



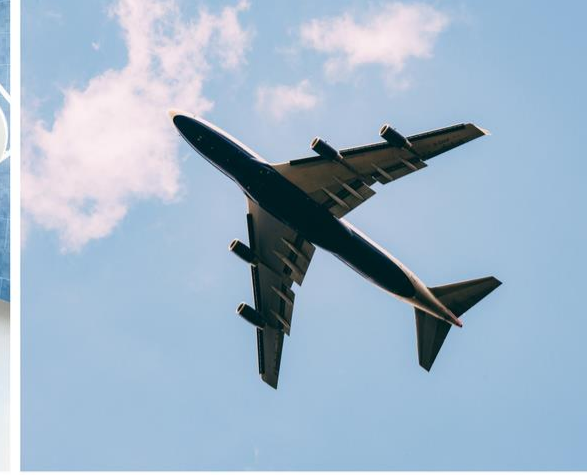
intercax

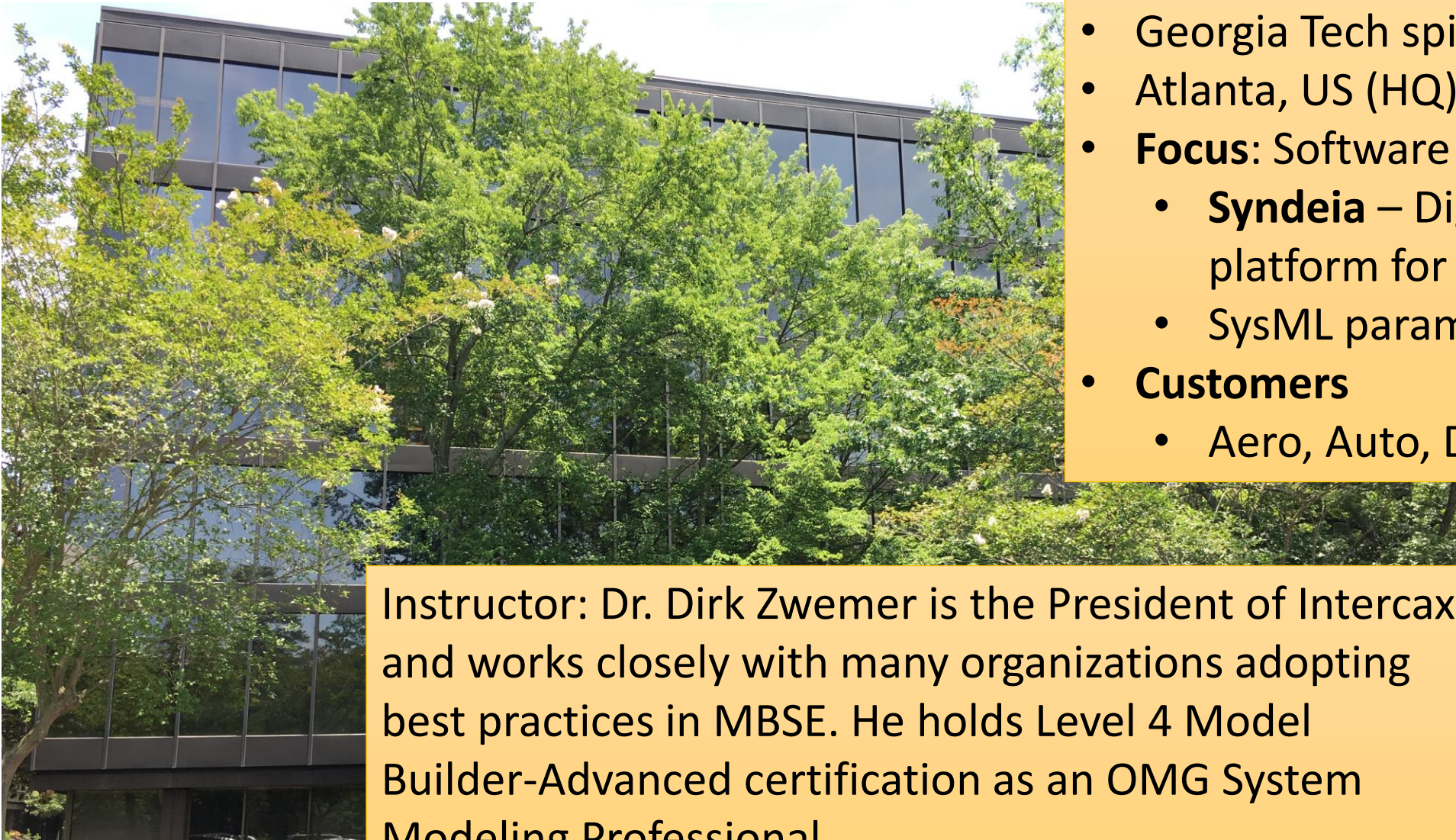
Building Digital Threads

June, 2023

Dirk Zwemer, PhD
President & CEO

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- Georgia Tech spin-off 2008
- Atlanta, US (HQ) and Pune, India
- **Focus:** Software for MBE/MBSE
 - **Syndeia** – Digital Thread platform for MBE/MBSE
 - SysML parametric solvers
- **Customers**
 - Aero, Auto, Defence, others

Instructor: Dr. Dirk Zwemer is the President of IntercaX and works closely with many organizations adopting best practices in MBSE. He holds Level 4 Model Builder-Advanced certification as an OMG System Modeling Professional.



What's the Problem?



Stakeholder Requirements

Knowledge Engineers waste an average of **4 hours each day** on menial data entry.
(<https://simplyflows.com/time-wasted-on-repetitive-tasks-is-40-percent>)

Paper-based processes are **75% Waste** compared to Digital Engineering (Hedberg et al., 2016)

Managing digital data streams through models, seamless transmission of digital information, advances in analyzing data and trends, and efficiently communicating information to Decision-makers would **SAVE** manufacturers **\$37 Billion** annually (Anderson, 2016).

- Diversity of models
 - Requirements
 - Architecture (SysML, UPDM, AADL,...)
 - 3D/2D Mechanical and Electrical Design
 - Design / Manufacturing BOM (PLM)
 - Software code, tests, releases
 - Simulation/Test/Failure Analysis
- Team members cannot find and share information efficiently.
- Data collection for review, analysis and documentation is slow.
- Capability Gaps and Design Errors are detected too late.
- Projects are behind schedule and over budget.

What is the Digital Thread?



A linked set of digital artifacts whose consistency is actively managed over the life cycle of a product, process, or system.

