict*.

13.1.47 $lib.model.edge

A Storm Library for interacting with light edges and manipulating their key-value attributes.

$lib.model.edge.del(verb, key)

Delete a key from the key-value store for a verb.

Args:
verb (str): The name of the Edge verb to remove a key from.

key (str): The name of the key to remove from the key-value store.

Returns:
The return type is `null`.

$lib.model.edge.get(verb)

Get the key-value data for a given Edge verb.

Args:
verb (str): The Edge verb to look up.

Returns:
A dictionary representing the key-value data set on a verb. The return type is *dict*.

$lib.model.edge.list()

Get a list of (verb, key-value dictionary) pairs for Edge verbs in the current Cortex View.

Returns:
A list of (str, dict) tuples for each verb in the current Cortex View. The return type is *list*.

$lib.model.edge.set(verb, key, valu)

Set a key-value for a given Edge verb.

Args:
verb (str): The Edge verb to set a value for.

key (str): The key to set.

valu (str): The value to set.

Returns:
The return type is `null`.

$lib.model.edge.validkeys()

Get a list of the valid keys that can be set on an Edge verb.

Returns:
A list of the valid keys. The return type is *list*.

13.1.48 $lib.model.ext

A Storm library for manipulating extended model elements.

$lib.model.ext.addForm(formname, basetype, typeopts, typeinfo)

Add an extended form definition to the data model.

Args:
formname (str): The name of the form to add.

basetype (str): The base type the form is derived from.

typeopts (dict): A Synapse type opts dictionary.

typeinfo (dict): A Synapse form info dictionary.

Returns:
The return type is `null`.

$lib.model.ext.addFormProp(formname, propname, typedef, propinfo)

Add an extended property definition to the data model.

Args:
formname (str): The name of the form to add the property to.

propname (str): The name of the extended property.

typedef (list): A Synapse type definition tuple.

propinfo (dict): A synapse property definition dictionary.

Returns:
The return type is `null`.

$lib.model.ext.addTagProp(propname, typedef, propinfo)

Add an extended tag property definition to the data model.

Args:
propname (str): The name of the tag property.

typedef (list): A Synapse type definition tuple.

propinfo (dict): A synapse property definition dictionary.

Returns:
The return type is `null`.

$lib.model.ext.addUnivProp(propname, typedef, propinfo)

Add an extended universal property definition to the data model.

Args:
propname (str): The name of the universal property.

typedef (list): A Synapse type definition tuple.

propinfo (dict): A synapse property definition dictionary.

Returns:
The return type is `null`.

$lib.model.ext.delForm(formname)

Remove an extended form definition from the model.

Args:
formname (str): The extended form to remove.

Returns:
The return type is `null`.

$lib.model.ext.delFormProp(formname, propname)

Remove an extended property definition from the model.

Args:
formname (str): The form with the extended property.

propname (str): The extended property to remove.

Returns:
The return type is `null`.

$lib.model.ext.delTagProp(propname)

Remove an extended tag property definition from the model.

Args:
propname (str): Name of the tag property to remove.

Returns:
The return type is `null`.

$lib.model.ext.delUnivProp(propname)

Remove an extended universal property definition from the model.

Args:
propname (str): Name of the universal property to remove.

Returns:
The return type is `null`.

13.1.49 $lib.model.tags

A Storm Library for interacting with tag specifications in the Cortex Data Model.

$lib.model.tags.del(tagname)

Delete a tag model specification.

Examples:

Delete the tag model specification for `cno.threat`:

```
$lib.model.tags.del(cno.threat)
```

Args:

tagname (str): The name of the tag.

Returns:

The return type is `null`.

$lib.model.tags.get(tagname)

Retrieve a tag model specification.

Examples:

Get the tag model specification for `cno.threat`:

```
$dict = $lib.model.tags.get(cno.threat)
```

Args:

tagname (str): The name of the tag.

Returns:

The tag model definition. The return type is *dict*.

$lib.model.tags.list()

List all tag model specifications.

Examples:

Iterate over the tag model specifications in the Cortex:

```
for ($name, $info) in $lib.model.tags.list() {
    ...
}
```

Returns:

List of tuples containing the tag name and model definition The return type is *list*.

$lib.model.tags.pop(tagname, propname)

Pop and return a tag model property.

Examples:

Remove the regex list from the `cno.threat` tag model:

```
$regxlist = $lib.model.tags.pop(cno.threat, regex)
```

Args:

tagname (str): The name of the tag.

propname (str): The name of the tag model property.

Returns:

The value of the property. The return type is `prim`.

$lib.model.tags.set(tagname, propname, propvalu)

Set a tag model property for a tag.

Examples:

Create a tag model for the `cno.cve` tag:

```
$regx = ($lib.null, $lib.null, "[0-9]{4}", "[0-9]{5}")
$lib.model.tags.set(cno.cve, regex, $regx)
```

Args:

tagname (str): The name of the tag.

propname (str): The name of the tag model property.

propvalu (prim): The value to set.

Returns:

The return type is `null`.

13.1.50 $lib.notifications

A Storm library for a user interacting with their notifications.

$lib.notifications.del(indx)

Delete a previously delivered notification.

Args:

indx (int): The index number of the notification to delete.

retn:

Returns an ($ok, $valu) tuple. The return type is *list*.

$lib.notifications.get(indx)

Return a notification by ID (or $lib.null).

Args:
indx (int): The index number of the notification to return.

retn:
The requested notification or $lib.null. The return type is *dict*.

$lib.notifications.list(size=None)

Yield (<indx>, <mesg>) tuples for a user's notifications.

Args:
size (int): The max number of notifications to yield.

Yields:
Yields (useriden, time, mesgtype, msgdata) tuples. The return type is *list*.

13.1.51 $lib.pipe

A Storm library for interacting with non-persistent queues.

$lib.pipe.gen(filler, size=10000)

Generate and return a Storm Pipe.

Notes:
The filler query is run in parallel with $pipe. This requires the permission `storm.pipe.gen` to use.

Examples:
Fill a pipe with a query and consume it with another:

```
$pipe = $lib.pipe.gen(${ $pipe.puts((1, 2, 3)) })

for $items in $pipe.slices(size=2) {
    $dostuff($items)
}
```

Args:
filler: A Storm query to fill the Pipe. The input type may one one of the following: `str`, `storm:query`.

size (int): Maximum size of the pipe.

Returns:
The pipe containing query results. The return type is *pipe*.

13.1.52 $lib.pkg

A Storm Library for interacting with Storm Packages.

$lib.pkg.add(pkgdef, verify=False)

Add a Storm Package to the Cortex.

Args:
pkgdef (dict): A Storm Package definition.

verify (boolean): Verify storm package signature.

Returns:
The return type is `null`.

$lib.pkg.del(name)

Delete a Storm Package from the Cortex.

Args:
name (str): The name of the package to delete.

Returns:
The return type is `null`.

$lib.pkg.deps(pkgdef)

Verify the dependencies for a Storm Package.

Args:
pkgdef (dict): A Storm Package definition.

Returns:
A dictionary listing dependencies and if they are met. The return type is *dict*.

$lib.pkg.get(name)

Get a Storm Package from the Cortex.

Args:
name (str): A Storm Package name.

Returns:
The Storm package definition. The return type is *dict*.

$lib.pkg.has(name)

Check if a Storm Package is available in the Cortex.

Args:
name (str): A Storm Package name to check for the existence of.

Returns:
True if the package exists in the Cortex, False if it does not. The return type is *boolean*.

$lib.pkg.list()

Get a list of Storm Packages loaded in the Cortex.

Returns:
A list of Storm Package definitions. The return type is *list*.

13.1.53 $lib.projects

A Storm Library for interacting with Projects in the Cortex.

$lib.projects.add(name, desc=)

Add a new project

Args:
name (str): The name of the Project to add

desc (str): A description of the overall project

Returns:
The newly created *proj:project* object The return type is *proj:project*.

$lib.projects.del(name)

Delete an existing project

Args:
name (str): The name of the Project to delete

Returns:
True if the project exists and gets deleted, otherwise False The return type is *boolean*.

$lib.projects.get(name)

Retrieve a project by name

Args:
name (str): The name of the Project to get

Returns:
The *proj:project `object, if it exists, otherwise null The return type is :ref: `stormprims-proj-project-f527*.

13.1.54 $lib.ps

A Storm Library for interacting with running tasks on the Cortex.

$lib.ps.kill(prefix)

Stop a running task on the Cortex.

Args:
prefix (str): The prefix of the task to stop. Tasks will only be stopped if there is a single prefix match.

Returns:
True if the task was cancelled, False otherwise. The return type is *boolean*.

$lib.ps.list()

List tasks the current user can access.

Returns:
A list of task definitions. The return type is *list*.

13.1.55 $lib.queue

A Storm Library for interacting with persistent Queues in the Cortex.

$lib.queue.add(name)

Add a Queue to the Cortex with a given name.

Args:
name (str): The name of the queue to add.

Returns:
The return type is *queue*.

$lib.queue.del(name)

Delete a given named Queue.

Args:
name (str): The name of the queue to delete.

Returns:
The return type is `null`.

$lib.queue.gen(name)

Add or get a Storm Queue in a single operation.

Args:
name (str): The name of the Queue to add or get.

Returns:
The return type is *queue*.

$lib.queue.get(name)

Get an existing Storm Queue object.

Args:
name (str): The name of the Queue to get.

Returns:
A queue object. The return type is *queue*.

$lib.queue.list()

Get a list of the Queues in the Cortex.

Returns:
A list of queue definitions the current user is allowed to interact with. The return type is *list*.

13.1.56 $lib.random

A Storm library for generating random values.

$lib.random.int(maxval, minval=0)

Generate a random integer.

Args:
maxval (int): The maximum random value.

minval (int): The minimum random value.

Returns:
A random integer in the range min-max inclusive. The return type is `int`.

13.1.57 $lib.regex

A Storm library for searching/matching with regular expressions.

$lib.regex.findall(pattern, text, flags=0)

Search the given text for the patterns and return a list of matching strings.

Note:
If multiple matching groups are specified, the return value is a list of lists of strings.

Example:

Extract the matching strings from a piece of text:

```
for $x in $lib.regex.findall("G[0-9]{4}", "G0006 and G0001") {
    $dostuff($x)
}
```

Args:
pattern (str): The regular expression pattern.

text (str): The text to match.

flags (int): Regex flags to control the match behavior.

Returns:
A list of lists of strings for the matching groups in the pattern. The return type is *list*.

$lib.regex.flags.i

Regex flag to indicate that case insensitive matches are allowed.

Returns:
The type is `int`.

$lib.regex.flags.m

Regex flag to indicate that multiline matches are allowed.

Returns:
The type is `int`.

$lib.regex.matches(pattern, text, flags=0)

Check if text matches a pattern. Returns $lib.true if the text matches the pattern, otherwise $lib.false.

Notes:
This API requires the pattern to match at the start of the string.

Example:
Check if the variable matches a expression:

```
if $lib.regex.matches("^[0-9]+.[0-9]+.[0-9]+$", $text) {
    $lib.print("It's semver! ...probably")
}
```

Args:
pattern (str): The regular expression pattern.

text (str): The text to match.

flags (int): Regex flags to control the match behavior.

Returns:
True if there is a match, False otherwise. The return type is *boolean*.

$lib.regex.replace(pattern, replace, text, flags=0)

Replace any substrings that match the given regular expression with the specified replacement.

Example:
Replace a portion of a string with a new part based on a regex:

```
$norm = $lib.regex.replace("\sAND\s", " & ", "Ham and eggs!", $lib.regex.flags.i)
```

Args:
pattern (str): The regular expression pattern.

replace (str): The text to replace matching sub strings.

text (str): The input text to search/replace.

flags (int): Regex flags to control the match behavior.

Returns:
The new string with matches replaced. The return type is *str*.

$lib.regex.search(pattern, text, flags=0)

Search the given text for the pattern and return the matching groups.

Note:
In order to get the matching groups, patterns must use parentheses to indicate the start and stop of the regex to return portions of. If groups are not used, a successful match will return a empty list and a unsuccessful match will return `$lib.null`.

Example:
Extract the matching groups from a piece of text:

```
$m = $lib.regex.search("^([0-9])+.([0-9])+.([0-9])+$", $text)
if $m {
    ($maj, $min, $pat) = $m
}
```

Args:
pattern (str): The regular expression pattern.

text (str): The text to match.

flags (int): Regex flags to control the match behavior.

Returns:
A list of strings for the matching groups in the pattern. The return type is *list*.

13.1.58 $lib.scrape

A Storm Library for providing helpers for scraping nodes from text.

$lib.scrape.context(text)

Attempt to scrape information from a blob of text, getting the context information about the values found.

Notes:
This does call the `scrape` Storm interface if that behavior is enabled on the Cortex.

Examples:
Scrape some text and make nodes out of it:

```
for ($form, $valu, $info) in $lib.scrape.context($text) {
    [ ( *$form ?= $valu ) ]
}
```

Args:
text (str): The text to scrape

yields:
A dictionary of scraped values, rule types, and offsets scraped from the text. The return type is *dict*.

$lib.scrape.genMatches(text, pattern, fangs=None, flags=2)

genMatches is a generic helper function for constructing scrape interfaces using pure Storm.

It accepts the text, a regex pattern, and produce results that can easily be used to create

Notes:
The pattern must have a named regular expression match for the key `valu` using the named group syntax. For example `(somekey\s)(?P<valu>[a-z0-9]+)\s`.

Examples:
A scrape implementation with a regex that matches name keys in text:

```
$re="(Name\:\s)(?P<valu>[a-z0-9]+)\s"
$form="ps:name"

function scrape(text, form) {
        $ret = $lib.list()
        for ($valu, $info) in $lib.scrape.genMatches($text, $re) {
            $ret.append(($form, $valu, $info))
        }
        return ( $ret )
    }
```

Args:
text (str): The text to scrape

pattern (str): The regular expression pattern to match against.

fangs (list): A list of (src, dst) pairs to refang from text. The src must be equal or larger than the dst in length.

flags (int): Regex flags to use (defaults to IGNORECASE).

yields:
The return type is *list*.

$lib.scrape.ndefs(text)

Attempt to scrape node form, value tuples from a blob of text.

Examples:
Scrape some text and attempt to make nodes out of it:

```
for ($form, $valu) in $lib.scrape($text) {
    [ ( *$form ?= $valu ) ]
}
```

Args:
text (str): The text to scrape

yields:
A list of (form, value) tuples scraped from the text. The return type is *list*.

13.1.59 $lib.service

A Storm Library for interacting with Storm Services.

$lib.service.add(name, url)

Add a Storm Service to the Cortex.

Args:
name (str): Name of the Storm Service to add.

url (str): The Telepath URL to the Storm Service.

Returns:
The Storm Service definition. The return type is *dict*.

$lib.service.del(iden)

Remove a Storm Service from the Cortex.

Args:
iden (str): The iden of the service to remove.

Returns:
The return type is `null`.

$lib.service.get(name)

Get a Storm Service definition.

Args:
name (str): The local name, local iden, or remote name, of the service to get the definition for.

Returns:
A Storm Service definition. The return type is *dict*.

$lib.service.has(name)

Check if a Storm Service is available in the Cortex.

Args:
name (str): The local name, local iden, or remote name, of the service to check for the existence of.

Returns:
True if the service exists in the Cortex, False if it does not. The return type is *boolean*.

$lib.service.list()

List the Storm Service definitions for the Cortex.

Notes:
The definition dictionaries have an additional `ready` key added to them to indicate if the Cortex is currently connected to the Storm Service or not.

Returns:
A list of Storm Service definitions. The return type is *list*.

$lib.service.wait(name, timeout=None)

Wait for a given service to be ready.

Notes:
If a timeout value is not specified, this will block a Storm query until the service is available.

Args:
name (str): The name, or iden, of the service to wait for.

timeout (int): Number of seconds to wait for the service.

Returns:
Returns true if the service is available, false on a timeout waiting for the service to be ready. The return type is *boolean*.

13.1.60 $lib.stats

A Storm Library for statistics related functionality.

$lib.stats.tally()

Get a Tally object.

Returns:
A new tally object. The return type is *stat:tally*.

13.1.61 $lib.stix

A Storm Library for interacting with Stix Version 2.1 CS02.

$lib.stix.lift(bundle)

Lift nodes from a STIX Bundle made by Synapse.

Notes:
This lifts nodes using the Node definitions embedded into the bundle when created by Synapse using custom extension properties.

Examples:
Lifting nodes from a STIX bundle:

```
yield $lib.stix($bundle)
```

Args:
bundle (dict): The STIX bundle to lift nodes from.

Yields:
Yields nodes The return type is *node*.

$lib.stix.validate(bundle)

Validate a STIX Bundle.

Notes:
This returns a dictionary containing the following values:

```
{
    'ok': <boolean> - False if bundle is invalid, True otherwise.
    'mesg': <str> - An error message if there was an error when validating the␣
↪bundle.
    'results': The results of validating the bundle.
}
```

Args:
bundle (dict): The stix bundle to validate.

Returns:
Results dictionary. The return type is *dict*.

13.1.62 $lib.stix.export

A Storm Library for exporting to STIX version 2.1 CS02.

$lib.stix.export.bundle(config=None)

Return a new empty STIX bundle.

The config argument maps synapse forms to stix types and allows you to specify how to resolve STIX properties and relationships. The config expects to following format:

```
{
    "maxsize": 10000,

    "forms": {
        <formname>: {
            "default": <stixtype0>,
            "stix": {
                <stixtype0>: {
                    "props": {
                        <stix_prop_name>: <storm_with_return>,
                        ...
                    },
                    "rels": (
                        ( <relname>, <target_stixtype>, <storm> ),
                        ...
                    ),
                    "revs": (
                        ( <revname>, <source_stixtype>, <storm> ),
                        ...
                    )
                },
                <stixtype1>: ...
            },
        },
    },
},
```

For example, the default config includes the following entry to map ou:campaign nodes to stix campaigns:

```
{ "forms": {
    "ou:campaign": {
        "default": "campaign",
        "stix": {
            "campaign": {
                "props": {
                    "name": "{+:name return(:name)} return($node.repr())",
                    "description": "+:desc return(:desc)",
                    "objective": "+:goal :goal -> ou:goal +:name return(:name)",
                    "created": "return($lib.stix.export.timestamp(.created))",
                    "modified": "return($lib.stix.export.timestamp(.created))",
                },
                "rels": (
```

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```
                    ("attributed-to", "threat-actor", ":org -> ou:org"),
                    ("originates-from", "location", ":org -> ou:org :hq -> geo:place"),
                    ("targets", "identity", "-> risk:attack :target:org -> ou:org"),
                    ("targets", "identity", "-> risk:attack :target:person -> ps:person
↪"),
                ),
            },
        },
}},
```

You may also specify pivots on a per form+stixtype basis to automate pivoting to additional nodes to include in the bundle:

```
{"forms": {
    "inet:fqdn":
        ...
        "domain-name": {
            ...
            "pivots": [
                {"storm": "-> inet:dns:a -> inet:ipv4", "stixtype": "ipv4-addr"}
            ]
        {
    }
}
```

Note:
The default config is an evolving set of mappings. If you need to guarantee stable output please specify a config.

Args:
config (dict): The STIX bundle export config to use.

Returns:
A new `stix:bundle` instance. The return type is *stix:bundle*.

$lib.stix.export.config()

Construct a default STIX bundle export config.

Returns:
A default STIX bundle export config. The return type is *dict*.

$lib.stix.export.timestamp(tick)

Format an epoch milliseconds timestamp for use in STIX output.

Args:
tick (time): The epoch milliseconds timestamp.

Returns:
A STIX formatted timestamp string. The return type is *str*.

13.1.63 $lib.stix.import

A Storm Library for importing Stix Version 2.1 data.

$lib.stix.import.config()

Return an editable copy of the default STIX ingest config.

Returns:
A copy of the default STIX ingest configuration. The return type is *dict*.

$lib.stix.import.ingest(bundle, config=None)

Import nodes from a STIX bundle.

Args:
bundle (dict): The STIX bundle to ingest.

config (dict): An optional STIX ingest configuration.

Yields:
Yields nodes The return type is *node*.

13.1.64 $lib.storm

A Storm library for evaluating dynamic storm expressions.

$lib.storm.eval(text, cast=None)

Evaluate a storm runtime value and optionally cast/coerce it.

Args:
text (str): A storm expression string.

cast (str): A type to cast the result to.

Returns:
The value of the expression and optional cast. The return type is `any`.

13.1.65 $lib.str

A Storm Library for interacting with strings.

$lib.str.concat(*args)

Concatenate a set of strings together.

Args:
*args (any): Items to join together.

Returns:
The joined string. The return type is *str*.

$lib.str.format(text, **kwargs)

Format a text string.

Examples:

Format a string with a fixed argument and a variable:

```
cli> storm $list=(1,2,3,4)
     $str=$lib.str.format('Hello {name}, your list is {list}!', name='Reader', list=
↪$list)
     $lib.print($str)

Hello Reader, your list is ['1', '2', '3', '4']!
```

Args:

text (str): The base text string.

**kwargs (any): Keyword values which are substituted into the string.

Returns:

The new string. The return type is *str*.

$lib.str.join(sepr, items)

Join items into a string using a separator.

Examples:

Join together a list of strings with a dot separator:

```
cli> storm $foo=$lib.str.join('.', ('rep', 'vtx', 'tag')) $lib.print($foo)

rep.vtx.tag
```

Args:

sepr (str): The separator used to join strings with.

items (list): A list of items to join together.

Returns:

The joined string. The return type is *str*.

13.1.66 $lib.tags

Storm utility functions for tags.

$lib.tags.prefix(names, prefix, ispart=False)

Normalize and prefix a list of syn:tag:part values so they can be applied.

Examples:

Add tag prefixes and then use them to tag nodes:

```
$tags = $lib.tags.prefix($result.tags, vtx.visi)
{ for $tag in $tags { [ +#$tag ] } }
```

Args:
names (list): A list of syn:tag:part values to normalize and prefix.

prefix (str): The string prefix to add to the syn:tag:part values.

ispart (boolean): Whether the names have already been normalized. Normalization will be skipped if set to true.

Returns:
A list of normalized and prefixed syn:tag values. The return type is *list*.

13.1.67 $lib.telepath

A Storm Library for making Telepath connections to remote services.

$lib.telepath.open(url)

Open and return a Telepath RPC proxy.

Args:
url (str): The Telepath URL to connect to.

Returns:
A object representing a Telepath Proxy. The return type is *telepath:proxy*.

13.1.68 $lib.time

A Storm Library for interacting with timestamps.

$lib.time.day(tick)

Returns the day part of a time value.

Args:
tick (time): A time value.

Returns:
The day part of the time expression. The return type is `int`.

$lib.time.dayofmonth(tick)

Returns the index (beginning with 0) of the day within the month.

Args:
tick (time): A time value.

Returns:
The index of the day within month. The return type is `int`.

$lib.time.dayofweek(tick)

Returns the index (beginning with monday as 0) of the day within the week.

Args:
tick (time): A time value.

Returns:
The index of the day within week. The return type is `int`.

$lib.time.dayofyear(tick)

Returns the index (beginning with 0) of the day within the year.

Args:
tick (time): A time value.

Returns:
The index of the day within year. The return type is `int`.

$lib.time.format(valu, format)

Format a Synapse timestamp into a string value using `datetime.strftime()`.

Examples:
Format a timestamp into a string:

```
cli> storm $now=$lib.time.now() $str=$lib.time.format($now, '%A %d, %B %Y') $lib.
↪print($str)

Tuesday 14, July 2020
```

Args:
valu (int): A timestamp in epoch milliseconds.

format (str): The strftime format string.

Returns:
The formatted time string. The return type is *str*.

$lib.time.fromunix(secs)

Normalize a timestamp from a unix epoch time in seconds to milliseconds.

Examples:
Convert a timestamp from seconds to millis and format it:

```
cli> storm $seconds=1594684800 $millis=$lib.time.fromunix($seconds)
     $str=$lib.time.format($millis, '%A %d, %B %Y') $lib.print($str)

Tuesday 14, July 2020
```

Args:
secs (int): Unix epoch time in seconds.

Returns:
The normalized time in milliseconds. The return type is `int`.

$lib.time.hour(tick)

Returns the hour part of a time value.

Args:
tick (time): A time value.

Returns:
The hour part of the time expression. The return type is `int`.

$lib.time.minute(tick)

Returns the minute part of a time value.

Args:
tick (time): A time value.

Returns:
The minute part of the time expression. The return type is `int`.

$lib.time.month(tick)

Returns the month part of a time value.

Args:
tick (time): A time value.

Returns:
The month part of the time expression. The return type is `int`.

$lib.time.monthofyear(tick)

Returns the index (beginning with 0) of the month within the year.

Args:
tick (time): A time value.

Returns:
The index of the month within year. The return type is `int`.

$lib.time.now()

Get the current epoch time in milliseconds.

Returns:
Epoch time in milliseconds. The return type is `int`.

$lib.time.parse(valu, format, errok=False)

Parse a timestamp string using `datetime.strptime()` into an epoch timestamp.

Examples:

Parse a string as for its month/day/year value into a timestamp:

```
cli> storm $s='06/01/2020' $ts=$lib.time.parse($s, '%m/%d/%Y') $lib.print($ts)

1590969600000
```

Args:

valu (str): The timestamp string to parse.

format (str): The format string to use for parsing.

errok (boolean): If set, parsing errors will return `$lib.null` instead of raising an exception.

Returns:

The epoch timestamp for the string. The return type is `int`.

$lib.time.second(tick)

Returns the second part of a time value.

Args:

tick (time): A time value.

Returns:

The second part of the time expression. The return type is `int`.

$lib.time.sleep(valu)

Pause the processing of data in the storm query.

Notes:

This has the effect of clearing the Snap's cache, so any node lifts performed after the `$lib.time.sleep(...)` executes will be lifted directly from storage.

Args:

valu (int): The number of seconds to pause for.

Returns:

The return type is `null`.

$lib.time.ticker(tick, count=None)

Periodically pause the processing of data in the storm query.

Notes:

This has the effect of clearing the Snap's cache, so any node lifts performed after each tick will be lifted directly from storage.

Args:

tick (int): The amount of time to wait between each tick, in seconds.

count (int): The number of times to pause the query before exiting the loop. This defaults to None and will yield forever if not set.

Yields:
This yields the current tick count after each time it wakes up. The return type is `int`.

$lib.time.toUTC(tick, timezone)

Adjust an epoch milliseconds timestamp to UTC from the given timezone.

Args:
tick (time): A time value.

timezone (str): A timezone name. See python pytz docs for options.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

$lib.time.year(tick)

Returns the year part of a time value.

Args:
tick (time): A time value.

Returns:
The year part of the time expression. The return type is `int`.

13.1.69 $lib.trigger

A Storm Library for interacting with Triggers in the Cortex.

$lib.trigger.add(tdef)

Add a Trigger to the Cortex.

Args:
tdef (dict): A Trigger definition.

Returns:
The new trigger. The return type is *trigger*.

$lib.trigger.del(prefix)

Delete a Trigger from the Cortex.

Args:
prefix (str): A prefix to match in order to identify a trigger to delete. Only a single matching prefix will be deleted.

Returns:
The iden of the deleted trigger which matched the prefix. The return type is *str*.

$lib.trigger.disable(prefix)

Disable a Trigger in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a trigger to disable. Only a single matching prefix will be disabled.

Returns:

The iden of the trigger that was disabled. The return type is *str*.

$lib.trigger.enable(prefix)

Enable a Trigger in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a trigger to enable. Only a single matching prefix will be enabled.

Returns:

The iden of the trigger that was enabled. The return type is *str*.

$lib.trigger.get(iden)

Get a Trigger in the Cortex.

Args:

iden (str): The iden of the Trigger to get.

Returns:

The requested `trigger` object. The return type is *trigger*.

$lib.trigger.list()

Get a list of Triggers in the current view.

Returns:

A list of `trigger` objects the user is allowed to access. The return type is *list*.

$lib.trigger.mod(prefix, query)

Modify an existing Trigger in the Cortex.

Args:

prefix (str): A prefix to match in order to identify a trigger to modify. Only a single matching prefix will be modified.

query: The new Storm query to set as the trigger query. The input type may one one of the following: `str`, `storm:query`.

Returns:

The iden of the modified Trigger The return type is *str*.

13.1.70 $lib.user

A Storm Library for interacting with data about the current user.

$lib.user.allowed(permname, gateiden=None, default=False)

Check if the current user has a given permission.

Args:

permname (str): The permission string to check.

gateiden (str): The authgate iden.

default (boolean): The default value.

Returns:

True if the user has the requested permission, false otherwise. The return type is *boolean*.

$lib.user.iden

The user GUID for the current storm user.

Returns:

The type is *str*.

$lib.user.name()

Get the name of the current runtime user.

Returns:

The username. The return type is *str*.

$lib.user.profile

Get a Hive dictionary representing the current user's profile information.

Returns:

The type is *hive:dict*.

$lib.user.vars

Get a Hive dictionary representing the current user's persistent variables.

Returns:

The type is *hive:dict*.

13.1.71 $lib.vars

A Storm Library for interacting with runtime variables.

$lib.vars.del(name)

Unset a variable in the current Runtime.

Args:
name (str): The variable name to remove.

Returns:
The return type is `null`.

$lib.vars.get(name, defv=None)

Get the value of a variable from the current Runtime.

Args:
name (str): Name of the variable to get.

defv (prim): The default value returned if the variable is not set in the runtime.

Returns:
The value of the variable. The return type is `any`.

$lib.vars.list()

Get a list of variables from the current Runtime.

Returns:
A list of variable names and their values for the current Runtime. The return type is *list*.

$lib.vars.set(name, valu)

Set the value of a variable in the current Runtime.

Args:
name (str): Name of the variable to set.

valu (prim): The value to set the variable too.

Returns:
The return type is `null`.

13.1.72 $lib.version

A Storm Library for interacting with version information.

$lib.version.commit()

The synapse commit hash for the local Cortex.

Returns:
The commit hash. The return type is *str*.

$lib.version.matches(vertup, reqstr)

Check if the given version triple meets the requirements string.

Examples:
Check if the synapse version is in a range:

```
$synver = $lib.version.synapse()
if $lib.version.matches($synver, ">=2.9.0") {
    $dostuff()
}
```

Args:
vertup (list): Triple of major, minor, and patch version integers.

reqstr (str): The version string to compare against.

Returns:
True if the version meets the requirements, False otherwise. The return type is *boolean*.

$lib.version.synapse()

The synapse version tuple for the local Cortex.

Returns:
The version triple. The return type is *list*.

13.1.73 $lib.view

A Storm Library for interacting with Views in the Cortex.

$lib.view.add(layers, name=None)

Add a View to the Cortex.

Args:
layers (list): A list of layer idens which make up the view.

name (str): The name of the view.

Returns:
A `view` object representing the new View. The return type is *view*.

$lib.view.del(iden)

Delete a View from the Cortex.

Args:
iden (str): The iden of the View to delete.

Returns:
The return type is `null`.

$lib.view.get(iden=None)

Get a View from the Cortex.

Args:
iden (str): The iden of the View to get. If not specified, returns the current View.

Returns:
The storm view object. The return type is *view*.

$lib.view.list(deporder=False)

List the Views in the Cortex.

Args:
deporder (bool): Return the lists in bottom-up dependency order.

Returns:
List of `view` objects. The return type is *list*.

13.1.74 $lib.xml

A Storm library for parsing XML.

$lib.xml.parse(valu)

Parse an XML string into an xml:element tree.

Args:
valu (str): The XML string to parse into an xml:element tree.

Returns:
An xml:element for the root node of the XML tree. The return type is *xml:element*.

13.1.75 $lib.yaml

A Storm Library for saving/loading YAML data.

$lib.yaml.load(valu)

Decode a YAML string/bytes into an object.

Args:
valu (str): The string to decode.

Returns:
The decoded primitive object. The return type is `prim`.

$lib.yaml.save(valu, sort_keys=True)

Encode data as a YAML string.

Args:
valu (object): The object to encode.

sort_keys (boolean): Sort object keys.

Returns:
A YAML string. The return type is *str*.

13.2 Storm Types

Storm Objects are used as view objects for manipulating data in the Storm Runtime and in the Cortex itself.

13.2.1 auth:gate

Implements the Storm API for an AuthGate.

iden

The iden of the AuthGate.

Returns:
The type is *str*.

roles

The role idens which are a member of the Authgate.

Returns:
The type is *list*.

type

The type of the AuthGate.

Returns:
The type is *str*.

users

The user idens which are a member of the Authgate.

Returns:
The type is *list*.

13.2.2 auth:role

Implements the Storm API for a Role.

addRule(rule, gateiden=None, indx=None)

Add a rule to the Role

Args:
rule (list): The rule tuple to added to the Role.

gateiden (str): The gate iden used for the rule.

indx (int): The position of the rule as a 0 based index.

Returns:
The return type is `null`.

delRule(rule, gateiden=None)

Remove a rule from the Role.

Args:
rule (list): The rule tuple to removed from the Role.

gateiden (str): The gate iden used for the rule.

Returns:
The return type is `null`.

gates()

Return a list of auth gates that the role has rules for.

Returns:
A list of `auth:gates` that the role has rules for. The return type is *list*.

get(name)

Get a arbitrary property from the Role definition.

Args:
name (str): The name of the property to return.

Returns:
The requested value. The return type is `prim`.

getRules(gateiden=None)

Get the rules for the role and optional auth gate.

Args:
gateiden (str): The gate iden used for the rules.

Returns:
A list of rules. The return type is *list*.

iden

The Role iden.

Returns:
The type is *str*.

name

A role's name. This can also be used to set the role name.

Example:
Change a role's name:

```
$role=$lib.auth.roles.byname(analyst) $role.name=superheroes
```

Returns:
The return type is *str*. When this is used to set the value, it does not have a return type.

pack()

Get the packed version of the Role.

Returns:
The packed Role definition. The return type is *dict*.

popRule(indx, gateiden=None)

Remove a rule by index from the Role.

Args:
indx (int): The index of the rule to remove.

gateiden (str): The gate iden used for the rule.

Returns:
The rule which was removed. The return type is *list*.

setRules(rules, gateiden=None)

Replace the rules on the Role with new rules.

Args:
rules (list): A list of rules to set on the Role.

gateiden (str): The gate iden used for the rules.

Returns:
The return type is `null`.

13.2.3 auth:user

Implements the Storm API for a User.

addRule(rule, gateiden=None, indx=None)

Add a rule to the User.

Args:
rule (list): The rule tuple to add to the User.

gateiden (str): The gate iden used for the rule.

indx (int): The position of the rule as a 0 based index.

Returns:
The return type is `null`.

allowed(permname, gateiden=None, default=False)

Check if the user has a given permission.

Args:
permname (str): The permission string to check.

gateiden (str): The authgate iden.

default (boolean): The default value.

Returns:
True if the rule is allowed, False otherwise. The return type is *boolean*.

delRule(rule, gateiden=None)

Remove a rule from the User.

Args:
rule (list): The rule tuple to removed from the User.

gateiden (str): The gate iden used for the rule.

Returns:
The return type is `null`.

email

A user's email. This can also be used to set the user's email.

Example:
Change a user's email address:

```
$user=$lib.auth.users.byname(bob) $user.email="robert@bobcorp.net"
```

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

gates()

Return a list of auth gates that the user has rules for.

Returns:
A list of `auth:gates` that the user has rules for. The return type is *list*.

get(name)

Get a arbitrary property from the User definition.

Args:
name (str): The name of the property to return.

Returns:
The requested value. The return type is `prim`.

getAllowedReason(permname, gateiden=None, default=False)

Return an allowed status and reason for the given perm.

Args:
permname (str): The permission string to check.

gateiden (str): The authgate iden.

default (boolean): The default value.

Returns:
An (allowed, reason) tuple. The return type is *list*.

getRules(gateiden=None)

Get the rules for the user and optional auth gate.

Args:
gateiden (str): The gate iden used for the rules.

Returns:
A list of rules. The return type is *list*.

grant(iden, indx=None)

Grant a Role to the User.

Args:
iden (str): The iden of the Role.

indx (int): The position of the Role as a 0 based index.

Returns:
The return type is `null`.

iden

The User iden.

Returns:
The type is *str*.

name

A user's name. This can also be used to set a user's name.

Example:
Change a user's name:

```
$user=$lib.auth.users.byname(bob) $user.name=robert
```

Returns:
The return type is *str*. When this is used to set the value, it does not have a return type.

notify(mesgtype, mesgdata)

Send an arbitrary user notification.

Args:
mesgtype (str): The notification type.

mesgdata (dict): The notification data.

Returns:
The return type is `null`.

pack()

Get the packed version of the User.

Returns:
The packed User definition. The return type is *dict*.

popRule(indx, gateiden=None)

Remove a rule by index from the User.

Args:
indx (int): The index of the rule to remove.

gateiden (str): The gate iden used for the rule.

Returns:
The rule which was removed. The return type is *list*.

profile

A user profile dictionary. This can be used as an application level key-value store.

Example:
Set a value:

```
$user=$lib.auth.users.byname(bob) $user.profile.somekey="somevalue"
```

Get a value:

```
$user=$lib.auth.users.byname(bob) $value = $user.profile.somekey
```

Returns:
The return type is *auth:user:profile*.

revoke(iden)

Remove a Role from the User

Args:
iden (str): The iden of the Role.

Returns:
The return type is `null`.

roles()

Get the Roles for the User.

Returns:
A list of `auth:roles` which the user is a member of. The return type is *list*.

setAdmin(admin, gateiden=None)

Set the Admin flag for the user.

Args:
admin (boolean): True to make the User an admin, false to remove their admin status.

gateiden (str): The gate iden used for the operation.

Returns:
The return type is `null`.

setEmail(email)

Set the email address of the User.

Args:
email (str): The email address to set for the User.

Returns:
The return type is `null`.

setLocked(locked)

Set the locked status for a user.

Args:
locked (boolean): True to lock the user, false to unlock them.

Returns:
The return type is `null`.

setPasswd(passwd)

Set the Users password.

Args:
passwd (str): The new password for the user. This is best passed into the runtime as a variable.

Returns:
The return type is `null`.

setRoles(idens)

Replace all the Roles of the User with a new list of roles.

Notes:
The roleiden for the "all" role must be present in the new list of roles. This replaces all existing roles that the user has with the new roles.

Args:
idens (list): The idens to of the Role.

Returns:
The return type is `null`.

setRules(rules, gateiden=None)

Replace the rules on the User with new rules.

Args:
rules (list): A list of rule tuples.

gateiden (str): The gate iden used for the rules.

Returns:
The return type is `null`.

tell(text)

Send a tell notification to a user.

Args:
text (str): The text of the message to send.

Returns:
The return type is `null`.

vars

Get a dictionary representing the user's persistent variables.

Returns:
The return type is *auth:user:vars*.

13.2.4 auth:user:json

Implements per-user JSON storage.

del(path, prop=None)

Delete a stored JSON object or object property for the user.

Args:
path (str|list): A path string or list of path parts.

prop (str|list): A property name or list of name parts.

Returns:
True if the del operation was successful. The return type is *boolean*.

get(path, prop=None)

Return a stored JSON object or object property for the user.

Args:
path (str|list): A path string or list of path parts.

prop (str|list): A property name or list of name parts.

Returns:
The previously stored value or $lib.null The return type is `prim`.

iter(path=None)

Yield (<path>, <valu>) tuples for the users JSON objects.

Args:
path (str|list): A path string or list of path parts.

Yields:
(<path>, <item>) tuples. The return type is *list*.

set(path, valu, prop=None)

Set a JSON object or object property for the user.

Args:
path (str|list): A path string or list of path elements.

valu (prim): The value to set as the JSON object or object property.

prop (str|list): A property name or list of name parts.

Returns:
True if the set operation was successful. The return type is *boolean*.

13.2.5 auth:user:profile

The Storm deref/setitem/iter convention on top of User profile information.

13.2.6 auth:user:vars

The Storm deref/setitem/iter convention on top of User vars information.

13.2.7 boolean

Implements the Storm API for a boolean instance.

13.2.8 bytes

Implements the Storm API for a Bytes object.

bunzip()

Decompress the bytes using bzip2.

Example:
Decompress bytes with bzip2:

```
$foo = $mybytez.bunzip()
```

Returns:
Decompressed bytes. The return type is *bytes*.

bzip()

Compress the bytes using bzip2 and return them.

Example:

Compress bytes with bzip:

```
$foo = $mybytez.bzip()
```

Returns:

The bzip2 compressed bytes. The return type is *bytes*.

decode(encoding=utf8, errors=surrogatepass)

Decode bytes to a string.

Args:

encoding (str): The encoding to use.

errors (str): The error handling scheme to use.

Returns:

The decoded string. The return type is *str*.

gunzip()

Decompress the bytes using gzip and return them.

Example:

Decompress bytes with bzip2:

```
$foo = $mybytez.gunzip()
```

Returns:

Decompressed bytes. The return type is *bytes*.

gzip()

Compress the bytes using gzip and return them.

Example:

Compress bytes with gzip:

```
$foo = $mybytez.gzip()
```

Returns:

The gzip compressed bytes. The return type is *bytes*.

json(encoding=None, errors=surrogatepass)

Load JSON data from bytes.

Notes:
The bytes must be UTF8, UTF16 or UTF32 encoded.

Example:
Load bytes to a object:

```
$foo = $mybytez.json()
```

Args:
encoding (str): Specify an encoding to use.

errors (str): Specify an error handling scheme to use.

Returns:
The deserialized object. The return type is `prim`.

slice(start, end=None)

Slice a subset of bytes from an existing bytes.

Examples:
Slice from index to 1 to 5:

```
$subbyts = $byts.slice(1,5)
```

Slice from index 3 to the end of the bytes:

```
$subbyts = $byts.slice(3)
```

Args:
start (int): The starting byte index.

end (int): The ending byte index. If not specified, slice to the end.

Returns:
The slice of bytes. The return type is *bytes*.

unpack(fmt, offset=0)

Unpack structures from bytes using python struct.unpack syntax.

Examples:
Unpack 3 unsigned 16 bit integers in little endian format:

```
($x, $y, $z) = $byts.unpack("<HHH")
```

Args:
fmt (str): A python struck.pack format string.

offset (int): An offset to begin unpacking from.

Returns:
The unpacked primitive values. The return type is *list*.

13.2.9 cmdopts

A dictionary like object that holds a reference to a command options namespace. (This allows late-evaluation of command arguments rather than forcing capture)

13.2.10 cronjob

Implements the Storm api for a cronjob instance.

iden

The iden of the Cron Job.

Returns:
The type is *str*.

pack()

Get the Cronjob definition.

Returns:
The definition. The return type is *dict*.

pprint()

Get a dictionary containing user friendly strings for printing the CronJob.

Returns:
A dictionary containing structured data about a cronjob for display purposes. The return type is *dict*.

set(name, valu)

Set an editable field in the cron job definition.

Example:
Change the name of a cron job:

```
$lib.cron.get($iden).set(name, "foo bar cron job")
```

Args:
name (str): The name of the field being set

valu (any): The value to set on the definition.

Returns:
The `cronjob` The return type is *cronjob*.

13.2.11 dict

Implements the Storm API for a Dictionary object.

13.2.12 hive:dict

A Storm Primitive representing a HiveDict.

get(name, default=None)

Get the named value from the HiveDict.

Args:
name (str): The name of the value.

default (prim): The default value to return if the name is not set.

Returns:
The requested value. The return type is `prim`.

list()

List the keys and values in the HiveDict.

Returns:
A list of tuples containing key, value pairs. The return type is *list*.

pop(name, default=None)

Remove a value out of the HiveDict.

Args:
name (str): The name of the value.

default (prim): The default value to return if the name is not set.

Returns:
The requested value. The return type is `prim`.

set(name, valu)

Set a value in the HiveDict.

Args:
name (str): The name of the value to set

valu (prim): The value to store in the HiveDict

Returns:
Old value of the dictionary if the value was previously set, or none. The return type may be one of the following: `null`, `prim`.

13.2.13 inet:http:oauth:v1:client

A client for doing OAuth V1 Authentication from Storm.

sign(baseurl, method=GET, headers=None, params=None, body=None)

Sign an OAuth request to a particular URL.

Args:

baseurl (str): The base url to sign and query.

method (dict): The HTTP Method to use as part of signing.

headers (dict): Optional headers used for signing. Can override the "Content-Type" header if the signature type is set to SIG_BODY

params (dict): Optional query parameters to pass to url construction and/or signing.

body (bytes): Optional HTTP body to pass to request signing.

Returns:

A 3-element tuple of ($url, $headers, $body). The OAuth signature elements will be embedded in the element specified when constructing the client. The return type is *list*.

13.2.14 inet:http:resp

Implements the Storm API for a HTTP response.

body

The raw HTTP response body as bytes.

Returns:

The type is *bytes*.

code

The HTTP status code. It is -1 if an exception occurred.

Returns:

The type is `int`.

err

Tufo of the error type and information if an exception occurred.

Returns:

The type is *list*.

headers

The HTTP Response headers.

Returns:
The type is *dict*.

json(encoding=None, errors=surrogatepass)

Get the JSON deserialized response.

Args:
encoding (str): Specify an encoding to use.

errors (str): Specify an error handling scheme to use.

Returns:
The return type is `prim`.

msgpack()

Yield the msgpack deserialized objects.

Yields:
Unpacked values. The return type is `prim`.

reason

The reason phrase for the HTTP status code.

Returns:
The type is *str*.

13.2.15 inet:http:socket

Implements the Storm API for a Websocket.

rx(timeout=None)

Receive a message from the web socket.

Args:
timeout (int): The timeout to wait for

Returns:
An ($ok, $valu) tuple. The return type is *list*.

tx(mesg)

Transmit a message over the web socket.

Args:
mesg (dict): A JSON compatible message.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

13.2.16 inet:imap:server

An IMAP server for retrieving email messages.

delete(uid_set)

Mark an RFC2060 UID message as deleted and expunge the mailbox.

The command uses the +FLAGS.SILENT command and applies the Deleted flag. The actual behavior of these commands are mailbox configuration dependent.

Examples:
Mark a single message as deleted and expunge:

```
($ok, $valu) = $server.delete("8182")
```

Mark ranges of messages as deleted and expunge:

```
($ok, $valu) = $server.delete("1:3,6:9")
```

Args:
uid_set (str): The UID message set to apply the flag to.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

fetch(uid)

Fetch a message by UID in RFC822 format.

The message is saved to the Axon, and a `file:bytes` node is returned.

Examples:
Fetch a message, save to the Axon, and yield `file:bytes` node:

```
yield $server.fetch("8182")
```

Args:
uid (str): The single message UID.

Returns:
The file:bytes node representing the message. The return type is *node*.

list(reference_name="", pattern=*)

List mailbox names.

By default this method uses a reference_name and pattern to return all mailboxes from the root.

Args:
reference_name (str): The mailbox reference name.

pattern (str): The pattern to filter by.

Returns:
An ($ok, $valu) tuple where $valu is a list of names if $ok=True. The return type is *list*.

login(user, passwd)

Login to the IMAP server.

Args:
user (str): The username to login with.

passwd (str): The password to login with.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

markSeen(uid_set)

Mark messages as seen by an RFC2060 UID message set.

The command uses the +FLAGS.SILENT command and applies the Seen flag.

Examples:
Mark a single messsage as seen:

```
($ok, $valu) = $server.markSeen("8182")
```

Mark ranges of messages as seen:

```
($ok, $valu) = $server.markSeen("1:3,6:9")
```

Args:
uid_set (str): The UID message set to apply the flag to.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

search(*args)

Search for messages using RFC2060 syntax.

Examples:
Retrieve all messages:

```
($ok, $uids) = $server.search("ALL")
```

Search by FROM and SINCE:

```
($ok, $uids) = $server.search("FROM", "visi@vertex.link", "SINCE", "01-Oct-2021")
```

Search by a subject substring:

```
($ok, $uids) = $search.search("HEADER", "Subject", "An email subject")
```

Args:
*args (str): A set of search criteria to use.

Returns:
An ($ok, $valu) tuple, where $valu is a list of UIDs if $ok=True. The return type is *list*.

select(mailbox=INBOX)

Select a mailbox to use in subsequent commands.

Args:
mailbox (str): The mailbox name to select.

Returns:
An ($ok, $valu) tuple. The return type is *list*.

13.2.17 inet:smtp:message

An SMTP message to compose and send.

headers

A dictionary of email header values.

Returns:
The type is *dict*.

html

The HTML body of the email message. This can also be used to set an HTML body in the message.

Returns:
The return type is *str*. When this is used to set the value, it does not have a return type.

recipients

An array of RCPT TO email addresses.

Returns:
The type is *list*.

send(host, port=25, user=None, passwd=None, usetls=False, starttls=False, timeout=60)

Transmit a message over the web socket.

Args:

host (str): The hostname or IP address of the SMTP server.

port (int): The port that the SMTP server is listening on.

user (str): The user name to use authenticating to the SMTP server.

passwd (str): The password to use authenticating to the SMTP server.

usetls (bool): Initiate a TLS connection to the SMTP server.

starttls (bool): Use the STARTTLS directive with the SMTP server.

timeout (int): The timeout (in seconds) to wait for message delivery.

Returns:

An ($ok, $valu) tuple. The return type is *list*.

sender

The inet:email to use in the MAIL FROM request. This can also be used to set the sender for the message.

Returns:

The return type is *str*. When this is used to set the value, it does not have a return type.

text

The text body of the email message. This can also be used to set the body of the message.

Returns:

The return type is *str*. When this is used to set the value, it does not have a return type.

13.2.18 json:schema

A JsonSchema validation object for use in validating data structures in Storm.

schema()

The schema belonging to this object.

Returns:

A copy of the schema used for this object. The return type is *dict*.

validate(item)

Validate a structure against the Json Schema

Args:
item (prim): A JSON structure to validate (dict, list, etc…)

Returns:
An ($ok, $valu) tuple. If $ok is True, then $valu should be used as the validated data structure. If $ok is False, $valu is a dictionary with a "mesg" key. The return type is *list*.

13.2.19 layer

Implements the Storm api for a layer instance.

addPull(url, offs=0)

Configure the layer to pull edits from a remote layer/feed.

Args:
url (str): The telepath URL to a layer/feed.

offs (int): The offset to begin from.

Returns:
Dictionary containing the pull definition. The return type is *dict*.

addPush(url, offs=0)

Configure the layer to push edits to a remote layer/feed.

Args:
url (str): A telepath URL of the target layer/feed.

offs (int): The local layer offset to begin pushing from

Returns:
Dictionary containing the push definition. The return type is *dict*.

delPull(iden)

Remove a pull config from the layer.

Args:
iden (str): The iden of the push config to remove.

Returns:
The return type is `null`.

delPush(iden)

Remove a push config from the layer.

Args:
iden (str): The iden of the push config to remove.

Returns:
The return type is `null`.

edits(offs=0, wait=True, size=None)

Yield (offs, nodeedits) tuples from the given offset.

Args:
offs (int): Offset to start getting nodeedits from the layer at.

wait (boolean): If true, wait for new edits, otherwise exit the generator when there are no more edits.

size (int): The maximum number of nodeedits to yield.

Yields:
Yields offset, nodeedit tuples from a given offset. The return type is *list*.

get(name, defv=None)

Get a arbitrary value in the Layer definition.

Args:
name (str): Name of the value to get.

defv (prim): The default value returned if the name is not set in the Layer.

Returns:
The value requested or the default value. The return type is `prim`.

getEdges()

Yield (n1iden, verb, n2iden) tuples for any light edges in the layer.

Example:
Iterate the light edges in `$layer`:

```
for ($n1iden, $verb, $n2iden) in $layer.getEdges() {
    $lib.print(`{$n1iden} -({$verb})> {$n2iden}`)
}
```

Yields:
Yields (<n1iden>, <verb>, <n2iden>) tuples The return type is *list*.

getEdgesByN1(nodeid)

Yield (verb, n2iden) tuples for any light edges in the layer for the source node id.

Example:

Iterate the N1 edges for $node:

```
for ($verb, $n2iden) in $layer.getEdgesByN1($node.iden()) {
    $lib.print(`-({$verb})> {$n2iden}`)
}
```

Args:

nodeid (str): The hex string of the node id.

Yields:

Yields (<verb>, <n2iden>) tuples The return type is *list*.

getEdgesByN2(nodeid)

Yield (verb, n1iden) tuples for any light edges in the layer for the target node id.

Example:

Iterate the N2 edges for $node:

```
for ($verb, $n1iden) in $layer.getEdgesByN2($node.iden()) {
    $lib.print(`-({$verb})> {$n1iden}`)
}
```

Args:

nodeid (str): The hex string of the node id.

Yields:

Yields (<verb>, <n1iden>) tuples The return type is *list*.

getFormCounts()

Get the formcounts for the Layer.

Example:

Get the formcounts for the current Layer:

```
$counts = $lib.layer.get().getFormCounts()
```

Returns:

Dictionary containing form names and the count of the nodes in the Layer. The return type is *dict*.

getMirrorStatus()

Return a dictionary of the mirror synchronization status for the layer.

Returns:
An info dictionary describing mirror sync status. The return type is *dict*.

getPropCount(propname, maxsize=None)

Get the number of property rows in the layer for the given full form or property name.

Args:
propname (str): The property or form name to look up.

maxsize (int): The maximum number of rows to look up.

Returns:
The count of rows. The return type is `int`.

getStorNode(nodeid)

Retrieve the raw storage node for the specified node id.

Args:
nodeid (str): The hex string of the node id.

Returns:
The storage node dictionary. The return type is *dict*.

getStorNodes()

Get buid, sode tuples representing the data stored in the layer.

Notes:
The storage nodes represent **only** the data stored in the layer and may not represent whole nodes.

Yields:
Tuple of buid, sode values. The return type is *list*.

getTagCount(tagname, formname=None)

Return the number of tag rows in the layer for the given tag and optional form.

Examples:
Get the number of `inet:ipv4` nodes with the `$foo.bar` tag:

```
$count = $lib.layer.get().getTagCount(foo.bar, formname=inet:ipv4)
```

Args:
tagname (str): The name of the tag to look up.

formname (str): The form to constrain the look up by.

Returns:
The count of tag rows. The return type is `int`.

iden

The iden of the Layer.

Returns:
The type is *str*.

liftByProp(propname, propvalu=None, propcmpr==)

Lift and yield nodes with the property and optional value set within the layer.

Example:
Yield all nodes with the property `ou:org:name` set in the top layer:

```
yield $lib.layer.get().liftByProp(ou:org:name)
```

Yield all nodes with the property `ou:org:name=woot` in the top layer:

```
yield $lib.layer.get().liftByProp(ou:org:name, woot)
```

Yield all nodes with the property `ou:org:name^=woot` in the top layer:

```
yield $lib.layer.get().liftByProp(ou:org:name, woot, "^=")
```

Args:
propname (str): The full property name to lift by.

propvalu (obj): The value for the property.

propcmpr (str): The comparison operation to use on the value.

Yields:
Yields nodes. The return type is *node*.

liftByTag(tagname, formname=None)

Lift and yield nodes with the tag set within the layer.

Example:
Yield all nodes with the tag #foo set in the layer:

```
yield $lib.layer.get().liftByTag(foo)
```

Yield all inet:fqdn with the tag #foo set in the layer:

```
yield $lib.layer.get().liftByTag(foo, inet:fqdn)
```

Args:
tagname (str): The tag name to lift by.

formname (str): The optional form to lift.

Yields:
Yields nodes. The return type is *node*.

pack()

Get the Layer definition.

Returns:
Dictionary containing the Layer definition. The return type is *dict*.

repr()

Get a string representation of the Layer.

Returns:
A string that can be printed, representing a Layer. The return type is *str*.

set(name, valu)

Set a arbitrary value in the Layer definition.

Args:
name (str): The name to set.

valu (any): The value to set.

Returns:
The return type is `null`.

verify(config=None)

Verify consistency between the node storage and indexes in the given layer.

Example:
Get all messages about consistency issues in the default layer:

```
for $mesg in $lib.layer.get().verify() {
    $lib.print($mesg)
}
```

Notes:
The config format argument and message format yielded by this API is considered BETA and may be subject to change! The formats will be documented when the convention stabilizes.

Args:
config (dict): The scan config to use (default all enabled).

Yields:
Yields messages describing any index inconsistencies. The return type is *list*.

13.2.20 list

Implements the Storm API for a List instance.

append(valu)

Append a value to the list.

Args:
valu (any): The item to append to the list.

Returns:
The return type is `null`.

extend(valu)

Extend a list using another iterable.

Examples:
Populate a list by extending it with to other lists:

```
$list = $lib.list()

$foo = (f, o, o)
$bar = (b, a, r)

$list.extend($foo)
$list.extend($bar)

// $list is now (f, o, o, b, a, r)
```

Args:
valu (list): A list or other iterable.

Returns:
The return type is `null`.

has(valu)

Check it a value is in the list.

Args:
valu (any): The value to check.

Returns:
True if the item is in the list, false otherwise. The return type is *boolean*.

index(valu)

Return a single field from the list by index.

Args:
valu (int): The list index value.

Returns:
The item present in the list at the index position. The return type is `any`.

length()

Get the length of the list. This is deprecated; please use `.size()` instead.

Returns:
The size of the list. The return type is `int`.

pop()

Pop and return the last entry in the list.

Returns:
The last item from the list. The return type is `any`.

reverse()

Reverse the order of the list in place

Returns:
The return type is `null`.

size()

Return the length of the list.

Returns:
The size of the list. The return type is `int`.

slice(start, end=None)

Get a slice of the list.

Examples:
Slice from index to 1 to 5:

```
$x=(f, o, o, b, a, r)
$y=$x.slice(1,5)  // (o, o, b, a)
```

Slice from index 3 to the end of the list:

```
$y=$x.slice(3)  // (b, a, r)
```

Args:
start (int): The starting index.

end (int): The ending index. If not specified, slice to the end of the list.

Returns:
The slice of the list. The return type is *list*.

sort(reverse=False)

Sort the list in place.

Args:
reverse (bool): Sort the list in reverse order.

Returns:
The return type is `null`.

13.2.21 model:form

Implements the Storm API for a Form.

name

The name of the Form

Returns:
The type is *str*.

prop(name)

Get a Property on the Form

Args:
name (str): The property to retrieve.

Returns:
The `model:property` instance if the property if present on the form or null. The return type may be one of the following: *model:property*, `null`.

type

Get the Type for the form.

Returns:
The return type is *model:type*.

13.2.22 model:property

Implements the Storm API for a Property.

form

Get the Form for the Property.

Returns:
The return type may be one of the following: *model:form*, `null`.

full

The full name of the Property.

Returns:
The type is *str*.

name

The short name of the Property.

Returns:
The type is *str*.

type

Get the Type for the Property.

Returns:
The return type is *model:type*.

13.2.23 model:tagprop

Implements the Storm API for a Tag Property.

name

The name of the Tag Property.

Returns:
The type is *str*.

type

Get the Type for the Tag Property.

Returns:
The return type is *model:type*.

13.2.24 model:type

A Storm types wrapper around a lib.types.Type

name

The name of the Type.

Returns:
The type is *str*.

norm(valu)

Get the norm and info for the Type.

Args:
valu (any): The value to norm.

Returns:
A tuple of the normed value and its information dictionary. The return type is *list*.

repr(valu)

Get the repr of a value for the Type.

Args:
valu (any): The value to get the repr of.

Returns:
The string form of the value as represented by the type. The return type is *str*.

stortype

The storetype of the Type.

Returns:
The type is `int`.

13.2.25 node

Implements the Storm api for a node instance.

addEdge(verb, iden)

Add a light-weight edge.

Args:
verb (str): The edge verb to add.

iden (str): The node id of the destination node.

Returns:
The return type is `null`.

delEdge(verb, iden)

Remove a light-weight edge.

Args:
verb (str): The edge verb to remove.

iden (str): The node id of the destination node to remove.

Returns:
The return type is `null`.

difftags(tags, prefix=None, apply=False)

Get and optionally apply the difference between the current set of tags and another set.

Args:
tags (list): The set to compare against.

prefix (str): An optional prefix to match tags under.

apply (boolean): If true, apply the diff.

Returns:
The tags which have been added/deleted in the new set. The return type is *dict*.

edges(verb=None, reverse=False)

Yields the (verb, iden) tuples for this nodes edges.

Args:
verb (str): If provided, only return edges with this verb.

reverse (boolean): If true, yield edges with this node as the dest rather than source.

Yields:
A tuple of (verb, iden) values for this nodes edges. The return type is *list*.

form()

Get the form of the Node.

Returns:
The form of the Node. The return type is *str*.

getByLayer()

Return a dict you can use to lookup which props/tags came from which layers.

Returns:
property / tag lookup dictionary. The return type is *dict*.

getStorNodes()

Return a list of "storage nodes" which were fused from the layers to make this node.

Returns:
List of storage node objects. The return type is *list*.

globtags(glob)

Get a list of the tag components from a Node which match a tag glob expression.

Args:
glob (str): The glob expression to match.

Returns:
The components of tags which match the wildcard component of a glob expression. The return type is *list*.

iden()

Get the iden of the Node.

Returns:
The nodes iden. The return type is *str*.

isform(name)

Check if a Node is a given form.

Args:
name (str): The form to compare the Node against.

Returns:
True if the form matches, false otherwise. The return type is *boolean*.

ndef()

Get the form and primary property of the Node.

Returns:
A tuple of the form and primary property. The return type is *list*.

pack(dorepr=False)

Return the serializable/packed version of the Node.

Args:
dorepr (boolean): Include repr information for human readable versions of properties.

Returns:
A tuple containing the ndef and property bag of the node. The return type is *list*.

repr(name=None, defv=None)

Get the repr for the primary property or secondary property of a Node.

Args:
name (str): The name of the secondary property to get the repr for.

defv (str): The default value to return if the secondary property does not exist

Returns:
The string representation of the requested value. The return type is *str*.

tags(glob=None, leaf=False)

Get a list of the tags on the Node.

Notes:
When providing a glob argument, the following rules are used. A single asterisk(*) will replace exactly one dot-delimited component of a tag. A double asterisk(**) will replace one or more of any character.

Args:
glob (str): A tag glob expression. If this is provided, only tags which match the expression are returned.

leaf (bool): If true, only leaf tags are included in the returned tags.

Returns:
A list of tags on the node. If a glob match is provided, only matching tags are returned. The return type is *list*.

value()

Get the value of the primary property of the Node.

Returns:
The primary property. The return type is `prim`.

13.2.26 node:data

A Storm Primitive representing the NodeData stored for a Node.

cacheget(name, asof=now)

Retrieve data stored with cacheset() if it was stored more recently than the asof argument.

Args:
name (str): The name of the data to load.

asof (time): The max cache age.

Returns:
The cached value or null. The return type is `prim`.

cacheset(name, valu)

Set a node data value with an envelope that tracks time for cache use.

Args:
name (str): The name of the data to set.

valu (prim): The data to store.

Returns:
The return type is `null`.

get(name)

Get the Node data for a given name for the Node.

Args:
name (str): Name of the data to get.

Returns:
The stored node data. The return type is `prim`.

has(name)

Check if the Node data has the given key set on it

Args:
name (str): Name of the data to check for.

Returns:
True if the key is found, otherwise false. The return type is *boolean*.

list()

Get a list of the Node data names on the Node.

Returns:
List of the names of values stored on the node. The return type is *list*.

load(name)

Load the Node data onto the Node so that the Node data is packed and returned by the runtime.

Args:
name (str): The name of the data to load.

Returns:
The return type is `null`.

pop(name)

Pop (remove) a the Node data from the Node.

Args:
name (str): The name of the data to remove from the node.

Returns:
The data removed. The return type is `prim`.

set(name, valu)

Set the Node data for a given name on the Node.

Args:
name (str): The name of the data.

valu (prim): The data to store.

Returns:
The return type is `null`.

13.2.27 node:path

Implements the Storm API for the Path object.

idens()

The list of Node idens which this Path has been forked from during pivot operations.

Returns:
A list of node idens. The return type is *list*.

listvars()

List variables available in the path of a storm query.

Returns:
List of tuples containing the name and value of path variables. The return type is *list*.

meta

The PathMeta object for the Path.

Returns:
The type is *node:path:meta*.

vars

The PathVars object for the Path.

Returns:
The type is *node:path:vars*.

13.2.28 node:path:meta

Put the storm deref/setitem/iter convention on top of path meta information.

13.2.29 node:path:vars

Put the storm deref/setitem/iter convention on top of path variables.

13.2.30 node:props

A Storm Primitive representing the properties on a Node.

get(name)

Get a specific property value by name.

Args:
name (str): The name of the property to return.

Returns:
The requested value. The return type is `prim`.

list()

List the properties and their values from the `$node`.

Returns:
A list of (name, value) tuples. The return type is *list*.

set(prop, valu)

Set a specific property value by name.

Args:
prop (str): The name of the property to set.

valu (prim): The value to set the property to.

Returns:
The set value. The return type is `prim`.

13.2.31 number

Implements the Storm API for a Number instance.

Storm Numbers are high precision fixed point decimals corresponding to the the hugenum storage type.

scaleb(other)

Return the number multiplied by 10**other.

Example:
Multiply the value by 10**-18:

```
$baz.scaleb(-18)
```

Args:
other (int): The amount to adjust the exponent.

Returns:
The exponent adjusted number. The return type is *number*.

tofloat()

Return the number as a float.

Returns:
The number as a float. The return type is `float`.

toint(rounding=None)

Return the number as an integer.

By default, decimal places will be truncated. Optionally, rounding rules can be specified by providing the name of a Python decimal rounding mode to the 'rounding' argument.

Example:

Round the value stored in $baz up instead of truncating:

```
$baz.toint(rounding=ROUND_UP)
```

Args:

rounding (str): An optional rounding mode to use.

Returns:

The number as an integer. The return type is `int`.

tostr()

Return the number as a string.

Returns:

The number as a string. The return type is *str*.

13.2.32 pipe

A Storm Pipe provides fast ephemeral queues.

put(item)

Add a single item to the Pipe.

Args:

item (any): An object to add to the Pipe.

Returns:

The return type is `null`.

puts(items)

Add a list of items to the Pipe.

Args:

items (list): A list of items to add.

Returns:

The return type is `null`.

size()

Retrieve the number of items in the Pipe.

Returns:
The number of items in the Pipe. The return type is `int`.

slice(size=1000)

Return a list of up to size items from the Pipe.

Args:
size (int): The max number of items to return.

Returns:
A list of at least 1 item from the Pipe. The return type is *list*.

slices(size=1000)

Yield lists of up to size items from the Pipe.

Notes:
The loop will exit when the Pipe is closed and empty.

Examples:
Operation on slices from a pipe one at a time:

```
for $slice in $pipe.slices(1000) {
    for $item in $slice { $dostuff($item) }
}
```

Operate on slices from a pipe in bulk:

```
for $slice in $pipe.slices(1000) {
    $dostuff_batch($slice)
}
```

Args:
size (int): The max number of items to yield per slice.

Yields:
Yields objects from the Pipe. The return type is `any`.

13.2.33 proj:comment

Implements the Storm API for a ProjectTicketComment

del()

Delete the comment.

Returns:
True if the ProjectTicketComment was deleted The return type is *boolean*.

text

The comment text. This can be used to set the text as well.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

13.2.34 proj:comments

Implements the Storm API for ProjectTicketComments objects, which are collections of comments associated with a ticket.

add(text)

Add a comment to the ticket.

Args:
text (str): The text for the new ProjectTicketComment.

Returns:
The newly created *proj:comment* object The return type is *proj:comment*.

get(guid)

Get a ticket comment by guid.

Args:
guid (str): The guid of the ProjectTicketComment to get.

Returns:
The *proj:comment* object The return type is *proj:comment*.

13.2.35 proj:epic

Implements the Storm API for a ProjectEpic

name

The name of the Epic. This can be used to set the name as well.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

13.2.36 proj:epics

Implements the Storm API for ProjectEpics objects, which are collections of ProjectEpic objects associated with a particular Project

add(name)

Add an epic.

Args:
name (str): The name for the new ProjectEpic.

Returns:
The newly created *proj:epic* object The return type is *proj:epic*.

del(name)

Delete an epic by name.

Args:
name (str): The name of the ProjectEpic to delete.

Returns:
True if the ProjectEpic can be found and deleted, otherwise False The return type is *boolean*.

get(name)

Get an epic by name.

Args:
name (str): The name (or iden) of the ProjectEpic to get.

Returns:
The *proj:epic* object The return type is *proj:epic*.

13.2.37 proj:project

Implements the Storm API for Project objects, which are used for managing a scrum style project in the Cortex

epics

A *proj:epics* object that contains the epics associated with the given project.

Returns:
The return type is *proj:epics*.

name

The name of the project. This can also be used to set the name of the project.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

sprints

A *proj:sprints* object that contains the sprints associated with the given project.

Returns:
The return type is *proj:sprints*.

tickets

A *proj:tickets* object that contains the tickets associated with the given project.

Returns:
The return type is *proj:tickets*.

13.2.38 proj:sprint

Implements the Storm API for a ProjectSprint

desc

A description of the sprint. This can also be used to set the description.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

name

The name of the sprint. This can also be used to set the name.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

status

The status of the sprint. This can also be used to set the status.

Returns:
The return type may be one of the following: `int`, `null`. When this is used to set the value, it does not have a return type.

tickets

Yields out the tickets associated with the given sprint (no call needed).

Returns:
The return type is `generator`.

13.2.39 proj:sprints

Implements the Storm API for ProjectSprints objects, which are collections of sprints associated with a single project

add(name, period=None)

Add a sprint.

Args:
name (str): The name for the new ProjectSprint.

period (ival): The time interval the ProjectSprint runs for

Returns:
The newly created *proj:sprint* object The return type is *proj:sprint*.

del(name)

Delete a sprint by name.

Args:
name (str): The name of the Sprint to delete.

Returns:
True if the ProjectSprint can be found and deleted, otherwise False The return type is *boolean*.

get(name)

Get a sprint by name.

Args:
name (str): The name (or iden) of the ProjectSprint to get.

Returns:
The *proj:sprint* object The return type is *proj:sprint*.

13.2.40 proj:ticket

Implements the Storm API for a ProjectTicket.

assignee

The user the ticket is assigned to. This can be used to set the assignee of the ticket.

Returns:
The return type may be one of the following: `int`, `null`. When this is used to set the value, it does not have a return type.

comments

A `proj:comments` object that contains comments associated with the given ticket.

Returns:
The return type is *proj:comments*.

desc

A description of the ticket. This can be used to set the description.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

epic

The epic associated with the ticket. This can be used to set the epic.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

name

The name of the ticket. This can be used to set the name of the ticket.

Returns:
The return type may be one of the following: *str*, `null`. When this is used to set the value, it does not have a return type.

priority

An integer value from the enums [0, 10, 20, 30, 40, 50] of the priority of the ticket. This can be used to set the priority of the ticket.

Returns:
The return type may be one of the following: `int`, `null`. When this is used to set the value, it does not have a return type.

sprint

The sprint the ticket is in. This can be used to set the sprint this ticket is in.

Returns:
The return type may be one of the following: `int`, `null`. When this is used to set the value, it does not have a return type.

status

The status of the ticket. This can be used to set the status of the ticket.

Returns:
The return type may be one of the following: `int`, `null`. When this is used to set the value, it does not have a return type.

13.2.41 proj:tickets

Implements the Storm API for ProjectTickets objects, which are collections of tickets associated with a project

add(name, desc=)

Add a ticket.

Args:
name (str): The name for the new ProjectTicket.

desc (str): A description of the new ticket

Returns:
The newly created *proj:ticket* object The return type is *proj:ticket*.

del(name)

Delete a sprint by name.

Args:
name (str): The name of the ProjectTicket to delete.

Returns:
True if the ProjectTicket can be found and deleted, otherwise False The return type is *boolean*.

get(name)

Get a ticket by name.

Args:
name (str): The name (or iden) of the ProjectTicket to get.

Returns:
The *proj:ticket* object The return type is *proj:ticket*.

13.2.42 queue

A StormLib API instance of a named channel in the Cortex multiqueue.

cull(offs)

Remove items from the queue up to, and including, the offset.

Args:
offs (int): The offset which to cull records from the queue.

Returns:
The return type is `null`.

get(offs=0, cull=True, wait=True)

Get a particular item from the Queue.

Args:
offs (int): The offset to retrieve an item from.

cull (boolean): Culls items up to, but not including, the specified offset.

wait (boolean): Wait for the offset to be available before returning the item.

Returns:
A tuple of the offset and the item from the queue. If wait is false and the offset is not present, null is returned. The return type is *list*.

gets(offs=0, wait=True, cull=False, size=None)

Get multiple items from the Queue as a iterator.

Args:
offs (int): The offset to retrieve an items from.

wait (boolean): Wait for the offset to be available before returning the item.

cull (boolean): Culls items up to, but not including, the specified offset.

size (int): The maximum number of items to yield

Yields:
Yields tuples of the offset and item. The return type is *list*.

name

The name of the Queue.

Returns:
The type is *str*.

pop(offs=None, wait=False)

Pop a item from the Queue at a specific offset.

Args:
offs (int): Offset to pop the item from. If not specified, the first item in the queue will be popped.

wait (boolean): Wait for an item to be available to pop.

Returns:
The offset and item popped from the queue. If there is no item at the offset or the queue is empty and wait is false, it returns null. The return type is *list*.

put(item)

Put an item into the queue.

Args:
item (prim): The item being put into the queue.

Returns:
The return type is `null`.

puts(items)

Put multiple items into the Queue.

Args:
items (list): The items to put into the Queue.

Returns:
The return type is `null`.

size()

Get the number of items in the Queue.

Returns:
The number of items in the Queue. The return type is `int`.

13.2.43 set

Implements the Storm API for a Set object.

add(*items)

Add a item to the set. Each argument is added to the set.

Args:
*items (any): The items to add to the set.

Returns:
The return type is `null`.

adds(*items)

Add the contents of a iterable items to the set.

Args:
*items (any): Iterables items to add to the set.

Returns:
The return type is `null`.

has(item)

Check if a item is a member of the set.

Args:
item (any): The item to check the set for membership.

Returns:
True if the item is in the set, false otherwise. The return type is *boolean*.

list()

Get a list of the current members of the set.

Returns:
A list containing the members of the set. The return type is *list*.

rem(*items)

Remove an item from the set.

Args:
*items (any): Items to be removed from the set.

Returns:
The return type is `null`.

rems(*items)

Remove the contents of a iterable object from the set.

Args:
*items (any): Iterables items to remove from the set.

Returns:
The return type is `null`.

size()

Get the size of the set.

Returns:
The size of the set. The return type is `int`.

13.2.44 stat:tally

A tally object.

An example of using it:

```
$tally = $lib.stats.tally()

$tally.inc(foo)

for $name, $total in $tally {
    $doStuff($name, $total)
}
```

get(name)

Get the value of a given counter.

Args:
name (str): The name of the counter to get.

Returns:
The value of the counter, or 0 if the counter does not exist. The return type is `int`.

inc(name, valu=1)

Increment a given counter.

Args:
name (str): The name of the counter to increment.

valu (int): The value to increment the counter by.

Returns:
The return type is `null`.

sorted(byname=False, reverse=False)

Get a list of (counter, value) tuples in sorted order.

Args:

byname (bool): Sort by counter name instead of value.

reverse (bool): Sort in descending order instead of ascending order.

Returns:

List of (counter, value) tuples in sorted order. The return type is *list*.

13.2.45 stix:bundle

Implements the Storm API for creating and packing a STIX bundle for v2.1

add(node, stixtype=None)

Make one or more STIX objects from a node, and add it to the bundle.

Examples:

Example Storm which would be called remotely via the `callStorm()` API:

```
init { $bundle = $lib.stix.bundle() }
#aka.feye.thr.apt1
$bundle.add($node)
fini { return($bundle) }
```

Args:

node (node): The node to make a STIX object from.

stixtype (str): The explicit name of the STIX type to map the node to. This will override the default mapping.

Returns:

The stable STIX id of the added object. The return type is *str*.

pack()

Return the bundle as a STIX JSON object.

Returns:

The return type is *dict*.

size()

Return the number of STIX objects currently in the bundle.

Returns:

The return type is `int`.

13.2.46 storm:query

A storm primitive representing an embedded query.

exec()

Execute the Query in a sub-runtime.

Notes:
The `.exec()` method can return a value if the Storm query contains a `return( ... )` statement in it.

Returns:
A value specified with a return statement, or none. The return type may be one of the following: `null`, `any`.

size(limit=1000)

Execute the Query in a sub-runtime and return the number of nodes yielded.

Args:
limit (int): Limit the maximum number of nodes produced by the query.

Returns:
The number of nodes yielded by the query. The return type is `int`.

13.2.47 str

Implements the Storm API for a String object.

encode(encoding=utf8)

Encoding a string value to bytes.

Args:
encoding (str): Encoding to use. Defaults to utf8.

Returns:
The encoded string. The return type is *bytes*.

endswith(text)

Check if a string ends with text.

Args:
text (str): The text to check.

Returns:
True if the text ends with the string, false otherwise. The return type is *boolean*.

find(valu)

Find the offset of a given string within another.

Examples:

Find values in the string `asdf`:

```
$x = asdf
$x.find(d) // returns 2
$x.find(v) // returns null
```

Args:

valu (str): The substring to find.

Returns:

The first offset of substring or null. The return type is `int`.

format(**kwargs)

Format a text string from an existing string.

Examples:

Format a string with a fixed argument and a variable:

```
$template='Hello {name}, list is {list}!' $list=(1,2,3,4) $new=$template.
↪format(name='Reader', list=$list)
```

Args:

**kwargs (any): Keyword values which are substituted into the string.

Returns:

The new string. The return type is *str*.

ljust(size, fillchar=)

Left justify the string.

Args:

size (int): The length of character to left justify.

fillchar (str): The character to use for padding.

Returns:

The left justified string. The return type is *str*.

lower()

Get a lowercased copy the of the string.

Examples:

Printing a lowercased string:

```
$foo="Duck"
$lib.print($foo.lower())
```

Returns:

The lowercased string. The return type is *str*.

lstrip(chars=None)

Remove leading characters from a string.

Examples:

Removing whitespace and specific characters:

```
$strippedFoo = $foo.lstrip()
$strippedBar = $bar.lstrip(w)
```

Args:

chars (str): A list of characters to remove. If not specified, whitespace is stripped.

Returns:

The stripped string. The return type is *str*.

replace(oldv, newv, maxv=None)

Replace occurrences of a string with a new string, optionally restricting the number of replacements.

Example:

Replace instances of the string "bar" with the string "baz":

```
$foo.replace('bar', 'baz')
```

Args:

oldv (str): The value to replace.

newv (str): The value to add into the string.

maxv (int): The maximum number of occurrences to replace.

Returns:

The new string with replaced instances. The return type is *str*.

reverse()

Get a reversed copy of the string.

Examples:

Printing a reversed string:

```
$foo="foobar"
$lib.print($foo.reverse())
```

Returns:

The reversed string. The return type is *str*.

rjust(size, fillchar=)

Right justify the string.

Args:
size (int): The length of character to right justify.

fillchar (str): The character to use for padding.

Returns:
The right justified string. The return type is *str*.

rsplit(text, maxsplit=-1)

Split the string into multiple parts, from the right, based on a separator.

Example:
Split a string on the colon character:

```
($foo, $bar) = $baz.rsplit(":", maxsplit=1)
```

Args:
text (str): The text to split the string up with.

maxsplit (int): The max number of splits.

Returns:
A list of parts representing the split string. The return type is *list*.

rstrip(chars=None)

Remove trailing characters from a string.

Examples:
Removing whitespace and specific characters:

```
$strippedFoo = $foo.rstrip()
$strippedBar = $bar.rstrip(asdf)
```

Args:
chars (str): A list of characters to remove. If not specified, whitespace is stripped.

Returns:
The stripped string. The return type is *str*.

size()

Return the length of the string.

Returns:
The size of the string. The return type is `int`.

slice(start, end=None)

Get a substring slice of the string.

Examples:

Slice from index to 1 to 5:

```
$x="foobar"
$y=$x.slice(1,5)  // "ooba"
```

Slice from index 3 to the end of the string:

```
$y=$x.slice(3)  // "bar"
```

Args:

start (int): The starting character index.

end (int): The ending character index. If not specified, slice to the end of the string

Returns:

The slice substring. The return type is *str*.

split(text, maxsplit=-1)

Split the string into multiple parts based on a separator.

Example:

Split a string on the colon character:

```
($foo, $bar) = $baz.split(":")
```

Args:

text (str): The text to split the string up with.

maxsplit (int): The max number of splits.

Returns:

A list of parts representing the split string. The return type is *list*.

startswith(text)

Check if a string starts with text.

Args:

text (str): The text to check.

Returns:

True if the text starts with the string, false otherwise. The return type is *boolean*.

strip(chars=None)

Remove leading and trailing characters from a string.

Examples:

Removing whitespace and specific characters:

```
$strippedFoo = $foo.strip()
$strippedBar = $bar.strip(asdf)
```

Args:

chars (str): A list of characters to remove. If not specified, whitespace is stripped.

Returns:

The stripped string. The return type is *str*.

upper()

Get a uppercased copy the of the string.

Examples:

Printing a uppercased string:

```
$foo="Duck"
$lib.print($foo.upper())
```

Returns:

The uppercased string. The return type is *str*.

13.2.48 telepath:proxy

Implements the Storm API for a Telepath proxy.

These can be created via `$lib.telepath.open()`. Storm Service objects are also Telepath proxy objects.

Methods called off of these objects are executed like regular Telepath RMI calls.

An example of calling a method which returns data:

```
$prox = $lib.telepath.open($url)
$result = $prox.doWork($data)
return ( $result )
```

An example of calling a method which is a generator:

```
$prox = $lib.telepath.open($url)
for $item in = $prox.genrStuff($data) {
    $doStuff($item)
}
```

13.2.49 text

A mutable text type for simple text construction.

add(text, **kwargs)

Add text to the Text object.

Args:
text (str): The text to add.

**kwargs (any): Keyword arguments used to format the text.

Returns:
The return type is `null`.

str()

Get the text content as a string.

Returns:
The current string of the text object. The return type is *str*.

13.2.50 trigger

Implements the Storm API for a Trigger.

iden

The Trigger iden.

Returns:
The type is *str*.

move(viewiden)

Modify the Trigger to run in a different View.

Args:
viewiden (str): The iden of the new View for the Trigger to run in.

Returns:
The return type is `null`.

pack()

Get the trigger definition.

Returns:
The definition. The return type is *dict*.

set(name, valu)

Set information in the Trigger.

Args:
name (str): Name of the key to set.

valu (prim): The data to set

Returns:
The return type is `null`.

13.2.51 view

Implements the Storm api for a View instance.

addNode(form, valu, props=None)

Transactionally add a single node and all it's properties. If any validation fails, no changes are made.

Args:
form (str): The form name.

valu (prim): The primary property value.

props (dict): An optional dictionary of props.

Returns:
The node if the view is the current view, otherwise null. The return type is *node*.

addNodeEdits(edits)

Add NodeEdits to the view.

Args:
edits (list): A list of nodeedits.

Returns:
The return type is `null`.

fork(name=None)

Fork a View in the Cortex.

Args:
name (str): The name of the new view.

Returns:
The `view` object for the new View. The return type is *view*.

get(name, defv=None)

Get a view configuration option.

Args:
name (str): Name of the value to get.

defv (prim): The default value returned if the name is not set in the View.

Returns:
The value requested or the default value. The return type is `prim`.

getEdgeVerbs()

Get the Edge verbs which exist in the View.

Yields:
Yields the edge verbs used by Layers which make up the View. The return type is *str*.

getEdges(verb=None)

Get node information for Edges in the View.

Args:
verb (str): The name of the Edges verb to iterate over.

Yields:
Yields tuples containing the source iden, verb, and destination iden. The return type is *list*.

getFormCounts()

Get the formcounts for the View.

Example:
Get the formcounts for the current View:

```
$counts = $lib.view.get().getFormCounts()
```

Returns:
Dictionary containing form names and the count of the nodes in the View's Layers. The return type is *dict*.

iden

The iden of the View.

Returns:
The type is *str*.

layers

The `layer` objects associated with the `view`.

Returns:
The type is *list*.

merge(force=False)

Merge a forked View back into its parent View.

Args:
force (boolean): Force the view to merge if possible.

Returns:
The return type is `null`.

pack()

Get the View definition.

Returns:
Dictionary containing the View definition. The return type is *dict*.

parent

The parent View. Will be `$lib.null` if the view is not a fork.

Returns:
The type is *str*.

repr()

Get a string representation of the View.

Returns:
A list of lines that can be printed, representing a View. The return type is *list*.

set(name, valu)

Set a view configuration option.

Current runtime updatable view options include:

name (str)
A terse name for the View.

desc (str)
A description of the View.

parent (str)
The parent View iden.

nomerge (bool)
Setting to $lib.true will prevent the layer from being merged.

layers (list(str))
Set the list of layer idens for a non-forked view. Layers are specified in precedence order with the first layer in the list being the write layer.

To maintain consistency with the view.fork() semantics, setting the "parent" option on a view has a few limitations:

- The view must not already have a parent
- The view must not have more than 1 layer

Args:
name (str): The name of the value to set.

valu (prim): The value to set.

Returns:
The return type is `null`.

triggers

The `trigger` objects associated with the `view`.

Returns:
The type is *list*.

wipeLayer()

Delete all nodes and nodedata from the write layer. Triggers will be run.

Returns:
The return type is `null`.

13.2.52 xml:element

A Storm object for dealing with elements in an XML tree.

attrs

The element attributes list.

Returns:
The type is *dict*.

find(name, nested=True)

Find all nested elements with the specified tag name.

Args:
name (str): The name of the XML tag.

nested (bool): Set to $lib.false to only find direct children.

Returns:
A generator which yields xml:elements. The return type is `generator`.

get(name)

Get a single child element by XML tag name.

Args:
name (str): The name of the child XML element tag.

Returns:
The child XML element or $lib.null The return type is *xml:element*.

name

The element tag name.

Returns:
The type is *str*.

text

The element text body.

Returns:
The type is *str*.

CHAPTER

FOURTEEN

SYNAPSE POWER-UPS

Power-Ups are part of The Vertex Project's commercial offering, Synapse Enterprise. Synapse Enterprise is an on-premises solution that includes Optic (the Synapse UI) and all of the Power-Ups. The license includes unlimited users and does not limit the amount of data or number of instances you deploy. We take a white-glove approach to each deployment where we're with you every step of the way from planning deployment sizes to helping to train your analysts.

Feel free to contact us or request a demo instance.

Power-Ups provide specific add-on capabilities to Synapse via Storm Packages and Services. For example, Power-Ups may provide connectivity to external databases, third-party data sources, or enable functionality such as the ability to manage YARA rules, scans, and matches.

For an introduction to Power-Ups from our analysts and seeing them in use, see the following video introducing them:

The Vertex Project is constantly releasing new Power-Ups and expanding features of existing Power-Ups. If you join the `#synapse-releases` channel in Synapse Slack, you can get realtime notices of these updates!

14.1 Rapid Power-Ups

Rapid Power-Ups are delivered to a Cortex as Storm packages directly, without requiring any additional containers to be deployed. This allows users to rapidly expand the power of their Synapse deployments without needing to engage with additional operations teams in their environments. For an introduction to Rapid Power-Ups and some information about publicly available Power-Ups, see the following blog post.

See the Rapid Power-Ups List for a complete list of all available Rapid Power-Ups.

14.1.1 Getting Started with Rapid Power-Ups

Vertex maintains a package repository which allows for loading public and private packages.

If you are a *Synapse User Interface* user, you can navigate to the **Power-Ups Tool** to register your Cortex and configure packages.

Alternatively, one can use the *storm* tool to get started with Rapid Power-Ups in their Cortex.

See our blog article for a step-by step guide to registering your Cortex to install the free `synapse-misp`, `synapse-mitre-attack`, and `synapse-tor` Power-Ups.

14.2 Advanced Power-Ups

Advanced Power-Ups are enhancements to a Cortex which require the deployment of additional containers in order to run their services.

Documentation for specific Advanced Power-Ups can be found here:

- Synapse Backup
- Synapse Fileparser
- Synapse Maxmind
- Synapse GCS
- Synapse Metrics
- Synapse Nettools
- Synapse NSRL
- Synapse Playwright
- Synapse Rapid7
- Synapse Rapid7 SonarRDNS
- Synapse S3
- Synapse Search
- Synapse Sidepocket
- Synapse Swarm
- Synapse Yara
- Synapse Axon Azure

CHAPTER

FIFTEEN

SYNAPSE USER INTERFACE

Optic (the Synapse UI) is part of The Vertex Project's commercial offering, Synapse Enterprise. Synapse Enterprise is an on-premises solution that includes Optic and all of the Power-Ups. The license includes unlimited users and does not limit the amount of data or number of instances you deploy. We take a white-glove approach to each deployment where we're with you every step of the way from planning deployment sizes to helping to train your analysts.

Feel free to contact us or request a demo instance.

For additional information see the Optic Documentation.

CHAPTER

SIXTEEN

SYNAPSE SUPPORT

Information for Vertex support.

16.1 Slack

Best effort chat based support is available through the Synapse Slack. You can find Vertex Project analysts, engineers, and other users who can help with questions you may have.

16.2 Service Desk

Commercial customers have access to the Vertex Support Service Desk. This is the ideal place for customers to submit issues, modeling questions, and feature requests.

CHAPTER

SEVENTEEN

SYNAPSE CHANGELOG

17.1 v2.141.0 - 2023-07-07

17.1.1 Model Changes

- Update to the `it` and `lang` models. (#3219)

  `it:host`
  The form had the following properties added to it:

  `keyboard:language`
  The primary keyboard input language configured on the host.

  `keyboard:layout`
  The primary keyboard layout configured on the host.

  `lang:language`
  The form had the following property added to it:

  `code`
  The language code for this language.

17.1.2 Features and Enhancements

- Update `$lib.infosec.cvss.vectToScore()` to include a normalized CVSS vector in the output. (#3211)
- Optimize the addition and removal of lightweight edges when operating on N1 edges in Storm. (#3214)
- Added `$lib.gen.langByCode`. (#3219)

17.1.3 Bugfixes

- Fix bug with regular expression comparisons for some types. (#3213)
- Fix a `TypeError` being raised when passing a heavy Number object to `$lib.math.number()`. (#3215)
- Fix an issue with the Cell backup space checks. They now properly calculate the amount of free space when the Cell backup directory is configured on a separate volume from the Cell storage directory. (#3216)
- Prevent the `yield` operator from directly emitting nodes into the Storm pipeline if those node objects came from a different view. Nodes previously lifted in this manner must be lifted by calling the `iden()` function on the object to ensure the node being lifted into the pipeline reflects the current view. (#3218)

- Always remove the `mirror` configuration option from `cell.mods.yaml` when provisioning a service via Aha. The previous behavior prevented the correct restoration of a service from a backup which had been changed from being a leader to being a mirror. (#3220)

17.2 v2.140.1 - 2023-06-30

17.2.1 Bugfixes

- Fix a typo which prevented the Synapse package for `v2.140.0` from being published on PyPI. (#3212)

17.3 v2.140.0 - 2023-06-30

17.3.1 Announcement

Synapse now only supports Python 3.11+.

17.3.2 Model Changes

- Update to the `inet`, `file`, and `org` models. (#3192) (#3202) (#3207)

  `file:archive:entry`
  : Add a type to capture an archive entry representing a file and metadata from within a parent archive file.

  `time`
  : Time values with precision beyond milliseconds are now truncated to millsecond values.

  `hex`
  : Hex types now have whitespace and colon (`:`) characters stripped from them when lifting and normalizing them.

  `inet:ipv6`
  : Add comparators for >=, >, <=, < operations when lifting and filtering IPV6 values.

  `ou:naics`
  : Update the type to allow recording NIACS sector and subsector prefixes.

17.3.3 Features and Enhancements

- Synapse now only supports Python 3.11+. The library will now fail to import on earlier Python interpeters, and the published modules on PyPI will no longer install on Python versions < 3.11. (#3156)
- Replace `setup.py` with a `pyproject.toml` file. (#3156) (#3195)
- Usages of `hashlib.md5()` and `hashlib.sha1()` have been updated to add the `usedforsecurity=False` argument. (#3163)
- The Storm `diff` command is now marked as safe for `readonly` execution. (#3207)
- Add a `svc:set` event to the Behold API message stream. This event is fired when a Cortex connects to a Storm Service. (#3205)

17.3.4 Bugfixes

- Catch `ZeroDivisionError` and `decimal.InvalidOperation` errors in Storm expressions and raise a `StormRuntimeError`. (#3203)
- Fix a bug where `synapse.lib.platforms.linux.getTotalMemory()` did not return the correct value in a process running in cgroupsv1 without a maximum memory limit set. (#3198)
- Fix a bug where a Cron job could be created with an invalid Storm query. Cron jobs now have their queries parsed as part of creation to ensure that they are valid Storm. `$lib.cron` APIs now accept heavy Storm query objects as query inputs. (#3201) (#3207)
- Field data sent via Storm `$lib.inet.http` APIs that uses a multipart upload without a valid `name` field now raises a `BadArg` error. Previously this would result in a Python `TypeError`. (#3199) (#3206)

17.3.5 Deprecations

- Remove the deprecated `synapse.common.lockfile()` function. (#3191)

17.4 v2.139.0 - 2023-06-16

17.4.1 Announcement

Due to the introduction of several powerful new APIs and performance improvements, Synapse will be updating to *only* support Python >=3.11. Our current plan is to drop support for Python <=3.10 in ~4 weeks on 2023-06-19. The next release after 2023-06-19 will include changes that are not backward compatible to earlier versions of Python.

If you currently deploy Synapse Open-Source or Synapse Enterprise via the standard docker containers, you will be unaffected. If you install Synapse via PyPI, you will need to ensure that your environment is updated to Python 3.11+.

17.4.2 Model Changes

- Update `it:sec:cpe` normalization to extend truncated CPE2.3 strings. (#3186)

17.4.3 Features and Enhancements

- The `str` type now accepts `float` values to normalize. (#3174)

17.4.4 Bugfixes

- Fix an issue where the `file:bytes:sha256` property set handler could fail during data merging. (#3180)
- Fix an issue where iterating light edges on nodes could result in degraded Cortex performance. (#3186)

17.4.5 Improved Documentation

- Update the Cortex admin guide to include additional examples for setting up user and role permissions. (#3187)

17.5 v2.138.0 - 2023-06-13

17.5.1 Features and Enhancements

- Add `it:sec:cwe` to the list of types identified with scrape APIs. (#3182)
- Update the calculations done by `$lib.infosec.cvss.vectToScore()` to more closely emulate the NVD CVSS calculator. (#3181)

17.5.2 Bugfixes

- Fix an issue with `synapse.tools.storm` where the `!export` command did not use the view specified when starting the tool. (#3184)
- The `synapse.common.getSslCtx()` API now only attempts to load files in the target directory. This avoids confusing errors that may be logged when the target directory contains sub directories. (#3179)
- Fix an edge case in `$lib.infosec.cvss.vectToScore()` when calculating CVSS v2 scores. (#3181)

17.5.3 Deprecations

- Mark the Python function `synapse.common.lockfile()` as deprecated. It will be removed in `v2.140.0`. (#3183)

17.6 v2.137.0 - 2023-06-09

17.6.1 Automatic Migrations

- Migrate any `inet:url` nodes with `:user` and `:passwd` properties which may have been URL encoded. These values are now decoded. (#3169)
- Migrate the storage type for the `file:bytes:mime:pe:imphash` property. (#3173)
- See *Data Migration* for more information about automatic migrations.

17.6.2 Model Changes

- Updates to the `geospace`, `inet`, `infotech`, `org`, `risk`, and `transport` models. (#3169)

  `it:mitre:attack:matrix`
  : Add a type to capture the enumeration of MITRE ATT&CK matrix values.

  `inet:egress`
  : Add a form to capture a host using a specific network egress client address.

  `it:prod:softreg`
  : Add a form to capture a registry entry is created by a specific software version.

transport:land:vehicle
Add a form to capture an individual vehicle.

transport:land:registration
Add a form to capture the registration issued to a contact for a land vehicle.

transport:land:license
Add a form to capture the license to operate a land vehicle issued to a contact.

inet:http:request
The form had the following property added to it:

referer
The referer URL parsed from the "Referer:" header in the request.

inet:search:query
The form had the following property added to it:

request
The HTTP request used to issue the query.

it:mitre:attack:tactic
The form had the following property added to it:

matrix
The ATT&CK matrix which defines the tactic.

it:mitre:attack:technique
The form had the following property added to it:

matrix
The ATT&CK matrix which defines the technique.

it:mitre:attack:mitigation
The form had the following property added to it:

matrix
The ATT&CK matrix which defines the mitigation.

it:app:snort:rule
The form had the following property added to it:

engine
The snort engine ID which can parse and evaluate the rule text.

it:app:yara:rule
The form had the following properties added to it:

ext:id
The YARA rule ID from an external system.

url
A URL which documents the YARA rule.

ou:campaign
The form had the following property added to it:

tag
The tag used to annotate nodes that are associated with the campaign.

ou:org
The form had the following properties added to it:

country
The organization's country of origin.

country:code
The 2 digit ISO 3166 country code for the organization's country of origin.

risk:threat
The form had the following properties added to it:

country
The reporting organization's assessed country of origin of the threat cluster.

country:code
The 2 digit ISO 3166 country code for the threat cluster's assessed country of origin.

risk:compromise
The form had the following property added to it:

vector
The attack assessed to be the initial compromise vector.

detects
When used with a `meta:rule` node, the edge indicates the rule was designed to detect instances of the target node.

When used with an `it:app:snort:rule` node, the edge indicates the rule was designed to detect instances of the target node.

When used with an `it:app:yara:rule` node, the edge indicates the rule was designed to detect instances of the target node.

contains
When used between two `geo:place` nodes, the edge indicates the source place completely contains the target place.

geo:place
The form had the following property marked as deprecated:

- `parent`

17.6.3 Features and Enhancements

- Add a modulo arithmetic operator (`%`) to Storm expression parsing. (#3168)
- Add `$lib.auth.easyperm` Storm library for interacting with objects that use a simplified permissions model. (#3167)
- Add `.vars` attribute to the Storm `auth:user` object. This can be used to access user variables. (#3167)
- Add `$lib.infosec.cvss.vectToScore()` to calculate CVSS scores. (#3171)
- The Storm `delnode` command node now requires the use of `--force` to delete a node which has lightweight edges pointing to it. (#3176)
- The STIX export configuration may now include a `synapse_extension` value set to `$lib.false` to disable the Synapse STIX extension data from being added to objects in the bundle. (#3177)
- Remove whitespace stripping from Storm queries prior to parsing them. This allows any error highlighting information to accurately reflect the query submitted to the Cortex. (#3175)

17.6.4 Bugfixes

- Fix an issue where raising an integer value to a fractional power in Storm was not handled correctly. (#3170)
- Handle a SyntaxError that may occur during Storm parsing due to a change in CPython 3.11.4. (#3170)
- The `inet:url` type now URL decodes the `user` and `passwd` properties when normalizing them. Thank you `captainGeech42` for the bug report. (#2568) (#3169)
- The URL parser in `synapse.lib.urlhelp` now URL decodes the `user` and `passwd` values when parsing URLs. (#3178)

17.6.5 Deprecations

- Mark the Storm functions `$lib.infosec.cvss.saveVectToNode()` and `$lib.infosec.cvss.vectToProps()` as deprecated. (#3178)

17.7 v2.136.0 - 2023-06-02

17.7.1 Model Changes

- Boolean values in the Synapse model now have lowercase `true` and `false` repr values. (#3159)
- The trailing `.` on the taxonomy repr has been removed. (#3159)

17.7.2 Features and Enhancements

- Normalize tag names when performing lift and filter operations. (#3094)
- Add `$lib.compression.bzip2`, `$lib.compression.gzip`, and `$lib.compression.zlib` Storm libraries to assist with compressing and decompressing bytes. (#3155) (#3162)
- Add a new Cell configuration option, `https:parse:proxy:remoteip`. When this is set to `true`, the Cell HTTPS server will parse `X-Forwarded-For` and `X-Real-IP` headers to determine the remote IP of an request. (#3160)
- Update the allowed versions of the `fastjsonschema` and `pycryptodome` libraries. Update the required version of the `vcrpy` library to account for changes in `urllib3`. Remove the pinned requirement for the `requests` library. (#3164)

17.7.3 Bugfixes

- Prevent zero length tag lift operations. (#3094)
- Fix an issue where tag properties with the type `ival`, or `time` types with `ismin` or `ismax` options set, were not properly merged when being set. (#3161)
- Fix a missing `mesg` value on `NoSuchForm` exception raised by the `layer` `liftByTag()` API. (#3165)

17.8 v2.135.0 - 2023-05-24

17.8.1 Features and Enhancements

- Add a `--index` option to the Storm `auth.user.grant` command. (#3150)
- Add additional type handling in the Storm view and layer `set()` APIs. (#3147)
- Add a new Storm command, `auth.perms.list`, to list all of the permissions registered with the Cortex. (#3135) (#3154)

17.8.2 Bugfixes

- Fix an issue where attempting a tag lift with a variable containing a zero-length string would raise an MDB error. (#3094)
- Fix an issue in the Axon `csvrows()` and `readlines()` APIs where certain exceptions would not be raised. (#3141)
- Fix an issue with the Storm `runas` command which prevented it being used with a privileged Storm runtime. (#3147)
- Fix support for Storm list objects in `$lib.max()` and `$lib.min()`. (#3153)

17.8.3 Improved Documentation

- Update the Cortex admin guide to include the output of the `auth.perms.list` command. (#3135)

17.9 v2.134.0 - 2023-05-17

17.9.1 Model Changes

- Updates to the `risk` model. (#3137)

  addresses
  : When used with a `risk:mitigation` and a `ou:technique` node, the edge indicates the mitigation addresses the technique.

17.9.2 Features and Enhancements

- Add a `--forms` option to the Storm `scrape` command. This can be used to limit the forms that are made from scraping the input text. The `scrape` command now uses the View scrape interface to generate its matches, which may include scrape functionality added via power-ups. The `scrape` command no longer produces warning messages when matched text is not valid for making nodes. (#3127)
- Add a `revs` definition to the STIX export configuration, to allow for adding in reverse relationships. (#3137)
- Add a `--delbytes` option to the Storm `delnode` command. This can be used to delete the bytes from an Axon when deleting a `file:bytes` node. (#3140)
- Add support for printing nice versions of the Storm `model:form`, `model:property`, `model:tagprop`, and `model:type` objects. (#3134) (#3139)

17.9.3 Bugfixes

- Fix an exception that was raised when setting the parent of a View. (#3131) (#3132)
- Fix an issue with the text scrape regular expressions misidentifying the `ftp://` scheme. (#3127)
- Correctly handle `readonly` properties in the Storm `copyto` command. (#3142)
- Fix an issue were partial service backups were not able to be removed. (#3143) (#3145)

17.10 v2.133.1 - 2023-05-09

17.10.1 Bugfixes

- Fix an issue where the Storm query hashing added in `v2.133.0` did not account for handling erroneous surrogate pairs in query text. (#3130)

17.10.2 Improved Documentation

- Update the Storm API Guide to include the `hash` key in the `init` message. (#3130)

17.11 v2.133.0 - 2023-05-08

17.11.1 Model Changes

- Updates to the `risk` model. (#3123)

  risk:vuln
  : The `risk:vuln` form had the following properties added to it:

    cvss:v2
    : The CVSS v2 vector for the vulnerability.

    cvss:v2_0:score
    : The CVSS v2.0 overall score for the vulnerability.

    cvss:v2_0:score:base
    : The CVSS v2.0 base score for the vulnerability.

    cvss:v2_0:score:temporal
    : The CVSS v2.0 temporal score for the vulnerability.

    cvss:v2_0:score:environmental
    : The CVSS v2.0 environmental score for the vulnerability.

    cvss:v3
    : The CVSS v3 vector for the vulnerability.

    cvss:v3_0:score
    : The CVSS v3.0 overall score for the vulnerability.

    cvss:v3_0:score:base
    : The CVSS v3.0 base score for the vulnerability.

    cvss:v3_0:scare:temporal
    : The CVSS v3.0 temporal score for the vulnerability.

cvss:v3_0:score:environmental
The CVSS v3.0 environmental score for the vulnerability.

cvss:v3_1:score
The CVSS v3.1 overall score for the vulnerability.

cvss:v3_1:score:base
The CVSS v3.1 base score for the vulnerability.

cvss:v3_1:scare:temporal
The CVSS v3.1 temporal score for the vulnerability.

cvss:v3_1:score:environmental
The CVSS v3.1 environmental score for the vulnerability.

risk:vuln
The `risk:vuln` form had the following properties marked as deprecated:

- `cvss:av`
- `cvss:ac`
- `cvss:pr`
- `cvss:ui`
- `cvss:s`
- `cvss:c`
- `cvss:i`
- `cvss:a`
- `cvss:e`
- `cvss:rl`
- `cvss:rc`
- `cvss:mav`
- `cvss:mac`
- `cvss:mpr`
- `cvss:mui`
- `cvss:ms`
- `cvss:mc`
- `cvss:mi`
- `cvss:ma`
- `cvss:cr`
- `cvss:ir`
- `cvss:ar`
- `cvss:score`
- `cvss:score:temporal`
- `cvss:score:environmental`

17.11.2 Features and Enhancements

- Update the base Synapse images to use Debian bookworm and use Python 3.11 as the Python runtime. For users which build custom images from our published images, see additional information at *Working with Synapse Images* for changes which may affect you. (#3025)
- Add a `highlight` parameter to BadSyntaxError and some exceptions raised during the execution of a Storm block. This contains detailed information about where an error occurred in the Storm code. (#3063)
- Allow callers to specify an `iden` value when creating a Storm Dmon or a trigger. (#3121)
- Add support for STIX export configs to specify pivots to include additional nodes. (#3122)
- The Storm `auth.user.addrule` and `auth.role.addrule` now have an optional `--index` argument that allows specifying the rule location as a 0-based index value. (#3124)
- The Storm `auth.user.show` command now shows the user's `admin` status on authgates. (#3124)
- Add a `--only-url` flag to the `synapse.tools.aha.provision.service` and `synapse.tools.aha.provision.user` CLI tools. When set, the tool only prints the URL to stdout. (#3125)
- Add additional layer validation in the View schema. (#3128)
- Update the allowed version of the `cryptography`, `coverage`, `idna`, `pycryptodome`, `python-bitcoin`, and `vcrpy` libraries. (#3025)

17.11.3 Bugfixes

- Ensure the CLI tools `synapse.tools.cellauth`, `synapse.tools.csvtool`, and `synapse.tools.easycert` now return 1 on an execution failure. In some cases they previously returned `-1`. (#3118)

17.12 v2.132.0 - 2023-05-02

17.12.1 Features and Enhancements

- Update the minimum required version of the `fastjsonschema`, `lark`, and `pytz` libraries. Update the allowed version of the `packaging` and `scalecodec` libraries. (#3118)

17.12.2 Bugfixes

- Cap the maximum version of the `requests` library until downstream use of that library has been updated to account for changes in `urllib3`. (#3119)
- Properly add parent scope vars to `background` command context. (#3120)

17.13 v2.131.0 - 2023-05-02

17.13.1 Automatic Migrations

- Migrate the `ou:campaign:name` property from a `str` to an `ou:campname` type and create the `ou:campname` nodes as needed. (#3082)
- Migrate the `risk:vuln:type` property from a `str` to a `risk:vuln:type:taxonomy` type and create the `risk:vuln:type:taxonomy` nodes as needed. (#3082)
- See *Data Migration* for more information about automatic migrations.

17.13.2 Features and Enhancements

- Updates to the `dns`, `inet`, `it`, `org`, `ps`, and `risk` models. (#3082) (#3108) (#3113)

  `inet:dns:answer`
  Add a `mx:priority` property to record the priority of the MX response.

  `inet:dns:dynreg`
  Add a form to record the registration of a domain with a dynamic DNS provider.

  `inet:proto`
  Add a form to record a network protocol name.

  `inet:web:attachment`
  Add a form to record the instance of a file being sent to a web service by an account.

  `inet:web:file`
  Deprecate the `client`, `client:ipv4`, and `client:ipv6` properties in favor of using `inet:web:attachment`.

  `inet:web:logon`
  Remove incorrect `readonly` markings for properties.

  `it:app:snort:rule`
  Add an `id` property to record the snort rule id. Add an `author` property to record contact information for the rule author. Add `created` and `updated` properties to track when the rule was created and last updated. Add an `enabled` property to record if the rule should be used for snort evaluation engines. Add a `family` property to record the software family the rule is designed to detect.

  `it:prod:softid`
  Add a form to record an identifier issued to a given host by a specific software application.

  `ou:campname`
  Add a form to record the name of campaigns.

  `ou:campaign`
  Change the `name` and `names` secondary properties from `str` to `ou:campname` types.

  `ps:contact`
  Add a `place:name` to record the name of the place associated with the contact.

  `risk:threat`
  Add an `active` property to record the interval of time when the threat cluster is assessed to have been active. Add a `reporter:published` property to record the time that a reporting organization first publicly disclosed the threat cluster.

risk:tool:software
: Add a `used` property to record the interval when the tool is assessed to have been deployed. Add a `reporter:discovered` property to record the time that a reporting organization first discovered the tool. Add a `reporter:published` property to record the time that a reporting organization first publicly disclosed the tool.

risk:vuln:soft:range
: Add a form to record a contiguous range of software versions which contain a vulnerability.

risk:vuln
: Change the `type` property from a `str` to a `risk:vuln:type:taxonomy`.

risk:vuln:type:taxonomy
: Add a form to record a taxonomy of vulnerability types.

- Add a new Storm command, `auth.user.allowed` that can be used to check if a user is allowed to use a given permission and why. (#3114)
- Add a new Storm command, `gen.ou.campaign`, to assist with generating or creating `ou:campaign` nodes. (#3082)
- Add a boolean `default` key to the permissions schema definition. This allows a Storm package permission to note what its default value is. (#3099)
- Data model migrations which fail to normalize existing secondary values into their new types now store those values in Node data on the affected nodes and remove those bad properties from the affected nodes. (#3117)

17.13.3 Bugfixes

- Fix an issue with the search functionality in our documentation missing the required jQuery library. (#3111)
- Unique nodes when performing multi-layer lifts on secondary properties without a value. (#3110)

17.13.4 Improved Documentation

- Add a section about managing data model deprecations to the Synapse Admin guide. (#3102)

17.13.5 Deprecations

- Remove the deprecated `synapse.lib.httpapi.HandlerBase.user()` and `synapse.lib.httpapi.HandlerBase.getUserBody()` functions. Remove the deprecated `synapse.axon.AxonFileHandler.axon()` function. (#3115)

17.14 v2.130.2 - 2023-04-26

17.14.1 Bugfixes

- Fix an issue where the `proxy` argument was not being passed to the Axon when attempting to post a file via Storm with the `$lib.inet.http.post()` API. (#3109)
- Fix an issue where adding a readonly layer that does not already exist would raise an error. (#3106)

17.15 v2.130.1 - 2023-04-25

17.15.1 Bugfixes

- Fix a race condition in a Telepath unit test which was happening during CI testing. (#3104)

17.16 v2.130.0 - 2023-04-25

17.16.1 Features and Enhancements

- Updates to the `infotech` model. (#3095)

  `it:host`
  : Add an `ext:id` property for recording an external identifier for a host.

- Add support for deleting node properties by assigning `$lib.undef` to the property to be removed through `$node.props`. (#3098)
- The `Cell.ahaclient` is longer cached in the `synapse.telepath.aha_clients` dictionary. This isolates the Cell connection to Aha from other clients. (#3008)
- When the Cell mirror loop exits, it now reports the current `ready` status to the Aha service. This allows a service to mark itself as "not ready" when the loop restarts and it is a follower, since it may no longer be in the realtime change window. (#3008)
- Update the required versions of the `nbconvert`, `sphinx` and `hide-code` libraries used for building documentation. Increased the allowed ranges for the `pygments` and `jupyter-client` libraries. (#3103)

17.16.2 Bugfixes

- Fix an issue in backtick format strings where single quotes in certain positions would raise a syntax error. (#3096)
- Fix an issue where permissions were not correctly checked when assigning a property value through `$node.props`. (#3098)
- Fix an issue where the Cell would report a static `ready` value to the Aha service upon reconnecting, instead of the current `ready` status. The `Cell.ahainfo` value was replaced with a `Cell.getAhaInfo()` API which returns the current information to report to the Aha service. (#3008)

17.17 v2.129.0 - 2023-04-17

17.17.1 Features and Enhancements

- Updates to the `ou` and `risk` models. (#3080)

  `ou:campaign`
  : Add a `names` property to record alternative names for the campaign. Add `reporter` and `reporter:name` properties to record information about a reporter of the campaign.

  `risk:attack`
  : Add `reporter` and `reporter:name` properties to record information about a reporter of the attack.

risk:compromise
Add reporter and reporter:name properties to record information about a reporter of the compromise.

risk:vuln
Add reporter and reporter:name properties to record information about a reporter of the vulnerability.

- Add leader status to the synapse.tools.aha.list tool output. This will only be available if a leader has been registered for the service. (#3078)
- Add support for private values in Storm modules, which are specified by beginning the name with a double underscore (__). These values cannot be dereferenced outside of the module they are declared in. (#3079)
- Update error messages for Axon.wget, Axon.wput, and Axon.postfiles to include more helpful information. (#3077)
- Update it:semver string normalization to attempt parsing improperly formatted semver values. (#3080)
- Update Axon to always pass size value when saving bytes. (#3084)

17.17.2 Bugfixes

- Add missing toprim() calls on arguments to some auth:user and auth:role APIs. (#3086)
- Fix the regular expression used to validate custom STIX types. (#3093)

17.17.3 Improved Documentation

- Add sections on user and role permissions to the Synapse Admin guide. (#3073)

17.18 v2.128.0 - 2023-04-11

17.18.1 Automatic Migrations

- Migrate the file:bytes:mime:pe:imphash property from a guid to a hash:md5 type and create the hash:md5 nodes as needed. (#3056)
- Migrate the ou:goal:name property from a str to a ou:goalname type and create the ou:goalname nodes as needed. (#3056)
- Migrate the ou:goal:type property from a str to a ou:goal:type:taxonomy type and create the ou:goal:type:taxonomy nodes as needed. (#3056)
- See *Data Migration* for more information about automatic migrations.

17.18.2 Features and Enhancements

- Updates to the belief, file, lang, it, meta, ou, pol, and risk models. (#3056)

belief:tenet
Add a desc property to record the description of the tenet.

file:bytes
Change the type of the mime:pe:imphash from guid to hash:md5.

inet:flow
Add a raw property which may be used to store additional protocol data about the flow.

it:app:snort:rule
Add a desc property to record a brief description of the snort rule.

ou:goal
Change the type of name from str to ou:goalname. Change the type of type from str to ou:goal:type:taxonomy. Add a names array to record alternative names for the goal. Deprecate the prev property in favor of types.

ou:goalname
Add a form to record the name of a goal.

ou:goalname:type:taxonomy
Add a taxonomy of goal types.

ou:industry
Add a type property to record the industry taxonomy.

ou:industry:type:taxonomy
Add a taxonomy to record industry types.

pol:immigration:status
Add a form to track the immigration status of a contact.

pol:immigration:status:type:taxonomy
Add a taxonomy of immigration types.

risk:attack
Add a detected property to record the first confirmed detection time of the attack. Add a url property to record a URL that documents the attack. Add a ext:id property to record an external identifier for the attack.

risk:compromise
Add a detected property to record the first confirmed detection time of the compromise.

- Add a Storm command copyto that can be used to create a copy of a node from the current view to a different view. (#3061)
- Add the current View iden to the structured log output of a Cortex executing a Storm query. (#3068)
- Update the allowed versions of the lmdb, msgpack, tornado and xxhash libraries. (#3070)
- Add Python 3.11 tests to the CircleCI configuration. Update some unit tests to account for Python 3.11 related changes. (#3070)
- Allow dereferencing from Storm expressions. (#3071)
- Add an ispart parameter to $lib.tags.prefix to skip syn:tag:part normalization of tag names. (#3074)
- Add getEdges(), getEdgesByN1(), and getEdgesByN2() APIs to the layer object. (#3076)

17.18.3 Bugfixes

- Fix an issue which prevented the auth.user.revoke Storm command from executing. (#3069)
- Fix an issue where $node.data.list() only returned the node data from the topmost layer containing node data. It now returns all the node data accessible for the node from the current view. (#3061)

17.18.4 Improved Documentation

- Update the Developer guide to note that the underlying Python runtime in Synapse images may change between releases. (#3070)

17.19 v2.127.0 - 2023-04-05

17.19.1 Features and Enhancements

- Set `Link` high water mark to one byte in preparation for Python 3.11 support. (#3064)
- Allow specifying dictionary keys in Storm with expressions and backtick format strings. (#3065)
- Allow using deref syntax (`*$form`) when lifting by form with tag (`*$form#tag`) and form with tagprop (`*$form#tag:tagprop`). (#3065)
- Add `cron:start` and `cron:stop` messages to the events emitted by the `behold()` API on the Cortex. These events are only emitted by the leader. (#3062)

17.19.2 Bugfixes

- Fix an issue where an Aha service running on a non-default port would not have that port included in the default Aha URLs. (#3049)
- Restore the `view.addNode()` Storm API behavior where making a node on a View object that corresponds to the currently executing view re-used the current Snap object. This allows nodeedits to be emitted from the Storm message stream. (#3066)

17.20 v2.126.0 - 2023-03-30

17.20.1 Features and Enhancements

- Add additional Storm commands to assist with managing Users and Roles in the Cortex. (#2923) (#3054)

  `auth.gate.show`
  : Shows the definition for an AuthGate.

  `auth.role.delrule`
  : Used to delete a rule from a Role.

  `auth.role.mod`
  : Used to modify properties of a Role.

  `auth.role.del`
  : Used to delete a Role.

  `auth.role.show`
  : Shows the definition for a Role.

  `auth.role.list`
  : List all Roles.

  `auth.user.delrule`
  : Used to delete a rule from a User.

`auth.user.grant`
: Used to grant a Role to a User.

`auth.user.revoke`
: Used to revoke a Role from a User.

`auth.role.mod`
: Used to modify properties of a User.

`auth.user.show`
: Shows the definition of a User.

`auth.user.list`
: List all Users.

- Update some of the auth related objects in Storm: (#2923)

  `auth:role`
  : Add `popRule()` and `getRules()` functions. Add a `.gates` accessor to get all of the AuthGates associated with a role.

  `auth:user`
  : Add `popRule()` and `getRules()` functions. Add a `.gates` accessor to get all of the AuthGates associated with a user.

- Add `$lib.auth.textFromRule()`, `$lib.auth.getPermDefs()` and `$lib.auth.getPermDef()` Storm library APIs to assist with working with permissions. (#2923)
- Add a new Storm library function, `$lib.iters.enum()`, to assist with enumerating an iterable object in Storm. (#2923)
- Update the `NoSuchName` exceptions which can be raised by Aha during service provisioning to clarify they are likely caused by re-using the one-time use URL. (#3047)
- Update `gen.ou.org.hq` command to set `ps:contact:org` if unset. (#3052)
- Add an `optional` flag for Storm package dependencies. (#3058)
- Add `.]`, `[.`, `http[:`, `https[:`, `hxxp[:` and `hxxps[:` to the list of known defanging strategies which are identified and replaced during text scraping. (#3057)

17.20.2 Bugfixes

- Fix an issue where passing a non-string value to `$lib.time.parse` with `errok=$lib.true` would still raise an exception. (#3046)
- Fix an issue where context managers could potentially not release resources after exiting. (#3055)
- Fix an issue where variables with non-string names could be passed into Storm runtimes. (#3059)
- Fix an issue with the Cardano regex used for scraping addresses. (#3057)
- Fix an issue where scraping a partial Cardano address could raise an error. (#3057)
- Fix an issue where the Storm API `view.addNode()` checked permissions against the incorrect authgate. This API now only returns a node if the View object is the same as the View the Storm query is executing in. (#3060)

17.20.3 Improved Documentation

- Fix link to Storm tool in Synapse Power-Ups section. (#3053)
- Add Kubernetes deployment examples, which show deploying Synapse services with Aha based provisioning. Add an example showing one mechanism to set `sysctl`'s in a managed Kubernetes deployment. (#3047)

17.21 v2.125.0 - 2023-03-14

17.21.1 Features and Enhancements

- Add a `size()` method on the STIX bundle object. (#3043)
- Update the minimum version of the `aio-socks` library to `0.8.0`. Update some unittests related to SOCKS proxy support to account for multiple versions of the `python-socks` library. (#3044)

17.21.2 Improved Documentation

- Update the Synapse documentation to add PDF and HTMLZip formats.

17.22 v2.124.0 - 2023-03-09

17.22.1 Features and Enhancements

- Added `--try` option to `gen.risk.vuln`, `gen.pol.country`, `gen.pol.country.government`, and `gen.ps.contact.email` commands and their associated Storm functions. (#3030)
- Added `$lib.gen.orgHqByName` and `$lib.gen.langByName`. (#3030)
- Added the configuration option `onboot:optimize` to all services to allow devops to delay service startup and allow LMDB to optimize storage for both size and performance. May also be set by environment variable `SYN_<SERVICE>_ONBOOT_OPTIMIZE=1` (#3001)
- Ensure that `AuthDeny` exceptions include the user iden in the `user` key, and the name in the `username` field. Previously the `AuthDeny` exceptions had multiple identifiers for these fields. (#3035)
- Add an optional `--view` argument to the `synapse.tools.storm` CLI tool. This allows a user to specify their working View for the Storm CLI. This was contributed by captainGeech42. (#2937)
- Updates to `synapse.lib.scope` and the `Scope` class. A `Scope.copy()` method has been added to create a shallow copy of a `Scope`. A module level `clone(task)` function has been added which clones the current task scope to the target `task`. Async Tasks created with `Base.schedCoro()` calls now get a shallow copy of the parent task scope. (#3021)
- Add a new Storm command, `batch`, to assist in processing nodes in batched sets. (#3034)
- Add global permissions, `storm.macro.admin` and `storm.macro.edit`, to allow users to administer or edit macros. (#3037)
- Mark the following Storm APIs as safe to execute in read-only queries: `$lib.auth.users.get()`, `$lib.auth.users.list()`, `$lib.auth.users.byname()`, `$lib.auth.roles.get()`, `$lib.auth.roles.list()`, `$lib.auth.roles.byname()`, `$lib.auth.gates.get()` and `$lib.auth.gates.list()`. (#3038)
- Added `uplink` key to `getCellInfo()`, which indicates whether the Cell is currently connected to an upstream mirror. (#3041)

17.22.2 Bugfixes

- Fix an issue in the Storm grammar where part of a query could potentially be incorrectly parsed as an unquoted case statement. (#3032)
- Fix an issue where exceptions could be raised which contained data that was not JSON serializable. `$lib.raise` arguments must now also be JSON safe. (#3029)
- Fix an issue where a spawned process returning a non-pickleable exception would not be handled properly. (#3036)
- Fix an issue where a locked user could login to a Synapse service on a TLS Telepath connection if the connection presented a trusted client certificate for the locked user. (#3035)
- Fix a bug in `Scope.enter()` where the added scope frame was not removed when the context manager was exited. (#3021)
- Restoring a service via the `SYN_RESTORE_HTTPS_URL` environment variable could timeout when downloading the file. The total timeout for this process has been disabled. (#3042)

17.22.3 Improved Documentation

- Update the Synapse glossary to add terms related to the permissions system. (#3031)
- Update the model docstrings for the `risk` model. (#3027)

17.22.4 Deprecations

- The `ctor` support in `Scope` has been removed. The population of the global default scope with environment variables has been removed. (#3021)

17.23 v2.123.0 - 2023-02-22

17.23.1 Automatic Migrations

- If the `risk:vuln:cvss:av` property equals `V` it is migrated to `P`. (#3013)
