Exploiting Digital Threads for Effective Model Lifecycle Management: Tactics for Governance and Curators

Lonnie VanZandt, INTERCAX

GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023

BOEING ELYSIUM NORTHROP GRUMMAN Parker PDES, Inc.® Connecting the Digital Enterprise

Presenters Bio

- Principal Solutions Architect
- Lonnie VanZandt
- Intercax

- ~35 years in Industry
- Bell Labs, Northrop Grumman, NoMagic, CACI
- Telecom/Datacom Operating Systems
- Software and Systems Engineering
- MagicDraw, Modeling, Data-Wrangler Expert

Agenda

- Knowledge
- Why we Model
- Seeking Answers
- Curation

- Using Syndeia™

Rhetorical Claim

- Knowledge enables us to make better decisions, we model in order to know more sooner – but modeling yields too much: we need curation to make apparent that which is relevant.

- Curators are an important and overlooked role in digital engineering.

- Curators communicate knowledge from clutter. Curators need modern platforms.

  Syndeia is the digital thread platform for model-based engineering. Syndeia enables curation for our mission-critical engineering disciplines.

What is Knowledge?

- Awareness of objective Truth

- The synthesis of new concepts from the fusion of analytical data.

A suitable Digital Thread Platform allows an analyst to both become aware of new facts and to synthesize concepts from or with that new information.

Why do we Model?

- To understand…
- To predict…
- To hypothesize…
- To design…
- To optimize…
- To present…
- …that which is Complex, using that which is Simplified.

To know more knowledge, sooner.

How do we (humans) request and share Knowledge?

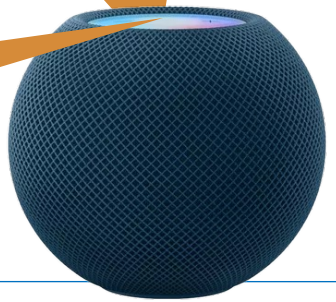
Via
Question and Answer
conversations.

Try asking a Question of your Model

Here's what's coming very Soon

Hey Syndeia, I'm working on Program P123. In my digital thread for P123, tell me latest modified requirements that System S123 satisfies.
No more than five, please.

Siri here. Connecting you to ChatGPT. Hi. Let me ask Syndeia for you. …
Syndeia says that in your Syndeia Digital Thread P123 there are 596 Requirements which System S123 satisfies. The 5 most recently modified are:
1. Req-ABC
2. Req-XYZ …



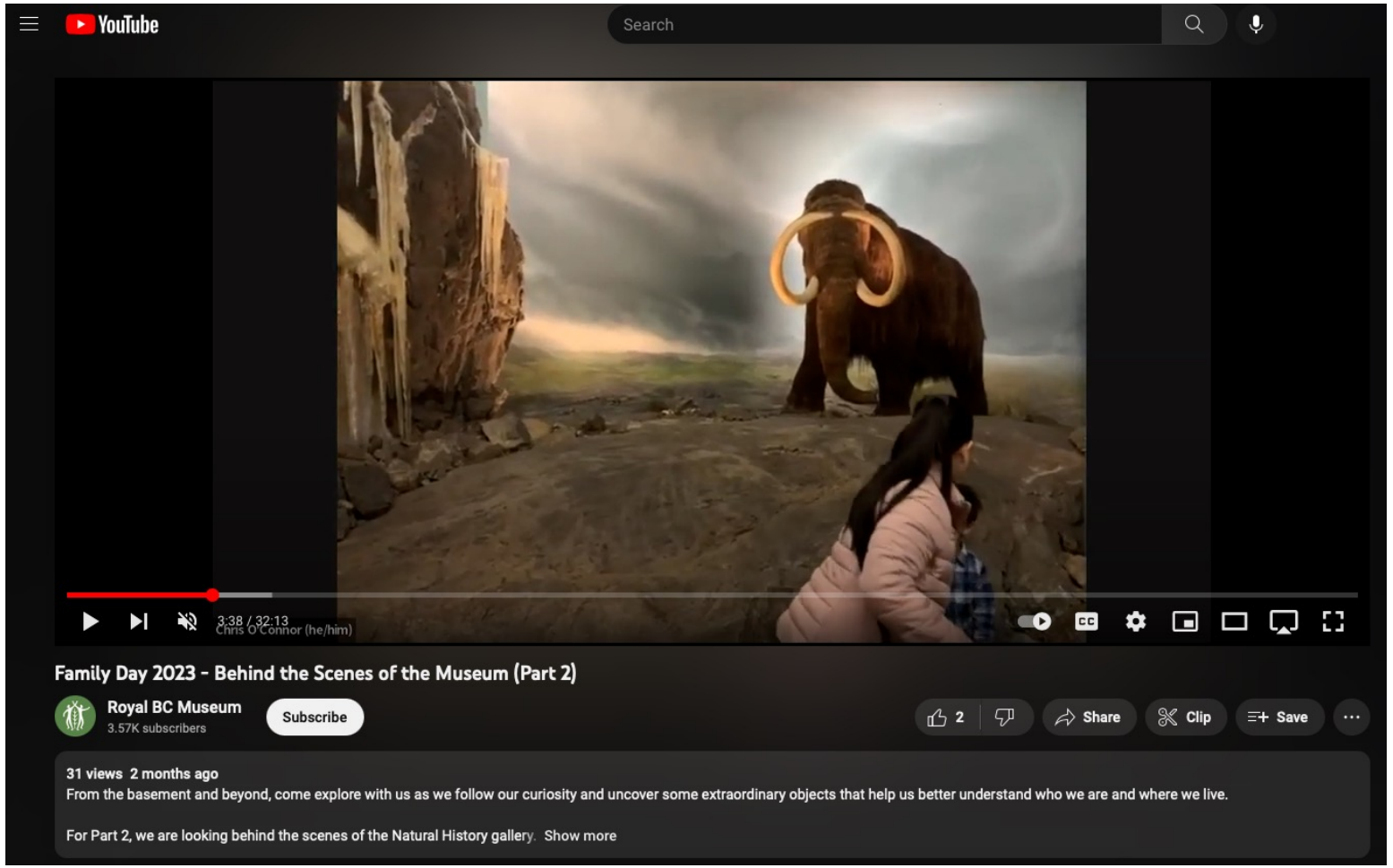
Would you like that in presentation-ready report format?

Forward-Looking, Yes

- But all the technology is available:
  - Natural Language Voice Processing and Text to Speech
  - High-quality audio user interfacing
  - Voice assistants
  - Generative Pre-trained Transformer ML processing
  - Easily-programmed chat APIs
  - Syndeia API
  - Syndeia Graph Query Engine
  - Syndeia integrations to your Repositories

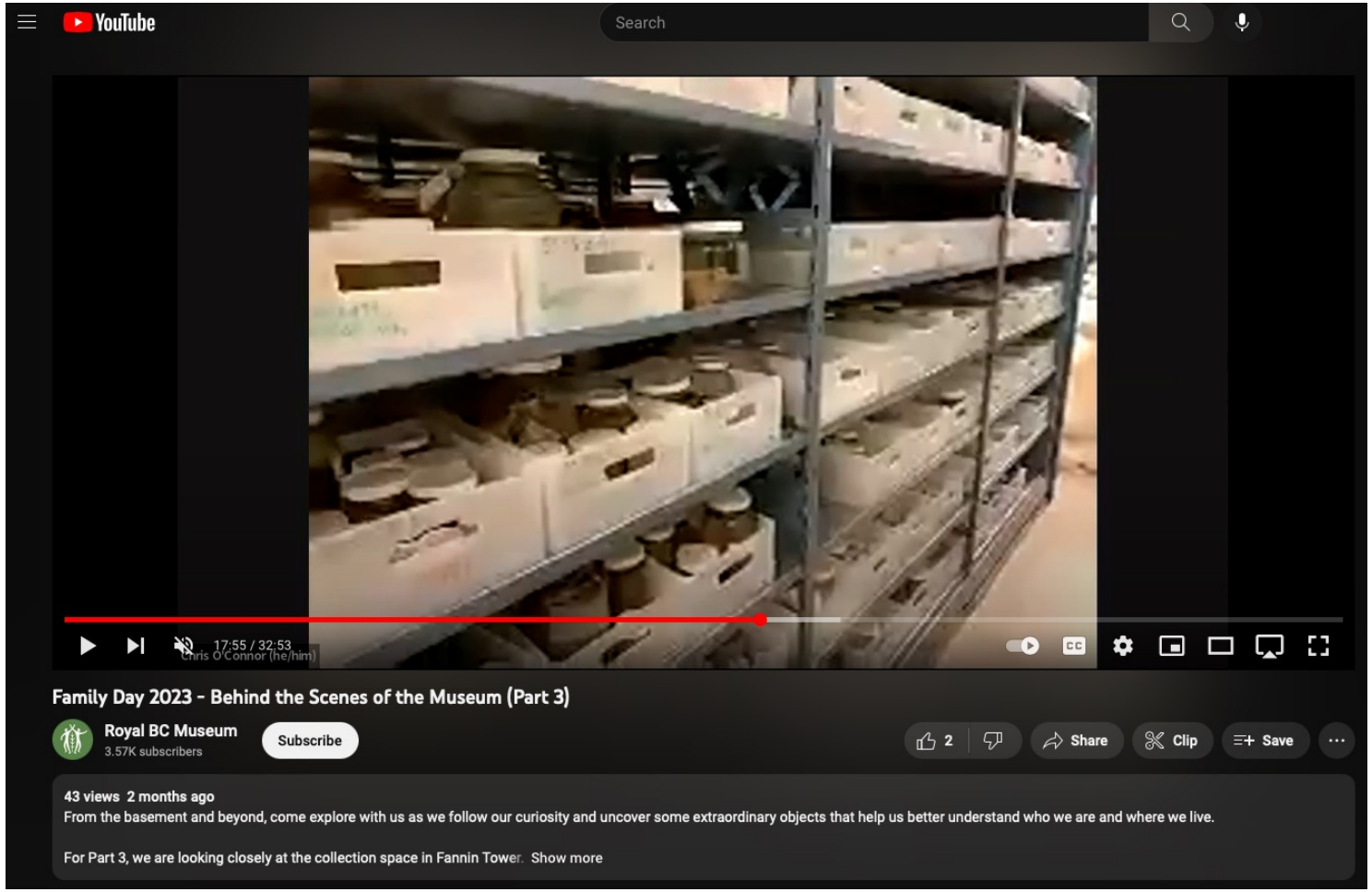
- All that is needed is the Curator
  and a technology integrator

What is Curation?



https://youtu.be/Et1LtXeNG6k (Royal BC Museum, British Columbia)

What is Curation?



The "Archives" of your Enterprise

UML / SysML / UAF / BPMN	magicdraw, Rhapsody, Teamwork Cloud, Cameo Enterprise Architecture
PLM	Teamcenter, windchill, aras Innovator
CAD	creo, Siemens NX
Simulation	MATLAB Simulink, Simulink Requirements, Stateflow, VOLTA
Data	Excel, MySQL, neo4j, <xml />
Requirements	jama connect, IBM DOORS
Project Management	Jira Software, Confluence
ALM	GitHub, Jira Software, SMARTBEAR
SCM	Bitbucket, GitLab, JFrog Artifactory, GitHub
Tests	Zephyr Scale, TestRail
Any Tool / Service	{:} **RESTful - Integrate any service / data source with a REST API**

Implication:

- Modern digital engineering is always going to entail weaving a digital fabric throughout an ecosystem of various repositories from various vendors.
- No single storehouse is forthcoming within which all content will be stored and within which all relationships will be held.
- Modern digital engineering demands technology that can span boundaries

- And it demands curation.

