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System Lifecycle Handler for NIST Digital Thread

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About Intercax



- Georgia Tech spin-off 2008
- **Headquartered** in Atlanta, GA
- **Focus:** Software for MBE/MBSE
 - **Syndeia** – MBSE (SysML) + PLM/CAD/CAE/Data/Simulations
 - SysML parametric solvers (**ParaMagic, Melody, Solvea, & ParaSolver**)
- Training, consulting, custom apps
 - 4500+ participants since 2008
- Customers
 - Gov.: NASA, DoD, DoE, DoC
 - Commercial: aero, auto, transportation, consumer goods, energy, mfg., healthcare

INCOSE SE Vision 2025



Systems


Interconnected

Interdependent

Complex

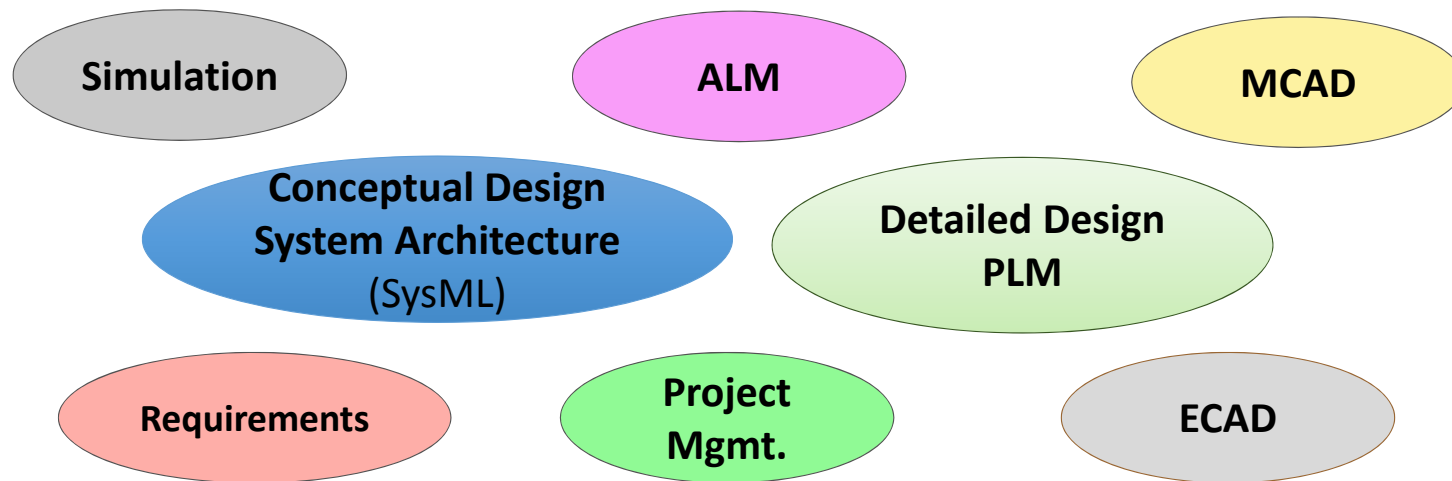
INCOSE SE Vision 2025
<http://goo.gl/uE5OS9>

Contents

- Model-Based Engineering 
- Total System Model
- NIST Digital Thread
- System Lifecycle Handler
 - Use Cases
 - Syndeia foundations
- Questions and Comments

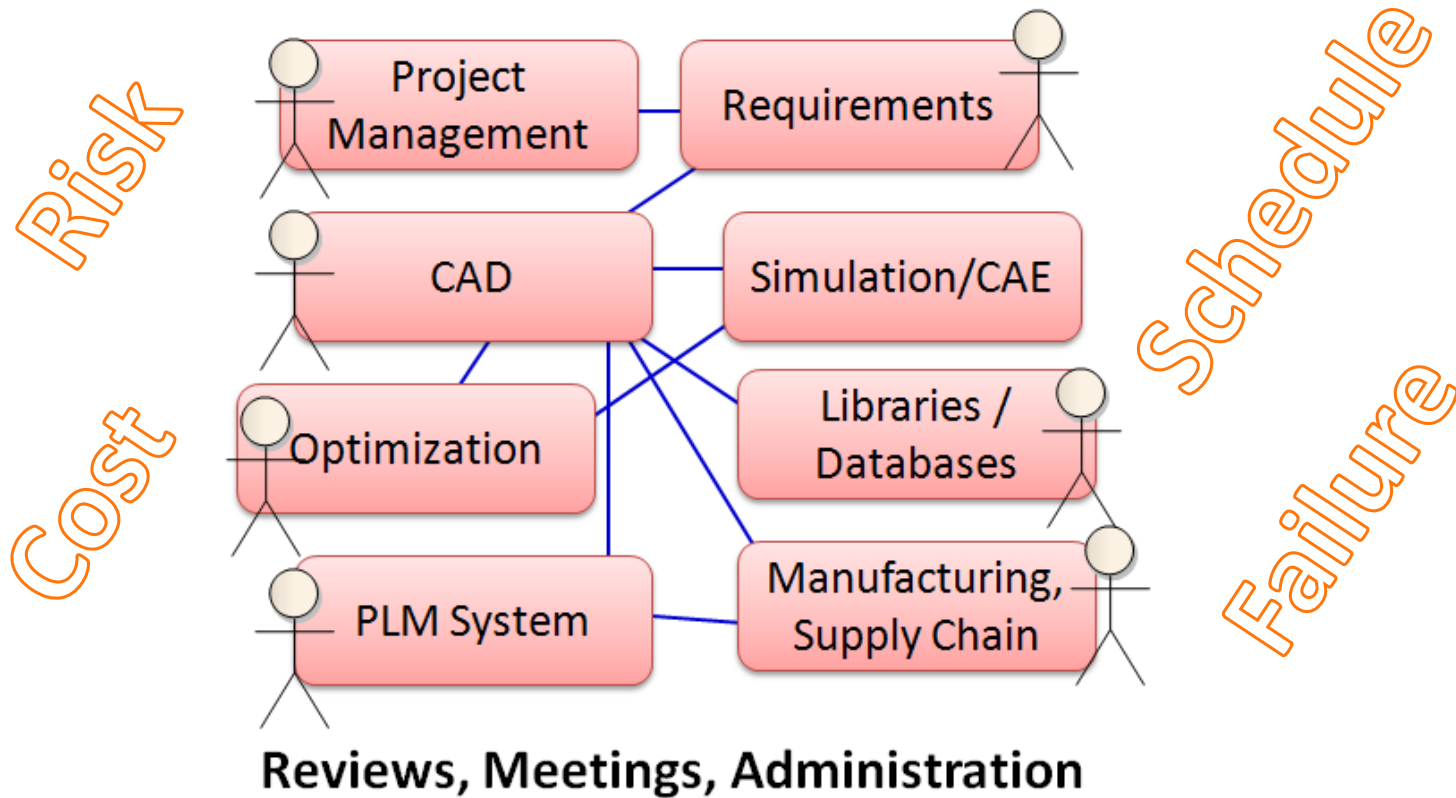
Diversity and Heterogeneity of Models across Lifecycle

- Model repositories/environments (PLM for hardware, ALM/SCM for software, Requirement management systems, Databases, and more)
- Modeling languages and standards (SysML, UPDM, FMI, STEP, Modelica, ...)