- Parse `inet:http:cookie` nodes to populate the newly added `:name` and `:value` properties. (#3015)
- See *Data Migration* for more information about automatic migrations.

17.23.2 Features and Enhancements

- Added the `belief` model which includes the following new forms: (#3015)

  `belief:system`
  : A belief system such as an ideology, philosophy, or religion.

  `belief:tenet`
  : A concrete tenet potentially shared by multiple belief systems.

  `belief:subscriber`
  : A contact which subscribes to a belief system.

belief:system:type:taxonomy
A hierarchical taxonomy of belief system types.

- Added declaration for `risk:compromise -(uses)> ou:technique` light-weight edges. (#3015)
- Updated `inet:http:session` and `inet:http:request` forms to include the following property: (#3015)

  :cookies
  An array of `inet:http:cookie` values associated with the node.

- Updated the `inet:http:cookie` form to include the following properties: (#3015)

  name
  The name of the cookie preceding the equal sign.

  value
  The value of the cookie after the equal sign if present.

- Added logic to allow constructing multiple `inet:http:cookie` nodes by automatically splitting on `;` such as `foo=bar; baz=faz` (#3015)
- Updated `it:log:event` to add the following properties: (#3015)

  type
  An `it:log:event:type:taxonomy` type for the log entry.

  ext:id
  An external ID that uniquely identifies this log entry.

  product
  An `it:prod:softver` of the product which produced the log entry.

- Updated the `risk:compromise` form to include the following properties: (#3015)

  goal
  An `ou:goal` node representing the assessed primary goal of the compromise.

  goals
  An array of `ou:goal` nodes representing additional goals of the compromise.

- Updated `risk:attack` and `risk:compromise` forms to deprecate the `techniques` property in favor of using `-(uses)> ou:technique` light-weight edges. (#3015)
- Updates to the `inet:dns`, and `media` models. (#3005) (#3017)

  inet:dns:answer
  Remove all read-only flags present on the secondary properties for this form.

  media:news
  Add an `updated` property to record last time the news item was updated.

- Updated `inet:flow` to include the following properties: (#3017)

  src:ssh:key
  The key sent by the client as part of an SSH session setup.

  dst:ssh:key
  The key sent by the server as part of an SSH session setup.

  src:ssl:cert
  The x509 certificate sent by the client as part of an SSL/TLS negotiation.

  dst:ssl:cert
  The x509 certificate sent by the server as part of an SSL/TLS negotiation.

`src:rdp:hostname`
: The hostname sent by the client as part of an RDP session setup.

`src:rdp:keyboard:layout`
: The keyboard layout sent by the client as part of an RDP session setup.

- Add `synapse.utils.stormcov`, a Coverage.py plugin for measuring code coverage of Storm files. (#2961)
- Clean up several references to the `cell.auth` object in HTTP API handlers. Move the logic in `/api/v1/auth/onepass/issue` API handler to the base Cell. (#2998) (#3004)
- Clarify the error message encountered by a Synapse mirrored service if the mirror gets desynchronized from its upstream service. (#3006)
- Update how read-only properties are handled during merges. The `.created` property will always be set when merging a node down. If two nodes have other conflicting read-only property values, those will now emit a warning in the Storm runtime. (#2989)
- The `Axon.wget()` API response now includes HTTP request history, which is added when the API request encounters redirects. The `$lib.axon.wget()` Storm API now includes information about the original request URL. This data is now used to create `inet:urlredir` nodes, such as when the Storm `wget` command is used to retrieve a file. (#3011)
- Ensure that `BadTypeValu` exceptions raised when normalizing invalid data with the `time` type includes the value in the exception message. (#3009)
- Add a callback on Slab size expansion to trigger a free disk space check on the related cell. (#3016)
- Add support for choices in Storm command arguments. (#3019)
- Add an optional parameter to the Storm `uniq` command to allow specifying a relative property or variable to operate on rather than node iden. (#3018)
- Synapse HTTP API logs now include the user iden and username when that information is available. For deployments with structured logging enabled, the HTTP path, HTTP status code, user iden, and username are added to that log message. (#3007)
- Add `web_useriden` and `web_username` attributes to the Synapse HTTP Handler class. These are used for HTTP request logging to populate the user iden and username data. These are automatically set when a user authenticates using a session token or via basic authentication. The HTTP Session tracking now tracks the username at the time the session was created. The `_web_user` value, which previously pointed to a heavy HiveUser object, is no longer populated by default. (#3007)
- Add `$lib.inet.http.codereason` Storm API for translating HTTP status codes to reason phrases. `inet:http:resp` objects now also have a `reason` value populated. (#3023)
- Update the minimum version of the `cryptography` library to `39.0.1` and the minimum version of the `pyopenssl` library to `23.0.0`. (#3022)

17.23.3 Bugfixes

- The Storm `wget` command created `inet:urlfile` nodes with the `url` property of the resolved URL from `aiohttp`. This made it so that a user could not pivot from an `inet:url` node which had a URL encoded parameter string to the resulting `inet:urlfile` node. The `inet:urlfile` nodes are now made with the original request URL to allow that pivoting to occur. (#3011)
- The `Axon.wget()` and `$lib.axon.wget()` APIs returned URLs in the `url` field of their responses which did not contain fragment identifiers. These API responses now include the fragment identifier if it was present in the resolved URL. (#3011)

- The Storm `tree` command did not properly handle Storm query arguments which were declared as `storm:query` types. (#3012)
- Remove an unnecessary permission check in the Storm `movenodes` command which could cause the command to fail. (#3002)
- When a user email address was provided to the HTTP API `/api/v1/auth/adduser`, the handler did not properly set the email using change controlled APIs, so that information would not be sent to mirrored cells. The email is now being set properly. (#2998)
- The `risk:vuln:cvss:av` enum incorrectly included `V` instead of `P`. (#3013)
- Fix an issue where the `ismax` specification on time types did not merge time values correctly. (#3017)
- Fix an issue where using a function call to specify the tag in a tagprop operation would not be correctly parsed. (#3020)

17.23.4 Improved Documentation

- Update copyright notice to always include the current year. (#3010)

17.23.5 Deprecations

- The `synapse.lib.httpapi.Handler.user()` and `synapse.lib.httpapi.Handler.getUserBody()` methods are marked as deprecated. These methods will be removed in Synapse `v2.130.0`. (#3007)

17.24 v2.122.0 - 2023-01-27

17.24.1 Features and Enhancements

- Updates to the `biz`, `file`, `lang`, `meta`, `pol`, and `risk` models. (#2984)

  `biz:service`
  : Add a `launched` property to record when the operator first made the service available.

  `file:bytes`
  : Add `exe:compiler` and `exe:packer` properties to track the software used to compile and encode the file.

  `lang:language`
  : Add a new guid form to represent a written or spoken language.

  `lang:name`
  : Add a new form to record the name of a language.

  `meta:node`
  : Add a `type` property to record the note type.

  `meta:note:type:taxonomy`
  : Add a form to record an analyst defined taxonomy of note types.

  `pol:country`
  : Correct the `vitals` property type from `ps:vitals` to `pol:vitals`.

  `ps:contact`
  : Add a `lang` property to record the language specified for the contact.

    Add a `langs` property to record the alternative languages specified for the contact.

ps:skill
Add a form to record a specific skill which a person or organization may have.

ps:skill:type:taxonomy
Add a form to record a taxonomy of skill types.

ps:proficiency
Add a form to record the assessment that a given contact possesses a specific skill.

risk:alert
Add a `priority` property that can be used to rank alerts by priority.

risk:compromise
Add a `severity` property that can be used as a relative severity score for the compromise.

risk:threat
Add a `type` property to record the type of the threat cluster.

risk:threat:type:taxonomy
Add a form to record a taxonomy of threat types.

- Add support for Python 3.10 to Synapse. (#2962)
- Update the Synapse docker containers to be built from a Debian based image, instead of an Ubuntu based image. These images now use Python 3.10 as the Python runtime. (#2962)
- Add an optional `--type` argument to the Storm `note.add` command. (#2984)
- Add a Storm command, `gen.lang.language`, to lift or generate a `lang:language` node by name. (#2984)
- Update the allowed versions of the `cbor2` library; and upgrade the versions of `aiostmplib` and `aiohttp-socks` to their latest versions. (#2986)
- The `X-XSS-Protection` header was removed from the default HTTP API handlers. This header is non-standard and only supported by Safari browsers. Service deployments which rely on this header should use the `https:headers` configuration option to inject that header into their HTTP responses. (#2997)

17.24.2 Bugfixes

- Malformed hash values normalized as `file:bytes` raised exceptions which were not properly caught, causing Storm ?= syntax to fail. Malformed values are now properly handled in `file:bytes`. (#3000)

17.24.3 Improved Documentation

- Update the Storm filters user guide to include expression filters (#2997)
- Update Storm type-specific behavior user guide to clarify `guid` deconfliction use cases and some associated best practices. (#2997)
- Update Storm command reference user guide to document `gen.*` commands. (#2997)

17.24.4 Deprecations

- The Cortex APIs `provStacks()` and `getProvStack(iden)` have been removed. (#2995)

17.25 v2.121.1 - 2022-01-23

17.25.1 Bugfixes

- When creating Storm Macros using `v2.121.0`, the creator of the Macro was incorrectly set to the `root` user. This is now set to the user that created the macro using the Storm `macro.set` command or the `$lib.macro.set()` API. (#2993)

17.26 v2.121.0 - 2022-01-20

17.26.1 Automatic Migrations

- Storm Macros stored in the Cortex are migrated from the Hive to the Cortex LMDB slab. (#2973)
- See *Data Migration* for more information about automatic migrations.

17.26.2 Features and Enhancements

- Updates to the `inet` and `org` models. (#2982) (#2987)

  `inet:dns:soa`
  : The `fqdn`, `ns` and `email` properties had the read-only flag removed from them.

  `ou:org`
  : Add a `goals` property to record the assessed goals of the organization.

- Add extended permissions for Storm Macro functionality using a new simplified permissions system. This allows users to opt into assigning users or roles the permission to read, write, administrate, or deny access to their Macros. These permissions can be set by the Storm `$lib.macro.grant()` API. (#2973)
- Add extended information about a Storm Macro, including its creation time, update time, and a description. The Macro name, description and Storm can now be set via the Storm `$lib.macro.mod()` API. (#2973)
- Allow users and Power-Ups to store graph projection definitions in the Cortex. Graph projections have the same simplified permissions system applied to them as introduced for Storm Macros. Storm users can now also load a stored graph projection into a running Storm query. These new features are exposed via the Storm `$lib.graph` APIs. (#2914)
- The disk space required to make the backup of a Synapse service is now checked prior to a live backup being made. If there is insufficient storage to make the backup on the volume storing the backup, a LowSpace exception will be raised. (#2990)

17.26.3 Bugfixes

- When normalizing the `inet:email` type, an unclear Python `ValueError` could have been raised to a user. This is now caught and a specific `BadTypeValu` exception is raised. (#2982)
- The `synapse.exc.StormRaise` exception caused an error when recreating the exception on the client side of a Telepath connection. This exception will now raise properly on the caller side. (#2985)
- When using the Storm `diff` command to examine a forked View, if a node was deleted out from the base layer and edited in the fork, an exception would be raised. This situation is now properly handled. (#2988)

17.26.4 Improved Documentation

- Update the Storm User Guide section on variables for clarity. (#2968)
- Correct Provenance API deprecation notice from `v2.221.0` to `v2.122.0`. (#2981)

17.27 v2.120.0 - 2023-01-11

17.27.1 Features and Enhancements

- Update to the `risk` models. (#2978)

  `risk:threat`
  : Add a `merge:time` and `merged:isnow` properties to track when a threat cluster was merged with another threat cluster.

  `risk:alert`
  : Add an `engine` property to track the software engine that generated the alert.

- Add events for `trigger:add`, `trigger:del`, and `trigger:set` to the Beholder API. (#2975)

17.27.2 Bugfixes

- Fix an infinite loop in `synapse.tools.storm` when using the tool in an environment without write access to the history file. (#2977)

17.28 v2.119.0 - 2023-01-09

17.28.1 Features and Enhancements

- Updates to the `biz`, `econ`, `org`, and `risk` models. (#2931)

  `biz:listing`
  : Add a form to track a specific product or service listed for sale at a given price by a specific seller.

  `biz:service`
  : Add a form to track a service performed by a specific organization.

  `biz:service:type`
  : Add a form to record an analyst defined taxonomy of business services.

biz:bundle
Add a `service` property to record the service included in the bundle.

Deprecate the `deal` and `purchase` secondary properties in favor of `econ:receipt:item` to represent bundles being sold.

biz:product
Add a `price:currency` property to denote the currency of the prices.

Add a `maker` property to represent the contact information for the maker of a product.

Deprecate the `madeby:org`, `madeby:orgname`, `madeby:orgfqdn` properties in favor of using the new `maker` property.

econ:receipt:item
Add a form to represent a line item included as part of a purchase.

econ:acquired
Deprecate the form in favor of an `acquired` light edge.

ou:campaign
Add a `budget` property to record the budget allocated for the campaign.

Add a `currency` property to record the currency of the `econ:price` secondary properties.

Add a `result:revenue` property to record the revenue resulting from the campaign.

Add a `result:pop` property to record the count of people affected by the campaign.

risk:alert:verdict:taxonomy
Add a form to record an analyst defined taxonomy of the origin and validity of an alert.

risk:alert
Add a `benign` property to record if the alert has been confirmed as benign or malicious.

Add a `verdict` property to record the analyst verdict taxonomy about why an alert is marked as benign or malicious.

- Annotate the following light edges. (#2931)

  acquired
  When used with an `econ:purchase` node, the edge indicates the purchase was used to acquire the target node.

  ipwhois
  When used with an `inet:whois:iprec` node and `inet:ipv4` or `inet:ipv6` nodes, the edge indicates the source IP whois record describes the target IP address.

- Add a new Cell configuration option, `limit:disk:free`. This represents the minimum percentage of free disk space on the volume hosting a Synapse service that is required in order to start up. This value is also monitored every minute and will disable the Cell Nexus if the free space drops below the specified value. This value defaults to five percent (`5 %`) free disk space. (#2920)

17.28.2 Improved Documentation

- Add a Devops task related to configuration of the free space requirement. (#2920)

17.29 v2.118.0 - 2023-01-06

17.29.1 Features and Enhancements

- Updates to the `inet`, `pol`, and `ps` models. (#2970) (#2971)

  `inet:tunnel`
  Add a form to represent the specific sequence of hosts forwarding connections, such as a VPN or proxy.

  `inet:tunnel:type:taxonomy`
  Add a form to record an analyst defined taxonomy of network tunnel types.

  `pol:country`
  Add a `government` property to represent the organization for the government of the country.

  `ps:contact`
  Add a `type` property to record the taxonomy of the node. This may be used for entity resolution.

  `ps:contact:type:taxonomy`
  Add a form to record an analyst defined taxonomy of contact types.

- Add the following Storm commands to help with analyst generation of several guid node types: (#2970)

  `gen.it.prod.soft`
  Lift (or create) an `it:prod:soft` node based on the software name.

  `gen.ou.industry`
  Lift (or create) an `ou:industry` node based on the industry name.

  `gen.ou.org`
  Lift (or create) an `ou:org` node based on the organization name.

  `gen.ou.org.hq`
  Lift (or create) the primary `ps:contact` node for the ou:org based on the organization name.

  `gen.pol.country`
  Lift (or create) a `pol:country` node based on the 2 letter ISO-3166 country code.

  `gen.pol.country.government`
  Lift (or create) the `ou:org` node representing a country's government based on the 2 letter ISO-3166 country code.

  `gen.ps.contact.email`
  Lift (or create) the `ps:contact` node by deconflicting the email and type.

  `gen.risk.threat`
  Lift (or create) a `risk:threat` node based on the threat name and reporter name.

  `gen.risk.tool.software`
  Lift (or create) a `risk:tool:software` node based on the tool name and reporter name.

  `gen.risk.vuln`
  Lift (or create) a `risk:vuln` node based on the CVE.

- Add `$lib.gen.riskThreat()`, `$lib.gen.riskToolSoftware()`, `$lib.gen.psContactByEmail()`, and `$lib.gen.polCountryByIso2()` Storm API functions to assist in generating `risk:threat`, `risk:tool:software`, `ps:contact` and `pol:country` nodes. (#2970)
- Update the CRL bundled within Synapse to revoke the `The Vertex Project Code Signer 00` key. (#2972)

17.29.2 Bugfixes

- Fix an issue in the Axon `csvrows()` and `readlines()` APIs which could cause the Axon service to hang. (#2969)

17.30 v2.117.0 - 2023-01-04

17.30.1 Automatic Migrations

- The `risk:tool:software:soft:names` and `risk:tool:software:techniques` properties are migrated to being unique arrays. (#2950)
- See *Data Migration* for more information about automatic migrations.

17.30.2 Features and Enhancements

- Updates to the `risk` model. (#2950)

  `risk:tool:software`
  : The `soft:names` and `techniques` properties are converted into sorted and uniqued arrays.

- Add support to the Cortex `addStormPkg()` and `$lib.pkg.add()` APIs to load Storm Packages which have been signed to allow cryptographic signature verification. Root CA and intermediate CA certificates have been embedded into Synapse to allow for verification of Rapid Power-Ups signed by The Vertex Project. (#2940) (#2957) (#2963)
- Update `synapse.tools.genpkg` to add optional code signing to Storm packages that it creates. (#2940)
- Update `synapse.tools.genpkg` to require the packages it produces will be JSON compatible when serialized, to avoid possible type coercion issues introduced by the Python `json` library. (#2958)
- Update `synapse.tools.easycert` to allow for creating code signing certificates and managing certificate revocation lists (CRLs). (#2940)
- Add the Nexus index (`nexsindx`) value to the data returned by the `getCellInfo()` APIs. (#2949)
- Allow the Storm backtick format strings to work with multiline strings. (#2956)
- The Storm `Bytes.json()` method now raises exceptions that are `SynErr` subclasses when encountering errors. This method has been updated to add optional `encoding` and `errors` arguments, to control how data is deserialized. (#2945)
- Add support for registering an OAuth2 provider in the Cortex and having user tokens automatically refreshed in the background. These APIs are exposed in Storm under the `$lib.inet.http.oauth.v2` library. (#2910)
- STIX validation no longer caches any downloaded files it may use when attempting to validate STIX objects. (#2966)
- Modified the behavior of Storm emitter functions to remove the read-ahead behavior. (#2953)

17.30.3 Bugfixes

- Fix some error messages in the Snap which did not properly add variables to the message. (#2951)
- Fix an error in the `synapse.tools.aha.enroll` command example. (#2948)
- Fix an error with the `merge` command creating `No form named None` warnings in the Cortex logs. (#2952)
- Fix the Storm `inet:smtp:message` getter and setter for the `html` property so it will correctly produce HTML formatted messages. (#2955)
- Several `certdir` APIs previously allowed through `openssl.crypto.X509StoreContextError` and `openssl.crypto.Error` exceptions. These now raise Synapse `BadCertVerify` and `BadCertBytes` exceptions. (#2940)
- Fix an issue where a Storm package's `modconf` values were mutable. (#2964)

17.30.4 Improved Documentation

- Removed outdated Kubernetes related devops documentation as it is in the process of being rewritten. (#2948)

17.30.5 Deprecations

- The Cortex APIs `provStacks()` and `getProvStack(iden)` and the corresponding Cortex configuration option `provenance:en` have been marked as deprecated and are planned to be removed in `v2.122.0`. (#2682)

17.31 v2.116.0 - 2022-12-14

17.31.1 Automatic Migrations

- The `ou:contract:award:price` and `ou:contract:budget:price` properties are migrated from `econ:currency` to `econ:price` types. (#2943)
- See *Data Migration* for more information about automatic migrations.

17.31.2 Features and Enhancements

- Updates to the `ou` model. (#2943)

  `ou:contract`
  : The `award:price` and `budget:price` properties had their types changed from `econ:currency` to `econ:price`. Add a `currency` secondary property to record the currency of the `econ:price` values.

17.31.3 Bugfixes

- The `synapse.tools.genpkg` tool could raise a Python `TypeError` when the specified package file did not exist. It now raises a `NoSuchFile` exception. (#2941)
- When a service is provisioned with an `aha:provision` URL placed in a `cell.yaml` file, that could create an issue when a mirror is deployed from that service, preventing it from starting up a second time. Services now remove the `aha:provision` key from a `cell.yaml` file when they are booted from a mirror if the URL does not match the boot URL. (#2939)
- When deleting a node from the Cortex, secondary properties defined as arrays were not checked for their references to other nodes. These references are now properly checked prior to node deletion. (#2942)

17.31.4 Improved Documentation

- Add a Devops task for stamping custom users into Synapse containers to run services with arbitrary user and group id values. (#2921)
- Remove an invalid reference to `insecure` mode in HTTP API documentation. (#2938)

17.32 v2.115.1 - 2022-12-02

17.32.1 Features and Enhancements

- Patch release to include an updated version of the `pytest` library in containers.

17.33 v2.115.0 - 2022-12-01

17.33.1 Automatic Migrations

- The `inet:flow:dst:softnames` and `inet:flow:dst:softnames` properties are migrated from `it:dev:str` to `it:prod:softname` types. (#2930)
- See *Data Migration* for more information about automatic migrations.

17.33.2 Features and Enhancements

- Updates to the `inet` model. (#2930)

  `inet:flow`
  : The `dst:softnames` and `src:softnames` properties had their types changed from `it:dev:str` values to `it:prod:softname`.

- Add support for secondary property pivots where the target property is an array type. (#2922)
- The Storm API `$lib.bytes.has()` now returns a false value when the input is null. (#2924)
- When unpacking loop values in Storm, use the primitive value when the item being unpacked is a Storm primitive. (#2928)
- Add a `--del` option to the `synapse.tools.moduser` tool to allow removing a user from a service. (#2933)

- Add entrypoint hooks to the Aha, Axon, Cortex, Cryotank, and JsonStor containers that allow a user to hook the container boot process. (#2919)
- Temporary files created by the Axon, Cortex and base Cell class are now created in the cell local `tmp` directory. In many deployments, this would be located in `/vertex/storage/tmp`. (#2925)
- Update the allowed versions of the `cbor2` and `pycryptodome` libraries. For users installing `synapse[dev]`, `coverage`, `pytest`, `pytest-cov` and `pytest-xdist` are also updated to their latest versions. (#2935)

17.33.3 Bugfixes

- When a Storm Dmon definition lacked a `view` iden, it would previously default to using the Cortex default view. Dmons now prefer to use the user default view before using the Cortex default view. This situation would only happen with Dmons created via the Telepath API where the `view` iden was not provided in the Dmon definition. (#2929)
- Non-integer mask values provided to `inet:cidr4` types now raise a `BadTypeValu` exception. (#2932)
- Fix an incorrect call to `os.unlink` in `synapse.tools.aha.enroll`. (#2926)

17.33.4 Improved Documentation

- Update the automation section of the Synapse User guide, expanding upon the use of cron jobs and triggers across views and forks. (#2917)

17.34 v2.114.0 - 2022-11-15

17.34.1 Features and Enhancements

- Updates to the `crypto` model. (#2909)

  `crypto:key`
  : Add `iv` and `mode` properties to record initialization vectors and cipher modes used with a key.

- Allow the creator for Cron jobs and the user for Triggers to be set. This can be used to effectively change the ownership of these automation elements. (#2908)
- When Storm package `onload` queries produce print, warning, or error messages, those now have the package name included in the message that is logged. (#2913)
- Update the Storm package schema to allow declaring configuration variables. (#2880)

17.34.2 Bugfixes

- The `delCertPath()` APIs in `synapse.lib.easycert` no longer attempt to create a file path on disk when removing the reference count to a certificate path. (#2907)
- Fix error handling when Axon is streaming files with the `readlines()` and `csvrows()` APIs. (#2911)
- The Storm `trigger.list` command failed to print triggers which were created in a Cortex prior to `v2.71.0`. These triggers no longer generate an exception when listed. (#2915)
- Fix an error in the HTTP API example documentation for the `requests` example. (#2918)

17.34.3 Improved Documentation

- Add a Devops task to enable the Python warnings filter to log the use of deprecated Synapse APIs. Python APIs which have been deprecated have had their docstrings updated to reflect their deprecation status. (#2905)

17.35 v2.113.0 - 2022-11-04

17.35.1 Automatic Migrations

- The `risk:tool:software:type` property is migrated to the `risk:tool:software:taxonomy` type. (#2900)
- See *Data Migration* for more information about automatic migrations.

17.35.2 Features and Enhancements

- Updates to the `inet`, `infotech`, `media`, `meta`, `org`, and `risk` models. (#2897) (#2900) (#2903)

  `inet:email:message:link`
  Add a `text` property to record the displayed hypertext link if it was not a raw URL.

  `inet:web:acct`
  Add a `banner` property representing the banner image for the account.

  `inet:web:mesg`
  Add a `deleted` property to mark if a message was deleted.

  `inet:web:post:link`
  Add a form to record a link contained in the post text.

  `it:mitre:attack:group`
  Add an `isnow` property to record the potential for MITRE groups to be deprecated and renamed.

  `it:mitre:attack:software`
  Add an `isnow` property to record the potential for MITRE software to be deprecated and renamed.

  `it:prod:soft:taxonomy`
  Add a form to record an analyst defined taxonomy of software.

  `it:prod:soft`
  Add a `type` property to record the taxonomy of the software. Deprecated the `techniques` property in favor of the `uses` light edge.

  `it:sec:cve`
  Deprecated the `desc`, `url` and `references` properties in favor of using the `risk:vuln:cve:desc`, `risk:vuln:cve:url`, and `risk:vuln:cve:references` properties.

  `media:news`
  Add a `topics` array property to record a list of relevant topics in the article.

  `media:topic`
  Add a form for recording different media topics.

  `meta:rule`
  Add a `url` property to record a URL that documents as rule.

  Add an `ext:id` property to record an external identifier for the rule.

meta:sophistication
Add a form to record sophistication score with named values: `very low`, `low`, `medium`, `high`, and `very high`.

ou:campaign
Add a `sophistication` property to record the assessed sophistication of a campaign.

Deprecate the `techniques` property in favor of using the `uses` light edge.

ou:hasgoal
Deprecate the `ou:hasgoal` form in favor of using the `ou:org:goals` property.

ou:org
Deprecate the `techniques` property in favor of using the `uses` light edge.

ou:technique
Add a `sophistication` property to record the assessed sophistication of a technique.

risk:alert
Add a `url` property for a URL that documents the alert.

Add an `ext:id` property to record an external ID for the alert.

risk:attack
Add a `sophistication` property to record the assessed sophistication of an attack.

risk:availability
Add a taxonomy for availability status values.

risk:threat
Add a `sophistication` property to record the assessed sophistication of a threat cluster.

Deprecate the `techniques` property in favor of the `uses` light edge.

risk:tool:software
Add an `availability` property to record the assessed availability of the tool.

Add a `sophistication` property to record the assessed sophistication of the software.

Migrate the `type` property to `risk:tool:software:taxonomy`.

Deprecate the `techniques` property in favor of the `uses` light edge.

risk:tool:software:taxonomy
Rename the type `risk:tool:taxonomy` to `risk:tool:software:taxonomy`.

risk:vuln
Add a `mitigated` property to record if a mitigation or fix is available for the vulnerability.

Add an `exploited` property to record if the vulnerability has been exploited in the wild.

Add `timeline:discovered`, `timeline:published`, `timeline:vendor:notified`, `timeline:vendor:fixed`, and `timeline:exploited` properties to record the timeline for significant events on a vulnerability.

Add `cve:desc`, `cve:url`, and `cve:references` secondary properties to record information about the CVE associated with a vulnerability.

Add `` `nist:nvd:source `` to record the name of the organization which reported the vulnerability in the NVD.

Add `nist:nvd:published` and `nist:nvd:modified` to record when the vulnerability was first published, and later modified, in the NVD.

Add `cisa:kev:name`, `cisa:kev:desc`, `cisa:kev:action`, `cisa:kev:vendor`, `cisa:kev:product`, `cisa:kev:added`, `cisa:kev:duedate` properties to record information about the CISA KEV database entry for the vulnerability.

- Annotate the following light edges. (#2900)

  `seen`
  When used with `meta:source` nodes, the edge indicates the target node was observed by the source node.

  `stole`
  When used with a `risk:compromise` node, the edge indicates the target node was stolen or copied as a result of the compromise.

  `targets`
  When used with `risk:attack`, the edge indicates the target node is targeted by the attack.

  When used with `risk:attack` and `ou:industry` nodes, the edge indicates the attack targeted the industry

  When used with `risk:threat`, the edge indicates the target node is targeted by the threat cluster.

  When used with `risk:threat` and `ou:industry` nodes, the edge indicates the threat cluster targets the industry.

  `uses`
  When used with `ou:campaign` and `ou:technique` nodes, the edge indicates the campaign used a given technique.

  When used with `ou:org` and `ou:technique` nodes, the edge indicates the organization used a given technique.

  When used with `risk:threat`, the edge indicates the target node was used to facilitate the attack.

  When used with `risk:attack` and `ou:technique` nodes, the edge indicates the attack used a given technique.

  When used with `risk:attack` and `risk:vuln` nodes, the edge indicates the attack used the vulnerability.

  When used with `risk:tool:software`, the edge indicates the target node is used by the tool.

  When used with `risk:tool:software` and `ou:technique` nodes, the edge indicates the tool uses the technique.

  When used with `risk:tool:software` and `risk:vuln` nodes, the edge indicates the tool used the vulnerability.

  When used with `risk:threat`, the edge indicates the target node was used by threat cluster.

  When used with `risk:threat` and `ou:technique` nodes, the edge indicates the threat cluster uses the technique.

  When used with `risk:threat` and `risk:vuln` nodes, the edge indicates the threat cluster uses the vulnerability.

- Add `$lib.gen.vulnByCve()` to help generate `risk:vuln` nodes for CVEs. (#2903)
- Add a unary negation operator to Storm expression syntax. (#2886)
- Add `$lib.crypto.hmac.digest()` to compute RFC2104 digests in Storm. (#2902)
- Update the Storm `inet:http:resp.json()` method to add optional `encoding` and `errors` arguments, to control how data is deserialized. (#2898)
- Update the Storm `bytes.decode()` method to add an optional `errors` argument, to control how errors are handled when decoding data. (#2898)
- Logging of role and user permission changes now includes the authgate iden for the changes. (#2891)

17.35.3 Bugfixes

- Catch `RecursionError` exceptions that can occur in very deep Storm pipelines. (#2890)

17.35.4 Improved Documentation

- Update the Storm reference guide to explain backtick format strings. (#2899)
- Update `guid` section on Storm type-specific behavior doc with some additional guid generation examples. (#2901)
- Update Storm control flow documentation to include `init`, `fini`, and `try` / `catch` examples. (#2901)
- Add examples for creating extended model forms and properties to the Synapse admin guide. (#2904)

17.36 v2.112.0 - 2022-10-18

17.36.1 Features and Enhancements

- Add `--email` as an argument to `synapse.tools.moduser` to allow setting a user's email address. (#2891)
- Add support for `hxxp[s]:` prefixes in scrape functions. (#2887)
- Make the SYNDEV_NEXUS_REPLAY resolution use `s_common.envbool()` in the `SynTest.withNexusReplay()` helper. Add `withNexusReplay()` calls to all test helpers which make Cells which previously did not have it available. (#2889) (#2890)
- Add implementations of `getPermDef()` and `getPermDefs()` to the base Cell class. (#2888)

17.36.2 Bugfixes

- Fix an idempotency issue in the JsonStor multiqueue implementation. (#2890)

17.36.3 Improved Documentation

- Add Synapse-GCS (Google Cloud Storage) Advanced Power-Up to the Power-Ups list.

17.37 v2.111.0 - 2022-10-12

17.37.1 Features and Enhancements

- Update the Storm grammar to allow specifying a tag property with a variable. (#2881)
- Add log messages for user and role management activities in the Cell. (#2877)
- The logging of service provisioning steps on Aha and when services were starting up was previously done at the `DEBUG` level. These are now done at the `INFO` level. (#2883)
- The `vertexproject/synapse:` docker images now have the environment variable `SYN_LOG_LEVEL` set to `INFO`. Previously this was `WARNING`. (#2883)

17.37.2 Bugfixes

- Move the Nexus `runMirrorLoop` task to hang off of the Telepath Proxy and not the Telepath client. This results in a faster teardown of the `runMirrorLoop` task during Nexus shutdown. (#2878)
- Remove duplicate tokens presented to users in Storm syntax errors. (#2879)
- When bootstrapping a service mirror with Aha provisioning, the `prov.done` file that was left in the service storage directory was the value from the upstream service, and not the service that has been provisioned. This resulted in `NoSuchName` exceptions when restarting mirrors. The bootstrapping process now records the correct value in the `prov.done` file. (#2882)

17.38 v2.110.0 - 2022-10-07

17.38.1 Features and Enhancements

- Updates to the `geo` model. (#2872)

  `geo:telem`
  : Add an `accuracy` property to record the accuracy of the telemetry reading.

- Add Nexus support to the Axon, to enable mirrored Axon deployments. (#2871)
- Add Nexus support for HTTP API sessions. (#2869)
- Add support for runtime string formatting in Storm. This is done with backtick (`` ` ``) encapsulated strings. An example of this is `$world='world' $lib.print(`hello {$world}`)` (#2870) (#2875)
- Expose user profile storage on the `auth:user` object, with the `profile` ctor. (#2876)
- Storm package command names are now validated against the same regex used by the grammar. The `synapse.tools.genpkg` tool now validates the compiled package against the same schema used by the Cortex. (#2864)
- Add `$lib.gen.newsByUrl()` and `$lib.gen.softByName()` to help generate `media:news` and `it:prod:soft` nodes, respectively. (#2866)
- Add a new realtime event stream system to the Cell, accessible remotely via `CellApi.behold()` and a websocket endpoint, `/api/v1/behold`. This can be used to get realtime changes about services, such as user creation or modification events; or layer and view change events in the Cortex. (#2851)
- Update stored user password hashing to use PBKDF2. Passwords are migrated to this format as successful user logins are performed. (#2868)
- Add the ability to restore a backup tarball from a URL to the Cell startup process. When a Cell starts via `initFromArgv()`, if the environment variable `SYN_RESTORE_HTTPS_URL` is present, that value will be used to retrieve a tarball via HTTPS and extract it to the service local storage, removing any existing data in the directory. This is done prior to any Aha based provisioning. (#2859)

17.38.2 Bugfixes

- The embedded Axon inside of a Cortex (used when the `axon` config option is not set) did not properly have its cell parent set to the Cortex. This has been corrected. (#2857)
- Fix a typo in the `cron.move` help. (#2858)

17.38.3 Improved Documentation

- Update Storm and Storm HTTP API documentation to show the set of `opts` and different types of message that may be streamed by from Storm APIs. Add example HTTP API client code to the Synapse repository. (#2834)
- Update the Data Model and Analytical model background documentation. Expand on the discussion of light edges use. Expand discussion of tags versus forms, linking the two via `:tag` props. (#2848)

17.38.4 Deprecations

- The Cortex HTTP API endpoint `/api/v1/storm/nodes` has been marked as deprecated. (#2682)
- Add deprecation notes to the help for the Storm `splice.undo` and `splice.list` commands. (#2861)
- Provisional Telepath support for Consul based lookups was removed. (#2873)

17.39 v2.109.0 - 2022-09-27

17.39.1 Features and Enhancements

- Add a `format()` API to `str` variables in Storm. (#2849)
- Update the Telepath user resolution for TLS links to prefer resolving users by the Cell `aha:network` over the certificate common name. (#2850)
- Update all Synapse tools which make telepath connections to use the `withTeleEnv()` helper. (#2844)
- Update the Telepath and HTTPs TLS listeners to drop RSA based key exchanges and disable client initiated renegotiation. (#2845)
- Update the minimum allowed versions of the `aioimaplib` and `oauthlib` libraries. (#2847) (#2854)

17.39.2 Bugfixes

- Correct default Telepath `cell://` paths in Synapse tools. (#2853)
- Fix typos in the inline documentation for several model elements. (#2852)
- Adjust expression syntax rules in Storm grammar to remove incorrect whitespace sensitivity in certain expression operators. (#2846)

17.39.3 Improved Documentation

- Update Storm and Storm HTTP API documentation to show the set of `opts` and different types of message that may be streamed by from Storm APIs. Add example HTTP API client code to the Synapse repository. (#2834)
- Update the Data Model and Analytical model background documentation. Expand on the discussion of light edges use. Expand discussion of tags versus forms, linking the two via `:tag` props. (#2848)

17.40 v2.108.0 - 2022-09-12

17.40.1 Features and Enhancements

- Update the Telepath TLS connections to require a minimum TLS version of 1.2. (#2833)
- Update the Axon implementation to use the `initServiceStorage()` and `initServiceRuntime()` methods, instead of overriding `__anit__`. (#2837)
- Update the minimum allowed versions of the `aiosmtplib` and `regex` libraries. (#2832) (#2841)

17.40.2 Bugfixes

- Catch `LarkError` exceptions in all Storm query parsing modes. (#2840)
- Catch `FileNotFound` errors in `synapse.tools.healthcheck`. This could be caused by the tool running during container startup, and prior to a service making its Unix listening socket available. (#2836)
- Fix an issue in `Axon.csvrows()` where invalid data would cause processing of a file to stop. (#2835)
- Address a deprecation warning in the Synapse codebase. (#2842)
- Correct the type of `syn:splice:splice` to be `data`. Previously it was `str`. (#2839)

17.40.3 Improved Documentation

- Replace `livenessProbe` references with `readinessProbe` in the Kubernetes documentation and examples. The `startupProbe.failureThreshold` value was increased to its maximum value. (#2838)
- Fix a typo in the Rapid Power-Up documentation. (#2831)

17.41 v2.107.0 - 2022-09-01

17.41.1 Automatic Migrations

- Migrate the `risk:alert:type` property to a `taxonomy` type and create new nodes as needed. (#2828)
- Migrate the `pol:country:name` property to a `geo:name` type and create new nodes as needed. (#2828)
- See *Data Migration* for more information about automatic migrations.

17.41.2 Features and Enhancements

- Updates to the `geo`, `inet`, `media`, `pol`, `proj`, and `risk` models. (#2828) (#2829)

  `geo:area`
  Add a new type to record the size of a geographic area.

  `geo:place:taxonomy`
  Add a form to record an analyst defined taxonomy of different places.

  `geo:place`
  Add a `type` property to record the taxonomy of a place.

  `inet:web:memb`
  This form has been deprecated.

  `inet:web:member`
  Add a guid form that represents a web account's membership in a channel or group.

  `media:news:taxonomy`
  Add a form to record an analyst defined taxonomy of different types or sources of news.

  `media:news`
  Add a `type` property to record the taxonomy of the news. Add an `ext:id` property to record an external identifier provided by a publisher.

  `pol:vitals`
  Add a guid form to record the vitals for a country.

  `pol:country`
  Add `names`, `place`, `dissolved` and `vitals` secondary properties. The `name` is changed from a `str` to a `geo:name` type. Deprecate the `pop` secondary property.

  `pol:candidate`
  Add an `incumbent` property to note if the candidate was an incumbent in a race.

  `proj`
  Add missing docstrings to the `proj` model forms.

  `risk:alert:taxonomy`
  Add a form to record an analyst defined taxonomy of alert types.

  `risk:alert`
  The `type` property is changed from a `str` to the `risk:alert:taxonomy` type.