Your Archives without a Curator

Your Archives *with* a Curator

Intercax, Silver Sponsor, 2023

Percentage of un-curated "*digital lint**" in your Engineering Repositories

Totally unsubstantiated – but think about your own repositories, full of prior projects, other people's stuff, failed projects, possible projects, what-ifs, training runs, proofs of concepts, drafts, and more.

Do you really want all that junk digitally-threaded into your mission-critical specifications, verifications, and presentation reports?

* First heard from Stan Przybylinksi, Vice President, CIMData

Curation

- Selecting, organizing, and presenting content in an informative way.
- Involves gathering, evaluating, and filtering information from various sources.
- To create a presentation that is relevant and useful to a particular audience.

- To help people make sense of the vast amount of information available to them.

The Vital Role of a Curator

- Gather
- Analyze
- Filter
- Synthesize
- Present

Who is a Curator

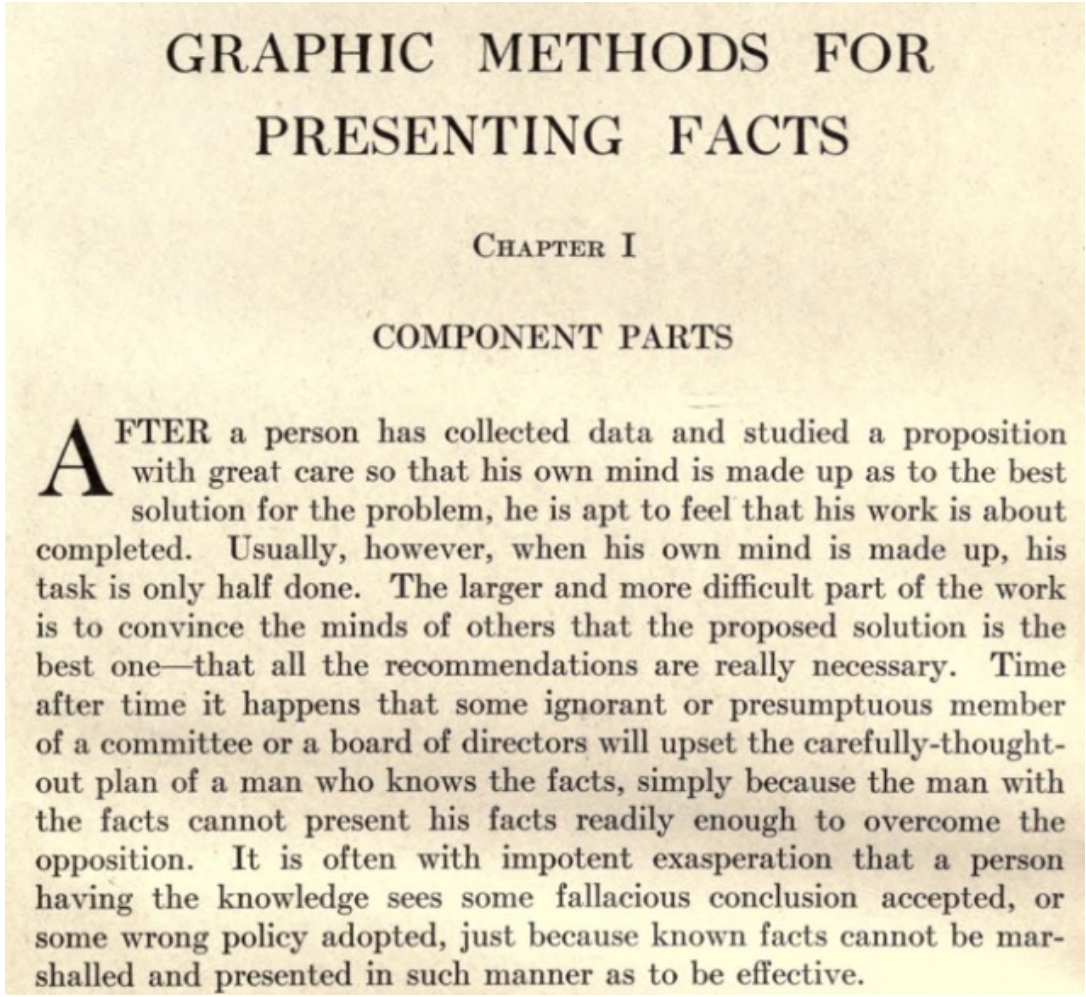
- Anyone with the responsibility to help individuals from diverse disciplines and with diverse agendas to understand situations and to make effective decisions.

- Practically, in mission-critical engineering these are:
  - Deputy Program Managers
  - Chief Systems Engineers
  - Business Analysts
  - Bid and Proposal Teams

Graphic Method for Presenting Facts

— Willard Brinton, 1919

- **AFTER a person has collected data and studied a proposition with great care so that his own mind is made up as to the best solution for the problem, he is apt to feel that his work is about completed. Usually, however, when his own mind is made up, his task is only half done.**
- ***The larger and more difficult part of the work is to convince the minds of others that the proposed solution is the best one that all the recommendations are really necessary.***
- **Time after time it happens that some ignorant or presumptuous member of a committee or a board of directors will upset the carefully-thought-out plan of a man who knows the facts, simply because the man with the facts cannot present his facts readily enough to overcome the opposition.**
- **It is often with impotent exasperation that a person having the knowledge sees some fallacious conclusion accepted, or some wrong policy adopted, just because known facts cannot be marshalled and presented in such manner as to be effective.**



GRAPHIC METHODS FOR PRESENTING FACTS

CHAPTER I

COMPONENT PARTS

AFTER a person has collected data and studied a proposition with great care so that his own mind is made up as to the best solution for the problem, he is apt to feel that his work is about completed. Usually, however, when his own mind is made up, his task is only half done. The larger and more difficult part of the work is to convince the minds of others that the proposed solution is the best one—that all the recommendations are really necessary. Time after time it happens that some ignorant or presumptuous member of a committee or a board of directors will upset the carefully-thought-out plan of a man who knows the facts, simply because the man with the facts cannot present his facts readily enough to overcome the opposition. It is often with impotent exasperation that a person having the knowledge sees some fallacious conclusion accepted, or some wrong policy adopted, just because known facts cannot be marshalled and presented in such manner as to be effective.

https://archive.org/details/graphicmethodsfo00brinrich/mode/2up

Do you have a designated Curator?

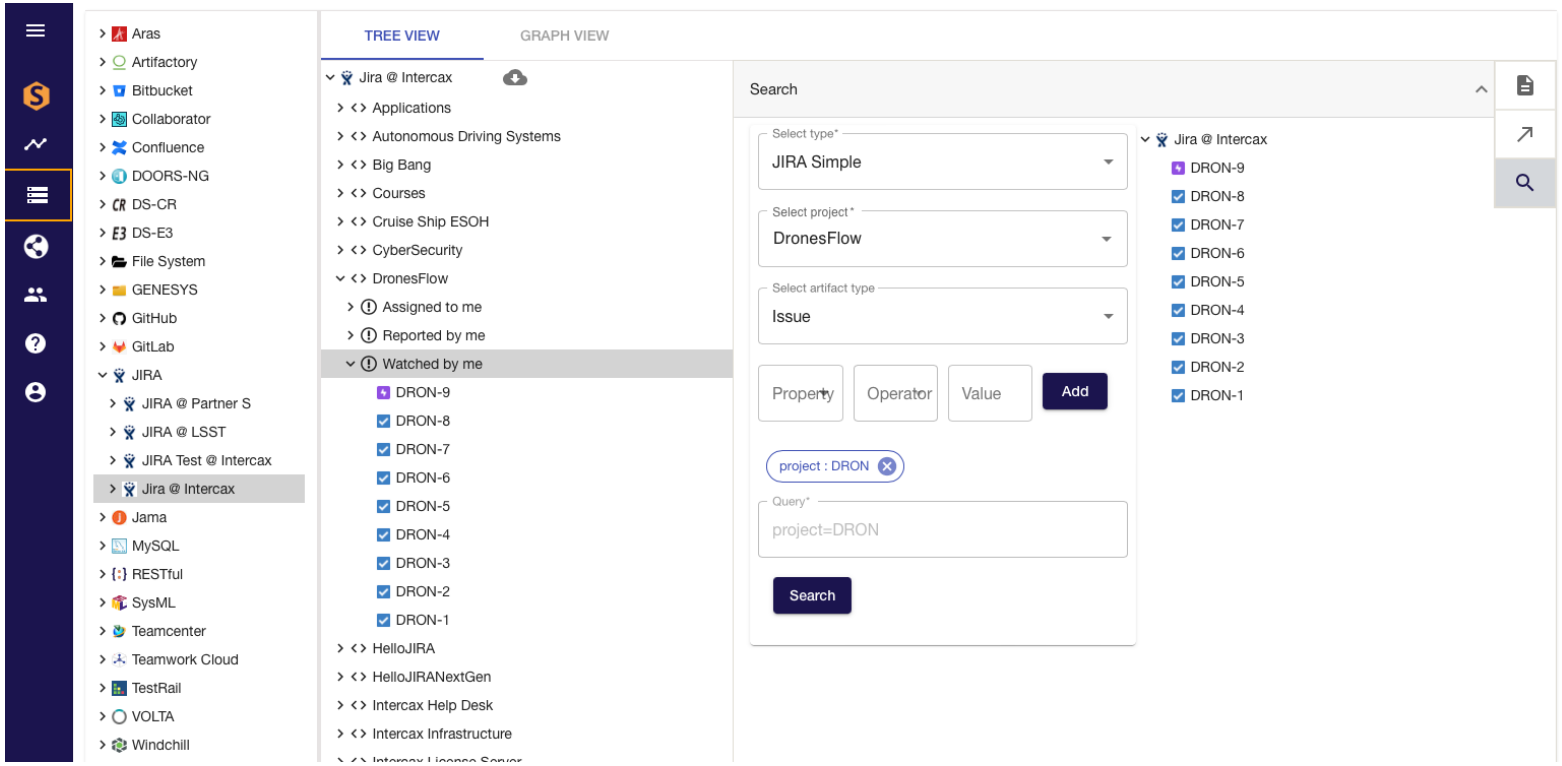
- Unfortunately, for many organizations, the answer is: no
- Recommended staffing profiles often only mention:
  - Chief Digital Officer
  - Missing Curator Role
  - Digital Engineering Manager
  - Model-Based Systems Engineer
  - Data Scientist
  - Software Developer
  - DevOps Engineer
  - User Experience Designer
  - Quality Assurance Engineer
  - Technical Writer
- You should have at least one.

We are looking for a Curator to join the Digital Engineering team to help lead programs or projects involving department and cross-functional teams focused on the delivery of new product offerings or upgrading existing products. In this highly visible role, the curator will help *drive alignment across many cross functional teams* in order to meet the key business objectives.