AIAA Digital Engineering Integration Committee, "DIGITAL THREAD: DEFINITION, VALUE, AND REFERENCE MODEL", June 2023

A powerful communication framework that allows a connected data flow and integrated view of an asset's data throughout its lifecycle across traditionally siloed functional perspectives.

iBaseT.com, 2023

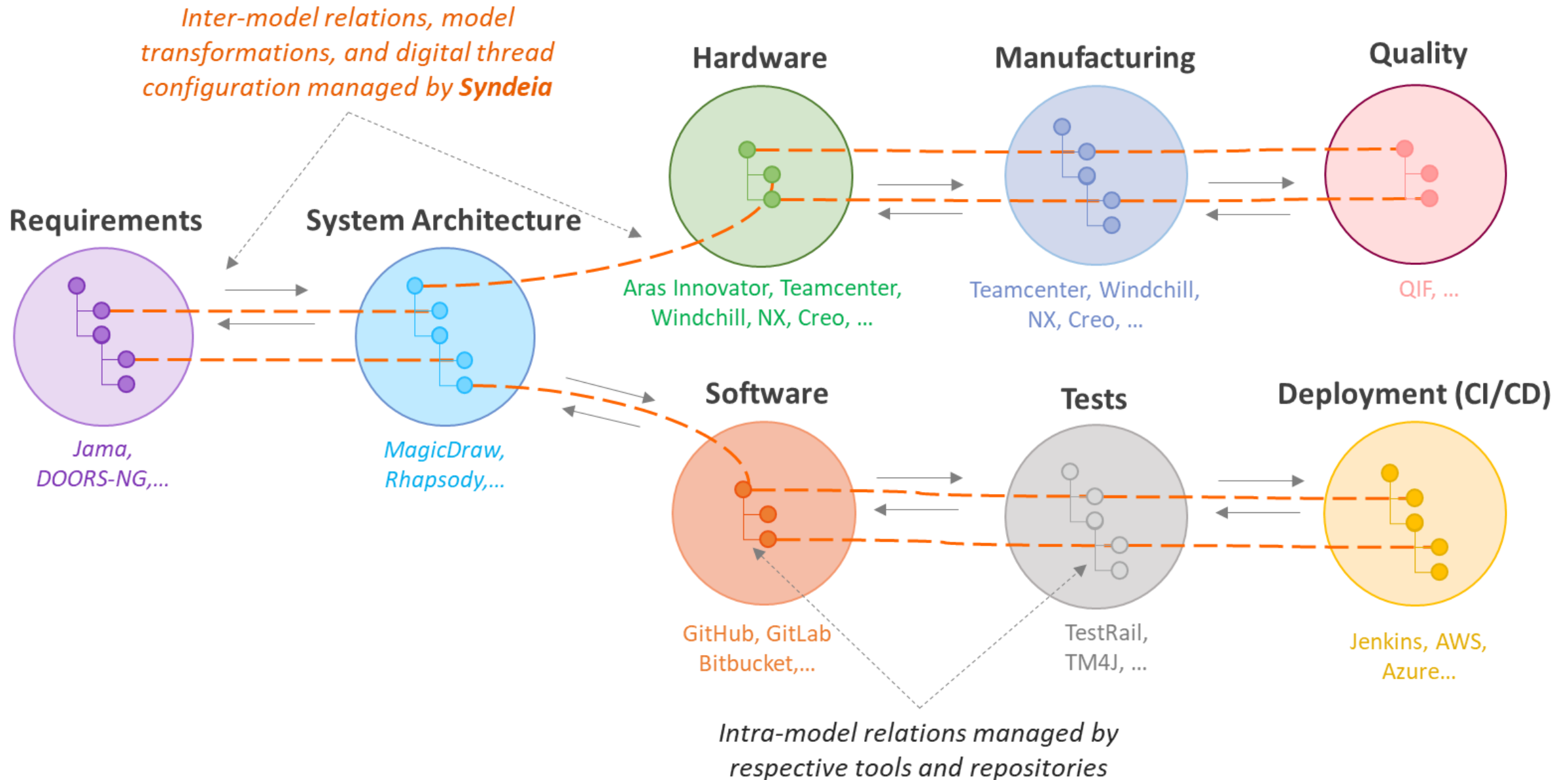
The use of digital tools and representations for design, evaluation, and life cycle management

USAF Global Science and Technology Vision, Task Force. ["Global Horizons Final Report"](#). 2013

A data-driven architecture that links together information generated from across the product lifecycle and is envisioned to be the primary or authoritative data and communication platform for a company's products at any instance of time

Singh, Victor. ["Engineering with a Digital Thread"](#). Aerospace Resource Central, 2018

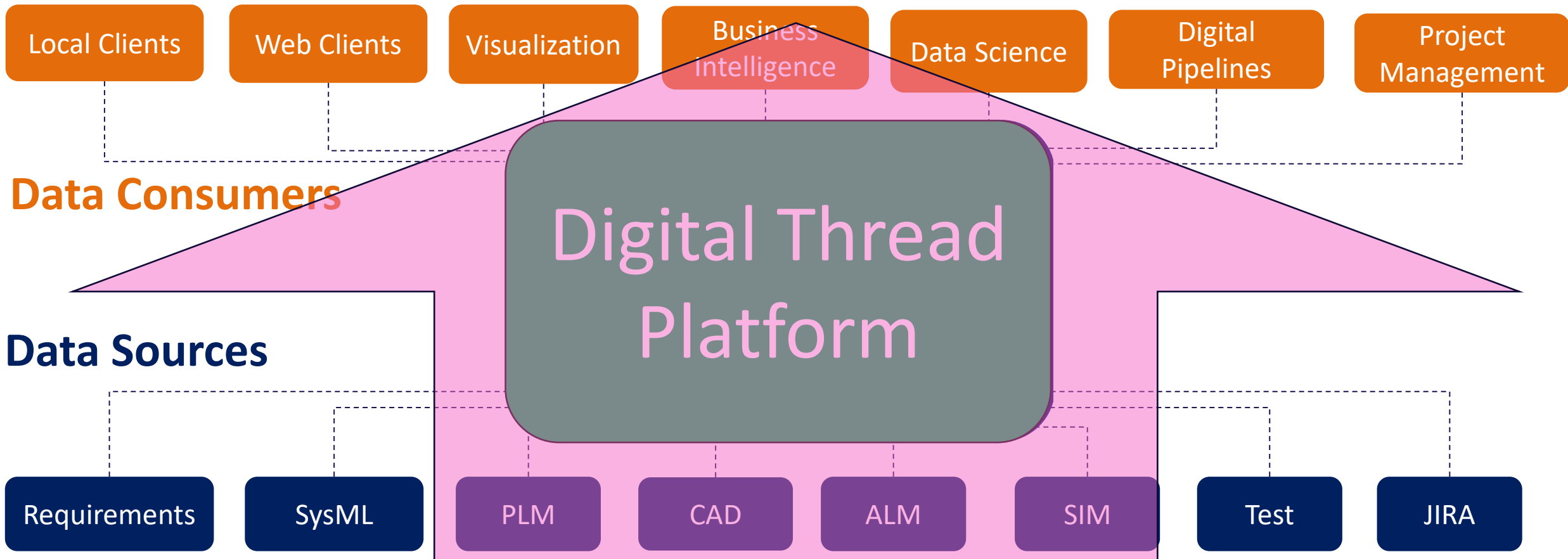
An Open Digital Thread – Federating models across repositories



