Future Directions for SysML v2

INCOSE IW
MBSE Workshop
January 28, 2017

Sanford Friedenthal
safriedenthal@gmail.com
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

Figure 18.1
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

Copyright © 2012-2017 by Sanford Friedenthal, All Rights Reserved.
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

MBE Enhances Affordability, Shortens Delivery and Reduces Risk Across the Acquisition Life Cycle

- Needs
- Current Capabilities
- Budget/Schedule
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 modeling 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 execute SE practices and apply domain specific user interfaces, patterns, libraries, and batch data imports
  - 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
Model Management services for the *Integrated System Model (ISM)*
- Versioning
- Configuration control
- Controls & permissions
- Change process
- Change history
- Branching & merging
- Model differencing

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

Each version of model contains model elements with different versions.
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 Mgm’t

Data Mgm’t

System Model (RFLP)

Product Definition (Elec, Mech, SW, Test)

Process Definition (Mfg, Support, ..)
Systems Modeling Environment
Logical Architecture

System Modeling Environment

Model Editor
‘Rich’ Interface
Synchronize
Orchestrate
Transform
Manage Viewpoint

Model Editor
‘Web’ Interface

Information Exchange Mgr

Model Manager
Access control
Configuration mgmt

Model Analyzer
Check
Solve
Simulate

Local Task Mgr

Model Repository

System Models
Analysis
Data
Metadata

Reuse Library

Information Model
• System model schema
• Analysis model schema

Development Environment
Ontology Definition
Domain Specific Model Editor
Metamodel Transformation

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

Consumers & Reviewers

Practices Repository

Systems Engineer

Developer/Customizer

Used to Customize & Adapt Environment
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

SysML V2 Spec
- Meta-model
- Profile
- Libraries
- Concrete Syntax
- Standard API
- Reference Model
- Conformance Tests

SECM – SysML V2 RFP

Vendor Implementations
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

Structured File Extract

SysML Diagrammatic

Tabular Data View

Architecture Geometry

Diagram Differencing

Semantic Zoom

Dynamic Visualization

Source: C. Schreiber, J. Feingold, M. Sarrel

Visualization Concept (cont.)

Source: C. Schreiber, J. Feingold, M. Sarrel
Selected Core SE Concepts from Industry Reference Model

Extract from John Watson presentation to SEBoK team at INCOSE IW on 1/30/2016
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
- …
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
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 requirements for improved visualization
  - Reference model & test cases to demonstrate vendor conformance levels
  - Migration from SysML v1 to SysML v2
Questions?