Using Syndeia™ to Curate Information

- Gathering and Analyzing "disorganized" data
- Using Syndeia Digital Thread Exploration
- Single Pane of Glass
- Single API
- Single Concept Model
  - Repositories
  - Containers
  - Artifacts
  - Relations

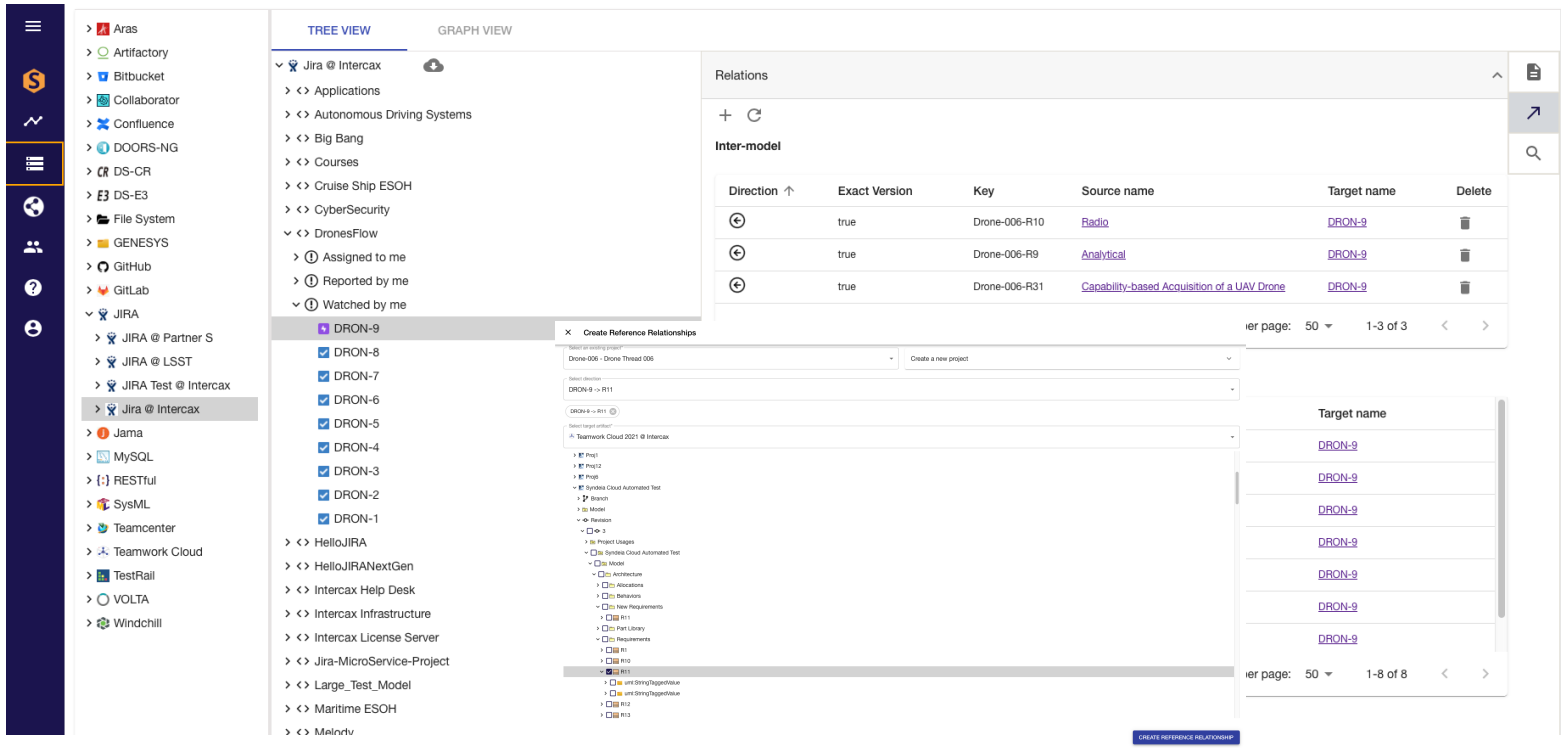
- Gather
- Analyze



Using Syndeia™ to Curate Information

- Filtering and Synthesizing Connections
- Using Syndeia References (++)
- Single API
- Single Concept Model
  - Repositories
  - Containers
  - Artifacts
  - Relations
- Extensible Filtering and Mapping

- Filter
- Synthesize

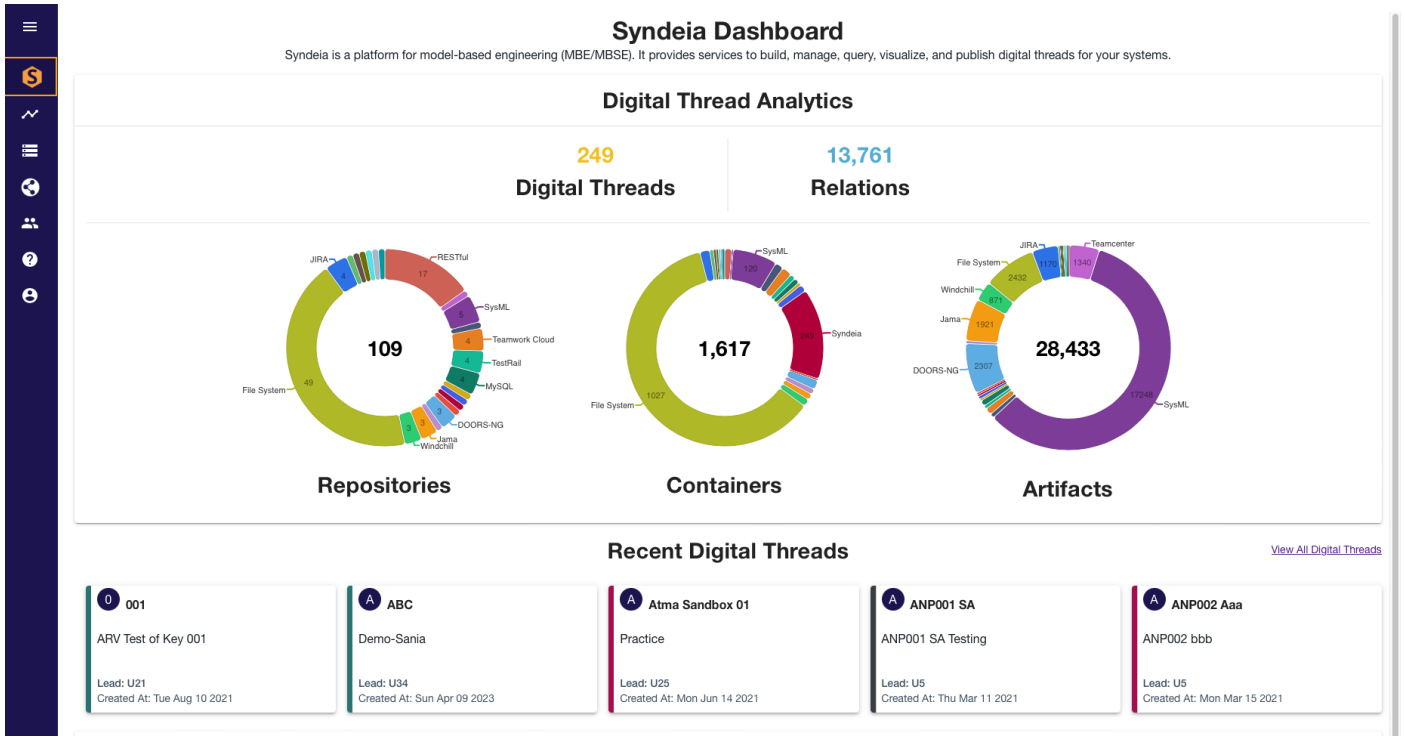


Using Syndeia™ to Curate Information

- Analyzing and Presenting
- Dashboard, Notebooks (++)
- Single API
- Single Concept Model
  - Repositories
  - Containers
  - Artifacts
  - Relations
- Graph Queries

• Analyze

• Present



Business Needs for Curated Graph Analytics

- Modern engineering (to acquire, implement, or operate a capability solution) involves a federation of engineering disciplines whose engineers use many different tools, formats, and storage repositories and who are distributed around the globe and across time.
- In order to make good decisions about what to acquire or when to perform, stakeholders need to be able to understand how change that is local to one discipline, or one aspect of the system, affects other aspects of the system or the environment.
- Stakeholders need to be able to ask questions about the connected engineering information and to receive answers promptly, often in seconds or minutes.
- Today's legacy engineering tools neither relate their information with peer tools nor are able to answer queries over large data sets in prompt time.
- Digital threads and graph analytics both: relate federated information and offer an ability to query for results in prompt and scalable time.

Sample Business Queries

- How many Requirements Repositories do we have?
- What is the URL for each of our Jira Repositories?
- Which of our Jama Repositories are offline?
- Which Requirements Project has the most disorganized (non-curated) Requirements?
- Which Jama Project has the most curated Requirements?
- What percentage of a Requirements Project is curated?
- What are the 5 most recently modified Requirements in all Requirements Repositories?
- Who modified the 5 most recently modified Requirements?
- Which disorganized Requirements mention the phrase "Acme Widget"?
- Which curated Requirements mention the phrase "Stanley Sprocket"?

- Among the curated Parts, which curated Parts for a given Project weigh the most?
- Among the curated Parts, which curated Parts for a given Project have the most volume?
- Among the curated Parts, which curated Parts for a given Project cost the most?

- Which curated Parts of a Project have a mass that exceeds the limits of its related Requirements?
- If a given Requirement is altered, which Parts have to be reverified and what were the verification plans for those Parts?

- These are all:

Questions about the existence of and relationships between cross-disciplinary content and provenance.

What is a Metric

- Regardless of its technical implementation details, a metric:
  - maps
  - filters
  - reduces (or accumulates)
  - compares
  - presents
- such that from a given starting point (such as the choice of a particular project or program), a mapping from that point to a set of data is then filtered. Once filtered, remaining data is visited and certain values from each element are projected out or accumulated in some combining operation. The result of the reduction (or accumulation) is then compared with other metrics. The comparison is then formulated for presentation to the viewer.
- Note that for complex data and complex metrics, a particular metric likely performs several map/filter/reduce/compare phases before it finally renders a result for presentation.
- The purpose of a metric is to enable an intelligent observer to assess a large body of data in a rapid and, ideally, accurate way.

Using Syndeia™ to provide Business Metrics

jupyter Syndeia_Cloud_3.4_JIRA Last Checkpoint: 08/02/2021 (autosaved)

File Edit View Insert Cell Kernel Help — Trusted — Python 3 (ipykernel)

Run Code

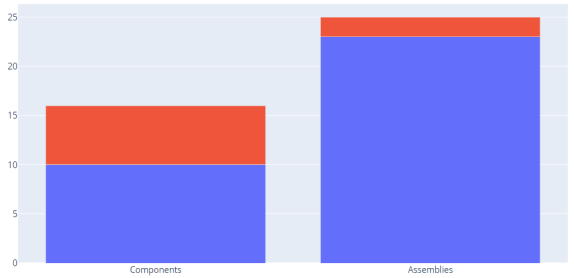
```
In [1]: # Step 1 -- Import libraries
from __future__ import print_function
import time
import getpass
import uuid
import syndeia_cloud_34x_client_sdk as sc
from syndeia_cloud_34x_client_sdk.rest import ApiException
from pprint import pprint
import pandas as pd
import plotly.graph_objects as go
import json

def formatHyperlink(value):
    split_list = value.split(",")
```

jupyter Syndeia_Cloud_3.4_Aras_Innovator_Latest Last Checkpoint: 16 hours ago (unsaved changes)