An *effective* digital thread platform offers



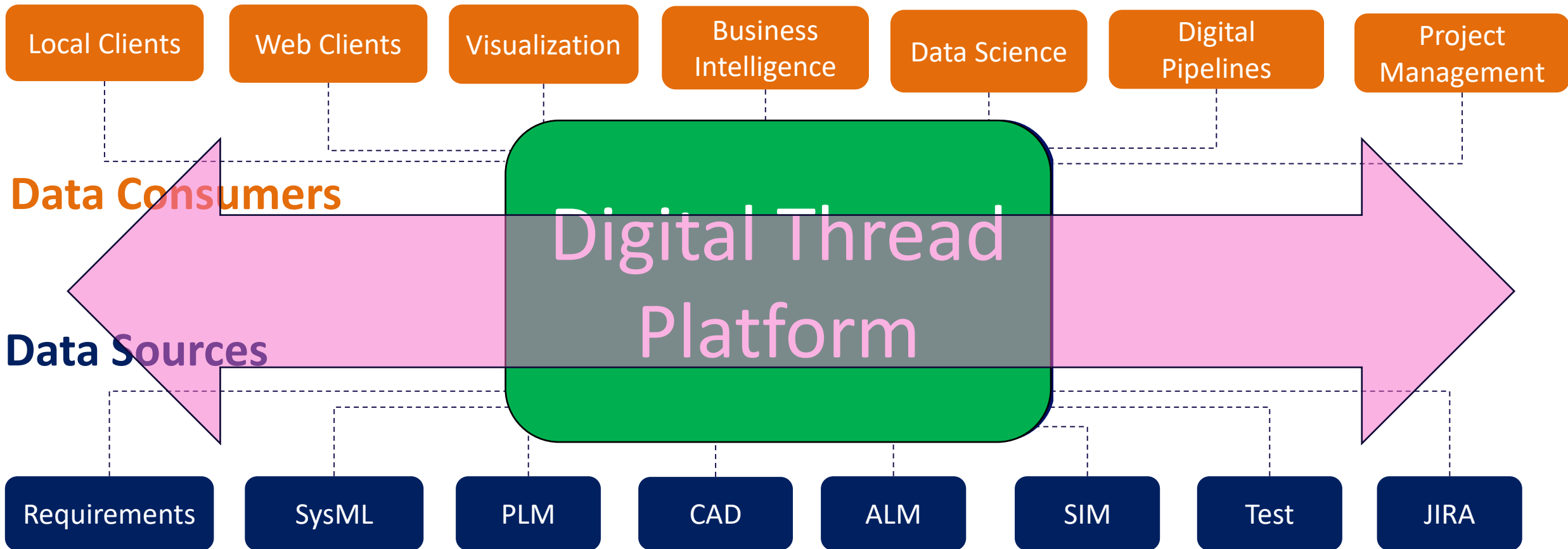
- the capability to explore disorganized data to discover what should be, for business or mission purposes, part of a digital thread,



An effective digital thread platform offers



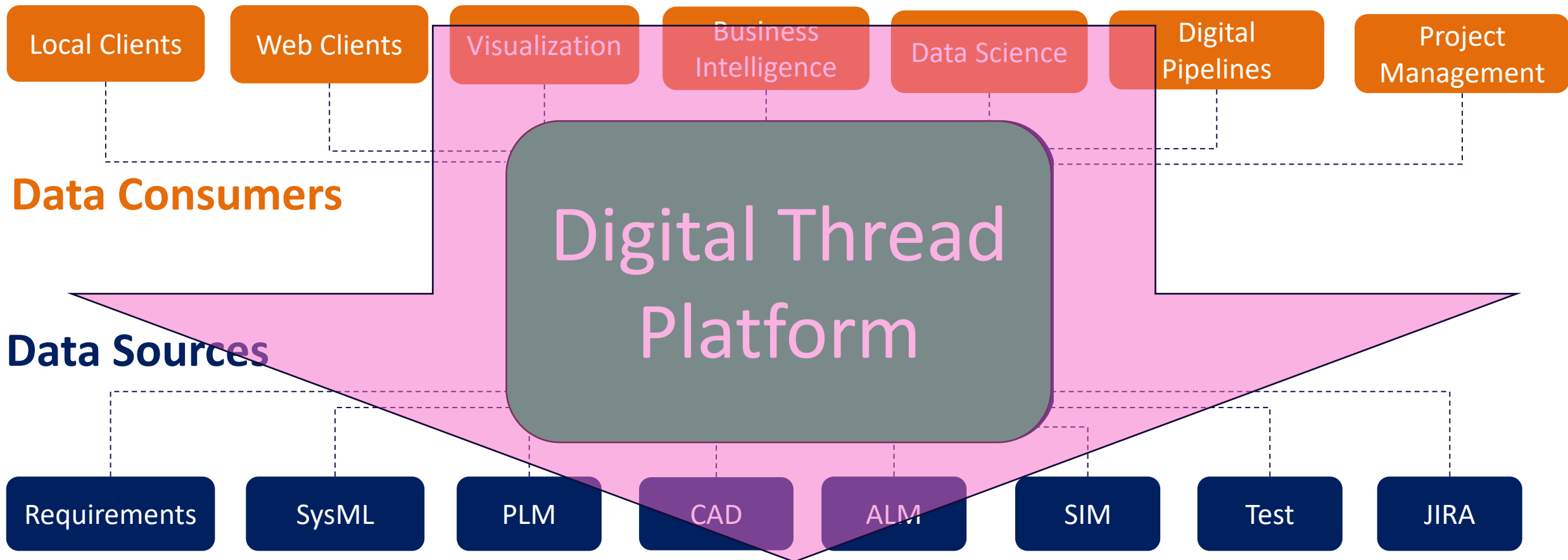
- curation for the creation, reporting, update, and deletion of these digital threads,



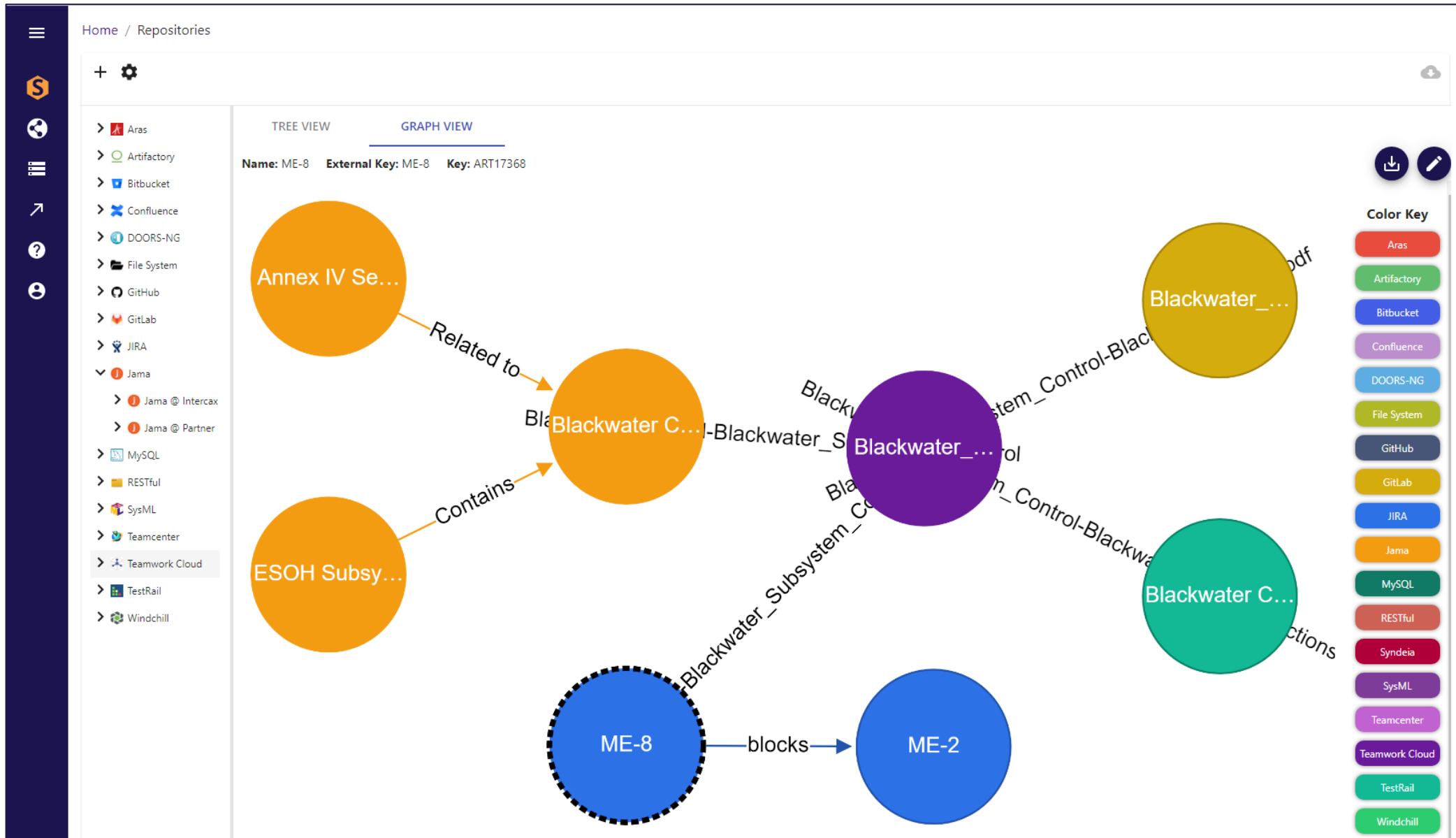
An *effective* digital thread platform offers