Where is the system architecture / blueprint?

Point-to-point ad-hoc information flows
without a common architecture model



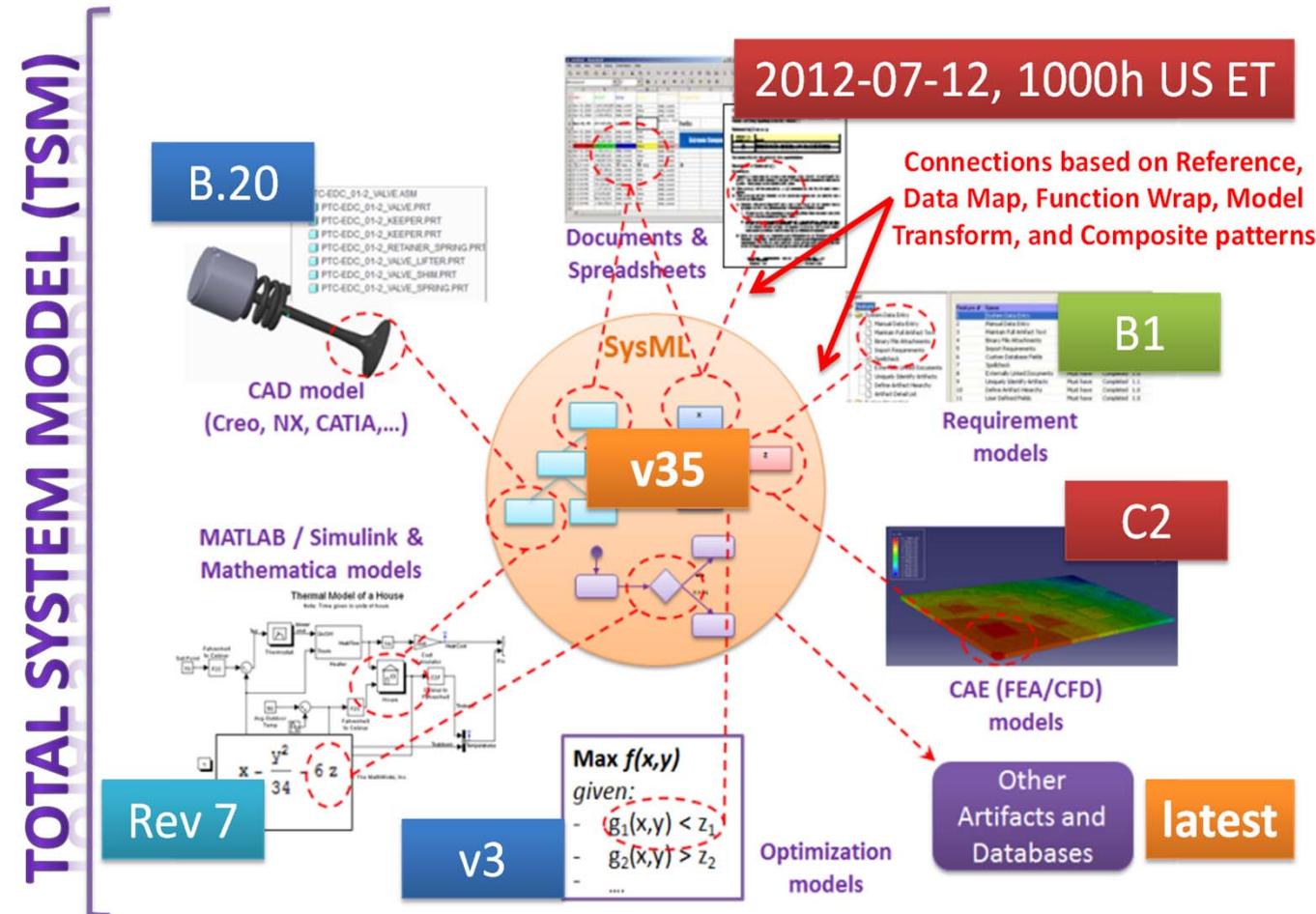
*Use of models in each engineering discipline does
not give us the Digital Product/System*

Foundations for MBE of Complex Systems

Bajaj, M., Zwemer, D., Yntema, R., Phung, A., Kumar, A., Dwivedi, A., Waikar, M. "MBSE++ — Foundations for Extended Model-Based Systems Engineering Across System Lifecycle". 26th Annual INCOSE International Symposium (IS 2016) Edinburgh, Scotland, UK, July 18-21, 2016

1. Heterogeneous and Decentralized Data
2. Capturing and Maintaining High-Level System Architecture
3. Spectrum of Model-Based Connections
4. Unified Framework for Model-Based Connections
5. From Traceability to Impact
6. Many Users, Many Views

Total System Model – A Federated *Graph*



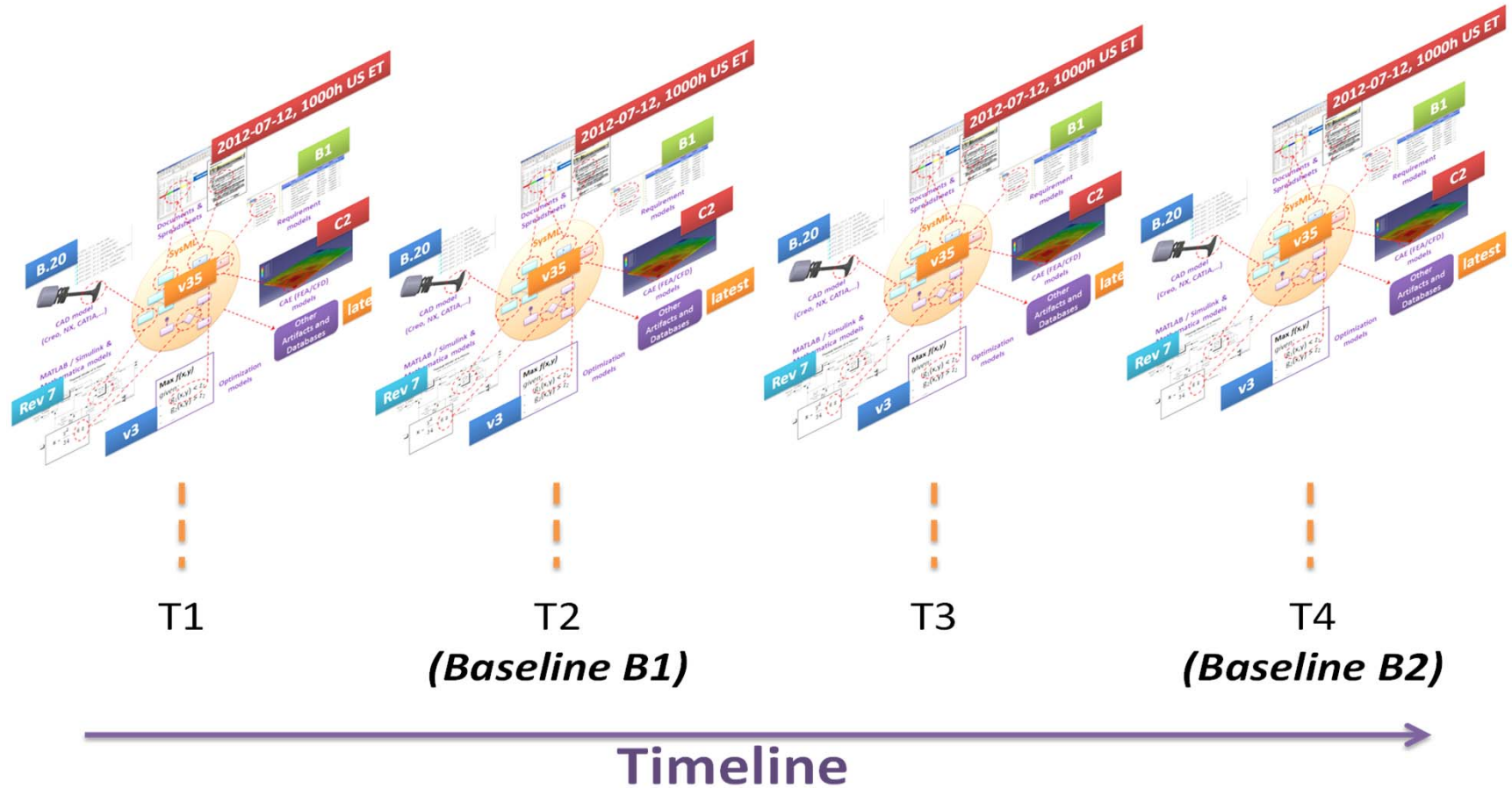
Connect architecture model (SysML) with domain-specific models