- Add ** as a power operator for Storm expression syntax. (#2827)
- Add a new test helper, `synapse.test.utils.StormPkgTest` to assist with testing Rapid Power-Ups. (#2819)
- Add `$lib.axon.metrics()` to get the metrics from the Axon that the Cortex is connected to. (#2818)
- Add `pack()` methods to the `auth:user` and `auth:role` objects. This API returns the definitions of the User and Role objects. (#2823)
- Change the Storm Package `require` values to log debug messages instead of raising exceptions if the requirements are not met. Add a `$lib.pkg.deps()` API that allows inspecting if a package has its dependencies met or has conflicts. (#2820)

17.41.3 Bugfixes

- Prevent `None` objects from being normalized as tag parts from variables in Storm. (#2822)
- Avoid intermediate conversion to floats during storage operations related to Synapse Number objects in Storm. (#2825)

17.41.4 Improved Documentation

- Add Developer documentation for writing Rapid Power-Ups. (#2803)
- Add the `synapse.tests.utils` package to the Synapse API autodocs. (#2819)
- Update Devops documentation to note the storage requirements for taking backups of Synapse services. (#2824)
- Update the Storm `min` and `max` command help to clarify their usage. (#2826)

17.42 v2.106.0 - 2022-08-23

17.42.1 Features and Enhancements

- Add a new tool, `synapse.tools.axon2axon`, for copying the data from one Axon to another Axon. (#2813) (#2816)

17.42.2 Bugfixes

- Subquery filters did not update runtime variables in the outer scope. This behavior has been updated to make subquery filter behavior consistent with regular subqueries. (#2815)
- Fix an issue with converting the Number Storm primitive into its Python primitive. (#2811)

17.43 v2.105.0 - 2022-08-19

17.43.1 Features and Enhancements

- Add a Number primitive to Storm to facilitate fixed point math operations. Values in expressions which are parsed as floating point values will now be Numbers by default. Values can also be cast to Numbers with `$lib.math.number()`. (#2762)
- Add `$lib.basex.encode()` and `$lib.basex.decode()` for encoding and decoding strings using arbitrary charsets. (#2807)
- The tag removal operator (`-#`) now accepts lists of tags to remove. (#2808)
- Add a `$node.difftags()` API to calculate and optionally apply the difference between a list of tags and those present on a node. (#2808)
- Scraped Ethereum addresses are now returned in their EIP55 checksummed form. This change also applies to lookup mode. (#2809)
- Updates to the `mat`, `ps`, and `risk` models. (#2804)

  `mass`
  : Add a type for storing mass with grams as a base unit.

ps:vitals
Add a form to record statistics and demographic data about a person or contact.

ps:person
Add a `vitals` secondary property to record the most recent known vitals for the person.

ps:contact
Add a `vitals` secondary property to record the most recent known vitals for the contact.

risk:tool:taxonomy
Add a form to record an analyst defined taxonomy of different tools.

risk:tool:software
Add a form to record software tools used in threat activity.

risk:threat
Add `reporter`, `reporter:name`, `org:loc`, `org:names`, and `goals` secondary properties.

- Annotate the following light edges. (#2804)

uses
When used with `risk:threat` nodes, the edge indicates the target node is used by the source node.

17.43.2 Bugfixes

- Fix language used in the `model.deprecated.check` command. (#2806)
- Remove the `-y` switch in the `count` command. (#2806)

17.44 v2.104.0 - 2022-08-09

17.44.1 Automatic Migrations

- Migrate *crypto:x509:cert:serial* from *str* to *hex* type. Existing values which cannot be converted as integers or hex values will be moved into nodedata under the key `migration:0_2_10` as `{'serial': value}` (#2789)
- Migrate `ps:contact:title` to the `ou:jobtitle` type and create `ou:jobtitle` nodes. (#2789)
- Correct hugenum property index values for values with more than 28 digits of precision. (#2766)
- See *Data Migration* for more information about automatic migrations.

17.44.2 Features and Enhancements

- Updates to the `crypto` and `ps` models. (#2789)

crypto:x509:cert
The `serial` secondary property has been changed from a `str` to a `hex` type.

ps:contact
The type of the `title` secondary property has been changed from a `str` to an `ou:jobtitle`.

- Add `$lib.hex.toint()`, `$lib.hex.fromint()`, `$lib.hex.trimext()` and `$lib.hex.signext()` Storm APIs for handling hex encoded integers. (#2789)
- Add `set()` and `setdefault()` APIs on the SynErr exception class. Improve support for unpickling SynErr exceptions. (#2797)

- Add logging configuration to methods which are called in spawned processes, and log exceptions occurring in the processes before tearing them down. (#2795)

17.44.3 Bugfixes

- BadTypeValu errors raised when normalizing a tag timestamp now include the name of the tag being set. (#2797)
- Correct a CI issue that prevented the v2.103.0 Docker images from being published. (#2798)

17.44.4 Improved Documentation

- Update data model documentation. (#2796)

17.45 v2.103.0 - 2022-08-05

17.45.1 Features and Enhancements

- Updates to the `it`, `ou`, and `risk` models. (#2778)

  `it:prod:soft`
  : Add a `techniques` secondary property to record techniques employed by the author of the software.

  `ou:campaign`
  : Add a `techniques` secondary property to record techniques employed by the campaign.

  `ou:org`
  : Add a `techniques` secondary property to record techniques employed by the org.

  `ou:technique`
  : Add a form to record specific techniques used to achieve a goal.

  `ou:technique:taxonomy`
  : Add a form to record an analyst defined taxonomy of different techniques.

  `risk:attack`
  : Add a `techniques` secondary property to record techniques employed during the attack. Deprecate the following secondary properties, in favor of using light edges.

    - `target`
    - `target:host`
    - `target:org`
    - `target:person`
    - `target:place`
    - `used:email`
    - `used:file`
    - `used:host`
    - `used:server`
    - `used:software`
    - `used:url`

- used:vuln
- via:email
- via:ipv4
- via:ipv6
- via:phone

risk:compromise
Add a techniques secondary property to record techniques employed during the compromise.

risk:threat
Add a form to record a threat cluster or subgraph of threat activity attributable to one group.

- Annotate the following light edges. (#2778)

  targets
  When used with ou:org, ou:campaign, risk:threat, or risk:attack nodes, the edge indicates the target node was targeted by the source node.

  uses
  When used with an ou:campaign or risk:attack node, the edge indicates the target node is used by the source node.

- Change the behavior of the Storm count command to consume nodes. If the previous behavior is desired, use the --yield option when invoking the count command. (#2779)
- Add $lib.random.int() API to Storm for generating random integers. (#2783)
- Add a new tool, synapse.tools.livebackup for taking a live backup of a service. (#2788)
- The Storm $lib.jsonstor.cacheset() API now returns a dict containing the path and time. The $lib.jsonstor.cacheget() API now has an argument to retrieve the entire set of enveloped data. (#2790)
- Add a HTTP 404 handler for the Axon v1/by/sha256/<sha256> endpoint which catches invalid <sha256> values. (#2780)
- Add helper scripts for doing bulk Synapse Docker image builds and testing. (#2716)
- Add aha:\\ support to synapse.tools.csvtool. (#2791)

17.45.2 Bugfixes

- Ensure that errors that occur when backing up a service are logged prior to tearing down the subprocess performing the backup. (#2781)
- Add missing docstring for $lib.stix.import. (#2786)
- Allow setting tags on a Node from a Storm List object. (#2782)

17.45.3 Improved Documentation

- Remove `synapse-google-ct` from the list of Rapid Power-Ups. (#2779)
- Add developer documentation for building Synapse Docker containers. (#2716)
- Fix spelling errors in model documentation. (#2782)

17.45.4 Deprecations

- The `vertexproject/synapse:master-py37` and `vertexproject/synapse:v2.x.x-py37` Docker containers are no longer being built. (#2716)

17.46 v2.102.0 - 2022-07-25

17.46.1 Features and Enhancements

- Updates to the `crypto`, `geo`, `inet`, `mat`, `media`, `ou`, `pol`, and `proj` models. (#2757) (#2771)

  `crypto:key`
  Add `public:md5`, `public:sha1`, and `public:sha256` secondary properties to record those hashes for the public key. Add `private:md5`, `private:sha1`, and `private:sha256` secondary properties to record those hashes for the public key.

  `geo:nloc`
  The `geo:nloc` form has been deprecated.

  `geo:telem`
  Add a new form to record a the location of a given node at a given time. This replaces the use of `geo:nloc`.

  `it:sec:c2:config`
  Add a `proxies` secondary property to record proxy URLS used to communicate to a C2 server. Add a `listens` secondary property to record urls the software should bind. Add a `dns:resolvers` secondary property to record DNS servers the software should use. Add a `http:headers` secondary property to record HTTP headers the software should use.

  `it:exec:query`
  Add a new form to record an instance of a query executed on a host.

  `it:query`
  Add a new form to record query strings.

  `mat:type`
  Add a taxonomy type to record taxonomies of material specifications or items.

  `mat:item`
  Add a `type` secondary property to record the item type.

  `mat:spec`
  Add a `type` secondary property to record the item type.

  `media:news`
  Add a `publisher` secondary property to record the org that published the news. Add a `publisher:name` secondary property to record the name of the org. Deprecate the `org` secondary property.

  `ou:campaign`
  Add a `conflict` secondary property to record the primary conflict associated the campaign.

`ou:conflict`
: Add a new form to record a conflict between two or more campaigns which have mutually exclusive goals.

`ou:contribution`
: Add a new form to represent contributing material support to a campaign.

`pol:election`
: Add a new form to record an election.

`pol:race`
: Add a new form to record indivdual races in an election.

`pol:office`
: Add a new form to record an appointed or elected office.

`pol:term`
: Add a new form to record the term in office for an individual.

`pol:candidate`
: Add a form to record a candidate for a given race.

`pol:pollingplace`
: Add a form to record the polling locations for a given election.

`proj:ticket`
: Add a `ext:creator` secondary form to record contact information from and external system.

- Annotate the following light edges. (#2757)

  `about`
  : A light edge created by the Storm `note.add` command, which records the relationship between a `meta:note` node and the target node.

  `includes`
  : When used with a `ou:contribution` node, the edge indicates the target node was the contribution made.

  `has`
  : When used with a `meta:ruleset` and `meta:rule` node, indicates the ruleset contains the rule.

  `matches`
  : When used with a `meta:rule` node, the edge indicates the target node matches the rule.

  `refs`
  : A light edge where the source node refers to the target node.

  `seenat`
  : When used with a `geo:telem` target node, the edge indicates the source node was seen a given location.

  `uses`
  : When used with a `ou:org` node, the edge indicates the target node is used by the organization.

- Commonly used light edges are now being annotated in the model, and are available through Cortex APIs which expose the data model. (#2757)
- Make Storm command argument parsing errors into exceptions. Previously the argument parsing would cause the Storm runtime to be torn down with `print` messages, which could be missed. This now means that automations which have a invalid Storm command invocation will fail loudly. (#2769)
- Allow a Storm API caller to set the task identifier by setting the `task` value in the Storm `opts` dictionary. (#2768) (#2774)
- Add support for registering and exporting custom STIX objects with the `$lib.stix` Storm APIS. (#2773)
- Add APIS and Storm APIs for enumerating mirrors that have been registered with AHA. (#2760)

17.46.2 Bugfixes

- Ensure that auto-adds are created when merging part of a View when using the Storm `merge --apply` command. (#2770)
- Add missing support for handling timezone offsets without colon separators when normalizing `time` values. `time` values which contain timezone offsets and not enough data to resolve minute level resolution will now fail to parse. (#2772)
- Fix an issue when normalizing `inet:url` values when the host value was the IPv4 address `0.0.0.0`. (#2771)
- Fix an issue with the Storm `cron.list` command, where the command failed to run when a user had been deleted. (#2776)

17.46.3 Improved Documentation

- Update the Storm user documentation to include the Embedded Property syntax, which is a shorthand (`::`) that can be used to reference properties on adjacent nodes. (#2767)
- Update the Synapse Glossary. (#2767)
- Update Devops documentation to clarify the Aha URLs which end with``...`` are intentional. (#2775)

17.47 v2.101.1 - 2022-07-14

17.47.1 Bugfixes

- Fix an issue where the Storm `scrape` command could fail to run with inbound nodes. (#2761)
- Fix broken links in documentation. (#2763)
- Fix an issue with the Axon `AxonHttpBySha256V1` API handler related to detecting `Range` support in the Axon. (#2764)

17.48 v2.101.0 - 2022-07-12

17.48.1 Automatic Migrations

- Create nodes in the Cortex for the updated properties noted in the data model updates listed below.
- Axon indices are migrated to account for storing offset information to support the new offset and size API options.
- See *Data Migration* for more information about automatic migrations.

17.48.2 Features and Enhancements

- Updates to the `crypto`, `infotech`, `ps`, and `transport` models. (#2720) (#2738) (#2739) (#2747)

  `crypto:smart:effect:minttoken`
  Add a new form to model smart contract effects which create non-fungible tokens.

  `crypto:smart:effect:burntoken``
  Add a new form to model smart contract effects which destroy non-fungible tokens.

  `crypto:smart:effect:proxytoken`
  Add a new form that tracks grants for a non-owner address the ability to manipulate a specific non-fungible token.

  `crypto:smart:effect:proxytokenall`
  Add a new form that tracks grants for a non-owner address the ability to manipulate all of the non-fungible tokens.

  `crypto:smart:effect:proxytokens`
  Add a new form that tracks grants for a non-owner address to manipulate fungible tokens.

  `it:av:signame`
  Add a new form to track AV signature names. Migrate `it:av:filehit:sig:name` and `it:av:sig:name` to use the new form.

  `it:exec:proc`
  Add a `name` secondary property to track the display name of a process. Add a `path:base` secondary property to track the basename of the executable for the process.

  `ps:contact`
  Add an `orgnames` secondary property to track an array of orgnames associated with a contact.

  `transport:sea:vessel`
  Add `make` and `model` secondary properties to track information about the vessel.

- Add a new Storm command, `movenodes`, that can be used to move a node entirely from one layer to another. (#2714)
- Add a new Storm library, `$lib.gen`, to assist with creating nodes based on secondary property based deconfliction. (#2754)
- Add a `sorted()` method to the `stat:tally` object, to simplify handling of tallied data. (#2748)
- Add a new Storm function, `$lib.mime.html.totext()`, to extract inner tag text from HTML strings. (#2744)
- Add Storm functions `$lib.crypto.hashes.md5()`, `$lib.crypto.hashes.sha1()`, `$lib.crypto.hashes.sha256()` and `$lib.crypto.hashes.sha512()` to allow hashing bytes directly in Storm. (#2743)
- Add an `Axon.csvrows()` API for streaming CSV rows from an Axon, and a corresponding `$lib.axon.csvrows()` Storm API. (#2719)
- Expand Synapse requirements to include updated versions of the `pycryptome`, `pygments`, and `scalecodec` modules. (#2752)
- Add range support to `Axon.get()` to read bytes from a given offset and size. The `/api/v1/axon/files/by/sha256/<SHA-256>` HTTP API has been updated to support a `Range` header that accepts a `bytes` value to read a subset of bytes that way as well. (#2731) (#2755) (#2758)

17.48.3 Bugfixes

- Fix `$lib.time.parse()` when `%z` is used in the format specifier. (#2749)
- Non-string form-data fields are now serialized as JSON when using the `Axon.postfiles()` API. (#2751) (#2759)
- Fix a byte-alignment issue in the `Axon.readlines()` API. (#2719)

17.49 v2.100.0 - 2022-06-30

17.49.1 Features and Enhancements

- Support parsing CVSS version 3.1 prefix values. (#2732)

17.49.2 Bugfixes

- Normalize tag value lists in `snap.addTag()` to properly handle JSON inputs from HTTP APIs. (#2734)
- Fix an issue that allowed multiple concurrent streaming backups to occur. (#2725)

17.49.3 Improved Documentation

- Add an entry to the devops task documentation for trimming Nexus logs. (#2730)
- Update the list of available Rapid Power-Ups. (#2735)

17.50 v2.99.0 - 2022-06-23

17.50.1 Features and Enhancements

- Add an extensible STIX 2.1 import library, `$lib.stix.import`. The function `$lib.stix.import.ingest()` can be used to STIX bundles into a Cortex via Storm. (#2727)
- Add a Storm `uptime` command to display the uptime of a Cortex or a Storm Service configured on the Cortex. (#2728)
- Add `--view` and `--optsfile` arguments to `synapse.tools.csvtool`. (#2726)

17.50.2 Bugfixes

- Fix an issue getting the maximum available memory for a host running with Linux cgroupsv2 apis. (#2728)

17.51 v2.98.0 - 2022-06-17

17.51.1 Features and Enhancements

- Updates to the `econ` model. (#2717)

  `econ:acct:balance`
  : Add `total:received` and `total:sent` properties to record total currency sent and received by the account.

- Add additional debug logging for Aha provisioning. (#2722)
- Adjust whitespace requirements on Storm grammar related to tags. (#2721)
- Always run the function provided to the Storm `divert` command per node. (#2718)

17.51.2 Bugfixes

- Fix an issue that prevented function arguments named `func` in Storm function calls. (#2715)
- Ensure that active coroutines have been cancelled when changing a Cell from active to passive status; before starting any passive coroutines. (#2713)
- Fix an issue where `Nexus._tellAhaReady` was registering with the Aha service when the Cell did not have a proper Aha service name set. (#2723)

17.52 v2.97.0 - 2022-06-06

17.52.1 Features and Enhancements

- Add an `/api/v1/aha/provision/service` HTTP API to the Aha service. This can be used to generate `aha:provision` URLs. (#2707)
- Add `proxy` options to `$lib.inet.http` Storm APIs, to allow an admin user to specify an alternative (or to disable) proxy setting. (#2706)
- Add a `--tag` and `--prop` option to the Storm `diff` command. Update the Storm `merge` command examples to show more real-world use cases. (#2710)
- Add the ability to set the layers in a non-forked view with the `$view.set(layers, $iden)` API on the Storm view object. (#2711)
- Improve Storm parser logic for handling list and expression syntax. (#2698) (#2708)

17.52.2 Bugfixes

- Improve error handling of double quoted strings in Storm when null characters are present in the raw query string. This situation now raises a BadSyntax error instead of an opaque Python ValueError. (#2709)
- Fix unquoted JSON keys which were incorrectly allowed in Storm JSON style expression syntax. (#2698)
- When merging layer data, add missing permission checks for light edge and node data changes. (#2671)

17.53 v2.96.0 - 2022-05-31

17.53.1 Features and Enhancements

- Updates to the `transport` model. (#2697)

  `velocity`
  : Add a new base type to record velocities in millimeters/second.

  `transport:direction`
  : Add a new type to indicate a direction of movement with respect to true North.

  `transport:air:telem`
  : Add `:course` and `:heading` properties to record the direction of travel. Add `:speed`, `:airspeed` and `:verticalspeed` properties to record the speed of travel.

  `transport:sea:telem`
  : Add `:course` and `:heading` properties to record the direction of travel. Add a `:speed` property to record the speed of travel. Add `:destination`, `:destination:name` and `:destination:eta` to record information about the destination.

- Restore the precedence of environment variables over `cell.yaml` options during Cell startup. API driven overrides are now stored in the `cell.mods.yaml` file. (#2699)
- Add `--dmon-port` and `--https-port` options to the `synapse.tools.aha.provision.service` tool in order to specify fixed listening ports during provisioning. (#2703)
- Add the ability of `synapse.tools.moduser` to set user passwords. (#2695)
- Restore the call to the `recover()` method on the Nexus during Cell startup. (#2701)
- Add `mesg` arguments to `NoSuchLayer` exceptions. (#2696)
- Make the LMDB slab startup more resilient to a corrupted `cell.opts.yaml` file. (#2694)

17.53.2 Bugfixes

- Fix missing variable checks in Storm. (#2702)

17.53.3 Improved Documentation

- Add a warning to the deployment guide about using Docker on Mac OS. (#2700)

17.54 v2.95.1 - 2022-05-24

17.54.1 Bugfixes

- Fix a regression in the Telepath `aha://` update from `v2.95.0`. (#2693)

17.55 v2.95.0 - 2022-05-24

17.55.1 Features and Enhancements

- Add a `search` mode to Storm. The `search` mode utilizes the Storm search interface to lift nodes. The `lookup` mode no longer uses the search interface. (#2689)
- Add a `?mirror=true` flag to `aha://` Telepath URLs which will cause the Aha service lookups to prefer using a mirror of the service rather than the leader. (#2681)
- Add `$lib.inet.http.urlencode()` and `$lib.inet.http.urldecode()` Storm APIs for handling URL encoding. (#2688)
- Add type validation for all Cell configuration options throughout the lifetime of the Cell and all operations which modify its configuration values. This prevents invalid values from being persisted on disk. (#2687) (#2691)

17.55.2 Bugfixes

- Fix an issue where the = sign in the Storm grammar was assigned an anonymous terminal name by the grammar parser. This caused an issue with interpreting various syntax errors. (#2690)

17.56 v2.94.0 - 2022-05-18

17.56.1 Automatic Migrations

- Re-normalize the migrated properties noted in the data model updates listed below. See *Data Migration* for more information about automatic migrations.

17.56.2 Features and Enhancements

- Updates to the `crypto`, `infotech`, `org`, and `person` models. (#2620) (#2684)

  `crypto:algorithm`
  Add a form to represent a named cryptography algorithm.

  `crypto:key`
  Add a form to represent a cryptographic key and algorithm.

  `crypto:smart:effect:transfertoken`
  Add a form to represent the effect of transferring ownership of a non-fungible token.

  `crypto:smart:effect:transfertokens`
  Add a form to represent the effect of transferring multiple fungible tokens.

  `crypto:smart:effect:edittokensupply`
  Add a form to represent the increase or decrease in the supply of fungible tokens.

  `it:prod:softname`
  Add a form to represent a software name.

  `it:host`
  Add a `:os:name` secondary property.

  `it:mitre:attack:software`
  Migrate the `:name` and `:names` properties to `it:prod:softname` type.

it:prod:soft
Migrate the :name and :names properties to it:prod:softname type.

it:prod:softver
Deprecate the :software:name property. Migrate the :name and :names properties to it:prod:softname type.

it:app:yara:rule
Add a :family property to represent the software family the rule is designed to detect.

it:sec:c2:config
Add a form to represent C2 configuration data.

ou:campaign
Add a :org:name property to represent the name of the organization responsible the campaign. Add a :org:fqdn property to represent the fqdn of the organization responsible the campaign. Add a :team property to represent the team responsible for the campaign.

ou:team
Add a form to represent a team within an organization.

ou:industry
Migrate the :name property to ou:industryname type. Add a :names property for alternative names.

ou:industryname
Add a form to represent the name of an industry.

ou:position
Add a :team property to represent the team associated with a given position.

ps:contact
Add a :crypto:address property to represent the crypto currency address associated with the contact.

- Add $lib.copy() to Storm. This allows making copies of objects which are compatible with being serialized with msgpack. (#2678)
- Remove *print* events from the Storm *limit* command. (#2674)

17.56.3 Bugfixes

- Fix an issue where client certificates presented in Telepath ssl connections could fallback to resolving users by a prefix. This was not intended to be allowed when client certificates are used with Telepath. (#2675)
- Fix an issue where node:del triggers could fail to fire when adding nodeedits directly to a view or snap. (#2654)
- Fix header escaping when generating autodoc content for Synapse Cells. (#2677)
- Assorted unit tests fixes to make tests more stable. (#2680)
- Fix an issue with Storm function argument parsing. (#2685)

17.56.4 Improved Documentation

- Add an introduction to Storm libraries and types. (#2670) (#2683)
- Fix small typos and corrections in the devops documentation. (#2673)

17.57 v2.93.0 - 2022-05-04

17.57.1 Features and Enhancements

- Updates to the `inet` and `infotech` models. (#2666)

  `:sandbox:file`
  : Add a `sandbox:file` property to record an initial sample from a sandbox environment to the following forms:

    ```
    it:exec:proc  it:exec:thread  it:exec:loadlib  it:exec:mmap  it:exec:mutex
    it:exec:pipe  it:exec:url  it:exec:bind  it:exec:file:add  it:exec:file:del
    it:exec:file:read  it:exec:file:write  it:exec:reg:del  it:exec:reg:get
    it:exec:reg:set
    ```

  `it:host:activity`
  : Update the interface to add a `sandbox:file` property to record an initial sample from a sandbox environment.

- Changed primary Storm parser to a LALR compatible syntax to gain 80x speed up in parsing Storm queries (#2649)
- Added service provisioning API to AHA service and associated tool `synapse.tools.aha.provision.service` and documentation to make it easy to bootstrap Synapse services using service discovery and SSL client-side certificates to identify service accounts. (#2641)
- Added user provisioning API to AHA service and associated tools `synapse.tools.aha.provision.user` and `synapse.tools.aha.enroll` to make it easy to bootstrap new users with SSL client-side certificates and AHA service discovery configuration. (#2641)
- Added automatic mirror initialization logic to Synapse services to enable new mirrors to be initilized dynamically via AHA provisioning rather than from a pre-existing backup. (#2641)
- Added `handoff()` API to Synapse services to allow mirrors to be gracefully promoted to leader. (#2641)
- Added `synapse.tools.promote` to allow easy promotion of mirror to leader using the new `handoff()` API. (#2641)
- Added `aha:provision` configuration to Synapse services to allow them to automatically provision and self-configure using AHA. (#2641)
- Adjusted Synapse service configuration preference to allow runtime settings to be stored in `cell.yaml`. (#2641)
- Added optional `certhash` parameter to telepath `ssl://` URLs to allow cert-pinning behavior and automatic trust of provisioning URLs. (#2641)
- Added `synapse.tools.moduser` and `synapse.tools.modrole` commands to modernize and ease user/role management from within Synapse service docker containers. (#2641)
- Add `$lib.jsonstor.cacheget()` and `lib.jsonstor.cacheset()` functions in Storm to easily implement data caching in the JSONStor. (#2662)
- Add a `params` option to `$lib.inet.http.connect()` to pass parameters when creating Websocket connections in Storm. (#2664)

17.57.2 Bugfixes

- Added `getCellRunId()` API to Synapse services to allow them to detect incorrect mirror configurations where they refer to themselves. (#2641)
- Ensure that CLI history files can be read and written upon starting interactive CLI tools. (#2660)
- Assorted unit tests fixes to make tests more stable. (#2656) (#2665)
- Fix several uses of Python features which are formally deprecated and may be removed in future Python versions. (#2668)

17.57.3 Improved Documentation

- Added new Deployment Guide with step-by-step production ready deployment instructions (#2641)
- Refactored Devops Guide to give task-oriented instructions on performing common devops tasks. (#2641)
- Added new minimal Admin Guide as a place for documenting Cortex admin tasks. (#2641)
- Updated Getting Started to direct users to synapse-quickstart instructions. (#2641)
- Added `easycert` tool documentation. (#2641)
- Removed `cmdr` tool documentation to emphasize newer tools such as `storm`. (#2641)
- Update the list of available Advanced and Rapid Power-Ups. (#2667)

17.58 v2.92.0 - 2022-04-28

17.58.1 Features and Enhancements

- Update the allowed versions of the `pyopenssl` and `pytz` libraries. (#2657) (#2658)

17.58.2 Bugfixes

- When setting ival properties, they are now properly merged with existing values. This only affected multi-layer views. (#2655)

17.59 v2.91.1 - 2022-04-24

17.59.1 Bugfixes

- Fix a parsing regression in inet:url nodes related to unencoded "@" symbols in URLs. (#2653)

17.60 v2.91.0 - 2022-04-21

17.60.1 Features and Enhancements

- Updates to the `inet` and `infotech` models. (#2634) (#2644) (#2652)

  `inet:url`
  : The `inet:url` type now recognizes various `file:///` values from RFC 8089.

  `it:sec:cve`
  : The `it:sec:cve` type now replaces various Unicode dashes with hyphen characters when norming. This allows a wider range of inputs to be accepted for the type. Scrape related APIs have also been updated to match on this wider range of inputs.

- The Cell now uses `./backup` as a default path for storing backups in, if the `backup:dir` path is not set. (#2648)
- Add POSIX advisory locking around the Cell `cell.guid` file, to prevent multiple processes from attempting to start a Cell from the same directory. (#2642)
- Change the default `SLAB_COMMIT_WARN` time from 5 seconds to 1 second, in order to quickly identify slow storage performance. (#2630)
- Change the Cell `iterBackupArchive` and `iterNewBackupArchive` routines to always log exceptions they encounter, and report the final log message at the appropriate log level for success and failure. (#2629)
- When normalizing the `str` types, when `onespace` is specified, we skip the `strip` behavior since it is redundant. (#2635)
- Log exceptions raised by Cell creation in `initFromArgv`. Catch `lmdb.LockError` when opening a LMDB database and re-raise an exception with a clear error message. (#2638)
- Update schema validation for Storm packages to ensure that cmd arguments do not have excess fields in them. (#2650)

17.60.2 Bugfixes

- Adjust comma requirements for the JSON style list and dictionary expressions in Storm. (#2636)
- Add Storm query logging in a code execution path where it was missing. (#2647)
- Tuplify the output of `synapse.tools.genpkg.loadPkgProto` to ensure that Python list constructs `[...]` do not make it into Power-Up documentation. (#2646)
- Fix an issue with heavy Stormtypes objects where caching was preventing some objects from behaving in a dynamic fashion as they were intended to. (#2640)
- In norming `int` values, when something is outside of the minimum or maximum size of the type, we now include the string representation of the valu instead of the raw value. (#2643)
- Raise a `NotReady` exception when a client attempts to resolve an `aha://` URL and there have not been any `aha` servers registered. (#2645)

17.60.3 Improved Documentation

- Update Storm command reference to add additional commands. (#2633)
- Expand Stormtypes API documentation. (#2637) (#2639)

17.61 v2.90.0 - 2022-04-04

17.61.1 Features and Enhancements

- Updates to the `meta` and `infotech` models. (#2624)

  `meta:rule`
  : Add a new form for generic rules, which should be linked to the nodes they match with a `matches` light edge.

  `meta:ruleset`
  : Add `:author`, `:created`, and `:updated` secondary properties.

  `it:app:yara:rule`
  : Add `:created` and `:updated` secondary properties.

- Add a new Docker image `vertexproject/synapse-jsonstor`. (#2627)
- Allow passing a version requirement string to `$lib.import()`. (#2626)

17.61.2 Bugfixes

- Fix an issue where using a regex lift on an array property could incorrectly yield the same node multiple times. (#2625)

17.61.3 Improved Documentation

- Update documentation regarding mirroring to be clearer about whether a given cell supports it. (#2619)

17.62 v2.89.0 - 2022-03-31

17.62.1 Features and Enhancements

- Update the `meta` model. (#2621)

  `meta:ruleset`
  : Add a new form to denote the collection of a set of nodes representing rules, which should be linked together with a `has` light edge.

- Add additional filter options for the Storm `merge` command. (#2615)
- Update the `BadSyntaxError` exception thrown when parsing Storm queries to additionally include line and column when available. Fix an issue where a `!` character being present in the exception text could truncate the output. (#2618)

17.63 v2.88.0 - 2022-03-23

17.63.1 Automatic Migrations

- Re-normalize the `geo:place:name`, `crypto:currency:block:hash`, and `crypto:currency:transaction:hash` values to account for their modeling changes. Migrate `crypto:currency:transaction:input` and `crypto:currency:transaction:output` values to the secondary properties on the respective `crypto:payment:input` and `crypto:payment:output` nodes to account for the modeling changes. Make `geo:name` nodes for `geo:place:name` secondary properties to account for the modeling changes. See *Data Migration* for more information about automatic migrations.

17.63.2 Features and Enhancements

- Several updates for the `crypto`, `geospace`, `inet`, and `meta` models. (#2594) (#2608) (#2611) (#2616)

  `crypto:payment:input`
  Add a secondary property `:transaction` to denote the transaction for the payment.

  `crypto:payment:output`
  Add a secondary property `:transaction` to denote the transaction for the payment.

  `crypto:currency:block`
  Change the type of the `:hash` property from a `0x` prefixed `str` to a `hex` type.

  `crypto:currency:transaction`
  Change the type of the `:hash` property from a `0x` prefixed `str` to a `hex` type. Deprecate the `:inputs` and `:outputs` secondary properties.

  `geo:place`
  Change the type of the `:name` secondary property to `geo:name`.

  `inet:web:channel`
  Add a new form to denote a channel within a web service or instance.

  `inet:web:instance`
  Add a new form to track an instance of a web service, such as a channel based messaging platform.

  `inet:web:mesg`
  Add `:channel`, `:place`, and `:place:name` secondary properties.

  `inet:web:post`
  Add `:channel` and `:place:name` secondary properties.

  `meta:event`
  Add a new form to denote an analytically relevant event in a curated timeline.

  `meta:event:taxonomy`
  Add a new form to represent a taxonomy of `meta:event:type` values.

  `meta:timeline`
  Add a new form to denote a curated timeline of analytically relevant events.

  `meta:timeline:taxonomy`
  Add a new form to represent a taxonomy of `meta:timeline:type` values.

- Add support for `$lib.len()` to count the length of emitter or generator functions. (#2603)
- Add support for scrape APIs to handle text that has been defanged with `\\.` characters. (#2605)
- Add a `nomerge` option to View objects that can be set to prevent merging a long lived fork. (#2614)

- Add `liftByProp()` and `liftByTag()` methods to the Stormtypes `layer` objects. These allow lifting of nodes based on data stored in a specific layer. (#2613)
- Expand Synapse requirements to include updated versions of the `pygments` library. (#2602)

17.63.3 Improved Documentation

- Fix the example regular expressions used in the `$lib.scrape.genMatches()` Storm library API examples. (#2606)

17.64 v2.87.0 - 2022-03-18

17.64.1 Features and Enhancements

- Several updates for the `inet` and `meta` models. (#2589) (#2592)

  `inet:ssl:jarmhash`
  : Add a form to record JARM hashes.

  `inet:ssl:jarmsample`
  : Add a form to record JARM hashes being present on a server.

  `meta:note`
  : Add a form for recording free text notes.

- Update the Synapse docker containers to be built from a Ubuntu based image, instead of a Debian based image. (#2596)
- Add a Storm `note.add` command that creates a `meta:note` node to record freeform text, and links that node to the input nodes using a `about` light edge. (#2592)
- Support non-writeable or non-existing directories within Synapse `certdir` directories. (#2590)
- Add an optional `tick` argument to the `synapse.lib.lmdbslab.Hist.add()` function. This is exposed internally for Axon implementations to use. (#2593)
- Expand Synapse requirements to include updated versions of the `pycryptome`, `pygments`, `scalecodec` and `xxhash` modules. (#2598)

17.64.2 Bugfixes

- Fix an issue where the StormDmon stop/start status was not properly being updated in the runtime object, despite being properly updated in the Hive. (#2598)
- Calls to `addUnivProp()` APIs when the universal property name already exists now raise a `DupPropName` exception. (#2601)

17.65 v2.86.0 - 2022-03-09

17.65.1 Automatic Migrations

- Migrate secondary properties in Cortex nodes which use `hugenum` type to account for updated ranges. See *Data Migration* for more information about automatic migrations.

17.65.2 Features and Enhancements

- Extend the number of decimal places the `hugenum` type can store to 24 places, with a new maximum value of 730750818665451459101842. (#2584) (#2586)
- Update `fastjsonschema` to version `2.15.3`. (#2581)

17.65.3 Bugfixes

- Add missing read-only flags to secondary properties of Comp type forms which were computed from the primary property of the node. This includes the following: (#2587)
  - `crypto:currency:address:coin`
  - `crypto:currency:address:iden`
  - `crypto:currency:block:coin`
  - `crypto:currency:block:offset`
  - `crypto:currency:client:coinaddr`
  - `crypto:currency:client:inetaddr`
  - `crypto:currency:smart:token:contract`
  - `crypto:currency:smart:token:tokenid`
  - `crypto:x509:revoked:crl`
  - `crypto:x509:revoked:cert`
  - `crypto:x509:signedfile:cert`
  - `crypto:x509:signedfile:file`
  - `econ:acquired:item`
  - `econ:acquired:purchase`
  - `inet:dns:query:client`
  - `inet:dns:query:name`
  - `inet:dns:query:type`
  - `inet:whois:contact:type`
  - `inet:wifi:ap:bssid`
  - `inet:wifi:ap:ssid`
  - `mat:itemimage:file`
  - `mat:itemimage:item`

- mat:specimage:file
- mat:specimage:spec
- ou:id:number:type
- ou:id:number:value
- ou:hasgoal:goal
- ou:hasgoal:org
- tel:mob:cell:carrier
- tel:mob:cell:carrier:mcc
- tel:mob:cell:carrier:mnc
- tel:mob:cell:cid
- tel:mob:cell:lac

- Fix an issue where Layers configured with writeback mirrors did not properly handle results which did not have any changes. (#2583)

17.65.4 Improved Documentation

- Fix spelling issues in documentation and API docstrings. (#2582) (#2585)

17.66 v2.85.1 - 2022-03-03

17.66.1 Bugfixes

- Fix a permission enforcement issue in autoadd mode that allowed users with view read permissions to add automatically detected and validated nodes but make no further edits. (#2579)
- Log errors encountered in the Layer mirror loop which don't have a local caller waiting on the change. (#2580)

17.67 v2.85.0 - 2022-03-03

17.67.1 Features and Enhancements

- Several updates for the crypto, geo, inet, it, ps and risk models. (#2570) (#2573) (#2574)

  crypto:payment:input
  Add a new form to record payments made into a transaction.

  crypto:payment:output
  Add a new form to record payments receieved from a transaction.

  crypto:currency:transaction
  Add inputs and outputs array secondary properties to record inputs and outputs for a given transaction.

  geo:name
  Add a new form representing an unstructured place name or address.

  geo:place
  Add a names secondary property which is an array of geo:name values.

inet:flow
: Add `dst:txcount`, `src:txcount`, `tot:txcount` and `tot:txbytes` secondary properties.

it:exec:proc
: Add an `account` secondary property as a `it:account` type. Mark the `user` secondary property as deprecated.

ps:contact
: Add `birth:place`, `birth:place:loc`, `birth:place:name`, `death:place`, `death:place:loc` and `death:place:name` secondary properties.

risk:compromise
: Add a `theft:price` secondary property to represent value of stolen assets.

- Embed Cron, StormDmon, and Trigger iden values and automation types into the Storm runtime when those automations are run. This information is populated in a dictionary variable named `$auto`. (#2565)
- Add `$lib.crypto.coin.ethereum.eip55()` to convert an Ethereum address to a checksummed address. (#2577)
- Add a `default` argument to the `$lib.user.allowed()` and `allowed()` method on `user` StormType. (#2570)
- Add a `inaugural` configuration key to the base `Cell` class. This can currently be used to bootstrap roles, permissions, and users in a Cell upon the first time it is started. (#2570)
- De-duplicate nodes when running the Storm `lookup` mode to lift nodes. (#2567)
- Add a test helper that can be used to isolate the `synapse.lib.certdir.certdir` singleton behavior via context manager. (#2564)

17.67.2 Bugfixes

- Calls to `addFormProp()` APIs when the property name already exists now raise a `DupPropName` exception. (#2566)
- Do not allow Storm `macro`'s to be created that have names greater than 492 characters in length. (#2569)
- Fix a bug in the scrape logic for Ethereum where the regular expression matched on `0X` prefixed strings but the validation logic did not account for that uppercase character. (#2575)

17.67.3 Improved Documentation

- Add documentation for the `$auto` variable embedded into the Cron, StormDmon, and Trigger automations. Add documentation for variables representing the form, node value, properties and tags which are responsible for Triggers running. (#2565)

17.68 v2.84.0 - 2022-02-22

17.68.1 Features and Enhancements

- Add `$lib.time.toUTC()` to adjust a local epoch milliseconds time to UTC. (#2550)
- Add a optional `timeout` argument to `$lib.service.wait()`. The function now returns `$lib.true` if the service is available, or `$lib.false` if the service does not become available during the timeout window. (#2561)
- Update the `Layer.verify()` routines to add verification of tagprop and array indexes in layers. These routines are in a beta status and are subject to change. (#2560)

- Update the Cortex's connection to a remote Axon to use a Telepath Client. (#2559)

17.69 v2.83.0 - 2022-02-17

17.69.1 Features and Enhancements

- Add `:ip:proto` and `:ip:tcp:flags` properties to the `inet:flow` form. (#2554)
- Add `$lib.log.debug()`, `$lib.log.info()`, `$lib.log.warning()`, and `$lib.log.error()` Stormtypes APIs. These allow a user to send log messages to the Cortex logging output directly.
- Update the `synapse.tools.genpkg` tool to support using files with the `.storm` extension. This is enabled by adding the following option to a Storm package definition. (#2555)