- visualization and analytics over the digital threads and to the connected digital artifacts.



Interactive Traceability



Graph Analysis Pattern Matching



Gremlin Query : `g.E().has('sLabel','Relation').has('container','MBDT01')`

Query Builder Raw Query

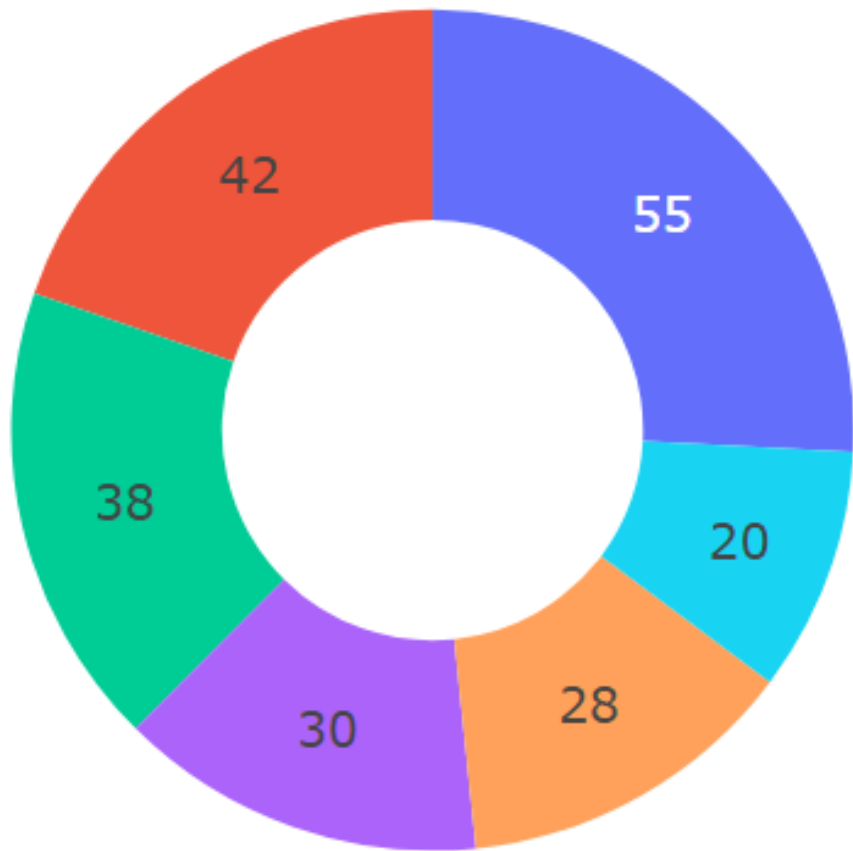
Label: Containers:

Color Key

- GENESYS
- Jama
- Windchill

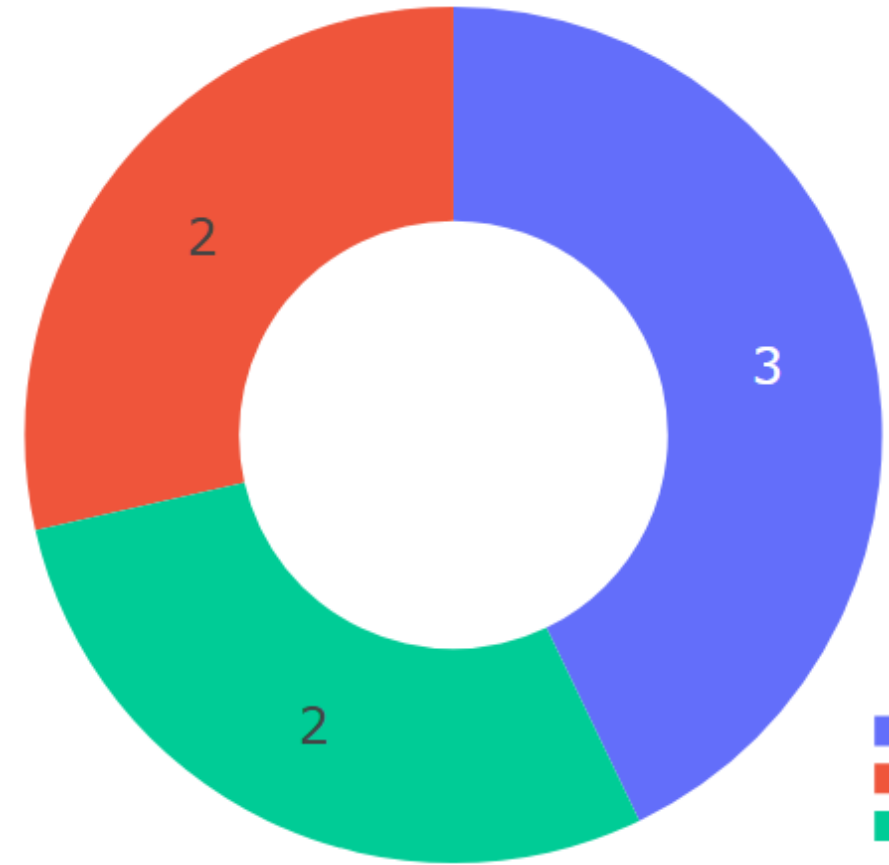


- Connected Artifacts by Repository



- Teamwork Cloud @ Intercax
- Windchill 11.1 @ Intercax
- Jira @ Intercax
- TestRail @ Intercax
- Jama @ Intercax
- Github @ Intercax