Total System Model (TSM) as a digital blueprint of the system connecting models across disciplines, tools, and version-management systems

Goal: Seamless traceability between disciplines across the system lifecycle

Total System Model (TSM)

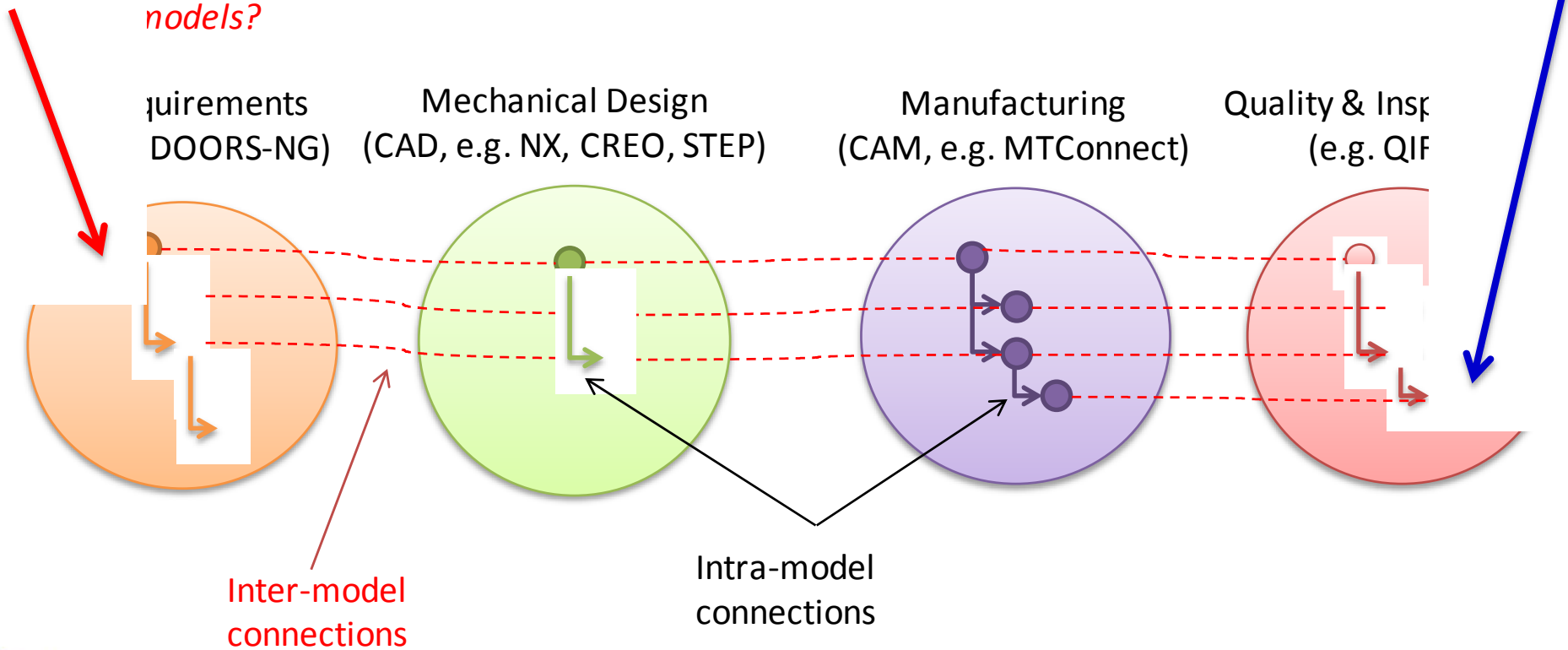
TSM evolves as each of the version-managed models evolve



Intra-Model and Inter-Model Connections

If I change this requirement, what is the downstream impact, e.g. to CAD and CAM models?

Trace the CAD and CAM models for this part and compare attributes against test results



Model-Based Connection Patterns

- What is the purpose of model-based connections?

Reference Connections

 **Track/compare/sync versions of connected elements**

Data Map Connections

 **+ Track/compare/sync element attributes**


Function Wrap Connections

 **+ Track/execute connection elements**

Model Transform Connections

 **+ Track/compare/sync element structure (multi-level)**

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NIST Digital Thread Initiative

- Developing methods & open standards to support validating, certifying, and connecting engineering models across lifecycle
- Goals
 - Seamless System -> Design -> Manufacturing -> Operations -> Maintenance
 - High-quality manufacturing
 - Enterprise knowledge reuse
- Learn more at:

<http://www.nist.gov/el/msid/syseng/dtism.cfm>

System Lifecycle Handler (SLH) for NIST Digital Thread

- **Use Cases**

- *Connect* to enterprise repositories, such as PLM systems, ALM systems, and databases, where models are version managed
- *Search* and *query* versioned models in repositories
- *Subscribe* and *track* model elements via a handle system (e.g. DOI for documents)
- *Visualize* and *trace* connected models


- **System Lifecycle Handler** is a web application (software environment)

- RESTful web-services for use cases above
- Founded on Syndeia platform (developed by Intercax)