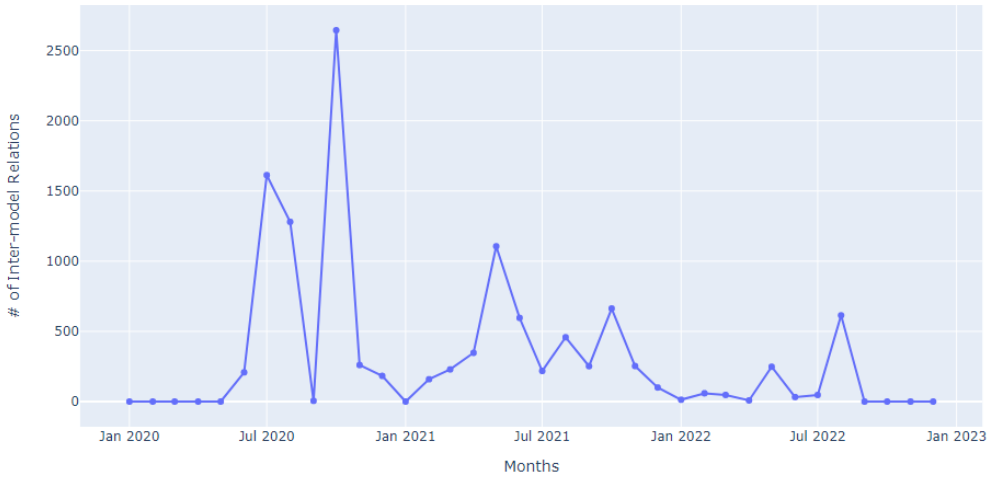
```
'SYN01-Part-C2 -> Part C2']
Parts of type Component and state Released = 6
['0403 -> Clamp',
 '1201 -> Gasket',
```

```
In [19]: # Step 3.4 -- Plot Preliminary and Released Parts and Assemblies
partTypes=['Components', 'Assemblies']
fig = go.Figure(data = [
    go.Bar(name='Preliminary', x=partTypes, y=[num_comps_prelim_parts, num_assy_prelim_parts]),
    go.Bar(name='Released', x=partTypes, y=[num_comps_released_parts, num_assy_released_parts])])
fig.update_layout(barmode='stack')
fig.show()
```

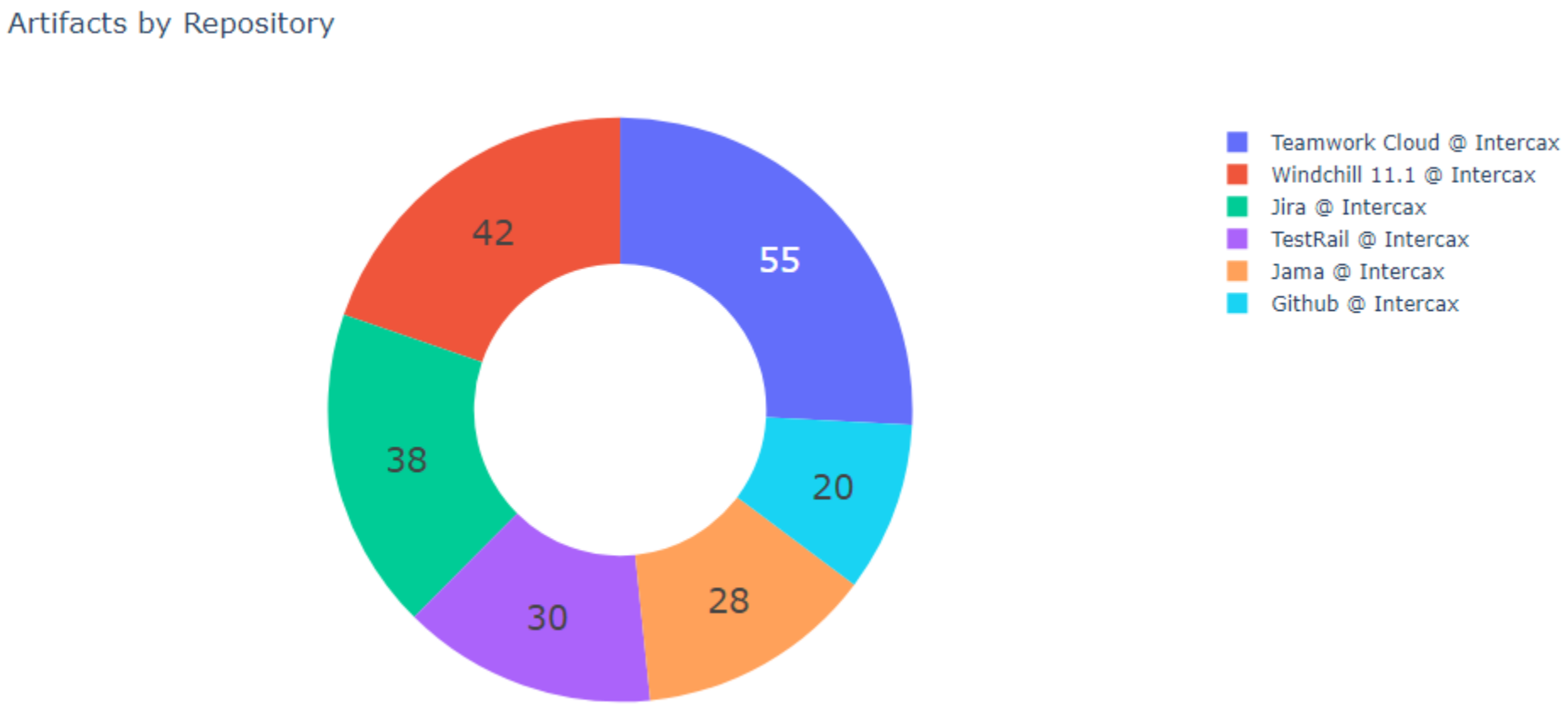



```
", ex: http://mySyndeiaCloudServer.domain.t
asic auth = your email address (usually)
word) | (specify)
 isn't in the trust store, or you want to s
```

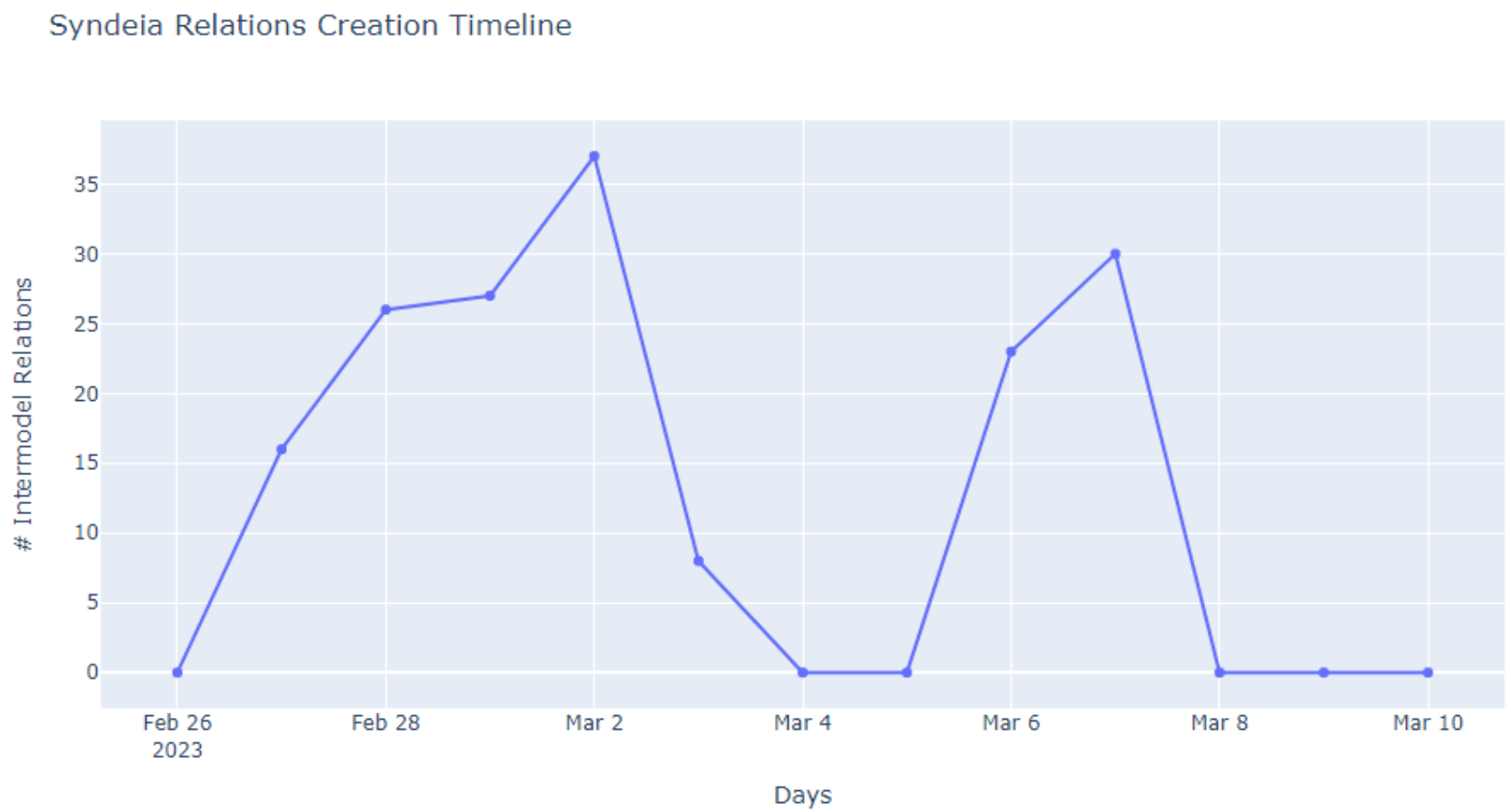
ID	Global ID	Name	Priority	Status
SYNAPP-REQ-1	GID-63657	Bilgewater Control	Medium	Completed
SYNAPP-REQ-10	GID-63666	SOx Control	High	Approved
SYNAPP-REQ-11	GID-63667	Solid Waste Management	Medium	Draft
SYNAPP-REQ-2	GID-63658	Ballast Water Control	High	Approved
SYNAPP-REQ-3	GID-63659	Blackwater Control	Low	Draft
SYNAPP-REQ-4	GID-63660	Condensate Control	Medium	Draft
SYNAPP-REQ-5	GID-63661	Cooling Water Control	High	Approved
SYNAPP-REQ-6	GID-63662	Fresh Water Control	Medium	Draft
SYNAPP-REQ-7	GID-63663	Greywater Control	Medium	Draft
SYNAPP-REQ-8	GID-63664	Incinerator Control	Medium	Rejected
SYNAPP-REQ-9	GID-63665	NOx Control	Medium	Draft