Tested Requirements by Test Status

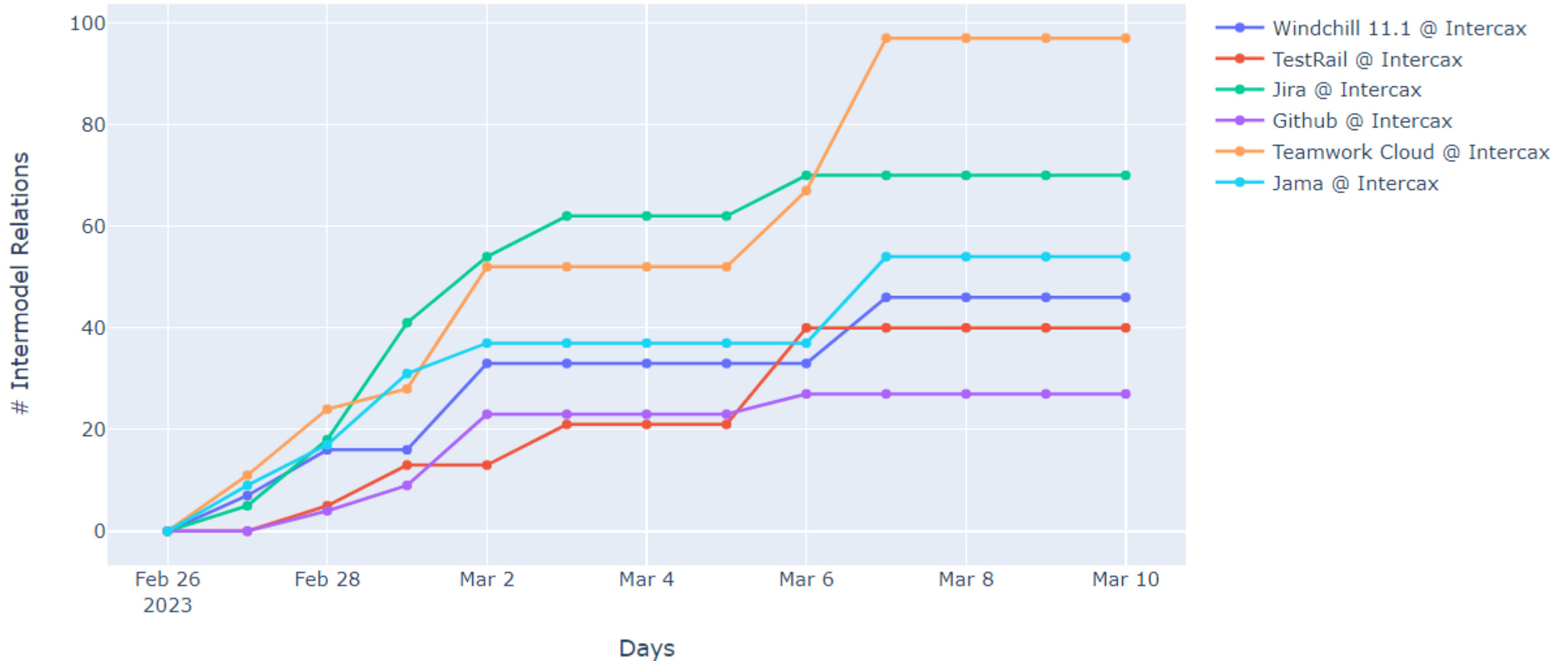


- Passed
- Failed
- Other

Project Metrics - Cumulative Intermodel Relations by Repository



Cumulative Intermodel Relations by Repository





- **Syndeia Cloud, a network-based set of microservices embedded in your development environment to**
 - Read/write the contents of the underlying repositories
 - Create and update a network of inter-model connections for users to navigate and share system data
 - Provide visualization and analytics over the digital threads and to the connected digital artifacts
 - Authenticate users' access to specific data sources
- **An open, fully documented REST API**
- **Specialized clients to support particular use cases:** e. g. Syndeia plug-in clients for Cameo and Rhapsody, Syndeia Web Dashboard, Python and Java language clients



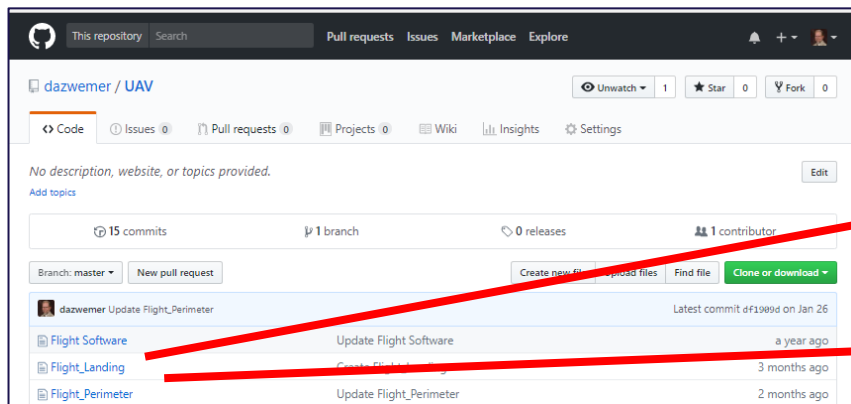
- Manually linking pre-existing data elements across model boundaries
- Creating linkages by transforming data between model repositories
- Using key parameter matches to link data elements
- Rule-based reasoning and automation
- Machine learning and automation



Reference connections link model elements in different tools

- They provide traceability between elements of different types
- They provide quick access to those elements
- They can detect version or timestamp changes in connected elements
- They can be updated to a newer version on demand