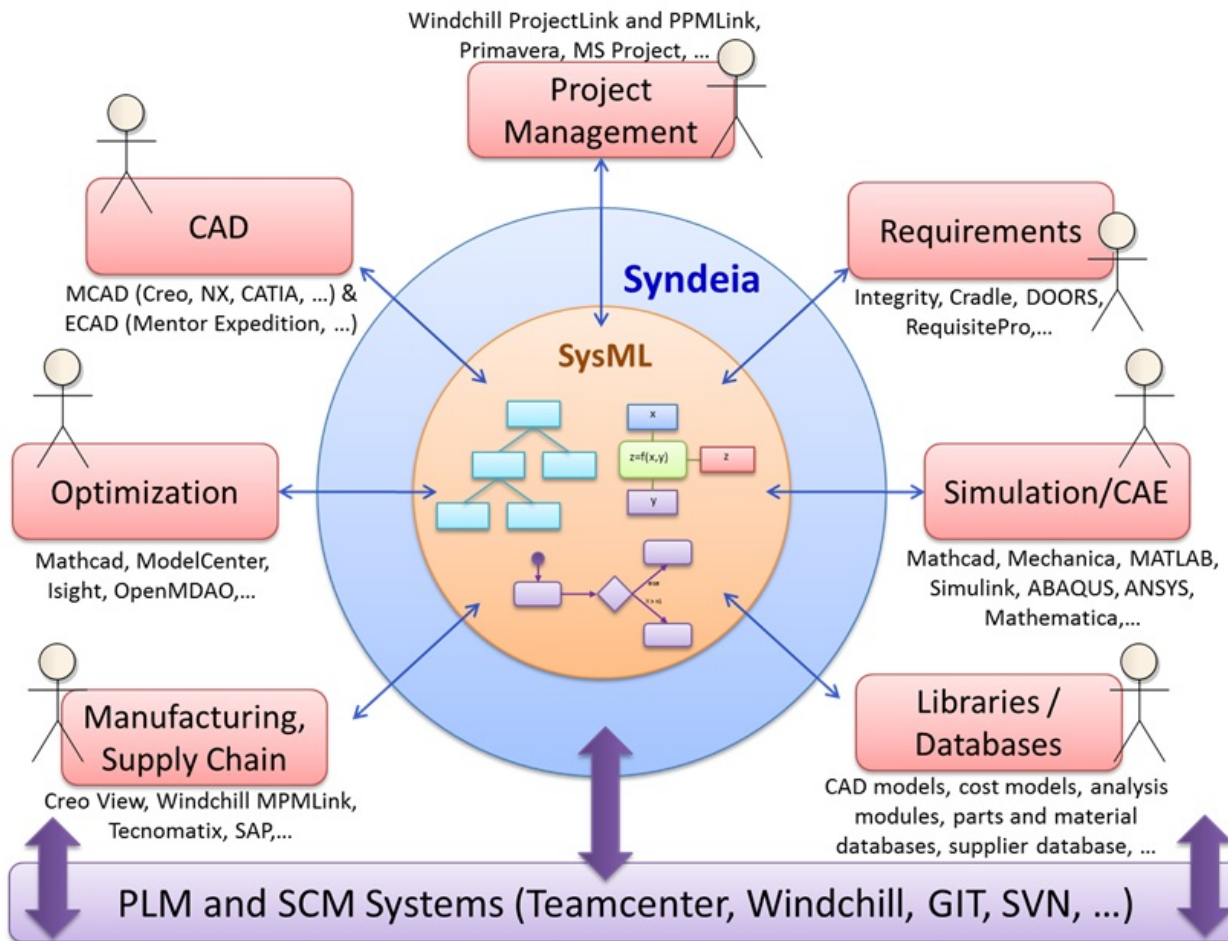
- **Expected Outcomes** of this project

- Meta-models for system lifecycle integration that can be standardized (OMG, ISO)
- Demonstration of SLH services for challenge problems at industry events
- Commercially available as **Syndeia Cloud** platform (Fall 2017)

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Syndeia = Software Platform for MBSE++



Search, Connect, Access,
Transform, Compare, Sync,
Visualize models in the TSM

We will illustrate 6 principles
of MBSE++ using Syndeia

Syndeia 3.0 released July
2016 – www.syndeia.com

Connect to enterprise repositories (PLM, ALM, DB,...)

The screenshot shows the Repository Manager interface with the following components:

- Repository Manager** (Title Bar)
- Repositories** (Left Panel): Lists various connections including DOORS, GitHub, JIRA, Local File System, MySQL, Teamcenter, and Windchill.
- Unmanned Aerial Vehicle** (Main Tree View):
 - Part Structure (latest)
 - UnmannedAerialVehicle (A.16)
 - auto1 : Autopilot (A.1)
 - comm_con1 : CommunicationsController (A.1)
 - databus : Data_Bus (A.1)
 - flight_con1 : FlightController (A.1)
 - gprs1 : GPRS_UMTS_Module (A.1)
 - gps : GPS (A.1)
 - pltfm1 : Aircraft Platform (A.1)
 - pyld_con1 : PayloadController (A.1)
 - ssr1 : SpreadSpectrum (A.1)
 - sw : UAS_Software (A.1)
 - therm1 : ThermalCamera (A.1)
 - therm2 : WideAngleIRDetector (A.1)
 - vis1 : VisualCamera (A.1)
 - wifi1 : WiFiModule (A.1)
 - Requirements
 - Satellite (Precise BOM)
 - TraceLinks
 - UAV (Imprecise BOM)
 - 000464-Unmanned Aerial Vehicle
 - 000464/A; 1-Unmanned Aerial Vehicle
 - 000464/B; 1-Unmanned Aerial Vehicle
 - 000464/C; 2-Unmanned Aerial Vehicle
 - Unmanned Aerial Vehicle->Fire UAV Specification
 - 000464/C-View (Imprecise)
 - aircraft platform : 000465/E; 1-Aircraft Platform
 - gps : 000466/A; 1-GPS
 - autopilot : 000467/A; 1-Autopilot
 - databus : 000468/A; 1-Databus
 - flight controller : 000469/A; 1-Flight Controller
 - payload controller : 000470/A; 1-Payload Controller
 - communications controller : 000471/A; 1-Communications Controller
 - wimax module : 000472/A; 1-WiMax Module
 - gprs module : 000473/A; 1-GPRS UMTS Module
 - modem : 000474/A; 1-Spread Spectrum Modem
 - visual camera : 000475/A; 1-Visual Camera
 - thermal camera : 000476/A; 1-Thermal Camera
 - ir detector : 000477/A; 1-Wide Angle IR Detector