```
genopts:
  dotstorm: true
```

- Add form and prop values to `BadTypeValu` exceptions when raised during node edit generation. (#2552)

17.69.2 Bugfixes

- Correct a race condition in the `CoreApi.syncLayersEvents` and `CoreApi.syncIndexEvents` APIs. (#2553)

17.69.3 Improved Documentation

- Remove outdated documentation related to making `CoreModule` classes. (#2556)

17.70 v2.82.1 - 2022-02-11

17.70.1 Bugfixes

- Re-order node edit validation to only check read-only status of properties if the value would change. (#2547)
- Raise the correct exception when parsing invalid time values, like `0000-00-00`. (#2548)
- Disable node caching for `StormDmon` runtimes to avoid potential cache coherency issues. (#2549)

17.71 v2.82.0 - 2022-02-10

17.71.1 Features and Enhancements

- Add an `addNode()` API to the Stormtypes `view` object. This allows the programmatic creation of a node with properties being set in a transactional fashion. (#2540)
- Add support to Storm for creating JSON style list and dictionary objects. (#2544)
- The `AhaCell` now bootstraps TLS CA certificates for the configured `aha:network` value, a host certificate for the `aha:name` value, and a user certificate for the `aha:admin` value. (#2542)
- Add `mesg` arguments to all exceptions raised in `synapse.lib.certdir`. (#2546)

17.71.2 Improved Documentation

- Fix some missing and incorrect docstrings for Stormtypes. (#2545)

17.71.3 Deprecations

- Telepath APIs and Storm commands related to `splices` have been marked as deprecated. (#2541)

17.72 v2.81.0 - 2022-01-31

17.72.1 Features and Enhancements

- The `it:sec:cpe` now recognizes CPE 2.2 strings during type normalization. CPE 2.2 strings will be upcast to CPE 2.3 and the 2.2 string will be added to the `:v2_2` secondary property of `it:sec:cpe`. The Storm hotfix `$lib.cell.hotFixesApply()` can be used to populate the `:v2_2` property on existing `it:sec:cpe` nodes where it is not set. (#2537) (#2538) (#2539)
- Setting properties on nodes may now take a fast path if the normed property has no subs, no autoadds and is not a locked property. (#2539)

17.72.2 Bugfixes

- Fix an issue with `Ival` `norm()` routines when norming a tuple or list of values. The max value returned previously could have exceeded the value of the future marker `?`, which would have been then caused an a `BadTypeValu` exception during node edit construction. This is is now caught during the initial `norm()` call. (#2539)

17.73 v2.80.1 - 2022-01-26

17.73.1 Bugfixes

- The embedded JsonStor added to the Cortex in `v2.80.0` needed to have a stable iden for the Cell and and auth subsystem. This has been added. (#2536)

17.74 v2.80.0 - 2022-01-25

17.74.1 Features and Enhancements

- Add a triple quoted string `'''` syntax to Storm for defining multiline strings. (#2530)
- Add a JSONStor to the Cortex, and expose that in Storm for storing user related content. (#2530) (#2513)
- Add durable user notifications to Storm that can be used to send and receive messages between users. (#2513)
- Add a `leaf` argument to `$node.tags()` that causes the function to only return the leaf tags. (#2535)
- Add an error message in the default help text in pure Storm commands when a user provides additional arguments or switches, in addition to the `--help` switch. (#2533)
- Update `synapse.tools.genpkg` to automatically bundle Optic workflows from files on disk. (#2531)

- Expand Synapse requirements to include updated versions of the `packaging`, `pycryptome` and `scalecodec` modules. (#2534)

17.74.2 Bugfixes

- Add a missing `tostr()` call to the Storm `background` query argument. (#2532)

17.75 v2.79.0 - 2022-01-18

17.75.1 Features and Enhancements

- Add `$lib.scrape.ndefs()` and `$lib.scrape.context()` to scrape text. The `ndefs()` API yields a unique set of node form and value pairs, while the `context()` API yields node form, value, and context information for all matches in the text. (#2508)
- Add `:name` and `:desc` properties to the `it:prod:softver` form. (#2528)
- Update the `Layer.verify()` routines to reduce false errors related to array types. The method now takes a dictionary of configuration options. These routines are in a beta status and are subject to change. (#2527)
- Allow setting a View's parent if does not have an existing parent View and only has a single layer. (#2515)
- Add `hxxp[:\\]` and `hxxps[:\\]` to the list of known defanging strategies which are identified and replaced during text scraping. (#2526)
- Expand Synapse requirements to include updated versions of the `typing-extensions` module. (#2525)

17.75.2 Bugfixes

- Storm module interfaces now populate `modconf` data when loaded. (#2508)
- Fix a missing keyword argument from the `AxonApi.wput()` method. (#2527)

17.75.3 Deprecations

- The `$lib.scrape()` function has been deprecated in favor the new `$lib.scrape` library functions. (#2508)

17.76 v2.78.0 - 2022-01-14

17.76.1 Automatic Migrations

- Migrate Cortex nodes which may have been skipped in an earlier migration due to missing tagprop indexes. See *Data Migration* for more information about automatic migrations.

17.76.2 Features and Enhancements

- Expand Synapse requirements to include updated versions of the `base58`, `cbor2`, `lmdb`, `pycryptodome`, `PyYAML`, `xxhash`. (#2520)

17.76.3 Bugfixes

- Fix an issue with the Tagprop migration from `v2.42.0` where a missing index could have resulted in Layer storage nodes not being updated. (#2522) (#2523)
- Fix an issue with `synapse.lib.platforms.linux.getTotalMemory()` when using a process segregated with the Linux cgroups2 API. (#2517)

17.76.4 Improved Documentation

- Add devops instructions related to automatic data migrations for Synapse components. (#2523)
- Update the model deprecation documentation for the `it:host:model` and `it:host:make` properties. (#2521)

17.77 v2.77.0 - 2022-01-07

17.77.1 Features and Enhancements

- Add Mach-O metadata support the file model. This includes the following new forms: `file:mime:macho:loadcmd`, `file:mime:macho:version`, `file:mime:macho:uuid`, `file:mime:macho:segment`, and `file:mime:macho:section`. (#2503)
- Add `it:screenshot`, `it:prod:hardware`, `it:prod:component`, `it:prod:hardwaretype`, and `risk:mitigation` forms to the model. Add `:hardware` property to `risk:hasvuln` form. Add `:hardware` property to `it:host` form. The `:manu` and `:model` secondary properties on `it:host` have been deprecated. (#2514)
- The `guid` type now strips hyphen (`-`) characters when doing norm. This allows users to provide external UUID / GUID strings for use. (#2514)
- Add a `Axon.postfiles()` to allow POSTing files as multi-part form encoded files over HTTP. This is also exposed through the `fields` argument on the Storm `$lib.inet.http.post()` and `$lib.inet:http:request` APIs. (#2516)
- Add `.yu` ccTLD to the list of TLDs identified by the Synapse scrape functionality. (#2518)
- Add `mesg` arguments to all instances of `NoSuchProp` exceptions. (#2519)

17.78 v2.76.0 - 2022-01-04

17.78.1 Features and Enhancements

- Add `emit` and `stop` keywords to Storm. The `emit` keyword is used in functions to make them behave as generators, which can yield arbitrary values. The `stop` keyword can be used to prematurely end a function which is `emit`'ing values. (#2475)

- Add Storm Module Interfaces. This allows Storm Package authors to define common module interfaces, so that multiple modules can implement the API convention to provide a consistent set of data across multiple Storm modules. A `search` convention is added to the Cortex, which will be used in `lookup` mode when the `storm:interface:search` configuration option is set. (#2475)
- Storm queries in `lookup` mode now fire `look:miss` events into the Storm message stream when the lookup value contains a valid node value, but the node is not present in the current View. (#2475)
- Add a `:host` secondary property to `risk:hasvuln` form to record `it:host` instances which have a vulnerability. (#2512)
- Add `synapse.lib.scrape` support for identifying `it:sec:cve` values. (#2509)

17.78.2 Bugfixes

- Fix an `IndexError` that can occur during `Layer.verify()` routines. These routines are in a beta status and are subject to change. (#2507)
- Ensure that parameter and header arguments passed to Storm `$lib.inet.http` functions are cast into strings values. (#2510)

17.79 v2.75.0 - 2021-12-16

This release contains an automatic data migration that may cause additional startup time on the first boot. This is done to unique array properties which previously were not uniqued. Deployments with startup or liveliness probes should have those disabled while this upgrade is performed to prevent accidental termination of the Cortex process. Please ensure you have a tested backup available before applying this update.

17.79.1 Features and Enhancements

- Update the following array properties to be unique sets, and add a data model migration to update the data at rest: (#2469)
  - `biz:rfp:requirements`
  - `crypto:x509:cert:ext:sans`
  - `crypto:x509:cert:ext:crls`
  - `crypto:x509:cert:identities:fqdns`
  - `crypto:x509:cert:identities:emails`
  - `crypto:x509:cert:identities:ipv4s`
  - `crypto:x509:cert:identities:ipv6s`
  - `crypto:x509:cert:identities:urls`
  - `crypto:x509:cert:crl:urls`
  - `inet:whois:iprec:contacts`
  - `inet:whois:iprec:links`
  - `inet:whois:ipcontact:roles`
  - `inet:whois:ipcontact:links`
  - `inet:whois:ipcontact:contacts`

  - it:account:groups
  - it:group:groups
  - it:reveng:function:impcalls
  - it:reveng:filefunc:funccalls
  - it:sec:cve:references
  - risk:vuln:cwes
  - tel:txtmesg:recipients

- Add Layer index verification routines, to compare the Layer indices against the stored data for Nodes. This is exposed via the `.verify()` API on the Stormtypes `layer` object. These routines are in a beta status and are subject to change. (#2488)
- The `.json()` API on `inet:http:resp` now raises a `s_exc.BadJsonText` exception, which can be caught with the Storm `try ... catch` syntax. (#2500)
- Add `$lib.inet.ipv6.expand()` to expand an IPv6 address to its long form. (#2502)
- Add `hasPathObj()`, `copyPathObj()` and `copyPathObjs()` APIs to the `JsonStor`. (#2438)
- Allow setting a custom title when making documentation for Cell `confdefs` with the `synapse.tools.autodoc` tool. (#2504)
- Update the minimum version of the `aiohttp` library to `v3.8.1`. (#2495)

17.79.2 Improved Documentation

- Add content previously hosted at `commercial.docs.vertex.link` to the mainline Synapse documentation. This includes some devops information related to orchestration, information about Advanced and Rapid Power-Ups, information about the Synapse User Interface, as well as some support information. (#2498) (#2499) (#2501)
- Add `Synapse-Malshare` and `Synapse-TeamCymru` Rapid Power-Ups to the list of available Rapid Power-Ups. (#2506)
- Document the `jsonlines` option for the `api/v1/storm` and `api/v1/storm/nodes` HTTP APIs. (#2505)

17.80 v2.74.0 - 2021-12-08

17.80.1 Features and Enhancements

- Add `.onion` and `.bit` to the TLD list used for scraping text. Update the TLD list from the latest IANA TLD list. (#2483) (#2497)
- Add support for writeback mirroring of layers. (#2463) (#2489)
- Add `$lib.scrape()` Stormtypes API. This can be used to do programmatic scraping of text using the same regular expressions used by the Storm `scrape` command and the `synapse.lib.scrape` APIs. (#2486)
- Add a `jsonlines` output mode to Cortex streaming HTTP endpoints. (#2493)
- Add a `--raw` argument to the Storm `pkg.load` command. This loads the raw JSON response as a Storm package. (#2491)
- Add a `blocked` enum to the `proj:ticket:status` property to represent a blocked ticket. (#2490)

17.80.2 Bugfixes

- Fix a behavior with `$path` losing variables in pure Storm command execution. (#2492)

17.80.3 Improved Documentation

- Update the description of the Storm `scrape` command. (#2494)

17.81 v2.73.0 - 2021-12-02

17.81.1 Features and Enhancements

- Add a Storm `runas` command. This allows admin users to execute Storm commands as other users. (#2473)
- Add a Storm `intersect` command. This command produces the intersection of nodes emitted by running a Storm query over all inbound nodes to the `intersect` command. (#2480)
- Add `wait` and `timeout` parameters to the `Axon.hashes()` and `$lib.axon.list()` APIs. (#2481)
- Add a `readonly` flag to `synapse.tools.genpkg.loadPkgProto()` and `synapse.tools.genpkg.tryLoadPkgProto()` APIs. If set to `True` this will open files in read only mode. (#2485)
- Allow Storm Prim objects to be capable of directly yielding nodes when used in `yield` statements. (#2479)
- Update the StormDmon subsystem to add debug log information about state changes, as well as additional data for structured logging output. (#2455)

17.81.2 Bugfixes

- Catch a fatal application error that can occur in the Cortex if the forked process pool becomes unusable. Previously this would cause the Cortex to appear unresponsive for executing Storm queries; now this causes the Cortex to shut down gracefully. (#2472)
- Fix a Storm path variable scoping issue where variables were improperly scoped when nodes were passed into pure Storm commands. (#2459)

17.82 v2.72.0 - 2021-11-23

17.82.1 Features and Enhancements

- Update the cron subsystem logs to include the cron name, as well as adding additional data for structured logging output. (#2477)
- Add a `sort_keys` argument to the `$lib.yaml.save()` Stormtype API. (#2474)

17.82.2 Bugfixes

- Update the `asyncio-socks` version to a version which has a pinned version range for the `python-socks` dependency. (#2478)

17.83 v2.71.1 - 2021-11-22

17.83.1 Bugfixes

- Update the `PyOpenSSL` version to `21.0.0` and pin a range of modern versions of the `cryptography` which have stronger API compatibility. This resolves an API compatibility issue with the two libraries which affected SSL certificate generation. (#2476)

17.84 v2.71.0 - 2021-11-19

17.84.1 Features and Enhancements

- Add support for asynchronous triggers. This mode of trigger operation queues up the trigger event in the View for eventual processing. (#2464)
- Update the crypto model to add a `crypto:smart:token` form to represent a token managed by a smart contract. (#2462)
- Add `$lib.axon.readlines()` and `$lib.axon.jsonlines()` to Stormtypes. (#2468)
- Add the Storm `mode` to the structured log output of a Cortex executing a Storm query. (#2466)

17.84.2 Bugfixes

- Fix an error when converting Lark exceptions to Synapse `BadSyntaxError`. (#2471)

17.84.3 Improved Documentation

- Revise the Synapse documentation layout. (#2460)
- Update type specific behavior documentation for `time` types, including the recently added wildcard time syntax. (#2467)
- Sort the Storm Type documentation by name. (#2465)
- Add 404 handler pages to our documentation. (#2461) (#2470)

17.84.4 Deprecations

- Remove `$path.trace()` objects. (#2445)

17.85 v2.70.1 - 2021-11-08

17.85.1 Bugfixes

- Fix an issue where `$path.meta` data was not being properly serialized when heavy Stormtype objects were set on the `$path.meta` dictionary. (#2456)
- Fix an issue with Stormtypes `Str.encode()` and `Bytes.decode()` methods when handling potentially malformed Unicode string data. (#2457)

17.85.2 Improved Documentation

- Update the Storm Control Flow documentation with additional examples. (#2443)

17.86 v2.70.0 - 2021-11-03

17.86.1 Features and Enhancements

- Add `:dst:handshake` and `src:handshake` properties to `inet:flow` to record text representations of the handshake strings of a given connection. (#2451)
- Add a `proj:attachment` form to the `project` model to represent attachments to a given `proj:ticket`. (#2451)
- Add a implicit wildcard behavior to the `time` type when lifting or filtering nodes. Dates ending in a * are converted into ranges covering all possible times in them. For example, `.created=202101*` would lift all nodes created on the first month of 2021. (#2446)
- Add the following `$lib.time` functions to chop information from a time value. (#2446)
  - `$lib.time.year()`
  - `$lib.time.month()`
  - `$lib.time.day()`
  - `$lib.time.hour()`
  - `$lib.time.minute()`
  - `$lib.time.second()`
  - `$lib.time.dayofweek()`
  - `$lib.time.dayofmonth()`
  - `$lib.time.monthofyear()`
- Add `List.extend()`, `List.slice()`, `Str.find()`, and `Str.size()` functions to Stormtypes. (#2450) (#2451)
- Add `$lib.json.schema()` and a `json:schema` object to Stormtypes. These can be used to validate arbitrary data JSON structures in Storm using JSON Schema. (#2448)

- Update syntax checking rules and address deprecation warnings for strings in the Synapse codebase. (#2426)

17.87 v2.69.0 - 2021-11-02

17.87.1 Features and Enhancements

- Add support for building Optic Workflows for Storm Packages in the `synapse.tools.genpkg` tool. (#2444)
- The `synapse.tools.storm` CLI tool now prints out node properties in precedence order. (#2449)
- Update the global Stormtypes registry to better track types when they are added or removed. (#2447)

17.88 v2.68.0 - 2021-10-29

17.88.1 Features and Enhancements

- Add `crypto:currency:transaction`, `crypto:currency:block`, `crypto:smart:contract` and `econ:acct:balanc` forms. (#2423)
- Add `$lib.hex.decode()` and `$lib.hex.encode()` Stormtypes functions to encode and decode hexidecimal data as bytes. Add `slice()` and `unpack()` methods to the Storm Bytes object. (#2441)
- Add `$lib.yaml` and `$lib.xml` Stormtypes libraries for interacting with YAML and XML text, respectively. (#2434)
- Add a Storm `version` command to show the user the current version of Synapse the Cortex is using. (#2440)

17.88.2 Bugfixes

- Fix overzealous `if` statement caching in Storm. (#2442)

17.89 v2.67.0 - 2021-10-27

17.89.1 Features and Enhancements

- Add `$node.addEdge()` and `$node.delEdge()` APIs in Storm to allow for programatically setting edges. Add a `reverse` argument to `$node.edges()` that allows traversing edges in reverse. (#2351)

17.89.2 Bugfixes

- Fix a pair of regressions related to unicode/IDNA support for scraping and normalizing FQDNs. (#2436)

17.89.3 Improved Documentation

- Add documentation for the Cortex `api/v1/storm/call` HTTP API endpoint. (#2435)

17.90 v2.66.0 - 2021-10-26

17.90.1 Features and Enhancements

- Improve unicode/IDNA support for scraping and normalizing FQDNs. (#2408)
- Add `$lib.inet.http.ouath` to support OAuth based workflows in Storm, starting with OAuth v1.0 support. (#2413)
- Replace `pysha3` requirement with `pycryptodome`. (#2422)
- Add a `tls:ca:dir` configuration option to the Cortex and Axon. This can be used to provide a directory of CA certificate files which are used in Storm HTTP API and Axon wget/wput APIs. (#2429)

17.90.2 Bugfixes

- Catch and raise bad ctors given in RStorm `storm-cortex` directives. (#2424)
- Fix an issue with the `cron.at` command not properly capturing the current view when making the Cron job. (#2425)
- Disallow the creation of extended properties, universal properties, and tag properties which are not valid properties in the Storm grammar. (#2428)
- Fix an issue with `$lib.guid()` missing a `toprim()` call on its input. (#2421)

17.90.3 Improved Documentation

- Update our Cell devops documentation to note how to replace the TLS keypair used by the built in webserver with third party certificates. (#2432)

17.91 v2.65.0 - 2021-10-16

17.91.1 Features and Enhancements

- Add support for interacting with IMAP email servers though Storm, using the `$lib.inet.imap.connect()` function. This returns a object that can be used to delete, read, and search emails in a given IMAP mailbox. (#2399)
- Add a new Storm command, `once`. This command can be used to 'gate' a node in a Storm pipeline such that the node only passes through the command exactly one time for a given named 'gate'. The gate information is stored in nodedata, so it is inspectable and subject to all other features that apply to nodedata. (#2404)
- Add a `:released` property to `it:prod:softver` to record when a software version was released. (#2419)
- Add a `tryLoadPkgProto` convenience function to the `synapse.tools.genpkg` for Storm service package generation with inline documentation. (#2414)

17.91.2 Bugfixes

- Add `asyncio.sleep(0)` calls in the `movetag` implementation to address some possible hot-loops. (#2411)
- Clarify and sanitize URLS in a Aha related log message i `synapse.telepath`. (#2415)

17.91.3 Improved Documentation

- Update our `fork` definition documentation. (#2409)
- Add documentation for using client-side TLS certificates in Telepath. (#2412)
- Update the Storm CLI tool documentation. (#2406)
- The Storm types and Storm library documentation now automatically links from return values to return types. (#2410)

17.92 v2.64.1 - 2021-10-08

17.92.1 Bugfixes

- Add a retry loop in the base `Cell` class when attempting to register with an `Aha` server. (#2405)
- Change the behavior of `synapse.common.yamlload()` to not create files when the expected file is not present on disk, and open existing files in read-only mode. (#2396)

17.93 v2.64.0 - 2021-10-06

17.93.1 Features and Enhancements

- Add support for scraping the following cryptocurrency addresses to the `synapse.lib.scrape` APIs and Storm `scrape` command. (#2387) (#2401)
  - Bitcoin
  - Bitcoin Cash
  - Ethereum
  - Ripple
  - Cardano
  - Polkadot

  The internal cache of regular expressions in the `synapse.lib.scrape` library is also now a private member; API users should use the `synapse.lib.scrape.scrape()` function moving forward.
- Add `:names` property to the `it:mitre:attack:software` form. (#2397)
- Add a `:desc` property to the `inet:whois:iprec` form. (#2392)
- Added several new Rstorm directives. (#2359) (#2400)
  - `storm-cli` - Runs a Storm query with the Storm CLI tool
  - `storm-fail` - Toggles whether or not the following Storm command should fail or not.

- `storm-multiline` - Allows embedding a multiline Storm query as a JSON encoded string for future execution.
- `storm-vcr-callback` - Allows specifying a custom callback which a VCR object is sent too.

17.93.2 Bugfixes

- Fix a missing `toprim()` call when loading a Storm package directly with Storm. (#2359)
- Fix a caching issue where tagprops were not always being populated in a `Node` tagprop dictionary. (#2396)
- Add a `mesg` argument to a few `NoSuchVar` and `BadTypeValu` exceptions. (#2403)

17.93.3 Improved Documentation

- Storm reference docs have been converted from Jupyter notebook format to Synapse `.rstorm` format, and now display examples using the Storm CLI tool, instead of the Cmdr CLI tool. (#2359)

17.94 v2.63.0 - 2021-09-29

17.94.1 Features and Enhancements

- Add a `risk:attacktype` taxonomy to the risk model. Add `:desc` and `:type` properties to the `risk:attack` form. (#2386)
- Add `:path` property to the `it:prod:softfile` form. (#2388)

17.94.2 Bugfixes

- Fix the repr for the``auth:user`` Stormtype when printing a user object in Storm. (#2383)

17.95 v2.62.1 - 2021-09-22

17.95.1 Bugfixes

- Fix an issue in the Nexus log V1 to V2 migration code which resulted in LMDB file copies being made instead of having directories renamed. This can result in a sparse file copy of the Nexus log, resulting in a condition where the volume containing the Cell directory may run out of space. (#2374)

17.96 v2.62.0 - 2021-09-21

17.96.1 Features and Enhancements

- Add APIs to support trimming, rotating and culling Nexus logs from Cells with Nexus logging enabled. These operations are distributed to downstream consumers, of the Nexus log (e.g. mirrors). For the Cortex, this can be invoked in Storm with the `$lib.cell.trimNexsLog()` Stormtypes API. The Cortex devops documentation contains more information about Nexus log rotation. (#2339) (#2371)
- Add `.size()` API to the Stormtypes `storm:query` object. This will run the query and return the number of nodes it would have yielded. (#2363)

17.96.2 Improved Documentation

- Document the tag glob meanings on the Stormtypes `$node.tags()` API. (#2368)

17.97 v2.61.0 - 2021-09-17

17.97.1 Features and Enhancements

- Add a `!export` command to the Storm CLI to save query results to a `.nodes` file. (#2356)
- Add `$lib.cell.hotFixesCheck()` and `$lib.cell.hotFixesApply()` Stormtypes functions. These can be used to apply optional hotfixes to a Cortex on demand by an admin. (#2348)
- Add `$lib.infosec.cvss.calculateFromProps()` to allow calculating a CVSS score from a dictionary of CVSS properties. (#2353)
- Add `$node.data.has()` API to Stormtypes to allow easy checking if a node has nodedata for a given name. (#2350)

17.97.2 Bugfixes

- Fix for large return values with `synapse.lib.coro.spawn()`. (#2355)
- Fix `synapse.lib.scrape.scrape()` capturing various common characters used to enclose URLs. (#2352)
- Ensure that generators being yielded from are always being closed. (#2358)
- Fix docstring for `str.upper()` in Stormtypes. (#2354)

17.97.3 Improved Documentation

- Add link to the Power-Ups blog post from the Cortex dev-ops documentation. (#2357)

17.98 v2.60.0 - 2021-09-07

17.98.1 Features and Enhancements

- Add new `risk:compromise` and `risk:compromisetype` forms. Add `attacker`, `compromise`, and `target` secondary properties to the `risk:attack` form. (#2348)

17.98.2 Bugfixes

- Add a missing `wait()` call when calling the `CoreApi.getAxonUpload()` and `CoreApi.getAxonBytes()` Telepath APIs. (#2349)

17.98.3 Deprecations

- Deprecate the `actor:org`, `actor:person`, `target:org` and `target:person` properties on `risk:attack` in favor of new `attacker` and `target` secondary properties. Deprecate the `type` property on `ou:campaign` in favor of the `camptype` property. (#2348)

17.99 v2.59.0 - 2021-09-02

17.99.1 Features and Enhancements

- Add a new Storm command, `pkg.docs`, to enumerate any documentation that has been bundled with a Storm package. (#2341)
- Add support for manipulating `'proj:comment` nodes via Stormtypes. (#2345)
- Add `Axon.wput()` and `$lib.axon.wput()` to allow POSTing a file from an Axon to a given URL. (#2347)
- Add `$lib.export.toaxon()` to allow exporting a `.nodes` file directly to an Axon based on a given storm query and opts. (#2347)
- The `synapse.tools.feed` tool now accepts a `--view` argument to feed data to a specific View. (#2342)
- The `synapse.tools.feed` tool now treats `.nodes` files as msgpack files for feeding data to a Cortex. (#2343)
- When the Storm `help` command has an argument without any matching commands, it now prints a helpful message. (#2338)

17.99.2 Bugfixes

- Fix a caching issue between `$lib.lift.byNodeData()` and altering the existing node data on a given node. (#2344)
- Fix an issue with backups were known lmdbslabs could be omitted from being treated as lmdb databases, resulting in inefficient file copies being made. (#2346)

17.100 v2.58.0 - 2021-08-26

17.100.1 Features and Enhancements

- Add `!pushfile`, `!pullfile`, and `!runfile` commands to the `synapse.tools.storm` tool. (#2334)
- Add multiname SNI support to `ssl://` listening configurations for the Daemon. (#2336)
- Add a new Cortex HTTP API Endpoint, `/api/v1/feed`. This can be used to add nodes to the Cortex in bulk. (#2337)
- Refactor the `syn.nodes` feed API implementation to smooth out the ingest rate. (#2337)
- Sort the Storm Package commands in documentation created by `synpse.tools.autodoc` alphabetically. (#2335)

17.100.2 Deprecations

- Deprecate the `syn.splices` and `syn.nodedata` feed API formats. (#2337)

17.101 v2.57.0 - 2021-08-24

17.101.1 Features and Enhancements

- Add a basic `synapse.tools.storm` CLI tool. This can be used to connect to a Cortex via Telepath and directly execute Storm commands. (#2332)
- Add an `inet:http:session` form to track the concept of a prolonged session a user may have with a webserver across multiple HTTP requests. Add an `:success` property to the `ou:campaign` form to track if a campaign was sucessful or not. Add an `:goal` property to the `risk:attack` form to track the specific goal of the attack. Add an `:desc` property to the `proj:project` form to capture a description of the project. (#2333)

17.101.2 Bugfixes

- Fix an issue with `synapse.lib.rstorm` where multiline node properties could produce RST which did not render properly. (#2331)

17.101.3 Improved Documentation

- Clean up the documentation for the Storm `wget` command. (#2325)

17.102 v2.56.0 - 2021-08-19

17.102.1 Features and Enhancements

- Refactor some internal Axon APIs for downstream use. (#2330)

17.102.2 Bugfixes

- Resolve an ambiguity in the Storm grammar with yield statement and dollar expressions inside filter expression. There is a slight backwards incompatibility with this change, as dollar expressions insider of filter expressions now require a `$` prepended where before it was optional. (#2322)

17.103 v2.55.0 - 2021-08-18

17.103.1 Features and Enhancements

- Add `$node.props.set()` Stormtypes API to allow programmatically setting node properties. (#2324)
- Deny non-runtsafe invocations of the following Storm commands: (#2326)
  - `graph`
  - `iden`
  - `movetag`
  - `parallel`
  - `tee`
  - `tree`
- Add a `Axon.hashset()` API to get the md5, sha1, sha256 and sha512 hashes of file in the Axon. This is exposed in Stormtypes via the `$lib.bytes.hashset()` API. (#2327)
- Add the `synapse.servers.stemcell` server and a new Docker image, `vertexproject/synaspe-stemcell`. The Stemcell server is similar to the `synapse.servers.cell` server, except it resolves the Cell ctor from the `cell:ctor` key from the `cell.yaml` file, or from the `SYN_STEM_CELL_CTOR` environment variable. (#2328)

17.104 v2.54.0 - 2021-08-05

17.104.1 Features and Enhancements

- Add `storm-envvar` directive to RST preprocessor to include environment variables in `storm-pre` directive execution context. (#2321)
- Add new `diff` storm command to allow users to easily lift the set of nodes with changes in the top layer of a forked view. Also adds the `--no-tags` option to the `merge` command to allow users to omit `tag:add` node edits and newly constructed `syn:tag` nodes when merging selected nodes. (#2320)
- Adds the following properties to the data model: (#2319)
  - `biz:deal:buyer:org`

  - biz:deal:buyer:orgname
  - biz:deal:buyer:orgfqdn
  - biz:deal:seller:org
  - biz:deal:seller:orgname
  - biz:deal:seller:orgfqdn
  - biz:prod:madeby:org
  - biz:prod:madeby:orgname
  - biz:prod:madeby:orgfqdn
  - ou:opening:posted
  - ou:opening:removed
  - ou:org:vitals

- Updates storm-mock-http to support multiple HTTP requests/responses in RST preprocessor. (#2317)

17.105 v2.53.0 - 2021-08-05

This release contains an automatic data migration that may cause additional startup time on the first boot. This is done to unique array properties which previously were not uniqued. Deployments with startup or liveliness probes should have those disabled while this upgrade is performed to prevent accidental termination of the Cortex process. Please ensure you have a tested backup available before applying this update.

17.105.1 Features and Enhancements

- Add an embeds option to Storm to allow extracting additional data when performing queries. (#2314)
- Enforce node data permissions at the Layer boundary. Remove the node.data.get and node.data.list permissions. (#2311)
- Add auth.self.set.email, auth.self.set.name, auth.self.set.passwd permissions on users when changing those values. These permissions default to being allowed, allowing a rule to be created that can deny users from changing these values. (#2311)
- Add $lib.inet.smtp to allow sending email messages from Storm. (#2315)
- Warn if a LMDB commit operation takes too long. (#2316)
- Add new data types, taxon and taxonomy, to describe hierarchical taxonomies. (#2312)
- Add a new Business Development model. This allows tracking items related to contract, sales, and purchasing lifecycles. This adds the following new forms to the data model: biz:dealtype, biz:prodtype, biz:dealstatus, biz:rfp, biz:deal, biz:bundle, biz:product, and biz:stake. The Org model is also updated to add new forms for supporting parts of the business lifecycle, adding ou:jobtype, ou:jobtitle, ou:employment, ou:opening, ou:vitals, ou:camptype, and ou:orgtype, ou:conttype forms. The Person model got a new form, ps:workhist. (#2312)
- Add a :deleted property to inet:web:post. (#2312)
- Update the following array properties to be unique sets, and add a data model migration to update the data at rest: (#2312)
  - edu:course:prereqs

- edu:class:assistants
- ou:org:subs
- ou:org:names
- ou:org:dns:mx
- ou:org:locations
- ou:org:industries
- ou:industry:sic
- ou:industry:subs
- ou:industry:isic
- ou:industry:naics
- ou:preso:sponsors
- ou:preso:presenters
- ou:conference:sponsors
- ou:conference:event:sponsors
- ou:conference:attendee:roles
- ou:conference:event:attendee:roles
- ou:contract:types
- ou:contract:parties
- ou:contract:requirements
- ou:position:reports
- ps:person:names
- ps:person:nicks
- ps:persona:names
- ps:persona:nicks
- ps:education:classes
- ps:contactlist:contacts

17.105.2 Bugfixes

- Prevent renaming the `all` role. (#2313)

17.105.3 Improved Documentation

- Add documentation about Linux kernel parameteres which can be tuned to affect Cortex performance. (#2316)

17.106 v2.52.1 - 2021-07-30

17.106.1 Bugfixes

- Fix a display regression when enumerating Cron jobs with the Storm `cron.list` command. (#2309)

17.107 v2.52.0 - 2021-07-29

17.107.1 Features and Enhancements

- Add a new specification for defining input forms that a pure Storm command knows how to natively handle. (#2301)
- Add `Lib.reverse()` and `Lib.sort()` methods to Stormtypes API. (#2306)
- Add `View.parent` property in Stormtypes API. (#2306)
- Support Telepath Share objects in Storm. (#2293)
- Allow users to specify a view to run a cron job against, move a cron job to a new view, and update permission check for adding/moving cron jobs to views. (#2292)
- Add CPE and software name infomation to the `inet:flow` form. Add `it:av:prochit`, `it:exec:thread`, `it:exec:loadlib`, `it:exec:mmap`, `it:app:yara:procmatch` forms to the infotech model. Add `:names` arrays to `it:prod:soft` and `it:prod:softver` forms to assist in entity resolution of software. Add a `risk:alert` form to the risk model to allow for capturing arbitrary alerts. (#2304)
- Allow Storm packages to specify other packages they require and possible conflicts would prevent them from being installed in a Cortex. (#2307)

17.107.2 Bugfixes

- Specify the View when lifting `syn:trigger` runt nodes. (#2300)
- Update the scrape URL regular expression to ignore trailing periods and commas. (#2302)
- Fix a bug in Path scope for nodes yielding by pure Storm commands. (#2305)

17.108 v2.51.0 - 2021-07-26

17.108.1 Features and Enhancements

- Add a `--size` option to the Storm `divert` command to limit the number of times the generator is iterated. (#2297)
- Add a `perms` key to the pure Storm command definition. This allows for adding intuitive permission boundaries for pure Storm commands which are checked prior to command execution. (#2297)

- Allow full properties with comparators when specifying the destination or source when walking light edges. (#2298)

17.108.2 Bugfixes

- Fix an issue with LMDB slabs not being backed up if their directories did not end in `.lmdb`. (#2296)

17.109 v2.50.0 - 2021-07-22

17.109.1 Features and Enhancements

- Add `.cacheget()` and `cacheset()` APIs to the Storm `node:data` object for easy caching of structured data on nodes based on time. (#2290)
- Make the Stormtypes unique properly with a Set type. This does disallow the use of mutable types such as dictionaries inside of a Set. (#2225)
- Skip executing non-runtsafe commands when there are no inbound nodes. (#2291)
- Add `asroot:perms` key to Storm Package modules. This allows package authors to easily declare permissions their packages. Add Storm commands `auth.user.add`, `auth.role.add`, `auth.user.addrule`, `auth.role.addrule`, and `pkg.perms.list` to help with some of the permission management. (#2294)

17.110 v2.49.0 - 2021-07-19

17.110.1 Features and Enhancements

- Add a `iden` parameter when creating Cron jobs to allow the creation of jobs with stable identifiers. (#2264)
- Add `$lib.cell` Stormtypes library to allow for introspection of the Cortex from Storm for Admin users. (#2285)
- Change the Telepath Client connection loop error logging to log at the Error level instead of the Info level. (#2283)
- Make the tag part normalization more resilient to data containing non-word characters. (#2289)
- Add `$lib.tags.prefix()` Stormtypes to assist with normalizing a list of tags with a common prefix. (#2289)
- Do not allow the Storm `divert` command to work with non-generator functions. (#2282)

17.110.2 Bugfixes

- Fix an issue with Storm command execution with non-runtsafe options. (#2284)
- Log when the process pool fails to initialize. This may occur in certain where CPython multiprocessing primitives are not completely supported. (#2288)
- In the Telepath Client, fix a race condition which could have raised an AttributeError in Aha resolutions. (#2286)
- Prevent the reuse of a Telepath Client object when it has been fini'd. (#2286)
- Fix a race condition in the Aha server when handling distributed changes which could have left the service in a desynchronized state. (#2287)

17.110.3 Improved Documentation

- Update the documentation for the `synapse.tools.feed` tool. (#2279)

17.111 v2.48.0 - 2021-07-13

17.111.1 Features and Enhancements

- Add a Storm `divert` command to ease the implementation of `--yield` constructs in Storm commands. This optionally yields nodes from a generator, or yields inbound nodes, while still ensuring the generator is conusmed. (#2277)
- Add Storm runtime debug tracking. This is a boolean flag that can be set or unset via `$lib.debug`. It can be used by Storm packages to determine if they should take extra actions, such as additional print statements, without needing to track additional function arguments in their implementations. (#2278)

17.111.2 Bugfixes

- Fix an ambiguity in the Storm grammar. (#2280)
- Fix an issue where form autoadds could fail to be created in specific cases of the model. (#2273)

17.112 v2.47.0 - 2021-07-07

17.112.1 Features and Enhancements

- Add `$lib.regex.replace()` Stormtypes API to perform regex based replacement of string parts. (#2274)
- Add universal properties to the dictionary returned by `Cortex.getModelDict()` as a `univs` key. (#2276)
- Add additional `asyncio.sleep(0)` statements to `Layer._storNodeEdits` to improve Cortex responsiveness when storing large numbers of edits at once. (#2275)

17.113 v2.46.0 - 2021-07-02

17.113.1 Features and Enhancements

- Update the Cortex `storm:log:level` configuration value to accept string values such as `DEBUG`, `INFO`, etc. The default log level for Storm query logs is now `INFO` level. (#2262)
- Add `$lib.regex.findall()` Stormtypes API to find all matching parts of a regular expression in a given string. (#2265)
- Add `$lib.inet.http.head()` Stormtypes API to perform easy HEAD requests, and `allow_redirects` arguments to existing `lib.inet.http` APIs to allow controlling the redirect behavior. (#2268)
- Add `$lib.storm.eval()` API to evaluate Storm values from strings. (#2269)
- Add `getSystemInfo()` and `getBackupInfo()` APIS to the Cell for getting useful system information. (#2267)
- Allow lists in rstorm bodies. (#2261)

- Add a `:desc` secondary property to the `proj:sprint` form. (#2261)
- Call _normStormPkg in all loadStormPkg paths, move validation to post normalization and remove mutation in validator (#2260)
- Add `SYN_SLAB_COMMIT_PERIOD` environment variable to control the Synapse slab commit period. Add `layer:lmdb:max_replay_log` Cortex option to control the slab replay log size. (#2266)
- Update Ahacell log messages. (#2270)

17.113.2 Bugfixes

- Fix an issue where the `Trigger.pack()` method failed when the user that created the trigger had been deleted. (#2263)

17.113.3 Improved Documentation

- Update the Cortex devops documentation for the Cortex to document the Storm query logging. Update the Cell devops documentation to explain the Cell logging and how to enable structured (JSON) logging output. (#2262)
- Update Stormtypes API documentation for `bool`, `proj:epic`, `proj:epics`, `proj:ticket`, `proj:tickets`, `proj:sprint`, `proj:sprints`, `proj:project`, `stix:bundle` types. (#2261)

17.114 v2.45.0 - 2021-06-25

17.114.1 Features and Enhancements

- Add a application level process pool the base Cell implemenation. Move the processing of Storm query text into the process pool. (#2250) (#2259)
- Minimize the re-validation of Storm code on Cortex boot. (#2257)
- Add the `ou:preso` form to record conferences and presentations. Add a `status` secondary property to the `it:mitre:attack:technique` form to track if techniques are current, deprecated or withdrawn. (#2254)

17.114.2 Bugfixes

- Remove incorrect use of `cmdopts` in Storm command definitions unit tests. (#2258

17.115 v2.44.0 - 2021-06-23

This release contains an automatic data migration that may cause additional startup time on the first boot. This only applies to a Cortex that is using user defined tag properties or using `ps:person:name` properties. Deployments with startup or liveliness probes should have those disabled while this upgrade is performed to prevent accidental termination of the Cortex process. Please ensure you have a tested backup available before applying this update.

17.115.1 Features and Enhancements

- Add a `.move()` method on Stormtypes `trigger` objects to allow moving a Trigger from one View to another View. (#2252)
- When the Aha service marks a service as down, log why that service is being marked as such. (#2255)
- Add `:budget:price` property to the `ou:contract` form. Add `:settled` property to the `econ:purchase` form. (#2253

17.115.2 Bugfixes

- Make the array property `ps:person:names` a unique array property. (#2253
- Add missing tagprop key migration for the bybuidv3 index. (#2256)

17.116 v2.43.0 - 2021-06-21

17.116.1 Features and Enhancements

- Add a `.type` string to the Stormtypes `auth:gate` object to allow a user to identify the type of auth gate it is. (#2238)
- Add `$lib.user.iden` reference to the Stormtype `$lib.user` to get the iden of the current user executing Storm code. (#2236)
- Add a `--no-build` option to `synapse.tools.genpkg` to allow pushing an a complete Storm Package file. (#2231) (#2232) (#2233)
- The Storm `movetag` command now checks for cycles when setting the `syn:tag:isnow` property. (#2229)
- Deprecate the `ou:org:has` form, in favor of using light edges for storing those relationships. (#2234)
- Add a `description` property to the `ou:industry` form. (#2239)
- Add a `--name` parameter to the Storm `trigger.add` command to name triggers upon creation. (#2237)
- Add `regx` to the `BadTypeValu` exception of the `str` type when a regular expression fails to match. (#2240)
- Consolidate Storm parsers to a single Parser object to improve startup time. (#2247)
- Improve error logging in the Cortex `callStorm()` and `storm()` APIs. (#2243)
- Add `from:contract`, `to:contract`, and `memo` properties to the `econ:acct:payment` form. (#2248)
- Improve the Cell backup streaming APIs link cleanup. (#2249)

17.116.2 Bugfixes

- Fix issue with grabbing the incorrect Telepath link when performing a Cell backup. (#2246)
- Fix missing `toprim` calls in `$lib.inet.http.connect()`. (#2235)
- Fix missing Storm command form hint schema from the Storm Package schema. (#2242)

17.116.3 Improved Documentation

- Add documentation for deprecated model forms and properties, along with modeling alternatives. (#2234)
- Update documentation for the Storm `help` command to add examples of command substring matching. (#2241)

17.117 v2.42.2 - 2021-06-11

17.117.1 Bugfixes

- Protect against a few possible RuntimeErrors due to dictionary sizes changing during iteration. (#2227)
- Fix StormType `Lib` lookups with imported modules which were raising a `TypeError` instead of a `NoSuchName` error. (#2228)
- Drop old Storm Packages if they are present when re-adding them. This fixes an issue with runtime updates leaving old commands in the Cortex. (#2230)

17.118 v2.42.1 - 2021-06-09

17.118.1 Features and Enhancements

- Add a `--no-docs` option to the `synapse.tools.genpkg` tool. When used, this not embed inline documentation into the generated Storm packages. (#2226)

17.119 v2.42.0 - 2021-06-03

17.119.1 Features and Enhancements

- Add a `--headers` and `--parameters` arguments to the Storm `wget` command. The default headers now includes a browser like UA string. (#2208)
- Add the ability to modify the name of a role via Storm. (#2222)

17.119.2 Bugfixes

- Fix an issue in the JsonStor cell where there were missing fini calls. (#2223)
- Add a missing timeout to an `getAhaSvc()` call. (#2224)
- Change how tagprops are serialized to avoid a issue with sending packed nodes over HTTP APIs. This changes the packed node structure of tagprops from a dictionary keyed with `(tagname, propertyname)` to a dictionary keyed off of the `tagname`, which now points to a dictionary containing the `propertyname` which represents the value of the tagprop. (*#2221* <https://github.com/vertexproject/synapse/pull/2221>`_)

17.120 v2.41.1 - 2021-05-27

17.120.1 Bugfixes

- Add PR #2117 to bugfix list in CHANGLOG.rst for v2.41.0 :D

17.121 v2.41.0 - 2021-05-27

17.121.1 Features and Enhancements

- Add an `it:cmd` form and update the `it:exec:proc:cmd` property to use it. This release includes an automatic data migration on startup to update the `it:exec:proc:cmd` on any existing `it:exec:proc` nodes. (#2219)

17.121.2 Bugfixes

- Fix an issue where passing a Base object to a sub-runtime in Storm did not correctly increase the reference count. (#2216)
- Fix an issue where the `tee` command could potentially run the specified queries twice. (#2218)
- Fix for rstorm using mock when the HTTP body is bytes. (#2217)

17.122 v2.40.0 - 2021-05-26

17.122.1 Features and Enhancements

- Add a `--parallel` switch to the `tee` Storm command. This allows for all of the Storm queries provided to the `tee` command to execute in parallel, potentially producing a mixed output stream of nodes. (#2209)
- Convert the Storm Runtime object in a Base object, allowing for reference counted Storm variables which are made from Base objects and are properly torn down. (#2203)
- Add `$lib.inet.http.connect()` method which creates a Websocket object inside of Storm, allowing a user to send and receive messages over a websocket. (#2203)
- Support pivot join operations on tags. (#2213)
- Add `stormrepr()` implementation for `synapse.lib.stormtypes.Lib`, which allows for `$lib.print()` to display useful strings for Storm Libraries and imported modules. (#2212)
- Add a storm API top updated a user name. (#2214)

17.122.2 Bugfixes

- Fix the logger name for `synapse.lib.aha`. (#2210)
- Log `ImportError` exceptions in `synapse.lib.dyndeps.getDynMod`. This allows easier debugging when using the `synapse.servers.cell` server when running custom Cell implementations. (#2211)
- Fix an issue where a Storm command which failed to set command arguments successfully would not teardown the Storm runtime. (#2212)

17.123 v2.39.1 - 2021-05-21

17.123.1 Bugfixes

- Fix an issue with referencing the Telepath user session object prior to a valid user being set. (#2207)

17.124 v2.39.0 - 2021-05-20

17.124.1 Features and Enhancements

- Add more useful output to Storm when printing heavy objects with `$lib.print()`. (#2185)
- Check rule edits for roles against provided authgates in Storm. (#2199)
- Add `Str.rsplit()` and maxsplit arguments to `split()/rsplit()` APIs in Storm. (#2200)
- Add default argument values to the output of Storm command help output. (#2198)
- Add a `syn:tag:part` Type and allow the `syn:tag` type to normalize a list of tag parts to create a tag string. This is intended to be used with the `$lib.cast()` function in Storm. (#2192)
- Add debug logging to the Axon for reading, writing, or deleting of blobs. (#2202)
- Add a timeout argument to the `$lib.inet.http` functions. The functions will all now always return a `inet:http:resp` object; if the `.code` is -1, an unrecoverable exception occurred while making the request. (#2205)
- Add support for embedding a logo and documentation into a Storm Package. (#2204)

17.124.2 Bugfixes

- Fix export filters to correctly filter tagprops. (#2196)
- Fix an issue with Hotcount which prevented it from storing negative values. (#2197)
- Fix an issue where `hideconf` configuration values were being included in autodoc output. (#2199)

17.125 v2.38.0 - 2021-05-14

17.125.1 Features and Enhancements

- Remove trigger inheritance from Views. Views will now only execute triggers which are created inside of them. (#2189)
- Remove read-only property flags from secondary properties on `file:bytes` nodes. (#2191)
- Add a simple `it:log:event` form to capture log events. (#2195)
- Add structured logging as an option for Synapse Cells. When enabled, this produces logs as JSONL sent to stderr. This can be set via the `SYN_LOG_STRUCT` environment variable, or adding the `--structured-logging` command line switch. (#2179)
- Add a `nodes.import` command to import a `.nodes` file from a URL. (#2186)
- Allow the `desc` key to View and Layer objects in Storm. This can be used to set descriptions for these objects. (#2190)
- Use the gateiden in Storm auth when modifying rules; allowing users to share Views and Layers with other users. (#2194)

17.125.2 Bugfixes

- Fix an issue with Storm Dmon deletion not behaving properly in mirror configurations. (#2188)
- Explicitly close generators in Telepath where an exception has caused the generator to exit early. (#2183)
- Fix an issue where a trigger owner not having access to a view would cause the Storm pipeline to stop. (#2189)

17.126 v2.37.0 - 2021-05-12

17.126.1 Features and Enhancements

- Add a `file:mime:image` interface to the Synapse model for recording MIME specific metadata from image files. (#2187)
- Add `file:mime:jpg`, `file:mime:tiff`, `file:mime:gif` and `file:mime:png` specific forms for recording metadata of those file types. (#2187)
- Add `$lib.pkg.has()` Stormtype API to check for for the existence of a given Storm package by name. (#2182)
- All `None / $lib.null` as input to setting a user password. This clears the password and prevents a user from being able to login. (#2181)
- Grab any Layer push/pull offset values when calling `Layer.pack()`. (#2184)
- Move the retrieval of `https:headers` from HTTP API handlers into a function so that downstream implementers can redirect where the extra values are retrieved from. (#2187)