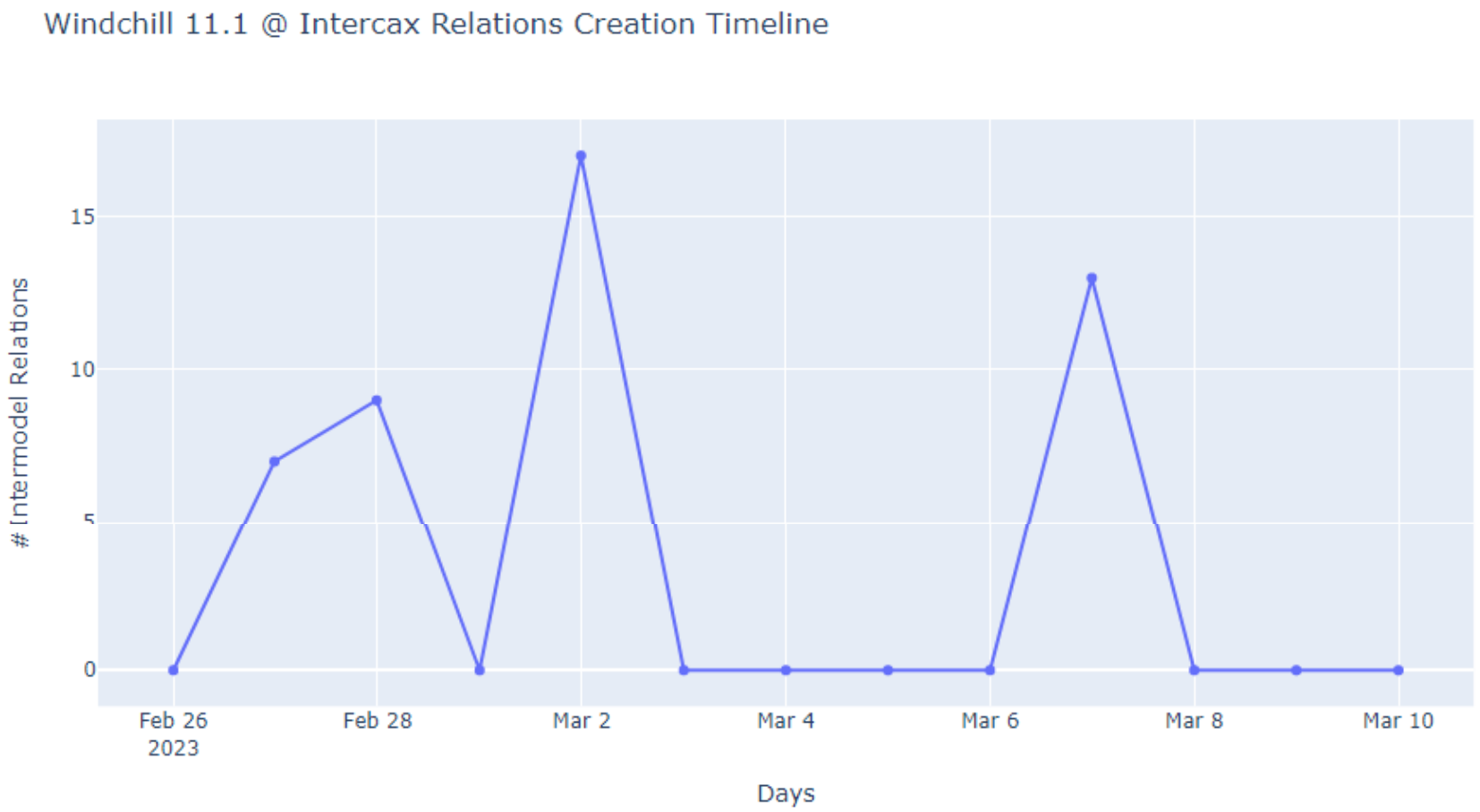
Connected Artifacts by Repository



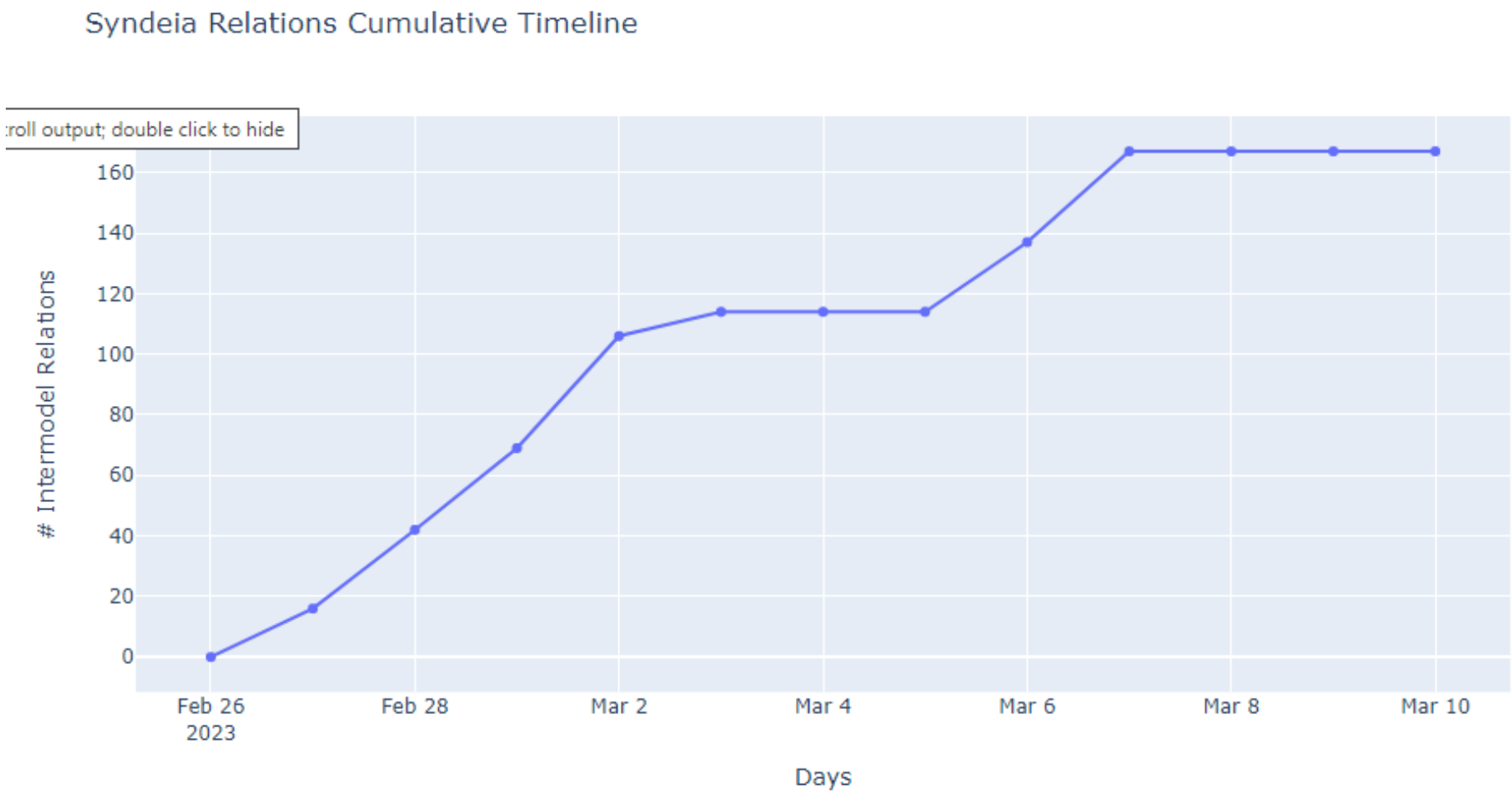
Total # Inter-model Relations by Time



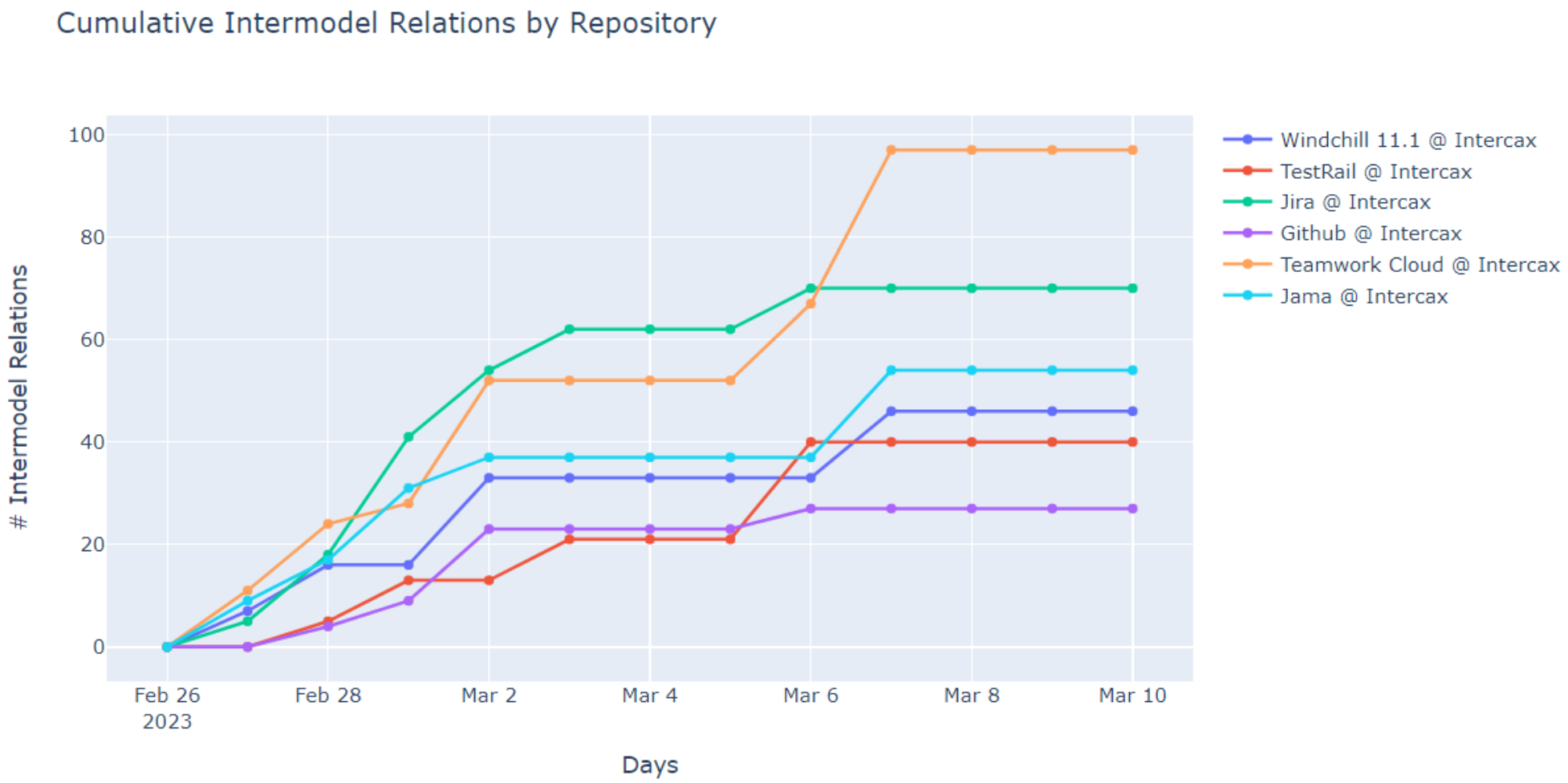
Inter-model Relations by Time for Windchill