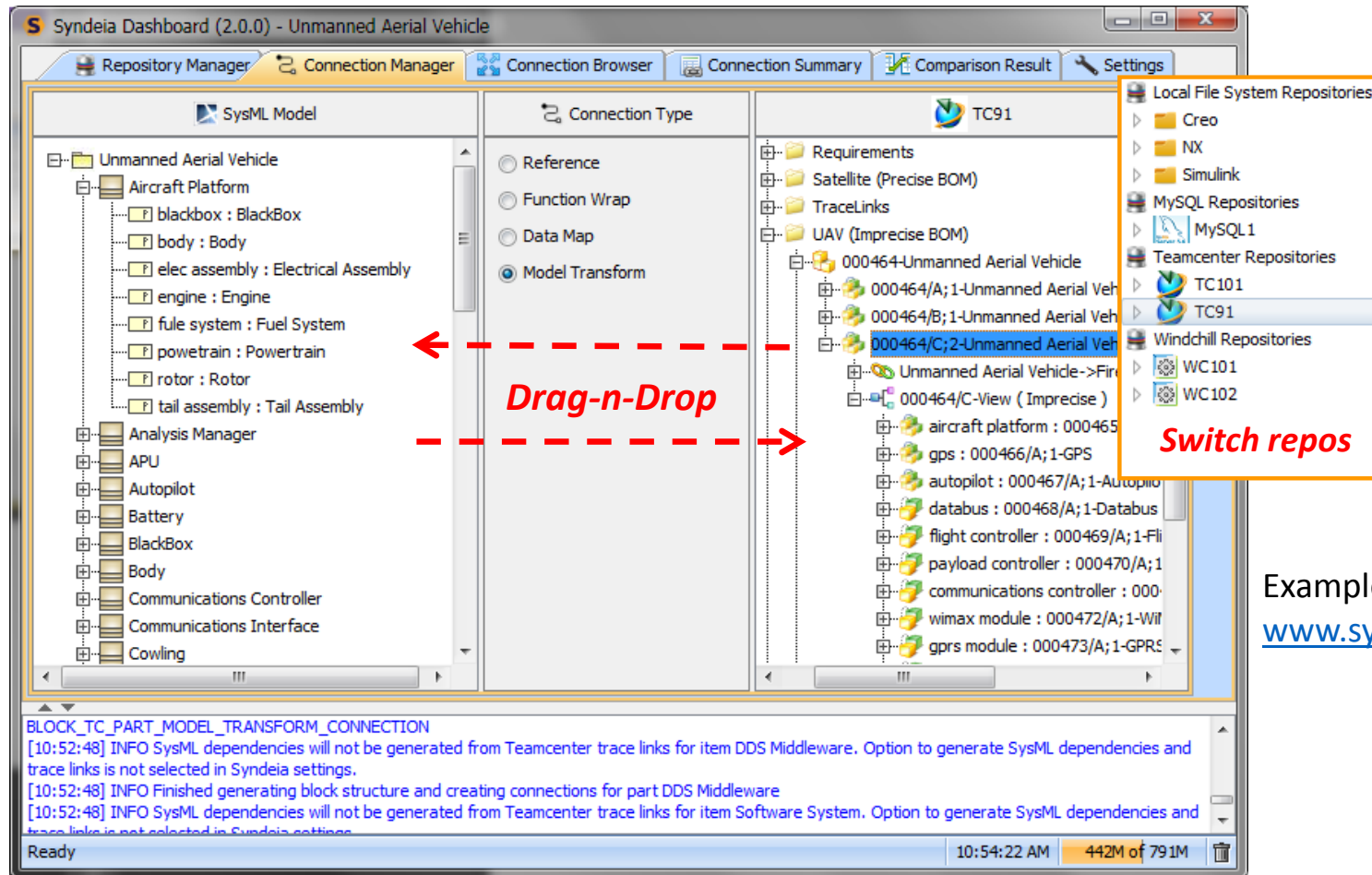
Windchill

Teamcenter

MySQL

Example – Connecting to multiple enterprise model repositories from a single interface (Syndeia – www.syndeia.com)

Drag-n-Drop connect existing or generate new models



Example using Syndeia
www.syndeia.com

Compare and synchronize across inter-model connections

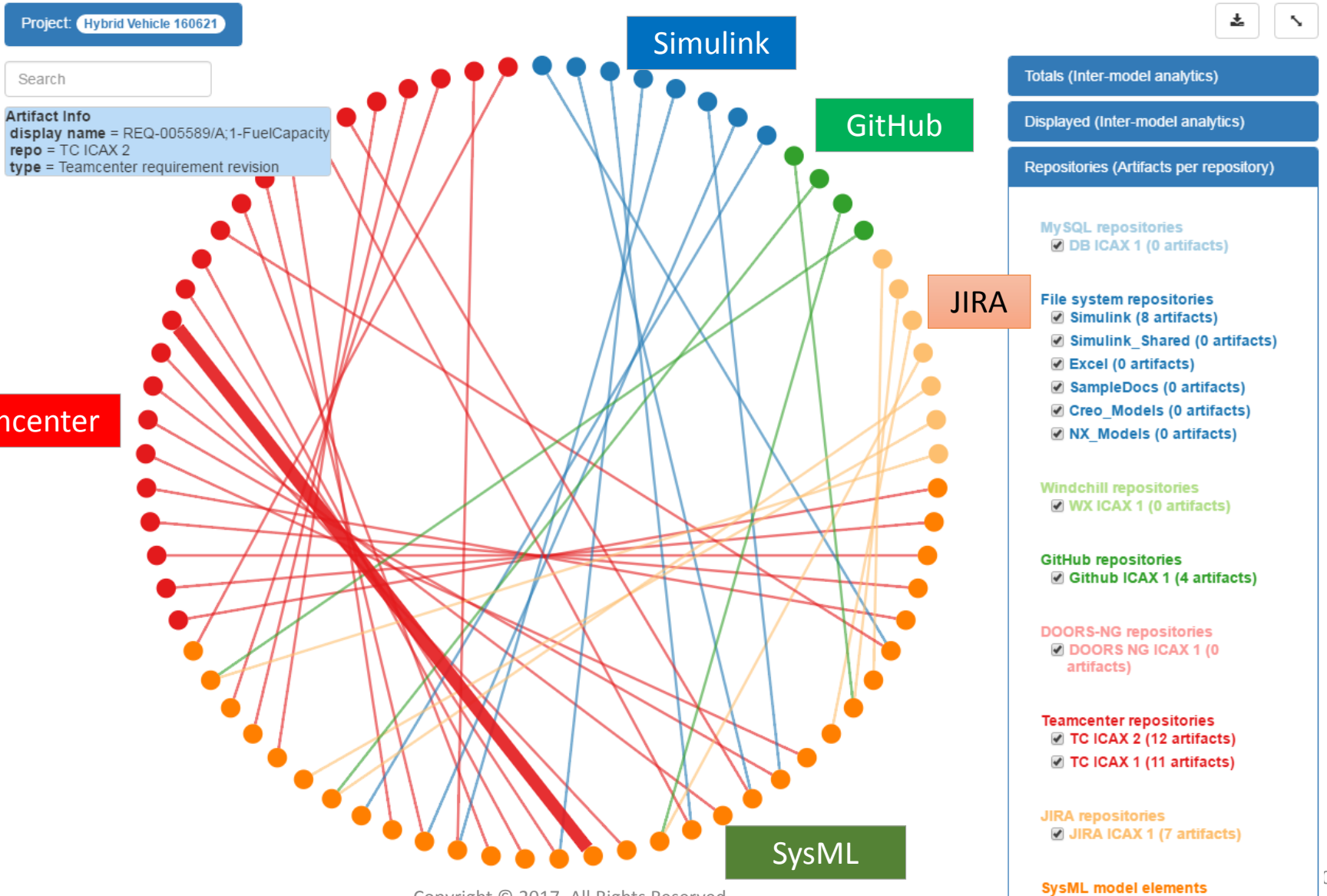
The screenshot displays the 'Comparison Result' window in the Syndeia application. The window has a menu bar with 'Repository Manager', 'Connection Manager', 'Connection Browser', 'Connection Summary', 'Comparison Result', and 'Settings'. Below the menu is a search bar with the text 'Type here to filter connections' and buttons for 'Clear' and 'Export to Excel'. The main area contains a table with the following columns: Conn ID, Source, Target, Latest Target, and Comment. The table lists various components and their connections, with some rows highlighted in red to indicate differences or errors.

