Future Directions for SysML v2

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MBSE Workshop
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Agenda

- Background
- System Modeling Environment (SME)
- SysML v2 Requirements Approach
- Summary
Background
SysML Background

- SysML v1 adopted in 2006
- Continued evolution to address user and vendor needs
  - SysML v1.4: current version
  - SysML v1.5: report finalized
  - SysML v1.6: started
- Facilitated awareness and adoption of MBSE
- Much learned from applications of MBSE using SysML
Using SysML Model as an Integration Framework
OMG SysML v2
Requirements Working Group

• Sponsor
  ○ OMG Systems Engineering Special Interest Group (SE DSIG)

• Objective
  ○ Develop requirements for the next generation of SysML (v2)
  ○ Issue RFP through OMG process & initiate SysML v2 submission teams – Sept ‘17

• Approach
  ○ Assess current limitations of system modeling support for MBSE
  ○ Define capabilities, effectiveness measures, and driving requirements for a system modeling environment (SME) to support MBSE
    ▪ Published in August ‘15 of INCOSE INSIGHT
  ○ Develop concepts for the system modeling environment (SME)
    ▪ Published in December ‘16 edition of INCOSE INSIGHT
  ○ Derive requirements for SysML v2 RFP that support the SME
System Modeling Environment (SME)
FROM

- Model-based systems engineering has grown in popularity as a way to deal with the limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/CAE.

TO

- **Formal systems modeling is standard practice** for specifying, analyzing, designing, and verifying systems, and is fully integrated with other engineering models.
- System models are adapted to the application domain, and include a broad spectrum of models for representing all aspects of systems.
- The use of internet-driven knowledge representation and immersive technologies **enable highly efficient and shared human understanding of systems** in a virtual environment that span the full life cycle from concept through development, manufacturing, operations, and support.
MBE To-Be State
Source: NDIA MBE Final Report dated February 2011

- Needs
- Current Capabilities
- Budget/Schedule

MBE Enhances Affordability, Shortens Delivery and Reduces Risk Across the Acquisition Life Cycle
System Modeling Environment (SME)

Purpose & Scope

- **Used to perform MBSE in the broader context of Model-Based Engineering**
  - A systems view of the MBE Environment

- **Provide modeling capabilities that include:**
  - model construction
  - model visualization
  - model analysis
  - model management
  - model exchange and integration
  - support for MBSE collaboration and workflow
  - extension/customization

- **Scope**
  - SysML language and tools (including customizations)
  - Model libraries (e.g., systems, components, interfaces, units,...)
  - Integrations with other engineering models and tools
  - Extension and customization facilities
System Modeling Environment

Key Features

- Accommodate different classes of users including different levels of modeling expertise, domains, lifecycle phases, and levels of rigor
- Role-based adaptations that apply domain specific user interfaces, patterns, libraries, and workflows
  - Help with continuous feedback (warning, errors)
- Interactive view generation including semantic filter, zoom, and pan capability
- Extensible systems engineering data model based on industry standards
- Precise semantic foundation that supports interpretation, transformation (to model, to text), model query, logical inferences, and model checking
- Support for analysis specification and execution using built-in solvers and integration with diverse engineering analysis tools
- Model management that includes versioning to the model element level, diff capability, and management of related artifacts (e.g., views, analysis results,)
- API based on web standards for linked data
System Model Interoperability

Source: Axel Reichwein
SysML v2 Model Interoperability & Standard API Requirements
**System Model Management Concept**

Source: Laura Hart and Model Management Team, 2017-Jan 13

**Model Management** services for the **Integrated System Model (ISM)**
- Versioning
- Configuration control
- Controls & permissions
- Change process
- Change history
- Branching & merging
- Model differencing

**ISM: System Model + Reference Links**

Each version of model contains model elements with different versions.