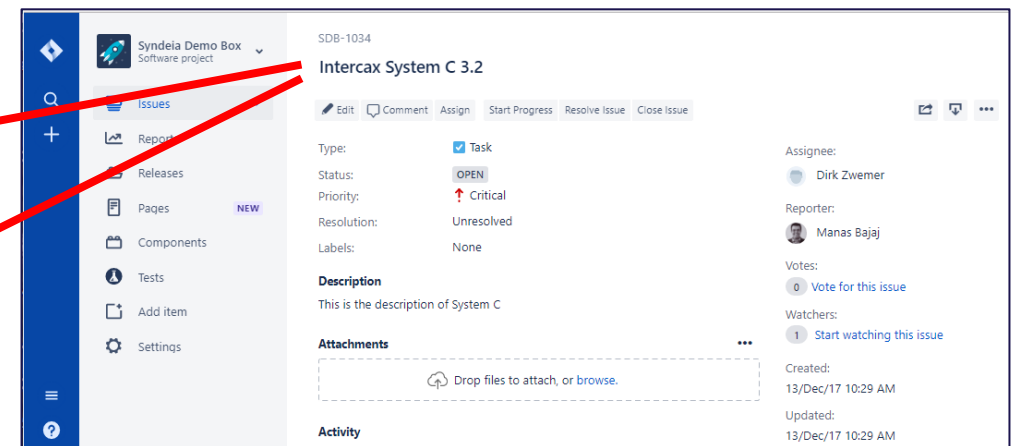
GitHub File



Syndeia Reference Connections

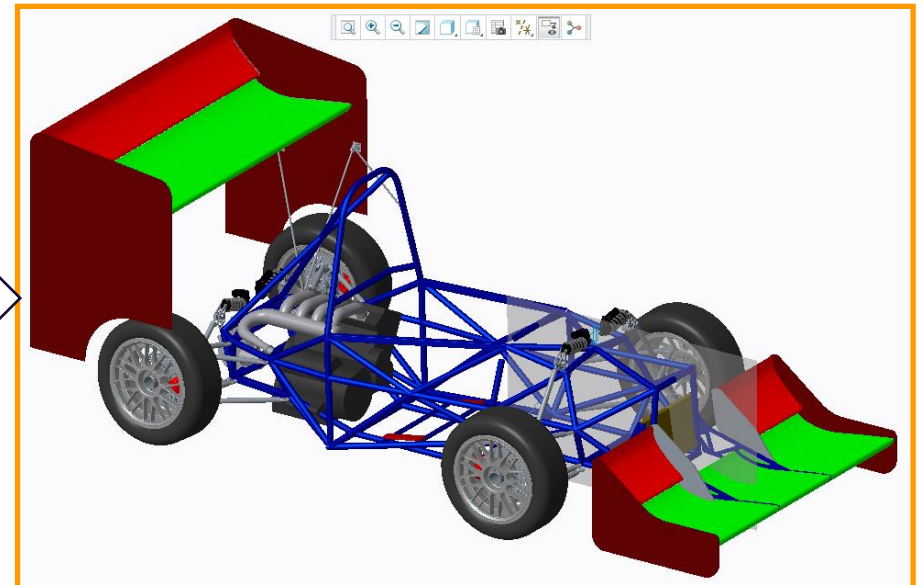
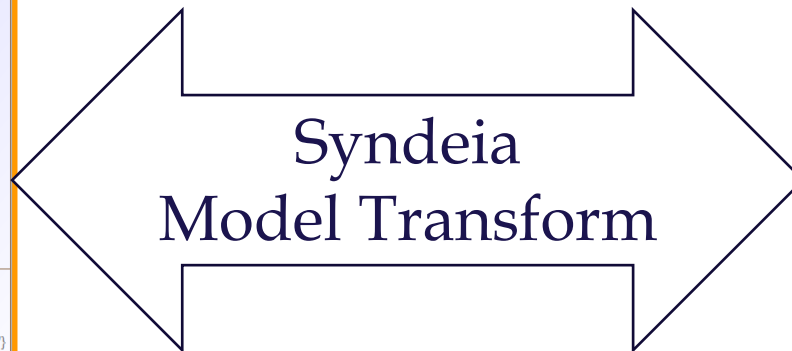
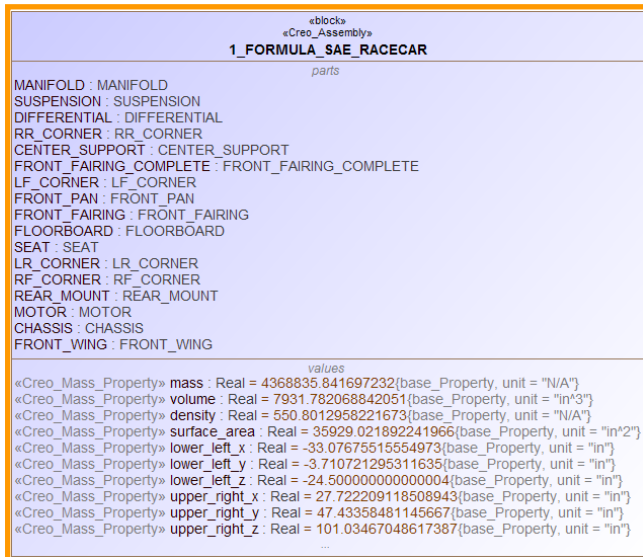


JIRA Issue





Model Transform connections take elements in one tool and create new elements in another, including model structure and attributes. The elements remain connected and can be compared and updated as the models evolve.

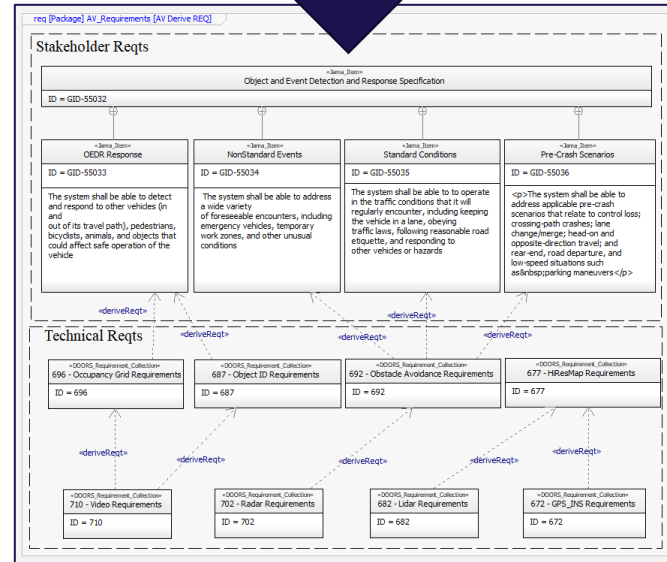
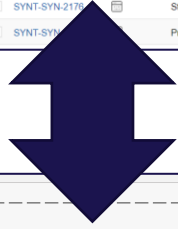


Syndeia Services – Model Transform

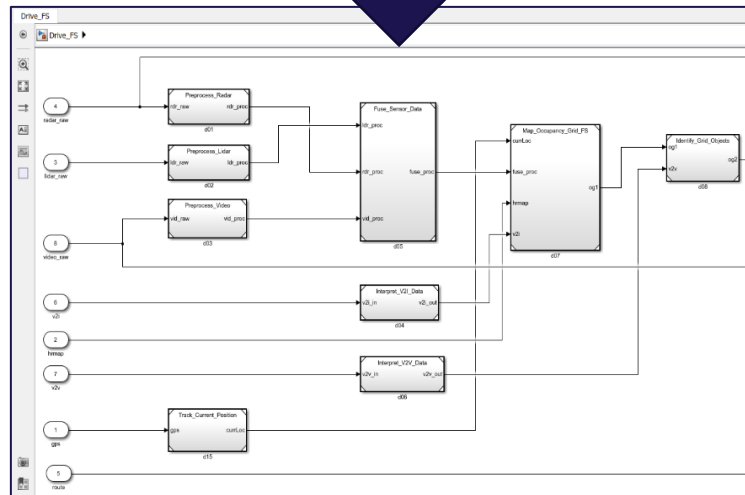
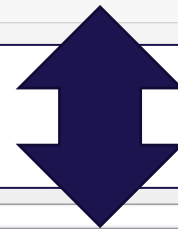
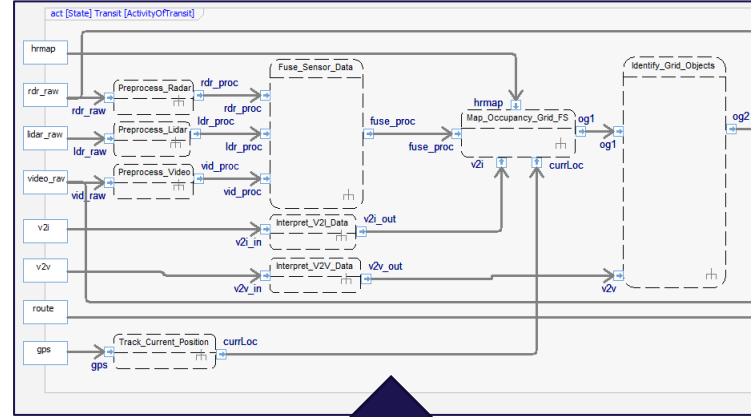