Conn ID	Source	Target	Latest Target	Comment
e3f03...	Unmanned Aerial Vehicle	000464/C;2-Unmanned Aerial Vehicle	000464/C;2-Unmanned Aerial Vehicle	The block Unmanned Aerial Vehic...
	wimax module : WiMax Module	wimax module : 000472/A;1-WiMa...	wimax module : 000472/A;1-WiMax M...	Part property wimax module and...
	visual camera : Visual Camera	visual camera : 000475/A;1-Visual ...	visual camera : 000475/A;1-Visual Ca...	Part property visual camera and ...
	trackers : Sensor			Part property trackers has no co...
	thermal camera : Thermal Camera	thermal camera : 000476/A;1-Ther...	thermal camera : 000476/A;1-Therma...	Part property thermal camera an...
	software : Software System	software : 000487/B;1-Software S...	software : 000487/B;1-Software Syst...	Part property software and part...
	payload controller : Payload Controller	payload controller : 000470/A;1-P...	payload controller : 000470/A;1-Payl...	Part property payload controller ...
	modem : Spread Spectrum Radio M...	modem : 000474/A;1-Spread Spec...	modem : 000474/A;1-Spread Spectru...	Part property modem and part o...
	ir detector : Wide Angle IR Detector	ir detector : 000477/A;1-Wide Ang...	ir detector : 000477/A;1-Wide Angle I...	Part property ir detector and pa...
	gps : GPS	gps : 000466/A;1-GPS	gps : 000466/A;1-GPS	Part property gps and part occu...
	gprs module : GPRS UMTS Module	gprs module : 000473/A;1-GPRS U...	gprs module : 000473/A;1-GPRS UMT...	Part property gprs module and p...
	flight controller : Flight Controller	flight controller : 000469/A;1-Fligh...	flight controller : 000469/A;1-Flight C...	Part property flight controller an...

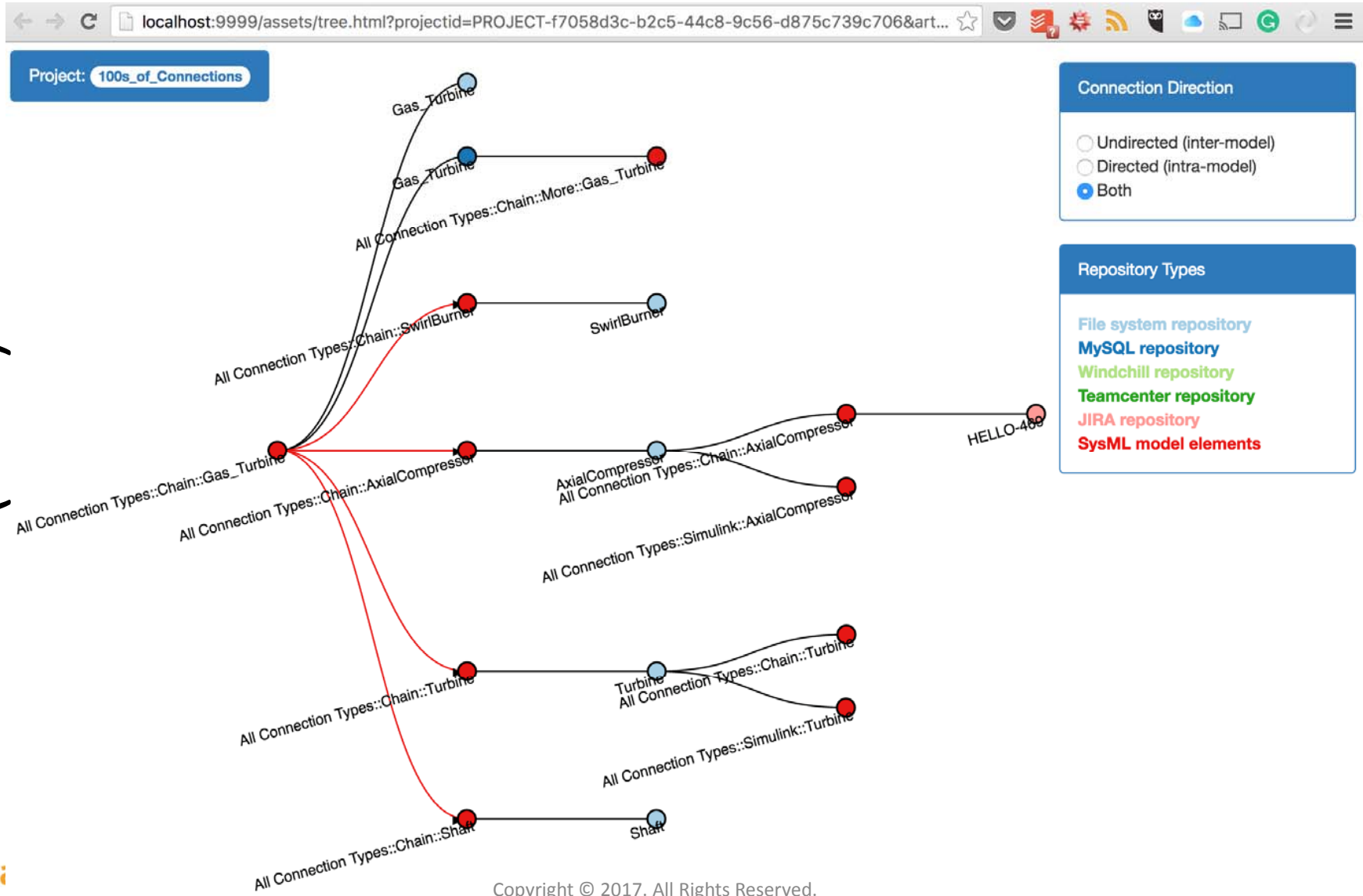
At the bottom of the window, there is a status bar with the text: [11:56:22] INFO Comparing SysML part property and Teamcenter part occurrence (BOM line with ref des) thermal camera. The status bar also shows 'Ready', the time '11:56:55 AM', and the progress '549M of 735M'.

Example using Syndeia
www.syndeia.com

Interactive Graph of Total System Model

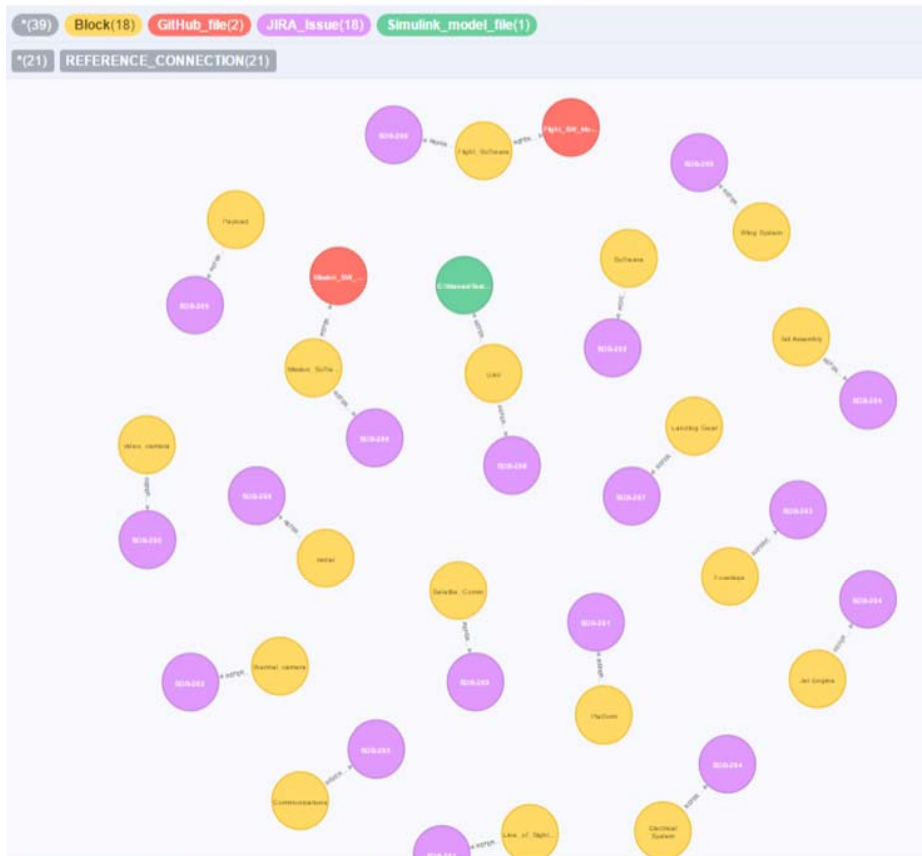


Explore your neighbors (cont.)