Cumulative Inter-model Relations Timeline

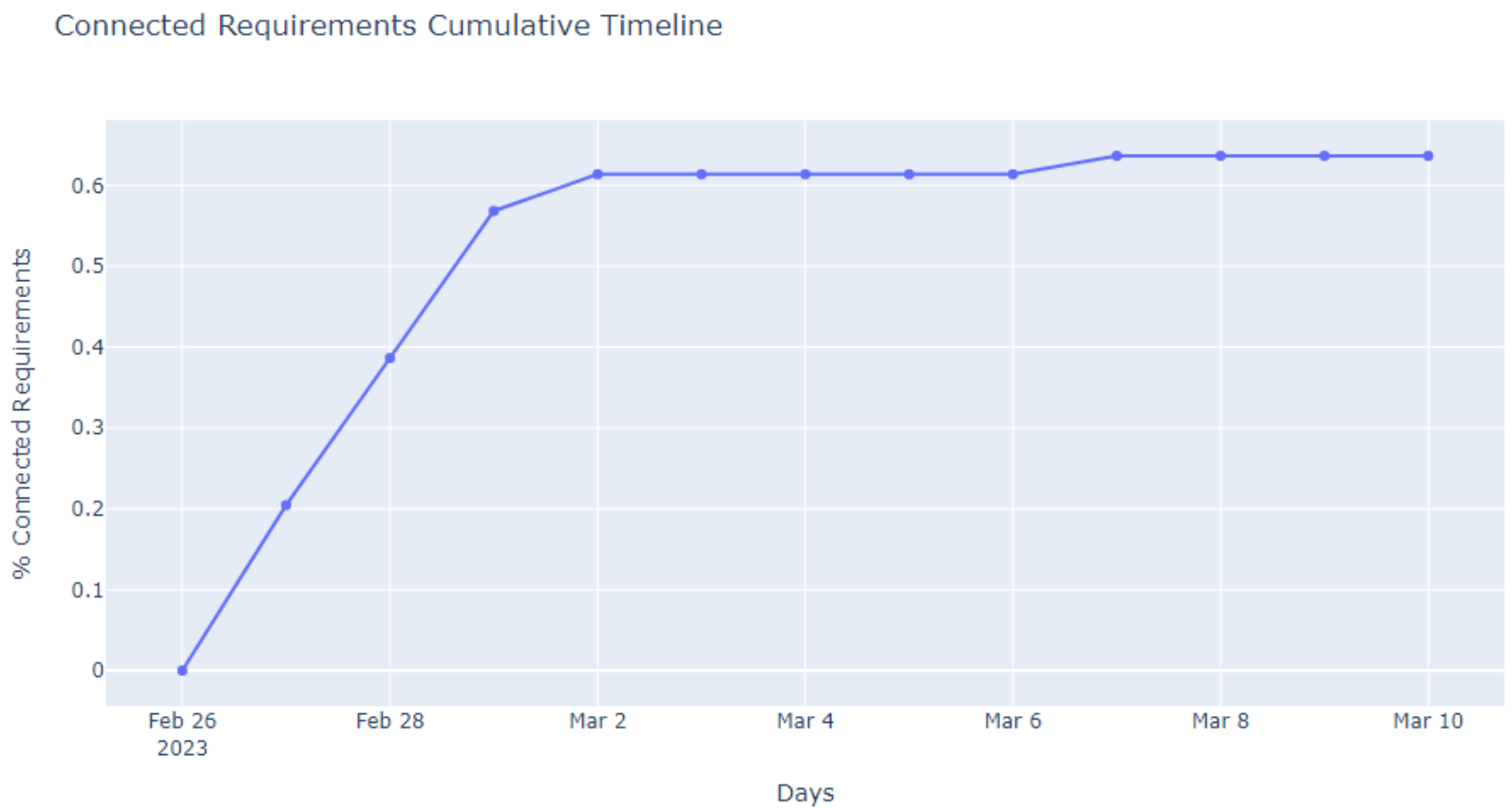


Cumulative Intermodel Relations by Repository

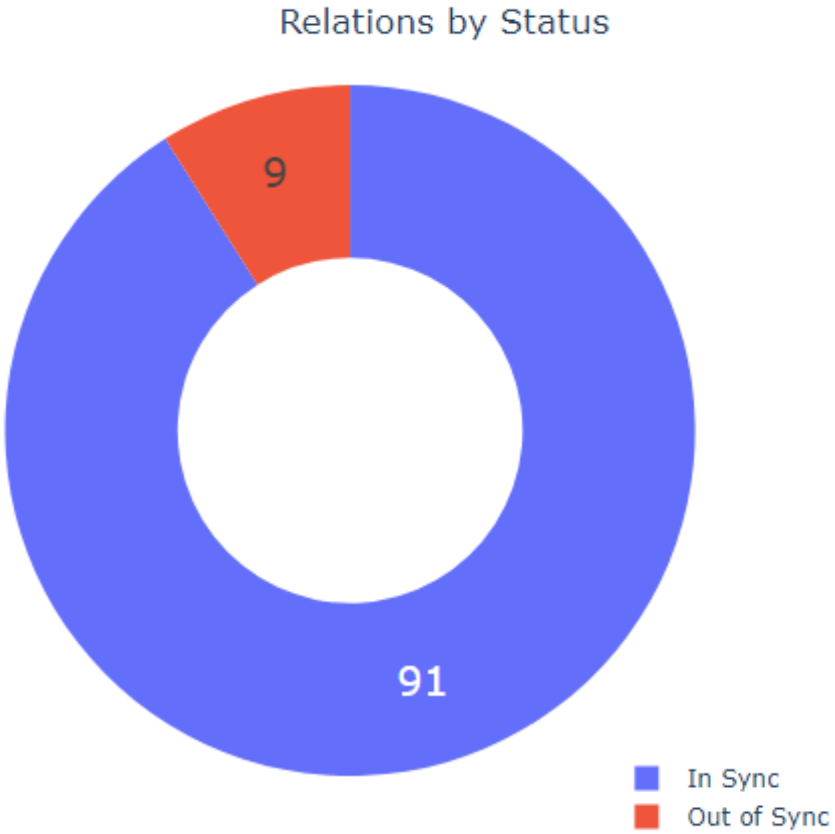


Inter-model Relations vs Plan by Time

% Jama Requirements Connected



JIRA Inter-model Relations out of sync

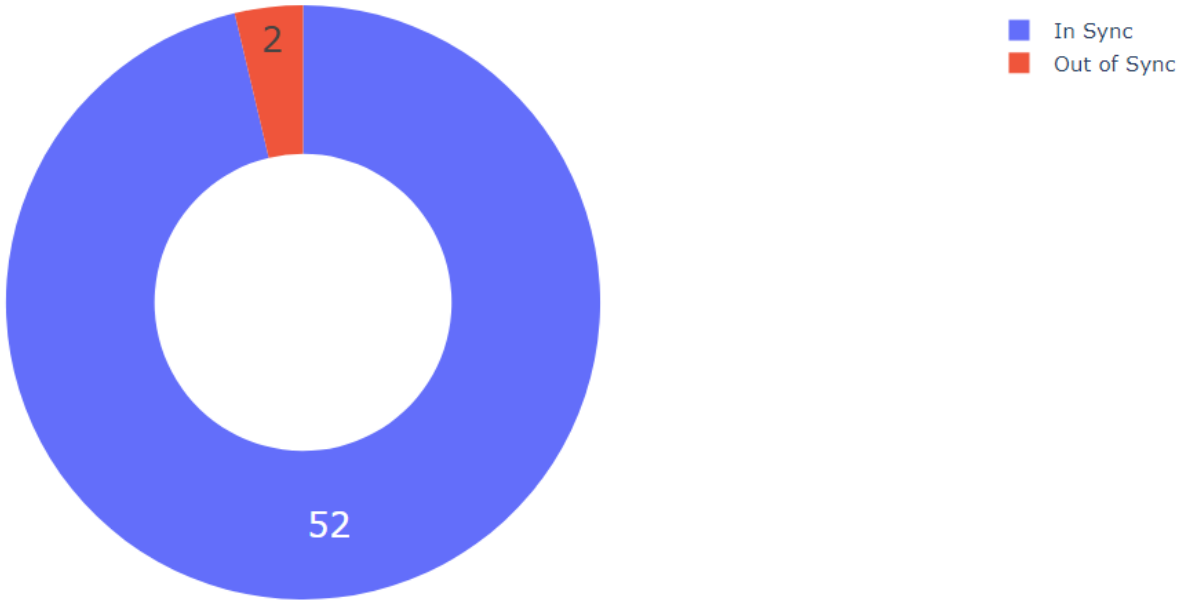


Relations with Jira issues in sync = 91

Relations with Jira issues out of sync = 9

Relation Key	Relation Name	Jira Issue Key	Jira Issue Version	Jira Issue Web URL	Jira Issue Version - Latest	Status
UGV02-R116	UGV-42-Operator Control Test	UGV-42	2019-08-20T13:57:39.911-0400	https://intercax.atlassian.net/browse/UGV-42	2023-03-06T10:46:49.797-0500	Out of Sync
UGV02-R25	Loose Sand and Gravel-UGV-6	UGV-6	2019-08-20T13:57:38.448-0400	https://intercax.atlassian.net/browse/UGV-6	2023-03-02T10:13:09.453-0500	Out of Sync
UGV02-R27	Stairs-UGV-11	UGV-11	2019-08-20T13:57:38.164-0400	https://intercax.atlassian.net/browse/UGV-11	2023-03-02T10:13:20.171-0500	Out of Sync
UGV02-R32	Control-UGV-42	UGV-42	2019-08-20T13:57:39.911-0400	https://intercax.atlassian.net/browse/UGV-42	2023-03-06T10:46:49.797-0500	Out of Sync
UGV02-R48	UGV-8-Command_Module.c	UGV-8	2019-08-20T13:57:33.041-0400	https://intercax.atlassian.net/browse/UGV-8	2023-03-02T10:10:40.523-0500	Out of Sync
UGV02-R57	5Axis_Manipulator-UGV-21	UGV-21	2019-08-20T13:57:39.573-0400	https://intercax.atlassian.net/browse/UGV-21	2023-03-02T10:11:00.929-0500	Out of Sync
UGV02-R58	Multicamera_Arm-UGV-8	UGV-8	2019-08-20T13:57:33.041-0400	https://intercax.atlassian.net/browse/UGV-8	2023-03-02T10:10:40.523-0500	Out of Sync
UGV02-R90	UGV-21-Payload_5Axis_Manipulator01	UGV-21	2019-08-20T13:57:39.573-0400	https://intercax.atlassian.net/browse/UGV-21	2023-03-02T10:11:00.929-0500	Out of Sync
UGV02-R92	UGV-8-Payload_Multicamera01	UGV-8	2019-08-20T13:57:33.041-0400	https://intercax.atlassian.net/browse/UGV-8	2023-03-02T10:10:40.523-0500	Out of Sync

Jama Inter-model Relations out of sync



Relation Key	Relation Name	Jama Reqt Key	Jama Reqt Version	Jama Reqt Web URL	Jama Reqt Version - Latest	Status
UGV02-R10	Weight-UGV-10	SYNAPP-REQ-14	2023-02-14T14:52:25.000+0000	https://intercax.jamacloud.com/perspective.req#/items/37540?projectId=55,https://intercax.jamacloud.com/perspective.req#/items/37540?projectId=55	2023-03-01T17:45:07.000+0000	Out of Sync
UGV02-R7	Speed-UGV-33	SYNAPP-REQ-15	2023-02-14T14:52:25.000+0000	https://intercax.jamacloud.com/perspective.req#/items/37541?projectId=55,https://intercax.jamacloud.com/perspective.req#/items/37541?projectId=55	2023-03-01T17:45:35.000+0000	Out of Sync

Tactics

- Mashup conversations in tooling such as Siri Shortcuts and ChatGPT API
- Query the Syndeia Graph from Gremlin clients like G.dot.V
- Interact with Stakeholder-Consumers via their human interfaces: dashboards, reports, mobile devices, IM clients, AI voice assistants, etc

- Interact with the Syndeia API via Intercax's Syndeia Plugins and Syndeia Web Dashboards
- Command, control, and Query the Syndeia API from CI/CD services such as Jenkins, Travis, Circle CI, GitHub Actions, etc
- Feed BI Visualization services such as PowerBI, Tableau, Toucan, etc
- Interact from data science notebooks such as Jupyter and Mathematica

Curating the Thread

“How many connected artifacts of each type are in my Syndeia Digital Thread for this project?”