Requirements ↔ Architecture

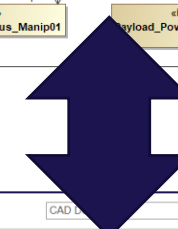
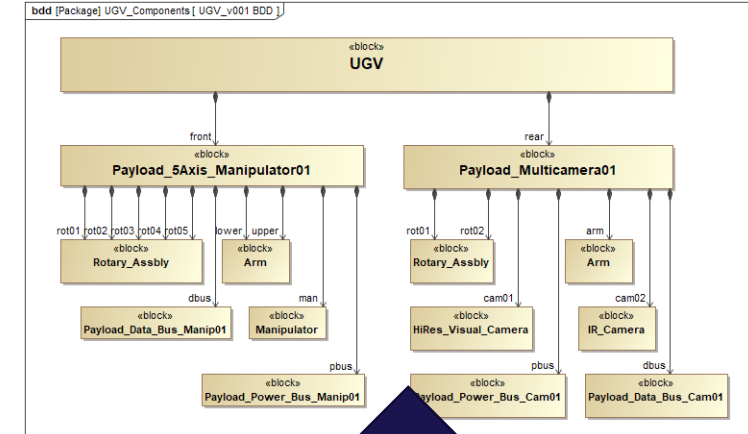
ID	Name	Description
SYNT-SYN-2168	DOT ADS Guidelines	
SYNT-SYN-2169	Operational Design Domain	The system shall define where (such as what roadw...
SYNT-SYN-2170	ODD Definition	The system shall be able to operate safely within th...
SYNT-SYN-2171	ODD Compliance	The system shall be able to operate safely within th...
SYNT-SYN-2172	Out of ODD Operation	The system shall transition to a minimal risk condi...
SYNT-SYN-2173	Object and Event Detection a...	
SYNT-SYN-2174	OEDR Response	The system shall be able to detect and respond to o...
SYNT-SYN-2175	NonStandard Events	The system shall be able to address a wide variety ...
SYNT-SYN-2176	Standard Conditions	The system shall be able to operate in the traffic ...
SYNT-SYN-2177	Pre-Crash Scenarios	The system shall be able to address applicable pre...



Architecture ↔ Simulation

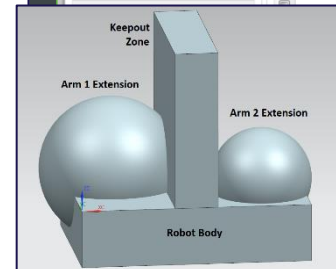


Architecture ↔ PLM/CAD




Folder - UGV2

Name	Number	Name
Syndeia Applications	0000005641	Payload_5Axis_Manipulator01
Autonomous Electric Vehicle	0000005648	StdM_Connector
Maritime_ESOH_Subsystems	0000005647	Payload_Base
Spacecraft	0000005646	Payload_Data_Bus_Manip01
UGV	0000005645	Manipulator
UGV2	0000005644	Arm
	0000005643	Payload_Power_Bus_Manip01
	0000005642	Rotary_Assbly
	0000005621	Payload_Multicamera01
	0000005629	StdM_Connector
	0000005628	Payload_Base
	0000005627	Payload_Power_Bus_Cam01
	0000005626	IR_Camera
	0000005625	Payload_Data_Bus_Cam01
	0000005624	HIRes_Visual_Camera
	0000005623	Arm
	0000005622	Rotary_Assbly





- Manually linking pre-existing data elements across model boundaries
- Creating linkages by transforming data between model repositories
- Using key parameter matches to link data elements 
- Rule-based reasoning and automation
- Machine learning and automation

Connection Generator



Generate Connections

Match existing artifacts and generate connections

Source

Repository: SysML Repository
Project: Model
Scope: Jama_Relationship_Mapping

Target

Repository: Jama @ Intercax
Project: Unmanned Aerial Vehicle
Scope: N/A

Recursive:

Base Type: Requirement

Additional Type: Jama_Requirement

Attribute Filters

Source Attribute Definition	Target Attribute Definition
Id	ID (documentKey)

Find Matches

4 matches found

Selected	Source Artifact	Target Artifact
<input checked="" type="checkbox"/>	requirement_3	Engine Power Requirement
<input checked="" type="checkbox"/>	requirement_2	Engine Size Requirement
<input checked="" type="checkbox"/>	requirement_4	Liftoff Requirement
<input checked="" type="checkbox"/>	requirement_1	Engine Requirement

Select All


Mappings: Requirement - Requirement (no attributes)

Generate Connections

Ready

10:45:22 PM



- Manually linking pre-existing data elements across model boundaries
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Syndeia Cloud – An API-first, Microservices Platform



Syndeia Cloud REST API – Key enabler for an Open Digital Thread

- Digital Engineering platform provides “ready-to-integrate” services
- Build custom interfaces for report generation, design reviews, project management, and more
- API is open and fully documented, secure access to all Digital Thread content through SSO/LDAP/...

Endpoints for core domain concepts and accessing external repositories (e.g. JIRA)

A list of REST API endpoints for managing a JIRA repository. The endpoints include GET and POST methods for various resources like repositories, containers, artifacts, and relations.

Digital documents (traceability report using OpenMBEE)

A screenshot of the Interacx software interface. It shows a project named 'CruiseShip v4' with a filter tree for 'UAV'. A report titled '4 UAV Structure & Related Artifacts' is displayed, including a table of UAV structure rapid table.

Blocks	Related Artifacts
Wastewater_Subsystem	Simulink model, Wastewater_Subsystem; Teamcenter ItemRevision, 003493/A; JIRA Task, CSE-4 (CSE-4)
Freshwater_Subsystem	Simulink model, Freshwater_Subsystem; Teamcenter ItemRevision, 003512/A; JIRA Task, CSE-23 (CSE-23)
Bilge_Water_Subsystem	Simulink model, Bilge_Water_Subsystem; Teamcenter ItemRevision, 003495/A; JIRA Task, CSE-6 (CSE-6)
Blackwater_Treatment	Simulink model, Blackwater_Treatment; Teamcenter ItemRevision, 003513/A; JIRA Task, CSE-24 (CSE-24)

Syndeia generates a complete report of the model connections and versions in **seconds vs. days or weeks** using traditional methods. **Traceability for stakeholders**

Data science (Jupyter notebook analysis of Aras Innovator PLM repository)

A screenshot of a Jupyter notebook titled 'Syndeia_Cloud_3.4_Aras_Innovator_Latest'. The notebook contains Python code for data analysis and a bar chart showing the results. The code uses the 'go' library to analyze parts and assemblies.

```
'SYN01-Part-C2 -> Part C2']
Parts of type Component and state Released = 6
['0403 -> Clamp',
'1201 -> Gasket',
'4209 -> Tank Top',
'5319 -> Valve Asm',
'5704 -> Tank Bottom',
'5746 -> Hose']

In [23]: # 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()
```