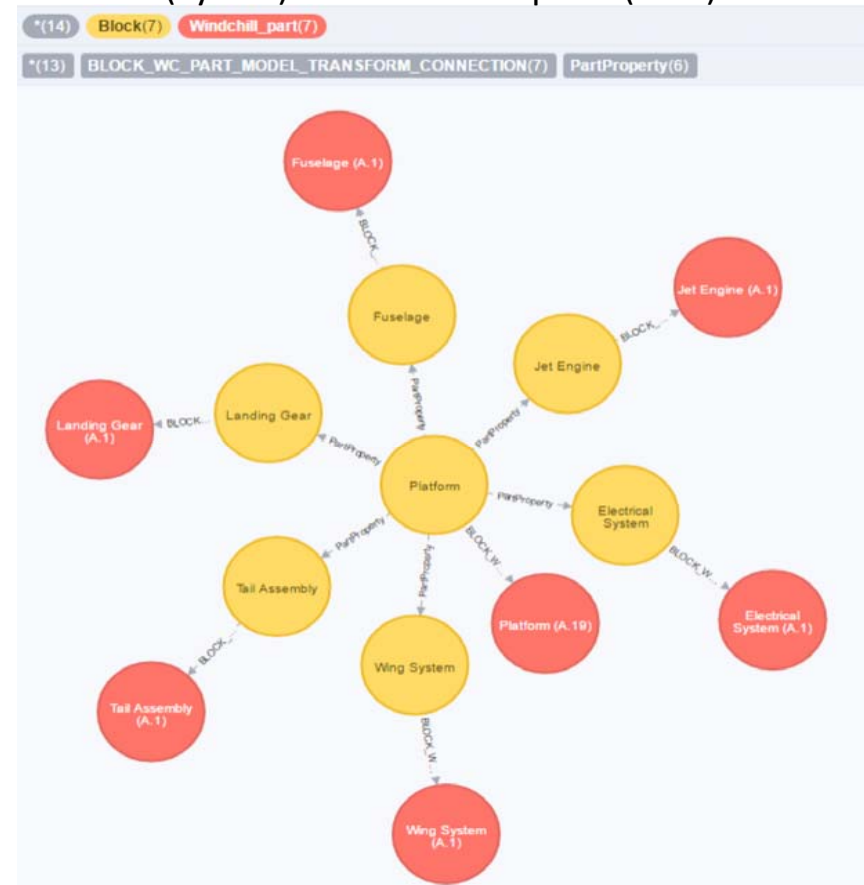


Graph Queries on the Total System Model (1/2)

1. Get all connections between system architecture, software, project tasks, and simulations

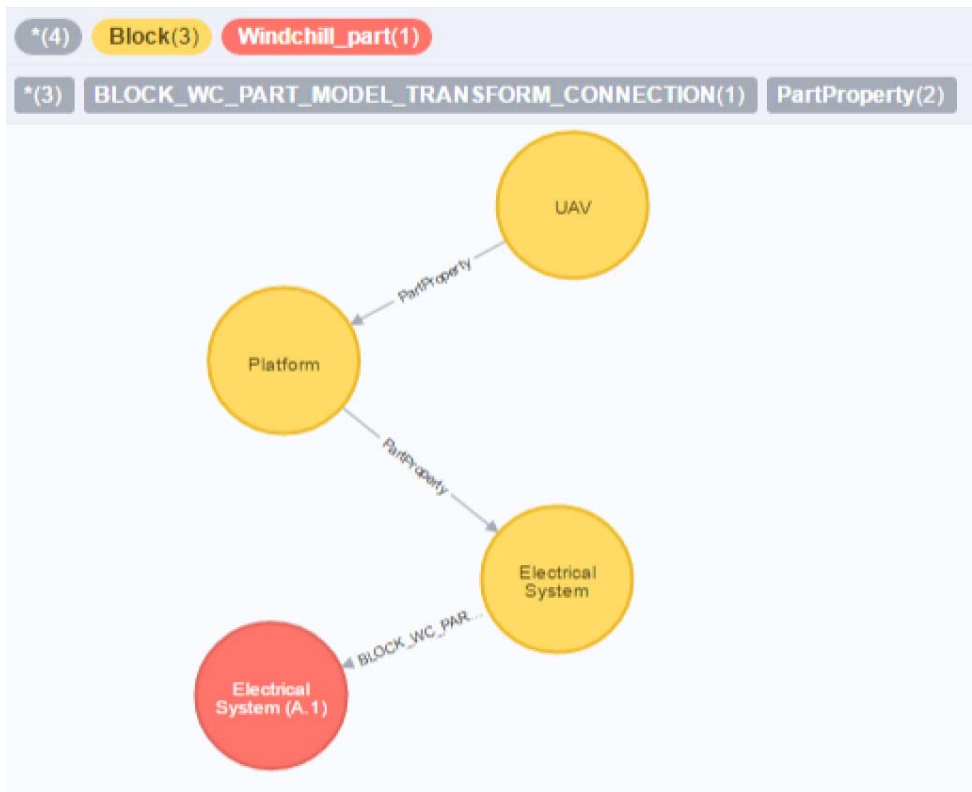


2. Get all connections between system architecture (SysML) and hardware parts (PLM)

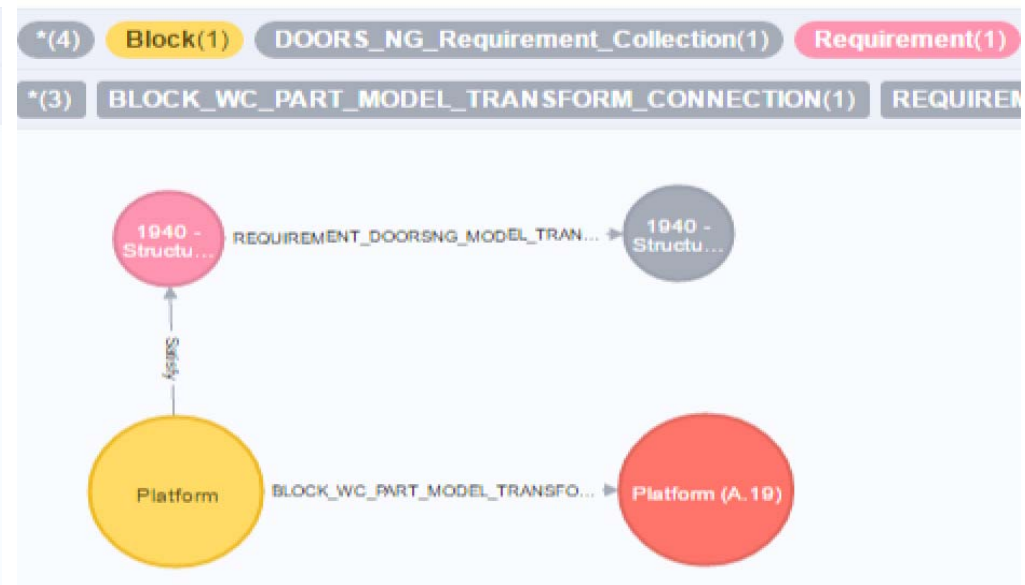


Graph Queries on the Total System Model (2/2)

