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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

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, ...)

Diagram:

- Simulation
- ALM
- MCAD
- Conceptual Design
  - System Architecture (SysML)
- Detailed Design
  - PLM
- Requirements
- Project Mgmt.
- ECAD

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Where is the system architecture / blueprint?

Use of models in each engineering discipline does not give us the Digital Product/System
Foundations for MBE of Complex Systems


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?

Requirements (DOORS-NG)

Mechanical Design (CAD, e.g. NX, CREO, STEP)

Inter-model connections

Intra-model connections

Manufacturing (CAM, e.g. MTConnect)

Quality & Inspection (e.g. QIF)

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

Inter-CAX
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/dtsm.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,...)

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

Example using Syndeia
www.syndeia.com
Explore your neighbors

Subject artifact whose neighbors we are exploring (highlighted in red)

Click to expand (fetch and show connections) or collapse (hide connections) an artifact. Green highlight implies collapsed state.

Color key for artifacts

Filter by inter- & intra-model connections

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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)
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](http://www.syndeia.com)
- 100+ Features
  - [http://goo.gl/BGz2Yd](http://goo.gl/BGz2Yd)
- YouTube demo video
  - [https://goo.gl/1EBmEb](https://goo.gl/1EBmEb)
## Syndeia 3.0 Interfaces

<table>
<thead>
<tr>
<th>Category</th>
<th>Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>SysML</td>
<td>MagicDraw (No Magic), Rhapsody (IBM)</td>
</tr>
<tr>
<td>PLM</td>
<td>Teamcenter (Siemens), Windchill (PTC)</td>
</tr>
<tr>
<td>CAD</td>
<td>Creo (PTC), NX (Siemens)</td>
</tr>
<tr>
<td>Simulation</td>
<td>Simulink (The Mathworks)</td>
</tr>
<tr>
<td>Database</td>
<td>MySQL (Oracle), Excel (Microsoft)</td>
</tr>
<tr>
<td>Requirements</td>
<td>DOORS NG (IBM), Teamcenter (Siemens)</td>
</tr>
<tr>
<td>Project Management</td>
<td>JIRA (Atlassian)</td>
</tr>
<tr>
<td>ALM</td>
<td>GitHub (GitHub)</td>
</tr>
</tbody>
</table>
## SLH Prototype #1 – List of connected repositories

### External Repository

<table>
<thead>
<tr>
<th>Repository Name</th>
<th>Repository Type</th>
<th>Repository ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>GitHub @ Intercax</td>
<td>GitHub repository</td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Teamcenter repository</td>
<td>Teamcenter repository</td>
<td><a href="http://office.intercax.com:7001/tcf/webclient">http://office.intercax.com:7001/tcf/webclient</a></td>
</tr>
<tr>
<td>Local Models</td>
<td>File system repository</td>
<td>/file:/users/manasbajai/uocumencs/scracch/</td>
</tr>
<tr>
<td>JIRA @ Intercax</td>
<td>JIRA repository</td>
<td><a href="https://intercax.atlassian.net">https://intercax.atlassian.net</a></td>
</tr>
<tr>
<td>Jama @ JS</td>
<td>Jama repository</td>
<td><a href="https://jama-cbjd.jamacloud.com">https://jama-cbjd.jamacloud.com</a></td>
</tr>
<tr>
<td>MySQL @ Intercax</td>
<td>MySQL repository</td>
<td>idbc:mysql://activity.intercax.com:33126</td>
</tr>
<tr>
<td>WC @ Intercax</td>
<td>Windchill repository</td>
<td><a href="http://intercax-wc102.intercax.com:8080/Windchill">http://intercax-wc102.intercax.com:8080/Windchill</a></td>
</tr>
<tr>
<td>DOORS @ Intercax</td>
<td>DOORS-NG repository</td>
<td>idbc:mysql://<a href="http://intercax-jazz.intercax.com:9443/rm">http://intercax-jazz.intercax.com:9443/rm</a></td>
</tr>
<tr>
<td>Jama @ Intercax</td>
<td>Jama repository</td>
<td><a href="http://intercax-jamacloud.com">http://intercax-jamacloud.com</a></td>
</tr>
</tbody>
</table>

Repository URLs not shown here for security purposes.

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SLH Prototype #2 – Connections between model elements

<table>
<thead>
<tr>
<th>Connection ID</th>
<th>Connection Name</th>
<th>Connection Type</th>
<th>Source Artifact Type</th>
<th>Source Artifact Name</th>
<th>Target Artifact Name</th>
<th>Target Artifact Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>de8306f37f7ae-46ff-9d0b-4f8f92d9abd4</td>
<td>myfirstelve</td>
<td>Model Transform</td>
<td>Sandbox</td>
<td>Jama component</td>
<td>dfalhla (A,1)</td>
<td>Windchill part</td>
</tr>
<tr>
<td>2455d86d-1f301-e9f-9e68c075</td>
<td>mySecondTest</td>
<td>Data Map</td>
<td>windchill part</td>
<td>windchill part</td>
<td>To Jama</td>
<td>Jama set</td>
</tr>
<tr>
<td>9a8b56e-985-474-d16e-4f8f92d9abd4</td>
<td>synediatcrorotype</td>
<td>model Transform</td>
<td>Test Component</td>
<td>Jama component</td>
<td>Flywheel (A,1)</td>
<td>windchill part</td>
</tr>
<tr>
<td>9cc68d-c55b-472-a-6a6cf7797946</td>
<td>AkkoActor</td>
<td>Reference</td>
<td>JRC</td>
<td>GitHub branch</td>
<td>PMOriginalNewShareCheckedOut (A,1)</td>
<td>Windchill part</td>
</tr>
<tr>
<td>4f6b0a9b-eb12-9f7b-c1fcb90f28f959</td>
<td>amitTEST</td>
<td>Model Transform</td>
<td>SharedTopDMZ (B,1)</td>
<td>Windchill part</td>
<td>bug1234</td>
<td>GitHub branch</td>
</tr>
</tbody>
</table>
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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