Part Type	Released	Preliminary
Components	6	15
Assemblies	6	25

Syndeia Services – Digital Pipelines



Conceptual Model of a Digital Pipeline

Automated Jama -> Jira model transform + digital thread synthesis pipeline (**Running in Jenkins**)

Schedule = Runs every 12 hours, starting 25-Feb-2021 at 0600 hours
 Current = Run #3 started 26-Feb-2021 at 0600 hours

Sandbox / Jama to Jira Pipeline < 34

Branch: – 10s No char
 Commit: – - Started

Start Extract from Jama P

Push to Jira - 4s

- transformed – Restore files previously stashed
- ./load.py – Shell Script

Jenkins

Sandbox / Jama to Jira Pipeline ☆ ⚙

Activity Branches Pull Requests

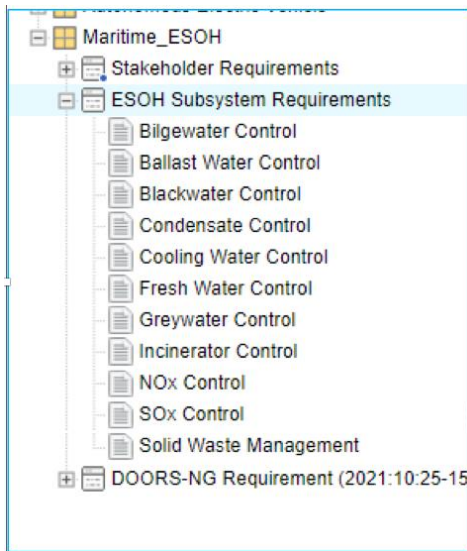
Run Disable

STATUS	RUN	COMMIT	MESSAGE	DURATION	COMPLETED
✓	33	–	Started by user Manas Bajaj	27s	a few seconds ago
✓	32	–	Started by user Ivan Gomes	29s	a day ago
✓	30	–	Started by user Ivan Gomes	29s	a day ago
✓	29	–	Started by user Ivan Gomes	24s	2 days ago
✓	28	–	Started by user Manas Bajaj	27s	3 days ago
✓	27	–	Started by GitHub push by ivan-at-intercax	27s	3 days ago
✓	26	–	Started by GitHub push by ivan-at-intercax	26s	3 days ago
✓	25	–	Started by GitHub push by ivan-at-intercax	53s	3 days ago
✗	24	–	Started by GitHub push by ivan-at-intercax	6s	3 days ago
✓	23	–	Started by GitHub push by ivan-at-intercax	5s	3 days ago
✓	22	–	Started by user Ivan Gomes	6s	3 days ago
✗	21	–	Started by user Ivan Gomes	48s	3 days ago
✗	20	–	Started by user Ivan Gomes	5s	3 days ago

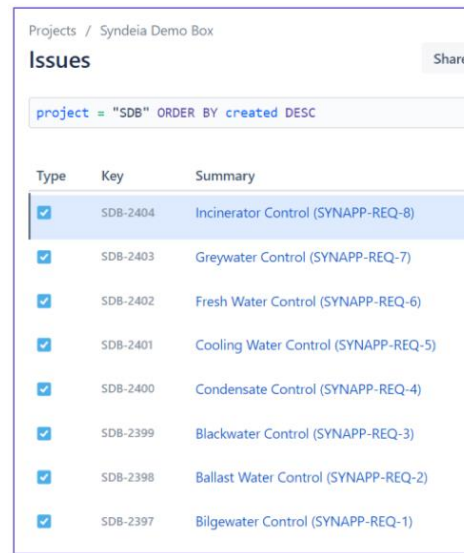


Digital Pipelines = CI/CD Pipelines for Digital Threads / MBE

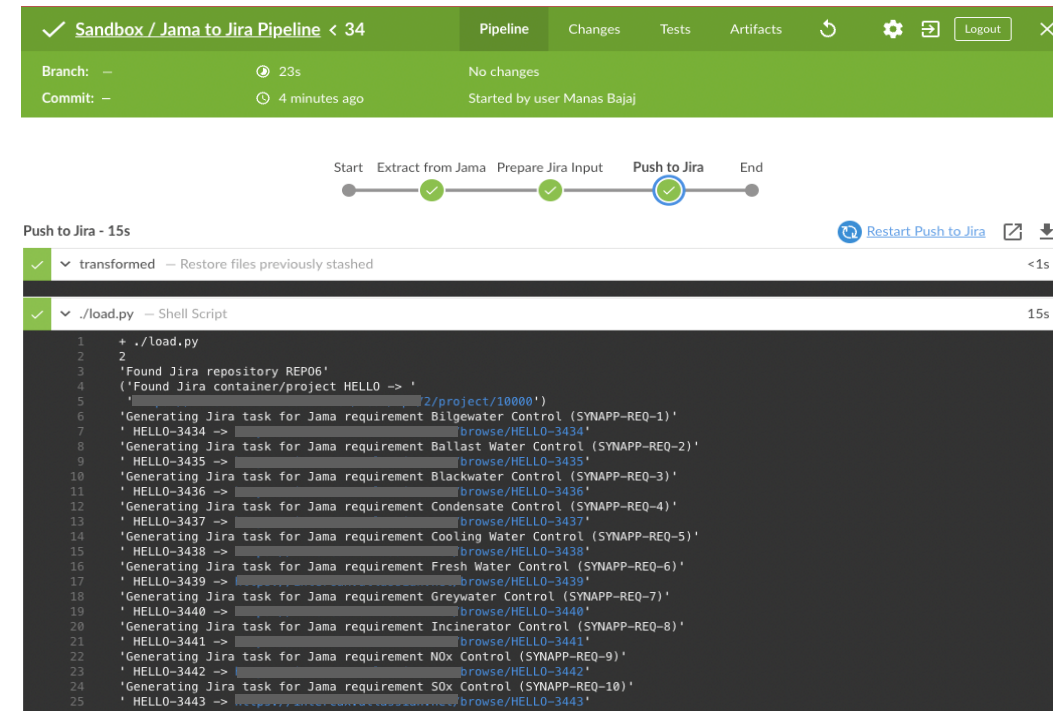
- Modern software DevOps uses CI/CD pipelines
- Digital Pipelines = DevSecOps + Digital Thread
 - Automatically build, update, test, baseline digital threads and generate reports
 - Schedule based on time and events
 - NASA SBIR Phase 1 and 2 awards (2021-2023)



Jama



Jira



Jenkins Pipeline using Syndeia Cloud API



- Building the Digital Thread is an important issue
- There are multiple effective approaches
- The long-term goal is to make it as transparent as possible to the users



- Check out our website for product info and video demonstrations at www.intercax.com/syndeia
- Read our on-line user guide and tutorials at <https://intercax.atlassian.net/wiki/spaces/SYN35>
- Schedule a web demo with InterCAX – contact us at info@intercax.com
- Request an evaluation license – set up an account and submit your request at www.intercax.com/help
- Syndeia Live Training Program – <https://intercax.com/services/syndeia-training-programs/>





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