**Analytic Model Version X**

**CAD Model Version Y**

**Model Evolution**
System Model & PLM

- System model with PLM can enable integration of multi-disciplinary product definition data to manage change across the life cycle
  - Requirements
  - Logical components
  - Function/Behavior
  - Interfaces and interconnections
  - Technical performance measures
  - Natural envir, ext systems, and users
  - Traceability (rea’ts, design, analysis, verification)

PLM Environment

- Workflow Mgmt
- Data Mgmt
- System Model (RFLP)
- Product Definition (Elec, Mech, SW, Test)
- Process Definition (Mfg, Support, ..)
Systems Modeling Environment
Logical Architecture

- System Modeling Environment
  - Rich Interface
  - Model Editor
  - Model Repository
  - Analysis Data
  - Ontology Definition
  - Domain Specific Model Editor
  - Metamodel Transformation

- Model Manager
  - Access control
  - Configuration mgmt

- Information Exchange Mgr
  - Synchronize
  - Orchestrate
  - Transform
  - Manage Viewpoint

- Model Analyzer
  - Check
  - Solve
  - Simulate

- Model Repository
  - System Models
  - Analysis Data
  - Metadata
  - Reuse Library

- External Sources
  - PLM/Global Task Manager
  - Engineering Tools/Models
  - External Data Sources

- Development Environment
  - Ontology Definition
  - Domain Specific Model Editor
  - Metamodel Transformation

- External Interface & Management
  - Query model
  - Perform analysis
  - Present results

- Consumers & Reviewers
- Used to Customize & Adapt Environment

Practices
Repository

Systems Engineer

Development Environment

Developer/
Customizer

Consumers & Reviewers

09/18/16

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SysML v2 Requirements
SysML v2 Specification Development

MBSE Use Cases

System Modeling Capabilities
- Model construction
- Model visualization
- Model analysis
- Model management
- Model exchange & integration
- MBSE collaboration & workflow
- Extension/customization support

SysML V2 Service Requirements

SysML V2 RFP

SECM — SysML V2 RFP

SysML V1.X Spec

SysML V2 Spec

Vendor Implementations

Conformance Tests

Reference Model

Standard API

Concrete Syntax

Libraries

Profile

Meta-model
SysML v2 Objectives & Approach

• Increase effectiveness of system modeling environment and MBSE through enhanced:
  ○ Precision
  ○ Usability
  ○ Interoperability

• Approach
  ○ Enhanced model construction and visualization capabilities
  ○ Improved data model with similar scope as current SysML
    ▪ Based on industry standards for systems engineering
    ▪ Not constrained by UML data model
    ▪ Grounded in logical formalisms
  ○ Standard API to improve interoperability and model access
Visualization Concept (cont.)

Source: C. Schreiber, J. Feingold, M. Sarrel
Element Concept from Industry Reference Model

Extract from John Watson presentation to SEBoK team at INCOSE IW on 1/30/2016
Property Concepts

Elaborates Industry Reference Model

Refer to Property Wiki for current version
Data Model Improvement Areas (Partial)

- Property-based requirements
- Integration between structure and behavior modeling
- Timelines
- Integration with analysis
- Geometric concepts
- Variant modeling concepts
- Metadata for element id, version, status, risk
- ...

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SysML v2 Service Requirements Support Modeling Capabilities

- create, read, update, delete
  - model elements
  - model queries
  - viewpoints
  - id, version, and other metadata
  - data protection controls (e.g., user access permissions, roles, data rights,)
  - workflows & notifications
  - links between SysML models and other data
  - transformations to/from SysML models

- export and import structured data
- apply model patterns, model libraries, and reference models
- setup, validate, and execute models
Related OMG Standards
(Partial List)

- Unified Modeling Language (UML)
- Unified Architecture Framework (UAF) – previously UPDM (POC M. Hause)
- Business Process Model and Notation (BPMN)
- UML Testing Profile (UTP)
- Profile for Safety and Reliability – in process (POC G. Biggs)
- Requirements Interchange Format (ReqIF)
- Software and Systems Process Engineering Metamodel (SPEM)
- Reusable Asset Specification (RAS)
- MOF Versioning and Development Lifecycle (MOFVD)
- XML Metadata Interchange (XMI)
- Diagram Definition (DD)
- Object Constraint Language (OCL)
Summary

- SysML v1 available for 10 years
  - An enabler of MBSE
  - Strengths and limitations understood and basis for future improvements
- SysML v2 is being specified in the context of a System Modeling Environment to improve support for MBSE:
  - Precision
  - Interoperability
  - Usability
- SysML v2 specification will include
  - Meta-model, profile, and model libraries, concrete syntax
  - Standard API
  - Flexible view and viewpoint for improved visualization
  - Reference model & test cases to demonstrate vendor conformance levels
  - Migration from SysML v1 to SysML v2
Questions ?