MBX Ecosystems Challenge Team

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Overview for INCOSE MBSE Initiative
Sun Jan 27, 2019

MBX = model-based X, where X includes engineering (MBE), systems engineering (MBSE), manufacturing (MBM), test (MBT), operations (MBO), ..., enterprise (MBE), sales/application engineering (MBSAE), ..., living (MBL), ...
MBX Ecosystems Challenge Team

Purpose

This challenge team collaborates on pre-competitive capabilities that help organizations better define and manage their MBX ecosystems. We officially kicked off at IW19 (Jan 2019) based on prior workshops at IW15, IW17, and IW18 organized by the INCOSE MBSE Modeling & Simulation Interoperability (MSI) Challenge Team.

In simple terms, your MBX ecosystems consist of the models, tools, processes, and people/roles that come together to develop the systems/products that your organization cares about.

But an ecosystem can be broader than that, depending on the scope you are concerned about. For example some organizations utilize their ecosystems to also support the operation of their systems/products. And some organizations include cross-project libraries and methods in their ecosystems, as well as interconnections with their supply chain ecosystems.

If these type of ecosystems are of interest to you, come and join us to help move things forward!

MBX = model-based X, where X includes engineering (MBE), systems engineering (MBSE), manufacturing (MBM), test (MBT), operations (MBO), ..., enterprise (MBE), sales/application engineering (MBSAE), ..., living (MBL), and so on.
Context: What is an “MBX Ecosystem”?
SysML-based Ecosystems: Example Early Work

Generic Model Architecture in a SysML-based Ecosystem

View: Framework for Models, Design/Analysis, and Traceability

FACT/ERS Environment (example MBX ecosystem for trade studies)

View: Software Implementation Architecture

Source: [Friedenthal et al. 2012]

Source: [Ender et al. 2014]
**Context: What is an “MBX Ecosystem”?**

Early Example in INCOSE MBSE Initiative

Prototype SysML-based MBX Ecosystem for Excavator Systems
Case study c.2008-2010 in Georgia Tech project sponsored by Deere and Lockheed Martin
http://www.pslm.gatech.edu/projects/incose-mbbe-msi/ including presentations at IW09 and IW10

View1: Tool Categories (with coarse-grain connections)

View2: Model Architecture - Patterns & Tools (with medium-grain connections)
Context: What is an “MBX Ecosystem”? 
Generic Example - OMG SysML v2 RFP (SysML model excerpt)
Context & Terminology (Informal)

**MBX Ecosystem Management**

- **MBX**, where X = MBE, MBSE, MBM, ...
- **Ecosystem** = combined system of tools, models, products, repositories, interconnections, people, processes, workflows, ...
  - [a “system of systems” - largely computer-based]
  - Level 1 – Overall ecosystem for organization X
  - Level 2 – Division sub-ecosystems
  - Level 0 – Level 1 in a global ecosystem with interfaces to ecosystems of customers, suppliers, regulators, ...
- **Management** = handling all ecosystem lifecycle phases
  - Vision/concepts, prototype, preliminary design, detailed design, deployment, maintenance, updates, migration, decommissioning
- Therefore, treat your MBX ecosystem as a **system**!
  - Apply systems engineering principles (“Alpo” approach) w/ ecosystem know-how
- Similar terms: system development environment, decision support system, modeling & simulation framework, ...
## MBX Ecosystem Metrics & Objectives

### Benefits of SysML-based MBE/MBSE Approach

<table>
<thead>
<tr>
<th>Enabling Capabilities</th>
<th>Reduced Time</th>
<th>Reduced Cost</th>
<th>Reduced Risk</th>
<th>Increased Understanding</th>
<th>Increased Corporate Memory</th>
<th>Increased Artifact Performance</th>
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<tbody>
<tr>
<td>Increased Knowledge Capture &amp; Completeness</td>
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<td>Increased Modularity &amp; Reusability</td>
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<td>Increased Traceability</td>
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<td>Reduced Manual Re-Creation</td>
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<td>Increased Automation</td>
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<td>Reduced Modeling Effort</td>
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<td>Increased Analysis Intensity</td>
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</table>