{Task=3, Element=4, Workflow Model=1, Session=1}

```
g.E().has( 'Relation', 'container', 'Drone-006' ).bothV().dedup()
  .where( and(
     out( 'hasType' ),
     out( 'ownedBy' ).or(
        has( 'name', 'DronesFlow' ),
        has( 'name', 'Drone_MDO_With_Mid_Fid_Aero' ),
        has( 'name', 'Esteco_Drone03-StructureAndParametrics_a' ) ) ) )
  .group().by( out( 'hasType' ).values( 'name' ) ).by( count() )
```

Observing the Team

“Who has been curating Syndeia Digital Threads in my Project and when?”

{Tuesday 06/21=[U16, U16, U16], Thursday 06/23=[U1, U1, U1]}

```
g.E().has( 'Relation', 'container', 'Drone-006' )
  .group()
    .by( values( 'modifiedDate' )
      .map{ ( new java.text.SimpleDateFormat( "yyyy-MM-dd" ).parse( it.get() ) ).format( "EEEE MM/dd" )
} )
    .by( 'modifiedBy' )
```

What's getting Done?

"For my Jira Issues, are they mapped to Requirements and to DO Models?"

```
g.E().has( 'Relation', 'container', 'Drone-006' )
  .where( bothV()
    .out( 'hasType' )
      .has( 'name', 'Task' ) )
```

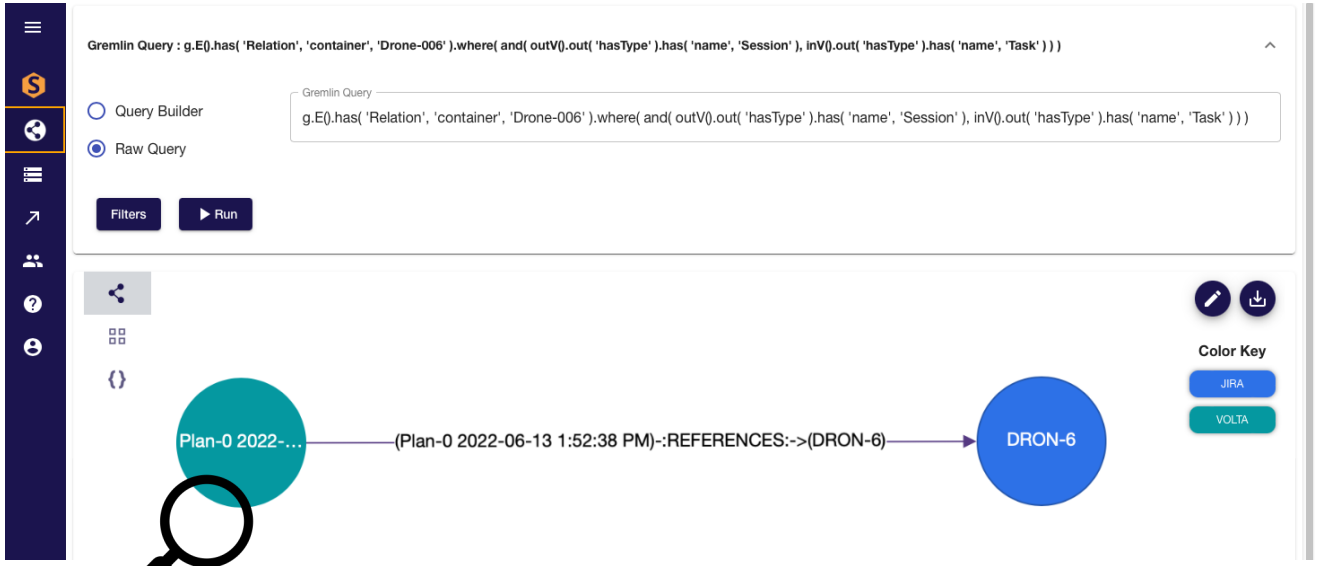
Zoomed


Gremlin Query : g.E().has('Relation', 'container', 'Drone-006').where(bothV().out('hasType').has('name', 'Task'))
Query Builder
Raw Query
Gremlin Query
g.E().has('Relation', 'container', 'Drone-006').where(bothV().out('hasType').has('name', 'Task'))
Filters
Run
Name: DRON-2 Type: ART-TYPE568 Key: ART28111 External Key: DRON-2 Version: 2022-06-19T13:47:18.576-0400
Color Key
JIRA
Teamwork Cloud
VOLTA
DRON-1
Surveillance_Drone_Candidate3-DRON-1
Surveillance_Drone_Candidate1-DRON-1
Surveillance_Drone_Candidate2-DRON-1
DRON-2
DRON-2-Drone_MDO_With_Mid_Fid_Aero
DRON-2-Drone_Range
Drone_Range

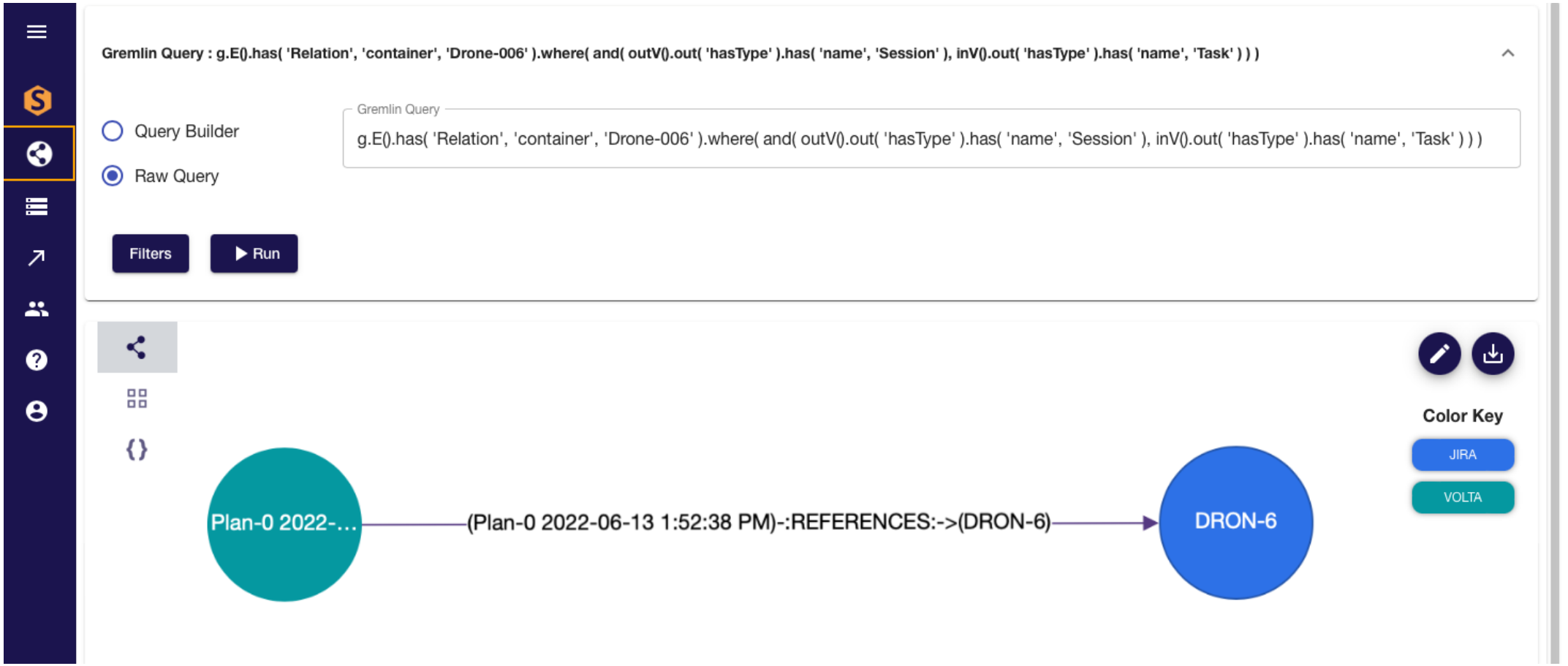
What's getting Done?

"Has anyone linked their DO Sessions to my "DOE" request yet?"

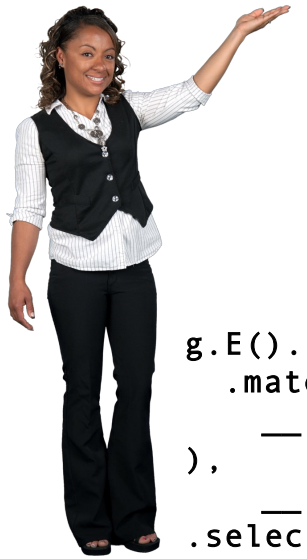
```
g.E().has( 'Relation', 'container', 'Drone-006'
)
  .where( and(
     outV().out( 'hasType' )
      .has( 'name', 'Session' ),
     inV().out( 'hasType' )
      .has( 'name', 'Task' ) ) )
```



Zoomed

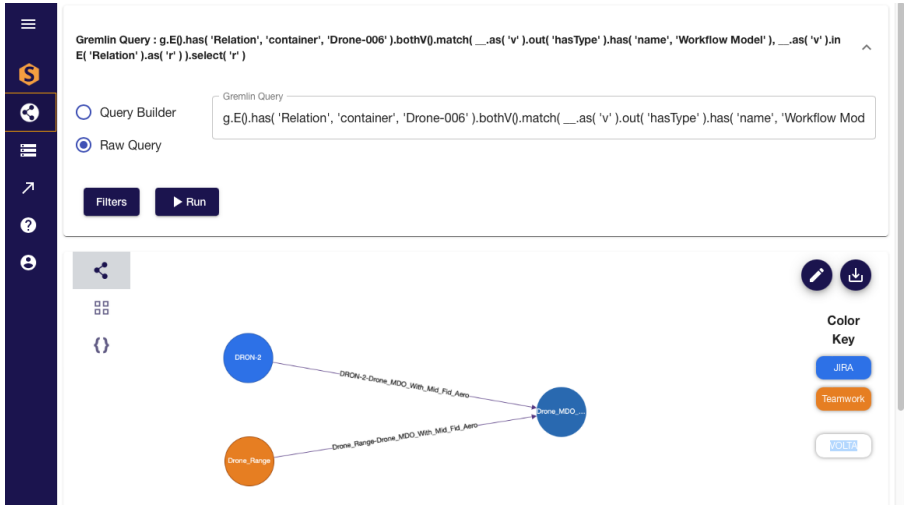

Gremlin Query : g.E().has('Relation', 'container', 'Drone-006').where(and(outV().out('hasType').has('name', 'Session'), inV().out('hasType').has('name', 'Task')))
Query Builder
Raw Query
Gremlin Query
g.E().has('Relation', 'container', 'Drone-006').where(and(outV().out('hasType').has('name', 'Session'), inV().out('hasType').has('name', 'Task')))
Filters
Run
Color Key
JIRA
VOLTA
Plan-0 2022-...
(Plan-0 2022-06-13 1:52:38 PM)-:REFERENCES:->(DRON-6)
DRON-6

Why am I doing this "DO"?