17.126.2 Bugfixes

- Fix an issue which allowed for deleted Storm Packages to be retrieved from memory. (#2182)

17.127 v2.36.0 - 2021-05-06

17.127.1 Features and Enhancements

- Add `risk:vuln` support to the default Stix 2.1 export, and capture vulnerability information used by threat actors and in campaigns. Add the ability to validate Stix 2.1 bundles to ensure that they are Stix 2.1 CS02 compliant. Add the ability to lift Synapse nodes based on bundles which were previously exported from Synapse. The lift feature only works with bundles created with Synapse v2.36.0 or greater. (#2174)
- Add a `Str.upper()` function for uppercasing strings in Storm. (#2174)
- Automatically bump a user's StormDmon's when they are locked or unlocked. (#2177)
- Add Storm Package support to `synapse.tools.autodocs` and update the rstorm implementation to capture additional directives. (#2172)
- Tighten lark-parser version requirements. (#2175)

17.127.2 Bugfixes

- Fix reported layer size to represent actual disk usage. (#2173)

17.128 v2.35.0 - 2021-04-27

17.128.1 Features and Enhancements

- Add `:issuer:cert` and `:selfsigned` properties to the `crypto:x509:cert` form to enable modeling X509 certificate chains. (#2163)
- Add a `https:headers` configuration option to the Cell to allow setting arbitrary HTTP headers for the Cell HTTP API server. (#2164)
- Update the Cell HTTP API server to have a minimum TLS version of v1.2. Add a default `/robots.txt` route. Add `X-XSS=Protection` and `X-Content-Type-Options` headers to the default HTTP API responses. (#2164)
- Update the minimum version of LMDB to `1.2.1`. (#2169)

17.128.2 Bugfixes

- Improve the error message for Storm syntax error handling. (#2162)
- Update the layer byarray index migration to account for arrays of `inet:fqdn` values. (#2165) (#2166)
- Update the `vertexproject/synapse-aha`, `vertexproject/synapse-axon`, `vertexproject/synapse-cortex`, and `vertexproject/synapse-cryotank` Docker images to use `tini` as a default entrypoint. This fixes an issue where signals were not properly being propagated to the Cells. (#2168)
- Fix an issue with enfanged indicators which were not properly being lifted by Storm when operating in `lookup` mode. (#2170)

17.129 v2.34.0 - 2021-04-20

17.129.1 Features and Enhancements

- Storm function definitions now allow keyword arguments which may have default values. These must be read-only values. (#2155) (#2157)
- Add a `getCellInfo()` API to the `Cell` and `CellAPI` classes. This returns metadata about the cell, its version, and the currently installed Synapse version. Cell implementers who wish to expose Cell specific version information must adhere to conventiosn documented in the API docstrings of the function. (#2151)
- Allow external Storm modules to be added in genpkg definitions. (#2159)

17.129.2 Bugfixes

- The `$lib.layer.get()` Stormtypes returned the top layer of the default view in the Cortex when called with no arguments, instead of the top layer of the current view. This now returns the top layer of the current view. (#2156)
- Avoid calling `applyNodeEdit` when editing a tag on a Node and there are no edits to make. (#2161)

17.129.3 Improved Documentation

- Fix typo in docstrings from `$lib.model.tags` Stormtypes. (#2160)

17.130 v2.33.1 - 2021-04-13

17.130.1 Bugfixes

- Fix a regression when expanding list objects in Storm. (#2154)

17.131 v2.33.0 - 2021-04-12

17.131.1 Features and Enhancements

- Add CWE and CVSS support to the `risk:vuln` form. (#2143)
- Add a new Stormtypes library, `$lib.infosec.cvss`, to assist with parsing CVSS data, computing scores, and updating `risk:vuln` nodes. (#2143)
- Add ATT&CK, CWD, and CPE support to the IT model. (#2143)
- Add `it:network`, `it:domain`, `it:account`, `it:group` and `it:login` guid forms to model common IT concepts. (#2096)
- Add a new model, `project`, to model projects, tickets, sprints and epics. The preliminary forms for this model include `proj:project`, `proj:sprint`, `proj:ticket`, `proj:comment`, and `projec:project`. (#2096)
- Add a new Stormtypes library, `$lib.project`, to assist with using the project model. The API is provisional. (#2096)
- Allow lifting `guid` types with the prefix (`^=`) operator. (#2096)

- Add `ou:contest:result:url` to record where to find contest results. (#2144)
- Allow subquery as a value in additional places in Storm. This use must yield exactly one node. Secondary property assignments to array types may yield multiple nodes. (#2137)
- Tighten up Storm iterator behavior on the backend. This should not have have user-facing changes in Storm behavior. (#2148) (#2096)
- Update the Cell backup routine so that it blocks the ioloop less. (#2145)
- Expose the remote name and version of Storm Services in the `service.list` command. (#2149)
- Move test deprecated model elements into their own Coremodule. (#2150)
- Update `lark` dependency. (#2146)

17.131.2 Bugfixes

- Fix incorrect grammer in model.edge commands. (#2147)
- Reduce unit test memory usage. (#2152)
- Pin `jupyter-client` library. (#2153)

17.132 v2.32.1 - 2021-04-01

17.132.1 Features and Enhancements

- The Storm `$lib.exit()` function now takes message arguments similar to `$lib.warn()` and fires that message into the run time as a `warn` prior to stopping the runtime. (#2138)
- Update `pygments` minimum version to `v2.7.4`. (#2139)

17.132.2 Bugfixes

- Do not allow light edge creation on runt nodes. (#2136)
- Fix backup test timeout issues. (#2141)
- Fix the `synapse.lib.msgpack.en()` function so that now raises the correct exceptions when operating in fallback mode. (#2140)
- Fix the `Snap.addNodes()` API handling of deprecated model elements when doing bulk data ingest. (#2142)

17.133 v2.32.0 - 2021-03-30

17.133.1 Features and Enhancements

- Increase the verbosity of logging statements related to Cell backup operations. This allows for better visibility into what is happening while a backup is occurring. (#2124)
- Add Telepath and Storm APIs for setting all the roles of a User at once. (#2127)
- Expose the Synapse package commit hash over Telepath and Stormtypes. (#2133)

17.133.2 Bugfixes

- Increase the process spawn timeout for Cell backup operations. Prevent the Cell backup from grabbing lmdb transactions for slabs in the cell local tmp directory. (#2124)

17.134 v2.31.1 - 2021-03-25

17.134.1 Bugfixes

- Fix a formatting issue preventing Python packages from being uploaded to PyPI. (#2131)

17.135 v2.31.0 - 2021-03-24

17.135.1 Features and Enhancements

- Add initial capability for exporting STIX 2.1 from the Cortex. (#2120)
- Refactor how lift APIs are implemented, moving them up to the Cortex itself. This results in multi-layer lifts now yielding nodes in a sorted order. (#2093) (#2128)
- Add `$lib.range()` Storm function to generate ranges of integers. (#2122)
- Add an `errok` option to the `$lib.time.parse()` Storm function to allow the function to return `$lib.null` if the time string fails to parse. (#2126)
- Don't execute Cron jobs, Triggers, or StormDmons for locked users. (#2123) (#2129)
- The `git` commit hash is now embedded into the `synapse.lib.version` module when building PyPi packages and Docker images. (#2119)

17.135.2 Improved Documentation

- Update Axon wget API documentation to note that we always store the body of the HTTP response, regardless of status code. (#2125)

17.136 v2.30.0 - 2021-03-17

17.136.1 Features and Enhancements

- Add `$lib.trycast()` to allow for Storm control flow based on type normalization. (#2113)

17.136.2 Bugfixes

- Resolve a bug related to pivoting to a secondary property that is an array value. (#2111)
- Fix an issue with Aha and persisting the online state of services upon startup. (#2103)
- Convert the type of `inet:web:acct:singup:client:ipv6` from a `inet:ipv4` to an `inet:ipv6`. (#2114)
- Fix an idempotency issue when deleting a custom form. (#2112)

17.136.3 Improved Documentation

- Update README.rst. (#2115) (#2117) (#2116)

17.137 v2.29.0 - 2021-03-11

This release includes a Cortex storage Layer bugfix. It does an automatic upgrade upon startup to identify and correct invalid array index values. Depending on time needed to perform this automatic upgrade, the Cortex may appear unresponsive. Deployments with startup or liveliness probes should have those disabled while this upgrade is performed to prevent accidental termination of the Cortex process.

17.137.1 Features and Enhancements

- Add a `reverse` argument to `$lib.sorted()` to allow a Storm user to easily reverse an iterable item. (#2109)
- Update minimum required versions of Tornado and PyYAML. (#2108)

17.137.2 Bugfixes

- Fix an issue with Array property type deletion not properly deleting values in the `byarray` index. This requires an automatic data migration done at Cortex startup to remove extra index values which may be present in the index. (#2104) (#2106)
- Fix issues with using the Storm ?= operator with types which can generate multiple values from a given input string when making nodes. (#2105) (#2107)

17.137.3 Improved Documentation

- Add Devops documentation explaining our Docker container offerings. (#2104) (#2110)

17.138 v2.28.1 - 2021-03-08

17.138.1 Bugfixes

- Fix `$lib.model.prop()` API when called with a universal property. It now returns `$lib.null` instead of raising an exception. (#2100)
- Fix the streaming backup API when used with Telepath and SSL. (#2101)

17.138.2 Improved Documentation

- Add API documentation for the Axon. (#2098)
- Update the Storm pivot reference documentation. (#2101)

17.139 v2.28.0 - 2021-02-26

17.139.1 Features and Enhancements

- Add `String.reverse()` Stormtypes API to reverse a string. (#2086)
- Add Cell APIs for streaming compressed backups. (#2084) (#2091)
- Refactor `snap.addNodes()` to reduce the transaction count. (#2087) (#2090)
- Add `$lib.axon.list()` Stormtypes API to list hashes in an Axon. (#2088)
- Add user permissions requirements for Aha CSR signing. (#2089)
- Add `aha:svcinfo` configuration option for the base Cell. (#2089)
- Add interfaces to the output of `model.getModelDefs()` and the `getModelDict()` APIs. (#2092)
- Update pylmdb to `v1.1.1`. (#2076)

17.139.2 Bugfixes

- Fix incorrect permissions check in the `merge --diff` Storm command. (#2085)
- Fix service teardown issue in Aha service on fini. (#2089)
- Fix possible `synapse.tools.cmdr` teardown issue when using Aha. (#2089)
- Cast `synapse_minversion` from Storm Packages into a tuple to avoid packages added with HTTP endpoints from failing to validate. (#2095)

17.139.3 Improved Documentation

- Add documentation for the Aha discovery service. (#2089)
- Add documentation for assigning secondary properties via subquery syntax. (#2097)

17.140 v2.27.0 - 2021-02-16

17.140.1 Features and Enhancements

- Allow property assignment and array operations from subqueries. (#2072)
- Add APIs to the Axon to allow the deletion of blobs via Telepath and HTTP APIs. (#2080)
- Add a `str.slice()` stormtypes method to allow easy string slicing. (#2083)
- Modularize the Storm HTTP API handlers. (#2082)

17.140.2 Bugfixes

- Fix Agenda events which were not being properly tracked via the Nexus. (#2078)

17.140.3 Improved Documentation

- Add documentation for the Cortex `/api/v1/storm/export` HTTP endpoint. This also included documentation for the scrub option in Storm. (#2079)
- Add a Code of Conduct for Synapse. (#2081)

17.141 v2.26.0 - 2021-02-05

17.141.1 Features and Enhancements

- Add Storm commands for easily adding, deleting, and listing layer push and pull configurations. (#2071)

17.141.2 Bugfixes

- Fix `layer.getPropCount()` API for universal properties. (#2073)
- Add a missing async yield in `Snap.addNodes()`. (#2074)
- Constrain lmdb version due to unexpected behavior in `v1.1.0`. (#2075)

17.141.3 Improved Documentation

- Update user docs for Storm flow control and data model references. (#2066)

17.142 v2.25.0 - 2021-02-01

17.142.1 Features and Enhancements

- Implement tag model based pruning behavior for controlling how individual tag trees are deleted from nodes. (#2067)
- Add model interfaces for defining common sets of properties for forms, starting with some file mime metadata. (#2040)
- Add `file:mime:msdoc`, `file:mime:msxls`, `file:mime:msppt`, and `file:mime:rtf` forms. (#2040)
- Tweak the ival normalizer to auto-expand intervals with a single element. (#2070)
- Removed the experimental `spawn` feature of the Storm runtime. (#2068)

17.142.2 Bugfixes

- Add a missing async yield statement in `View.getEdgeVerbs()`. (#2069)

17.142.3 Improved Documentation

- Correct incorrect references to the `synapse.tools.easycert` documentation. (#2065)

17.143 v2.24.0 - 2021-01-29

17.143.1 Features and Enhancements

- Add support for storing model metadata for tags and support for enforcing tag trees using regular expressions. (#2056)
- Add `ou:contest:url` secondary property. (#2059)
- Add `synapse.lib.autodoc` to collect some Storm documentation helpers into a single library. (#2034)
- Add `tag.prune` Storm command to remove parent tags when removing a leaf tag from a node. (#2062)
- Update the `msgpack` Python dependency to version `v1.0.2`. (#1735)
- Add logs to Cell backup routines. (#2060)
- Export the Layer iterrows APIs to the CoreApi. (#2061)

17.143.2 Bugfixes

- Do not connect to Aha servers when they are not needed. (#2058)
- Make the array property `ou:org:industries` a unique array property. (#2059)
- Add permission checks to the Storm `movetag` command. (#2063)
- Add permissions checks to the Storm `edges.del` command. (#2064)

17.143.3 Improved Documentation

- Add documentation for the `synapse.tools.genpkg` utility, for loading Storm packages into a Cortex. (#2057)
- Refactor the Stormtypes documentation generation to make it data driven. (#2034)

17.144 v2.23.0 - 2021-01-21

17.144.1 Features and Enhancements

- Add support for ndef based light edge definitions in the `syn.nodes` feed API. (#2051) (#2053)
- Add ISIC codes to the `ou:industry` form. (#2054) (#2055)
- Add secondary properties `:loc`, `:latlong`, and `:place` to the `inet:web:action` and `inet:web:logon` forms. (#2052)

- Add secondary property `:enabled` to the form `it:app:yara:rule`. (#2052)
- Deprecate the `file:string` and `ou:member` forms, in favor of using light edges for storing those relationships. (#2052)

17.145 v2.22.0 - 2021-01-19

17.145.1 Features and Enhancements

- Allow expression statements to be used in Storm filters. (#2041)
- Add `file:subfile:path` secondary property to record the path a file was stored in a parent file. The corresponding `file:subfile:name` property is marked as deprecated. (#2043)
- Make the Axon `wget()` timeout a configurable parameter. (#2047)
- Add a `Cortex.exportStorm()` on the Cortex which allows for exporting nodes from a Storm query which can be directly ingested with the `syn.nodes` feed function. If the data is serialized using msgpack and stored in a Axon, it can be added to a Cortex with the new `Cortex.feedFromAxon()` API. A new HTTP API, `/api/v1/storm/export`, can be used to get a msgpacked file using this export interface. (#2045)

17.145.2 Bugfixes

- Fix issues in the Layer push and pull loop code. (#2044) (#2048)
- Add missing `toprim()` and `tostr()` calls for the Stormtypes Whois guid generation helpers. (#2046)
- Fix behavior in the Storm lookup mode which failed to lookup some expected results. (#2049)
- Fix `$lib.pkg.get()` return value when the package is not present. (#2050)

17.146 v2.21.1 - 2021-01-04

17.146.1 Bugfixes

- Fix a variable scoping issue causing a race condition. (#2042)

17.147 v2.21.0 - 2020-12-31

17.147.1 Features and Enhancements

- Add a Storm `wget` command which will download a file from a URL using the Cortex Axon and yield `inet:urlfile` nodes. (#2035)
- Add a `--diff` option to the `merge` command to enumerate changes. (#2037)
- Allow StormLib Layer API to dynamically update a Layer's logedits setting. (#2038)
- Add StormLib APIs for adding and deleting extended model properties, forms and tag properties. (#2039)

17.147.2 Bugfixes

- Fix an issue with the JsonStor not created nested entries properly. (#2036)

17.148 v2.20.0 - 2020-12-29

17.148.1 Features and Enhancements

- Correct the StormType `Queue.pop()` API to properly pop and return only the item at the specified index or the next entry in the Queue. This simplifies the intent behind the `.pop()` operation; and removes the `cull` and `wait` parameters which were previously on the method. (#2032)

17.148.2 Bugfixes

- Use `resp.iter_chunked` in the Axon `.wget()` API to improve compatibility with some third party libraries. (#2030)
- Require the use of a msgpack based deepcopy operation in handling storage nodes. (#2031)
- Fix for ambiguous whitespace in Storm command argument parsing. (#2033)

17.149 v2.19.0 - 2020-12-27

17.149.1 Features and Enhancements

- Add APIs to remove decommissioned services from AHA servers.
- Add (optional) explicit network parameters to AHA APIs. (#2029)
- Add cell.isCellActive() API to differentiate leaders/mirrors. (#2028)
- Add pop() method to Storm list objects. (#2027)

17.149.2 Bugfixes

- Fix bug in dry-run output of new merge command. (#2026)

17.150 v2.18.1 - 2020-12-24

17.150.1 Bugfixes

- Make syncIndexEvents testing more resiliant
- Make syncIndexEvents yield more often when filtering results (#2025)
- Update push/pull tests to use new waittask() API
- Raise clear errors in ambiguous use of node.tagglobs() API
- Update model docs and examples for geo:latitude and geo:longitude

- Support deref form names in storm node add expressions (#2024)
- Update tests to normalize equality comparison values (#2023)

17.151 v2.18.0 - 2020-12-23

17.151.1 Features and Enhancements

- Added axon.size() API and storm plumbing (#2020)

17.151.2 Bugfixes

- Fix active coro issue uncovered with cluster testing (#2021)

17.152 v2.17.1 - 2020-12-22

17.152.1 Features and Enhancements

- Added (BETA) RST pre-processor to embed Storm output into RST docs. (#1988)
- Added a `merge` command to allow per-node Layer merge operations to be done. (#2009)
- Updated storm package format to include a semver version string. (#2016)
- Added telepath proxy getPipeline API to minimize round-trip delay. (#1615)
- Added Node properties iteration and setitem APIs to storm. (#2011)

17.152.2 Bugfixes

- Fixes for active coro API and internal layer API name fixes. (#2018)
- Allow :prop -+> * join syntax. (#2015)
- Make getFormCount() API return a primitive dictionary. (#2014)
- Make StormVarListError messages more user friendly. (#2013)

17.153 v2.17.0 - 2020-12-22

`2.17.0` was not published due to CI issues.

17.154 v2.16.1 - 2020-12-17

17.154.1 Features and Enhancements

- Allow the `matchdef` used in the `Layer.syncIndexEvents()` API to match on tagprop data. (#2010)

17.154.2 Bugfixes

- Properly detect and raise a client side exception in Telepath generators when the underlying Link has been closed. (#2008)
- Refactor the Layer push/push test to not reach through the Layer API boundary. (#2012)

17.154.3 Improved Documentation

- Add documentation for Storm raw pivot syntax. (#2007)
- Add documentation for recently added Storm commands. (#2007)
- General cleanup and clarifications. (#2007)

17.155 v2.16.0 - 2020-12-15

17.155.1 Features and Enhancements

- Replaced the View sync APIs introduced in `v2.14.0` with Layer specific sync APIs. (#2003)
- Add `$lib.regex.matches()` and `$lib.regex.search()` Stormtypes APIs for performing regular expression operations against text in Storm. (#1999) (#2005)
- Add `synapse.tools.genpkg` for generating Storm packages and loading them into a Cortex. (#2004)
- Refactored the StormDmon implementation to use a single async task and allow the Dmons to be restarted via `$lib.dmon.bump(iden)`. This replaces the outer task / inner task paradigm that was previously present. Also add the ability to persistently disable and enable a StomDmon. (#1998)
- Added `aha://` support to the `synapse.tools.pushfile` and `synapse.tools.pullfile` tools. (#2006)

17.155.2 Bugfixes

- Properly handle whitespace in keyword arguments when calling functions in Storm. (#1997)
- Fix some garbage collection issues causing periodic pauses in a Cortex due to failing to close some generators used in the Storm Command AST node. (#2001) (#2002)
- Fix scope based permission checks in Storm. (#2000)

17.156 v2.15.0 - 2020-12-11

17.156.1 Features and Enhancements

- Add two new Cortex APIs: `syncIndexEvents` and `syncLayerEvents` useful for external indexing. (#1948) (#1996)
- LMDB Slab improvements: Allow dupfixed dbs, add `firstkey` method, inline `_ispo2`, add HotCount deletion. (#1948)
- Add method to merge sort sorted async generators. (#1948)

17.156.2 Bugfixes

- Ensure parent FQDN exists even in out-of-order node edit playback. (#1995)

17.157 v2.14.2 - 2020-12-10

17.157.1 Bugfixes

- Fix an issue with the new layer push / pull code. (#1994)
- Fix an issue with the url sanitization function when the path contains an `@` character. (#1993)

17.158 v2.14.1 - 2020-12-09

17.158.1 Features and Enhancements

- Add a `/api/v1/active` HTTP API to the Cell that can be used as an unauthenticated liveliness check. (#1987)
- Add `$lib.pip.gen()` Stormtypes API for ephemeral queues and bulk data access in Storm. (#1986)
- Add a `$lib.model.tagprop()` Stormtypes API for retrieving Tagprop definitions. (#1990)
- Add efficient View and Layer push/pull configurations. (#1991) (#1992)
- Add `getAhaUrls()` to the Aha service to prepare for additional service discovery. (#1989)
- Add a `/api/v1/auth/onepass/issue` HTTP API for an admin to mint a one-time password for a Cell user. (#1982)

17.158.2 Bugfixes

- Make `aha://` urls honor local paths. (#1985)

17.159 v2.14.0 - 2020-12-09

`2.14.0` was not published due to CI issues.

17.160 v2.13.0 - 2020-12-04

17.160.1 Features and Enhancements

- Add `$lib.pkg.get()` StormTypes function to get the Storm Package definition for a given package by name. (#1983)

17.160.2 Bugfixes

- The user account provisioned by the `aha:admin` could be locked out. Now, upon startup, if they have been locked out or had their admin status removed, they are unlocked and admin is reset. (#1984)

17.161 v2.12.3 - 2020-12-03

17.161.1 Bugfixes

- Prevent OverflowError exceptions which could have resulted from lift operations with integer storage types. (#1980)
- Remove `inet:ipv4` norm routine wrap-around behavior for integers which are outside the normal bounds of IPv4 addresses. (#1979)
- Fix `view.add` and fork related permissions. (#1981)
- Read `telepath.yaml` when using the `synapse.tools.cellauth` tool. (#1981)

17.162 v2.12.2 - 2020-12-01

This release also includes the changes from v2.12.1, which was not released due to an issue with CI pipelines.

17.162.1 Bugfixes

- Add the missing API `getPathObjs` on the JsonStorCell. (#1976)
- Fix the HasRelPropCond AST node support for Storm pivprop operations. (#1972)
- Fix support for the `aha:registry` config parameter in a Cell to support an array of strings. (#1975)
- Split the `Cortex.addForm()` Nexus handler into two parts to allow for safe event replay. (#1978)
- Stop forking a large number of child layers in a View persistence test. (#1977)

17.163 v2.12.1 - 2020-12-01

17.163.1 Bugfixes

- Add the missing API `getPathObjs` on the JsonStorCell. (#1976)
- Fix the HasRelPropCond AST node support for Storm pivprop operations. (#1972)
- Fix support for the `aha:registry` config parameter in a Cell to support an array of strings. (#1975)

17.164 v2.12.0 - 2020-11-30

17.164.1 Features and Enhancements

- Add a `onload` paramter to the `stormpkg` definition. This represents a Storm query which is executed every time the `stormpkg` is loaded in a Cortex. (#1971) (#1974)
- Add the ability, in Storm, to unset variables, remove items from dictionaries, and remove items from lists. This is done via assigning `$lib.undef` to the value to be removed. (#1970)
- Add support for SOCKS proxy support for outgoing connections from an Axon and Cortex, using the `'http:proxy` configuration option. This configuration value must be a valid string for the `aiohttp_socks.ProxyConnector.from_url()` API. The SOCKS proxy is used by the Axon when downloading files; and by the Cortex when making HTTP connections inside of Storm. (#1968)
- Add `aha:admin` to the Cell configuration to provide a common name that is used to create an admin user for remote access to the Cell via the Aha service. (#1969)
- Add `auth:ctor` and `auth:conf` config to the Cell in order to allow hooking the construction of the `HiveAuth` object. (#1969)

17.165 v2.11.0 - 2020-11-25

17.165.1 Features and Enhancements

- Optimize Storm lift and filter queries, so that more efficient lift operations may be performed in some cases. (#1966)
- Add a `Axon.wget()` API to allow the Axon to retrieve files directly from a URL. (#1965)
- Add a JsonStor Cell, which allows for hierarchical storage and retrieval of JSON documents. (#1954)
- Add a Cortex HTTP API, `/api/v1/storm/call`. This behaves like the `CoreApi.callStorm()` API. (#1967)
- Add `:client:host` and `:server:host` secondary properties to the `inet:http:request` form. (#1955)
- Add `:host` and `:acct` secondary properties to the `inet:search:query` form. (#1955)
- Add a Telepath service discovery implementation, the Aha cell. The Aha APIs are currently provisional and subject to change. (#1954)

17.166 v2.10.2 - 2020-11-20

17.166.1 Features and Enhancements

- The Storm `cron.at` command now supports a `--now` flag to create a cron job which immediately executes. (#1963)

17.166.2 Bugfixes

- Fix a cleanup race that caused occasional `test_lmdbslab_base` failures. (#1962)
- Fix an issue with `EDIT_NODEDATA_SET` nodeedits missing the `oldv` value. (#1961)
- Fix an issue where `cron.cleanup` could have prematurely deleted some cron jobs. (#1963)

17.167 v2.10.1 - 2020-11-17

17.167.1 Bugfixes

- Fix a CI issue which prevented the Python `sdist` package from being uploaded to PyPi. (#1960)

17.168 v2.10.0 - 2020-11-17

17.168.1 Announcements

The `v2.10.0` Synapse release contains support for Python 3.8. Docker images are now built using a Python 3.8 image by default. There are also Python 3.7 images available as `vertexproject/synapse:master-py37` and `vertexproject/synapse:v2.x.x-py37`.

17.168.2 Features and Enhancements

- Python 3.8 release support for Docker and PyPi. (#1921) (#1956)
- Add support for adding extended forms to the Cortex. This allows users to define their own forms using the existing types which are available in the Synapse data model. (#1944)
- The Storm `and` and `or` statements now short-circuit and will return when their logical condition is first met. This means that subsequent clauses in those statements may not be executed. (#1952)
- Add a mechanism for Storm Services to specify commands which may require privilege elevation to execute. An example of this may be to allow a command to create nodes; without managning individual permissions on what nodes a user may normally be allowed to create. Services using this mechanism wiill use the `storm.asroot.cmd.<<cmd name>>` hierarchy to grant this permission. (#1953) (#1958)
- Add `$lib.json` Stormtypes Library to convert between string data and primitives. (#1949)
- Add a `parallel` command to allow for executing a portion of a Storm query in parallel. Add a `background` command to execute a Storm query as a detached task from the current query, capturing variables in the process. (#1931) (#1957)
- Add a `$lib.exit()` function to StormTypes to allow for quickly exiting a Storm query. (#1931)

- Add `$lib.bytes.upload()` to Stormtypes for streaming bytes into the Axon that the Cortex is configured with. (#1945)
- Add Storm commands to manage locking and unlocking deprecated model properties. (#1909)
- Add `cron.cleanup` command to make it easy to clean up completed cron jobs. (#1942)
- Add date of death properties and consistently named photo secondary properties. (#1929)
- Add model additions for representing education and awards. (#1930)
- Add additional account linkages to the `inet` model for users and groups. (#1946)
- Add `inet:web:hashtag` as its own form, and add `:hashtags` to `inet:web:post`. (#1946)
- Add `lang:translation` to capture language translations of texts in a more comprehensive way than older `lang` model forms did. The `lang:idiom` and `lang:trans` forms have been marked as deprecated. (#1946)
- Update the `ou` model to add `ou:attendee` and `ou:contest` and `ou:contest:result` forms. Several secondary properties related to conference attendance have been marked deprecated. (#1946)
- The `ps:persona` and `ps:persona:has` forms have been marked as deprecated. (#1946)
- Add `ps:contactlist` to allow collecting multiple `ps:contact` nodes together. (#1935)
- Allow the Storm Service cmdargs to accept any valid model type in the `type` value. (#1923) (#1936)
- Add >, <, >= and <= comparators for `inet:ipv4` type. (#1938)
- Add configuration options to the Axon to limit the amount of data which can be stored in it. Add a configuration option the Cortex to limit the number of nodes which may be stored in a given Cortex. (#1950)

17.168.3 Bugfixes

- Fix a potential incorrect length for Spooled sets during fallback. (#1937)
- Fix an issue with the Telepath `Client` object caching their `Method` and `GenrMethod` attributes across reconnections of the underlying `Proxy` objects. (#1939) (#1941)
- Fix a bug where a temporary spool slab cleanup failed to remove all files from the filesystem that were created when the slab was made. (#1940)
- Move exceptions which do not subclass `SynErr` out of `synapse/exc.py`. (#1947) (#1951)

17.169 v2.9.2 - 2020-10-27

17.169.1 Bugfixes

- Fix an issue where a Cortex migrated from a *01x* release could overwrite entries in a Layer's historical nodeedit log. (#1934)
- Fix an issue with the layer definition schema. (#1927)

17.170 v2.9.1 - 2020-10-22

17.170.1 Features and Enhancements

- Reuse existing an existing `DateTime` object when making time strings. This gives a slight performance boost for the `synapse.lib.time.repr()` function. (#1919)
- Remove deprecated use of `loop` arguments when calling `asyncio` primitives. (#1920)
- Allow Storm Services to define a minimum required Synapse version by the Cortex. If the Cortex is not running the minimum version, the Cortex will not load (#1900)
- Only get the nxsindx in the `Layer.storeNodeEdits()` function if logging edits. (#1926)
- Include the Node iden value in the `CantDelNode` exception when attempting to delete a Node failes due to existing references to the node. (#1926)
- Take advantage of the LMDB append operation when possible. (#1912)

17.170.2 Bugfixes

- Fix an issues in the Telepath Client where an exception thrown by a onlink function could cause additional linkloop tasks to be spawned. (#1924)

17.171 v2.9.0 - 2020-10-19

17.171.1 Announcements

The `v2.9.0` Synapse release contains an automatic Cortex Layer data migration. The updated layer storage format reduces disk and memory requirements for a layer. It is recommended to test this process with a backup of a Cortex before updating a production Cortex.

In order to maximize the space savings from the new layer storage format, after the Cortex has been migrated to `v2.9.0`, one can take a cold backup of the Cortex and restore the Cortex from that backup. This compacts the LMDB databases which back the Layers and reclaims disk space as a result. This is an optional step; as LMDB will eventually re-use the existing space on disk.

If there are any questions about this, please reach out in the Synapse Slack channel so we can assist with any data migration questions.

17.171.2 Features and Enhancements

- Optimize the layer storage format for memory size and performance. (#1877) (#1885) (#1899) (#1917)
- Initial support Python 3.8 compatibility for the core Synapse library. Additional 3.8 support (such as wheels and Docker images) will be available in future releases. (#1907)
- Add a read only Storm option to the Storm runtime. This option prevents executing commands or Stormtypes functions which may modify data in the Cortex. (#1869) (#1916)
- Allow the Telepath Dmon to disconnect clients using a ready status. (#1881)
- Ensure that there is only one online backup of a Cell occurring at a time. (#1883)

- Added `.lower()`, `.strip()`, `.lstrip()` and `.rstrip()` methods to the Stormtypes Str object. These behave like the Python `str` methods. (#1886) (#1906)
- When scraping text, defanged indicators are now refanged by default. (#1888)
- Normalize read-only property declarations to use booleans in the data model. (#1887)
- Add `lift.byverb` command to allow lifting nodes using a light edge verb. (#1890)
- Add netblock and range lift helpers for `inet:ipv6` type, similar to the helpers for `inet:ipv4`. (#1869)
- Add a `edges.del` command to bulk remove light weight edges from nodes. (#1893)
- The `yield` keyword in Storm now supports iterating over Stormtypes List and Set objects. (#1898)
- Add `ou:contract`, `ou:industry` and `it:reveng:function:strings` forms to the data model. (#1894)
- Add some display type-hinting to the data model for some string fields which may be multi-line fields. (#1892)
- Add `getFormCounts()` API to the Stormtypes View and Layer objects. (#1903)
- Allow Cortex layers to report their total size on disk. This is exposed in the Stormtypes `Layer.pack()` method for a layer. (#1910)
- Expose the remote Storm Service name in the `$lib.service.get()` Stormtypes API. This allows getting a service object without knowing the name of the service as it was locally added to a Cortex. Also add a `$lib.service.has()` API which allows checking to see if a service is available on a Cortex. (#1908) (#1915)
- Add regular expression (~=) and prefix matching (^=) expression comparators that can be used with logical expressions inside of Storm. (#1906)
- Promote `CoreApi.addFeedData()` calls to tracked tasks which can be viewed and terminated. (#1918)

17.171.3 Bugfixes

- Fixed a Storm bug where attempting to access an undeclared variable silently fails. This will now raise a `NoSuchVar` exception. This is verified at runtime, not at syntax evaluation. (#1916)
- Ensure that Storm HTTP APIs tear down the runtime task if the remote disconnects before consuming all of the messages. (#1889)
- Fix an issue where the `model.edge.list` command could block the ioloop for large Cortex. (#1890)
- Fix a regex based lifting bug. (#1899)
- Fix a few possibly greedy points in the AST code which could have resulted in greedy CPU use. (#1902)
- When pivoting across light edges, if the destination form was not a valid form, nothing happened. Now a StormRuntimeError is raised if the destination form is not valid. (#1905)
- Fix an issue with spawn processes accessing lmdb databases after a slab resize event has occurred by the main process. (#1914)
- Fix a slab teardown race seen in testing Python 3.8 on MacOS. (#1914)

17.171.4 Deprecations

- The `0.1.x` to `2.x.x` Migration tool and associated Cortex sync service has been removed from Synapse in the `2.9.0` release.

17.171.5 Improved Documentation

- Clarify user documentation for pivot out and pivot in operations. (#1891)
- Add a deprecation policy for Synapse Data model elements. (#1895)
- Pretty print large data structures that may occur in the data model documentation. (#1897)
- Update Storm Lift documentation to add the ?= operator. (#1904)

17.172 v2.8.0 - 2020-09-22

17.172.1 Features and Enhancements

- Module updates to support generic organization identifiers, generic advertising identifiers, asnet6 and a few other secondary property additions. (#1879)
- Update the Cell backup APIs to perform a consistent backup across all slabs for a Cell. (#1873)
- Add support for a environment variable, `SYN_LOCKMEM_DISABLE` which will disable any memory locking of LMDB slabs. (#1882)

17.172.2 Deprecations

- The `0.1.x` to `2.x.x` Migration tool and and associated Cortex sync service will be removed from Synapse in the `2.9.0` release. In order to move forward to `2.9.0`, please make sure that any Cortexes which still need to be migrated will first be migrated to `2.8.x` prior to attempting to use `2.9.x`.

17.172.3 Improved Documentation

- Add Synapse README content to the Pypi page. This was a community contribution from https://github.com/wesinator. (#1872)

17.173 v2.7.3 - 2020-09-16

17.173.1 Deprecations

- The `0.1.x` to `2.x.x` Migration tool and and associated Cortex sync service will be removed from Synapse in the `2.9.0` release. In order to move forward to `2.9.0`, please make sure that any Cortexes which still need to be migrated will first be migrated to `2.8.x` prior to attempting to use `2.9.x`. (#1880)

17.173.2 Bugfixes

- Remove duplicate words in a comment. This was a community contribution from enadjoe. (#1874)
- Fix a nested Nexus log event in Storm Service deletion. The `del` event causing Storm code execution could lead to nested Nexus events, which is incongruent with how Nexus change handlers work. This now spins off the Storm code in a free-running coroutine. This does change the service `del` semantics since any support Storm packages a service had may be removed by the time the handler executes. (#1876)
- Fix an issue where the `cull` parameter was not being passed to the multiqueue properly when calling `.gets()` on a Storm Types Queue object. (#1876)
- Pin the `nbconvert` package to a known working version, as `v6.0.0` of that package broke the Synapse document generation by changing how templates work. (#1876)
- Correct `min` and `max` integer examples in tagprop documentation and tests. (#1878)

17.174 v2.7.2 - 2020-09-04

17.174.1 Features and Enhancements

- Update tests for additional test code coverage. This was a community contribution from blackout. (#1867)
- Add implicit links to documentation generated for Storm services, to allow for direct linking inside of documentation to specific Storm commands. (#1866)
- Add future support for deprecating model elements in the Synapse data model. This support will produce client and server side warnings when deprecated model elements are used or loaded by custom model extensions or CoreModules. (#1863)

17.174.2 Bugfixes

- Update `FixedCache.put()` to avoid a cache miss. This was a community contribution from blackout. (#1868)
- Fix the ioloop construction to be aware of `SYN_GREEDY_CORO` environment variable to put the ioloop into debug mode and log long-running coroutines. (#1870)
- Fix how service permissions are checked in `$lib.service.get()` and `$lib.service.wait()` Storm library calls. These APIs now first check `service.get.<service iden>` before checking `service.get.<service name>` permissions. A successful `service.get.<service name>` check will result in a warning to the client and the server. (#1871)

17.175 v2.7.1 - 2020-08-26

17.175.1 Features and Enhancements

- Refactor an Axon unit test to make it easier to test alternative Axon implementations. (#1862)

17.175.2 Bugfixes

- Fix an issue in `synapse.tools.cmdr` where it did not ensure that the users Synapse directory was created before trying to open files in the directory. (#1860) (#1861)

17.175.3 Improved Documentation

- Fix an incorrect statement in our documentation about the intrinsic Axon that a Cortex creates being remotely accessible. (#1862)

17.176 v2.7.0 - 2020-08-21

17.176.1 Features and Enhancements

- Add Telepath and HTTP API support to set and remove global Storm variables. (#1846)
- Add Cell level APIs for performing the backup of a Cell. These APIs are exposed inside of a Cortex via a Storm Library. (#1844)
- Add support for Cron name and doc fields to be editable. (#1848)
- Add support for Runtime-only (`runt`) nodes in the PivotOut operation (`-> *`). (#1851)
- Add `:nicks` and `:names` secondary properties to `ps:person` and `ps:persona` types. (#1852)
- Add a new `ou:position` form and a few associated secondary properties. (#1849)
- Add a step to the CI build process to smoke test the sdist and wheel packages before publishing them to PyPI. (#1853)
- Add support for representing `nodedata` in the command hinting for Storm command implementations and expose it on the `syn:cmd` runt nodes. (#1850)
- Add package level configuration data to Storm Packages in the `modconf` value of a package definition. This is added to the runtime variables when a Storm package is imported, and includes the `svciden` for packages which come from Storm Services. (#1855)
- Add support for passing HTTP params when using `$lib.inet.http.*` functions to make HTTP calls in Storm. (#1856)
- Log Storm queries made via the `callStorm()` and `count()` APIs. (#1857)

17.176.2 Bugfixes

- Fix an issue were some Storm filter operations were not yielding CPU time appropriately. (#1845)

17.176.3 Improved Documentation

- Remove a reference to deprecated `eval()` API from quickstart documentation. (#1858)

17.177 v2.6.0 - 2020-08-13

17.177.1 Features and Enhancements

- Support +`hh:mm` and +`hh:mm` timezone offset parsing when normalizing `time` values. (#1833)
- Enable making mirrors of Cortex mirrors work. (#1836)
- Remove read-only properties from `inet:flow` and `inet:http:request` forms. (#1840)
- Add support for setting nodedata and light edges in the `syn.nodes` ingest format. (#1839)
- Sync the LMDB Slab replay log if it gets too large instead of waiting for a force commit operation. (#1838)
- Make the Agenda unit tests an actual component test to reduce test complexity. (#1837)
- Support glob patterns when specifying files to upload to an Axon with `synapse.tools.pushfile`. (#1837)
- Use the node edit metadata to store and set the `.created` property on nodes, so that mirrors of Cortexes have consistent `.created` timestamps. (#1765)
- Support parent runtime variables being accessed during the execution of a `macro.exec` command. (#1841)
- Setting tags from variable values in Storm now calls `s_stormtypes.tostr()` on the variable value. (#1843)

17.177.2 Bugfixes

- The Storm `tree` command now catches the Synapse `RecursionLimitHit` error and raises a `StormRuntimeError` instead. The `RecursionLimitHit` being raised by that command was, in practice, confusing. (#1832)
- Resolve memory leak issues related to callStorm and Base object teardowns with exceptions. (#1842)

17.178 v2.5.1 - 2020-08-05

17.178.1 Features and Enhancements

- Add performance oriented counting APIs per layer, and expose them via Stormtypes. (#1813)
- Add the ability to clone a layer, primarily for benchmarking and testing purposes. (#1819)
- Update the benchmark script to run on remote Cortexes. (#1829)

17.178.2 Bugfixes

- Sanitize passwords from Telepath URLs during specific cases where the URL may be logged. (#1830)

17.178.3 Improved Documentation

- Fix a few typos in docstrings. (#1831)

17.179 v2.5.0 - 2020-07-30

17.179.1 Features and Enhancements

- Refactor the Nexus to remove leadership awareness. (#1785)
- Add support for client-side certificates in Telepath for SSL connections. (#1785)
- Add multi-dir support for CertDir. (#1785)
- Add a `--no-edges` option to the Storm `graph` command. (#1805)
- Add `:doc:url` to the `syn:tag` form to allow recording a URL which may document a tag. (#1805)
- Add `CoreApi.reqValidStorm()` and a `/api/v1/reqvalidstorm` Cortex HTTP API endpoint to validate that a given Storm query is valid Storm syntax. (#1806)
- Support Unicode white space in Storm. All Python *s* (Unicode white space + ASCII separators) is now treated as white space in Storm. (#1812)
- Refactor how StormLib and StormPrim objects access their object locals, and add them to a global registry to support runtime introspection of those classes. (#1804)
- Add smoke tests for the Docker containers built in CircleCI, as well as adding Docker healthchecks to the Cortex, Axon and Cryotank images. (#1815)
- Initialize the names of the default view and layer in a fresh Cortex to `default`. (#1814)
- Add HTTP API endpoints for the Axon to upload, download and check for the existend of files. (#1817) (#1822) (#1824) (#1825)
- Add a `$lib.bytes.has()` API to check if the Axon a Cortex is configured with knows about a given sha256 value. (#1822)
- Add initial model for prices, currences, securities and exchanges. (#1820)
- Add a `:author` field to the `it:app:yara:rule` form. (#1821)
- Add an experimental option to set the NexusLog as a `map_async` slab. (#1826)
- Add an initial transportation model. (#1816)
- Add the ability to dereference an item, from a list of items, in Storm via index. (#1827)
- Add a generic `$lib.inet.http.request()` Stormlib function make HTTP requests with arbitrary verbs. (#1828)

17.179.2 Bugfixes

- Fix an issue with the Docker builds for Synapse where the package was not being installed properly. (#1815)

17.179.3 Improved Documentation

- Update documentation for deploying Cortex mirrors. (#1811)
- Add automatically generated documentation for all the Storm `$lib...` functions and Storm Primitive types. (#1804)
- Add examples of creating a given Form to the automatically generated documentation for the automatically generated datamodel documentation. (#1818)
- Add additional documentation for Cortex automation. (#1797)
- Add Devops documentation for the list of user permissions relevant to a Cell, Cortex and Axon. (#1823)

17.180 v2.4.0 - 2020-07-15

17.180.1 Features and Enhancements

- Update the Storm `scrape` command to make `refs` light edges, instead of `edge:refs` nodes. (#1801) (#1803)
- Add `:headers` and `:response:headers` secondary properties to the `inet:http:request` form as Array types, so that requests can be directly linked to headers. (#1800)
- Add `:headers` secondary property to the `inet:email:messaage` form as Array types, so that messages can be directly linked to headers. (#1800)
- Add additional model elements to support recording additional data for binary reverse engineering. (#1802)

17.181 v2.3.1 - 2020-07-13

17.181.1 Bugfixes

- Prohibit invalid rules from being set on a User or Role object. (#1798)

17.182 v2.3.0 - 2020-07-09

17.182.1 Features and Enhancements

- Add `ps.list` and `ps.kill` commands to Storm, to allow introspecting the runtime tasks during (#1782)
- Add an `autoadd` mode to Storm, which will extract basic indicators and make nodes from them when executed. This is a superset of the behavior in the `lookup` mode. (#1795)
- Support skipping directories in the `synapse.tools.backup` tool. (#1792)
- Add prefix based lifting to the Hex type. (#1796)

17.182.2 Bugfixes

- Fix an issue for prop pivot out syntax where the source data is an array type. (#1794)

17.182.3 Improved Documentation

- Add Synapse data model background on light edges and update the Storm data modification and pivot references for light edges. (#1784)
- Add additional terms to the Synapse glossary. (#1784)
- Add documentation for additional Storm commands. (#1784)
- Update documentation for Array types. (#1791)

17.183 v2.2.2 - 2020-07-03

17.183.1 Features and Enhancements

- Add some small enhancements to the Cortex benchmarking script. (#1790)

17.183.2 Bugfixes

- Fix an error in the help for the `macro.del` command. (#1786)
- Fix rule indexing for the `synapse.tools.cellauth` tool to correctly print the rule offsets. (#1787)
- Remove extraneous output from the Storm Parser output. (#1789)
- Rewrite the language (and private APIs) for the Storm `model.edge` related commands to remove references to extended properties. That was confusing language which was unclear for users. (#1789)
- During 2.0.0 migrations, ensure that Cortex and Layer idens are unique; and make minimum 0.1.6 version requirement for migration. (#1788)

17.184 v2.2.1 - 2020-06-30

17.184.1 Bugfixes

- The Axon test suite was missing a test for calling `Axon.get()` on a file it did not have. This is now included in the test suite. (#1783)

17.184.2 Improved Documentation

- Improve Synapse devops documentation hierarchy. Add note about Cell directories being persistent. (#1781)

17.185 v2.2.0 - 2020-06-26

17.185.1 Features and Enhancements

- Add a `postAnit()` callback to the `synapse.lib.base.Base()` object which is called *after* the `__anit__()` call chain is completed, but before `Base.anit()` returns the object instance to the caller. This is used by the Cell to defer certain Nexus actions until the Cell has completed initializing all of its instance attributes. (#1768)
- Make `synapse.lib.msgpack.en()` raise a `SynErr.NotMsgpackSafe` exception instead of passing through the exception raised by msgpack. (#1768)

17.185.2 Bugfixes

- Add a missing `toprim()` call in `$lib.globals.set()`. (#1778)
- Fix an issue in the quickstart documentation related to permissions. Thank you `enadjoe` for your contribution. (#1779)
- Fix an Cell/Cortex startup issue which caused errors when starting up a Cortex when the last Nexus event was replayed. This has a secondary effect that Cell implementers cannot be making Nexus changes during the `__anit__` methods. (#1768)

17.185.3 Improved Documentation

- Add a minimal Storm Service example to the developer documentation. (#1776)
- Reorganize the Synapse User Guide into a more hierarchical format. (#1777)
- Fill out additional glossary items. (#1780)

17.186 v2.1.2 - 2020-06-18

17.186.1 Bugfixes

- Disallow command and bare string contensts from starting with `//` and `/*` in Storm syntax. (#1769)

17.187 v2.1.1 - 2020-06-16

17.187.1 Bugfixes

- Fix an issue in the autodoc tool which failed to account for Storm Service commands without cmdargs. (#1775)

17.188 v2.1.0 - 2020-06-16

17.188.1 Features and Enhancements

- Add information about light edges to graph carving output. (#1762)
- Add a `geo:json` type and `geo:place:geojson` property to the model. (#1759)
- Add the ability to record documentation for light edges. (#1760)
- Add the ability to delete and set items inside of a MultiQueue. (#1766)

17.188.2 Improved Documentation

- Refactor `v2.0.0` changelog documentation. (#1763)
- Add Vertex branding to the Synapse documentation. (#1767)
- Update Backups documentation in the Devops guide. (#1764)
- Update the autodoc tool to generate documentation for Cell confdefs and StormService information. (#1772)
- Update to separate the devops guides into distinct sections. (#1772)
- Add documentation for how to do boot-time configuration for a Synapse Cell. (#1772)
- Remove duplicate information about backups. (#1774)

17.189 v2.0.0 - 2020-06-08

Initial 2.0.0 release.

CHAPTER

EIGHTEEN

INDICES AND TABLES

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- search

PYTHON MODULE INDEX

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