### Primary Impacts

- Reduced Time
- Reduced Cost
- Reduced Risk
- Increased Understanding
- Increased Corporate Memory
- Increased Artifact Performance

**Precision Knowledge for the Model-Based Enterprise**
OpenMBEE: An Open Framework for MBX Ecosystems

www.openmbee.org

Simplified View:

• A practical combination of commercial tools and open-source tools within an extensible framework

• Includes “model-based wiki”-like capabilities
  – Exposes rich underlying SysML models as web pages
  – Engages project members who do not know SysML
- ~200 participants in email list / google group
- ~35 participants in biweekly webcons (started ~Feb 2017)
- ~45 participants in biweekly developer webcons
- Formalized as a Challenge Team in the INCOSE MBSE Initiative (Jan 2019)
- Semi-public OpenMBEE instance (*thanks to No Magic, Inc*)
  - Used for collaboration on work by OMG / INCOSE / etc. (pre-competitive topics & resources)
<table>
<thead>
<tr>
<th>Organization</th>
<th>Projects Using OpenMBEE</th>
<th>OpenMBEE Deployment Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boeing</td>
<td>Various programs (<em>it is their enterprise model-based solution</em>)</td>
<td>Production</td>
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<tr>
<td>Ford</td>
<td>Various pilots</td>
<td><em>Pilot</em></td>
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<tr>
<td>GT/ASDL</td>
<td>~5 research projects/demos</td>
<td><em>Pilot/Demo</em></td>
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<tr>
<td>GTRI</td>
<td>Various projects (<em>after setup is ready</em>)</td>
<td><em>WIP</em></td>
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<td>Lockheed</td>
<td>Various programs</td>
<td>Production</td>
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<td>NASA JPL</td>
<td>~8 main flight projects (Europa Clipper, Mars 2020, Mars Sample Return, ...)</td>
<td>Production</td>
</tr>
<tr>
<td>OMG [1]</td>
<td>SysML 1.x spec; SysML v2 SST proposal</td>
<td>Production</td>
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<tr>
<td>Stevens/SERC</td>
<td>Several research projects/demos</td>
<td><em>Pilot/Demo</em></td>
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[1] = Using openmbee.org semi-public instance
Context: What is an “MBX Ecosystem”?  
Example Production Ecosystem @ JPL Using OpenMBEE

Full-Featured End User Workstation (client-side)  
MD Teamwork Server (TWS) (server-side)

OpenMBEE MMS (server-side)

SysML Authoring (MagicDraw)

Wiki-like Interaction (web browser)

Issue & Change Mgt.

CAE Tools & Interfaces

Document Generation

Model Checkers

Other server-side ecosystem things (beyond just OpenMBEE)

Generic Libraries

Domain-Specifics Libraries

Ontologies, Patterns, ...

SysML Model Repository (Teamwork Server, TWS)

Model-Based Wiki Capability (OpenMBEE MMS)

And so on ...

Source: Excerpt from R Karban’s presentation at NMWS 2016

Excerpt from ecosystem SysML model.
Join us at IW19!
Mon-Tue Jan 28-29, 2019

• See Challenge Team wiki for agenda specifics
  – Includes overviews of production ecosystems at Boeing, ESA, JPL, Lockheed, ...

<table>
<thead>
<tr>
<th>Day/Time</th>
<th>Group</th>
<th>Location</th>
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<tbody>
<tr>
<td>Mon 8:00-17:30</td>
<td>MBX Ecosystems &amp; OpenMBEE</td>
<td>Salon E</td>
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<tr>
<td>Tue 8:00-16:30</td>
<td>MBX Ecosystems &amp; OpenMBEE</td>
<td>Salon F/G</td>
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