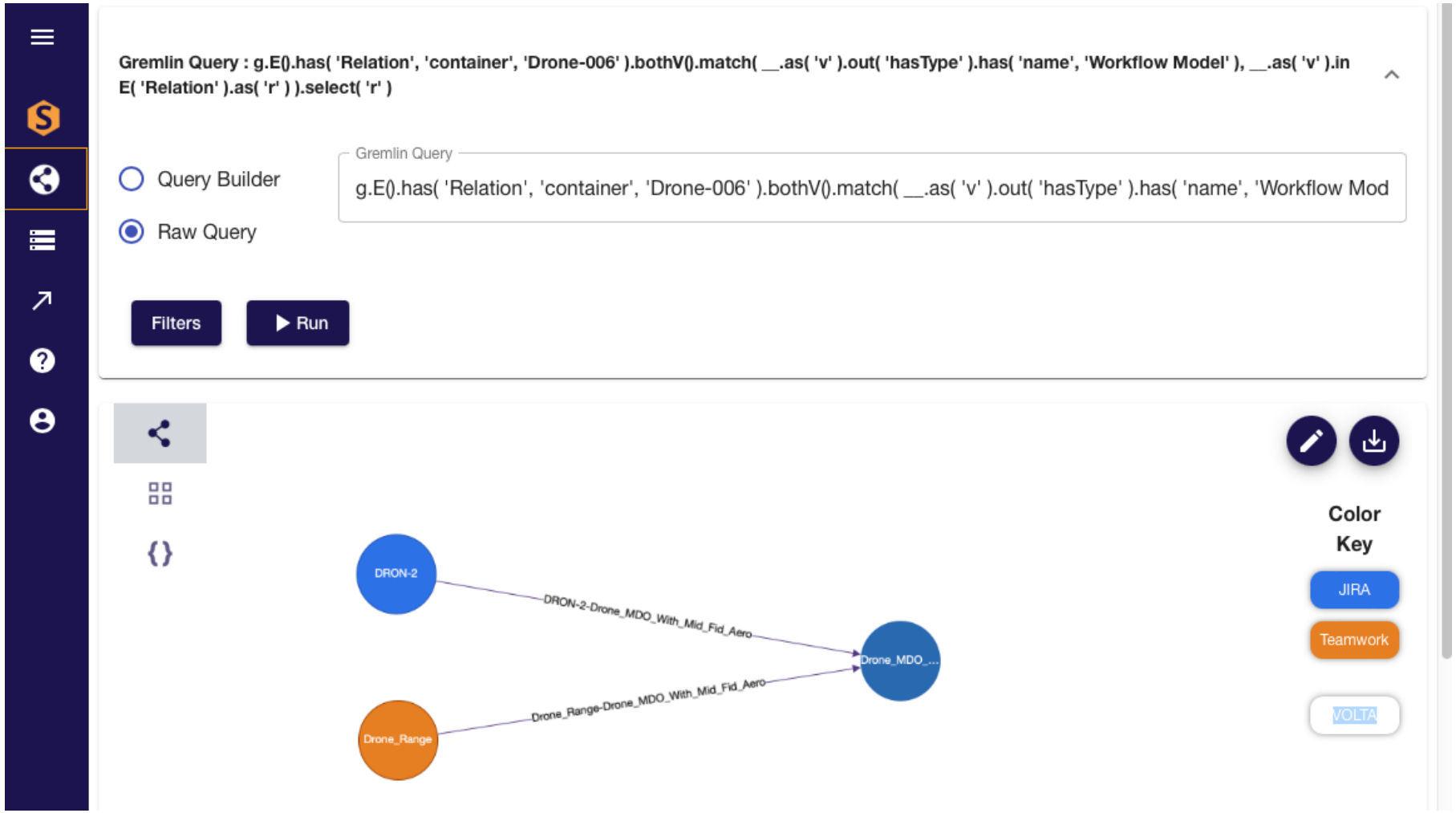


"What are my Tasks and which Requirements should my design optimization honor?"

```
g.E().has( 'Relation', 'container', 'Drone-006' ).bothV()
  .match(
    __.as( 'v' ).out( 'hasType' ).has( 'name', 'Workflow Model'
),
    __.as( 'v' ).inE( 'Relation' ).as( 'r' ) )
.select( 'r' )
```



Zoomed

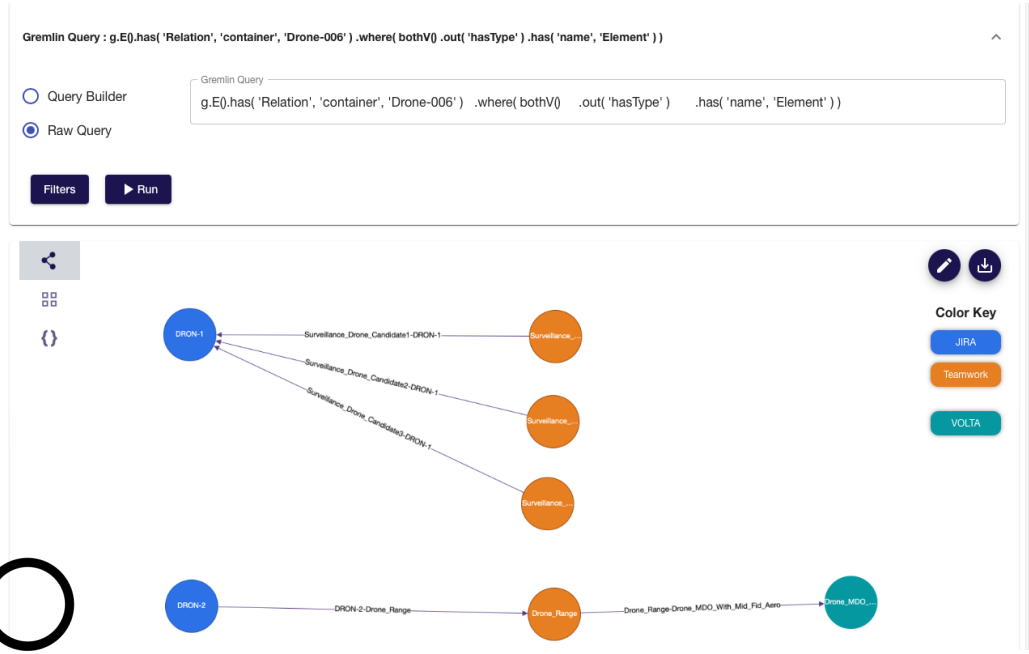


Intercax, Silver Sponsor, 2023

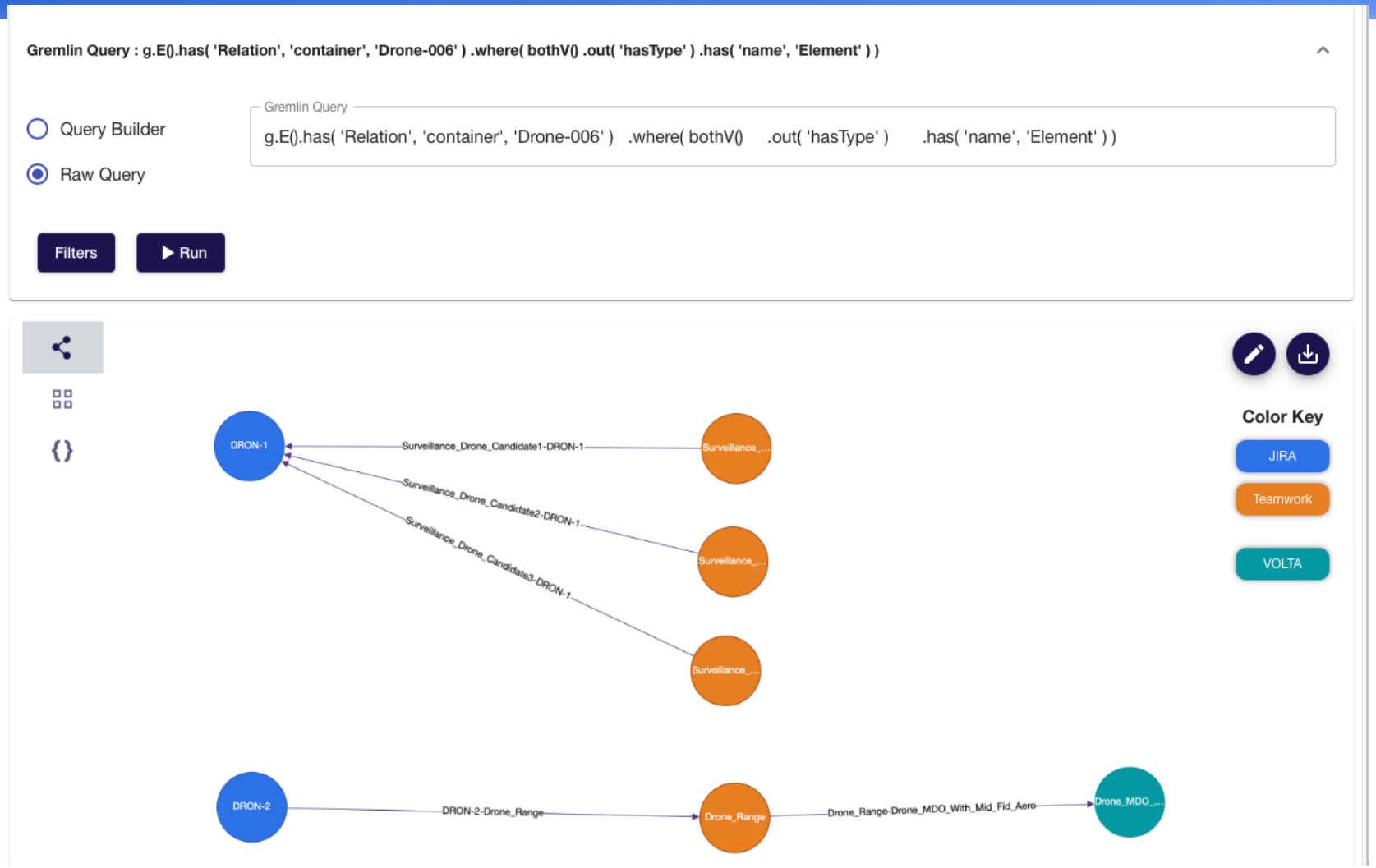
Is my MBSE tied into the Project?

"Which Jira Tasks and VOLTA DO Models are tracking my SysML specifications?"

```
g.E().has( 'Relation', 'container', 'Drone-006' )
  .where( bothV()
    .out( 'hasType' )
      .has( 'name', 'Element' ) )
```



Zoomed


Gremlin Query : g.E().has('Relation', 'container', 'Drone-006') .where(bothV() .out('hasType') .has('name', 'Element'))
Query Builder
Raw Query
Gremlin Query
g.E().has('Relation', 'container', 'Drone-006') .where(bothV() .out('hasType') .has('name', 'Element'))
Filters
Run
DRON-1
Surveillance_Drone_Candidate1-DRON-1
Surveillance_Drone_Candidate2-DRON-1
Surveillance_Drone_Candidate3-DRON-1
Color Key
JIRA
Teamwork
VOLTA
DRON-2
DRON-2-Drone_Range
Drone_Range
Drone_Range-Drone_MDO_With_Mid_Fid_Aero

Would you agree?

- Knowledge enables us to make better decisions, we model in order to know more sooner – but modeling yields too much: we need curation to make apparent what is relevant.

- Curators are an important and overlooked role in digital engineering. Curators communicate knowledge from clutter. Curators need modern platforms.

- Syndeia is the digital thread platform for model-based engineering. Syndeia enables curation for our mission-critical engineering disciplines.

Conversation

- What are your pains?
- What would you connect?
- What questions will you ask of your digital thread?
- Who's your curator?

Questions / Comments

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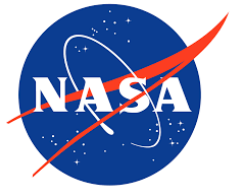
Syndeia – A Sample of Clients



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