3. How does a failure in the Electrical System assembly (PLM) affect the overall UAV architecture (SysML)?



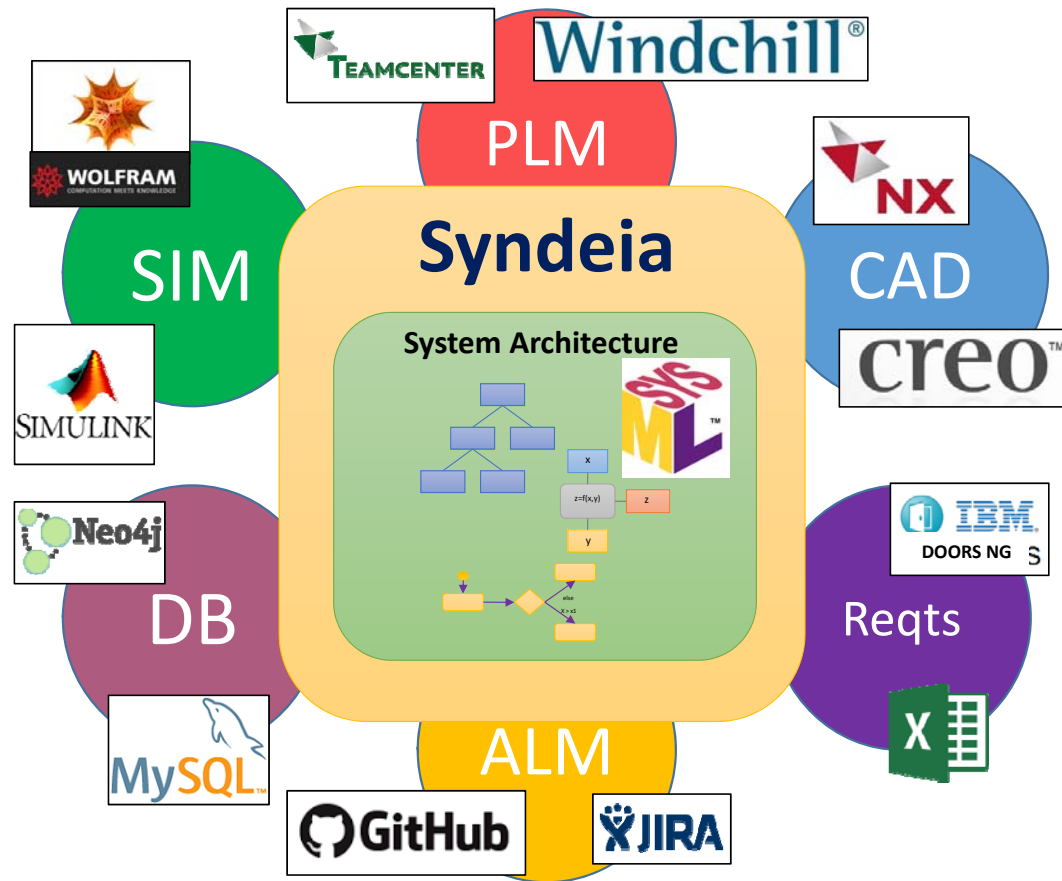
4. What hardware parts (PLM) may get affected if a requirement is changed (DOORS-NG)?



Syndeia 1.0 (SLIM)
Jul 2014

Syndeia 2.0
Jul 2015

Syndeia 3.0
Jul 2016



Syndeia 3.0

- www.syndeia.com
- 100+ Features
- <http://goo.gl/BGz2Yd>
- YouTube demo video <https://goo.gl/1EBmEb>

Syndeia 3.0 Interfaces

Syndeia 3.0 Interfaces

SysML	MagicDraw (No Magic), Rhapsody (IBM)
PLM	Teamcenter (Siemens), Windchill (PTC)
CAD	Creo (PTC), NX (Siemens)
Simulation	Simulink (The Mathworks)
Database	MySQL (Oracle), Excel (Microsoft)
Requirements	DOORS NG (IBM), Teamcenter (Siemens)
Project Management	JIRA (Atlassian)
ALM	GitHub (GitHub)

SLH Prototype #1 – List of connected repositories

External Repository

Repository Name	Repository Type	Repository ID
GitHub @ Intercax	GitHub repository	Not Implemented
DOORS 6.0.2	DOORS-NG repository	idbc:mysql://https://ec2-35-154-6-232.ap-south-1.compute.amazonaws.com:9443/rm
TC @ Intercax	Teamcenter repository	http://office.intercax.com:7001/tc/webclient
Local Models	File system repository	file:/Users/manasbajaj/Documents/Scratch/
JIRA @ Intercax	JIRA repository	https://intercax.atlassian.net
Jama @ JS	Jama repository	https://jama-cbjd.jamacloud.com
MySQL @ Intercax	MySQL repository	idbc:mysql://activity.intercax.com:33126
WC @ Intercax	Windchill repository	http://intercax-wc102.intercax.com:8080/windchill
DOORS @ Intercax	DOORS-NG repository	idbc:mysql://https://intercax-jazz.intercax.com:9443/rm
Jama @ Intercax	Jama repository	https://intercax.jamacloud.com

Repository URLs not shown here for security purposes

SLH Prototype #2 – Connections between model elements

Syndeia Cloud Repositories Connections

New

Connections

Connection ID	Connection Name	Connection Type	Source Artifact Name	Source Artifact Type	Target Artifact Name	Target Artifact Type
de83068f-3f3e-481f-98bc-48d9d2dfea9c	myfirstelve	Model Transform	Sandbox	Jama component	dsfdsfdf (A.6)	Windchill part
2435dbe0-153c-11e7-a4ea-a1ee9bcf8275	mySecondTest	Data Map	ertreytrej (A.1)	Windchill part	To Jama	Jama set
e368b65e-f985-4e17-bd46-f88dbc9795db	SyndeiaPrototype	Model Transform	Test Component	Jama component	FlyWheel (A.1)	Windchill part
9cc68e6c-058b-4d29-afaa-edd63f4cffb7	AkkaActor	Reference	abc	GitHub branch	PDMOriginalNowSharedCheckedOut1 (A.1)	Windchill part
43bb098a-da12-45f7-bc1b-f40ef28fd59	amitTEST	Model Transform	SharedToPDM2 (B.1)	Windchill part	bug1234	GitHub branch



Syndeia leverages open standards, open frameworks, and open APIs

- Systems Modeling Language
 - MagicDraw, Rhapsody, Enterprise Architect, Integrity Modeler
- REST Web Services
- JSON
- JDBC
- ISO STEP 10303
- Apache projects (multiple)
- OSLC
- FMI
- ... and others

Questions / Comments

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