SysML
Past, Present, and Future

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Sparx Systems Ambassador
Sparx Systems Pty Ltd
A Specification Produced by the OMG Process

RFI – optional
Issued by Task Forces

RFI responses
– submitted by any interested
party, evaluated by
working groups

RFP
Issued by Domain
or Platform
Technology Committee

RFP responses,
known as submissions

Published Specification

Finalization Task Force/Revision Task Force

Approved Submission

Reviews

SysML 1.0
SysML 1.1
Etc.
What is SysML?

A graphical modelling language in response to the UML for Systems Engineering RFP developed by the OMG in coordination with INCOSE

a UML Profile that represents a subset of UML 2 with extensions

Supports the specification, analysis, design, verification, and validation of systems that include hardware, software, data, personnel, procedures, and facilities

Supports model and data interchange via XML Metadata Interchange (XMI®)

SysML is Critical Enabler for Model Driven SE
Specification status

- Adopted by OMG in May ’06
- Finalization Task Force Report in March ’07
- Available Specification v1.0 June ‘07
- Revision task force chartered for SysML ® v1.1 in March ‘07
- OMG SysML ® v1.2 published June 2010
- OMG SysML ® v1.3 published June 2012
- OMG SysML ® v1.4 published August 2015
- OMG SysML ® v1.5 published May 2017
Revision Task Force (RTF)

A Task Force with a closed membership of named individuals, responsible for clarifications of and minor modifications to an OMG Formal Specification.

In some specific circumstances an RTF (but not an FTF) may recommend changes that extend a Specification. Under all other circumstances enhancement of a Formal Specification shall only be accomplished by a new adoption process.
SE DSIG

Led by Sandy Friedenthal
INCOSE rep to OMG
Former chair of the INCOSE MBSE Initiative
Co-author of A Practical Guide to SysML

MBSE Wiki
http://www.omgwiki.org/MBSE/doku.php
OMG RFPs Explained

RFPs are proposed by Task Forces
For SysML this is the Analysis and Design Task Force

RFPs and published by Technology Committees
For SysML this is the Platform Technology Committee

Responses to an RFP are called submissions
It is not uncommon for RFP authors to be members of a submission team
The SysML® v2 RFP was issued on December 8, 2017. This culminated an 18-month effort to develop the requirements for the next-generation systems modeling language, which is intended to improve the precision, expressiveness, and usability over SysML v1. The requirements reflect lessons-learned from applying model-based systems engineering (MBSE) with SysML since its adoption more than 10 years ago.
The RFP requires the specification to include both a SysML profile of UML® and a SysML metamodel, and a mapping between them. In addition, submitters have the option to specify additional features that include model interchange and formal semantics.
Using SysML Model as an Integration Framework

System Model (SysML)

System Documentation and Specifications
External Requirements

traceability rationale

viewpoint

requirements

System Model (SysML)

Mechanical Design Models
Electrical Design Models
Software Design Models
Testing Methods and Models

performance estimates

analysis needs

closed form
discrete event
network

Analysis Models

Source: A Practical Guide to SysML 3rd Ed: Figure 18.1
SysML v2 Specification Development

MBSE Use Cases

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

Vendor Implementations

MBSE Use Cases

SysML V2 Service Requirements

System Modeling Concepts

SysML V2 Service Requirements

SysML V2 API & Services RFP

SysML V2 Specification
- Meta-model Profile Libraries
- Reference Model
- Conformance Tests

Vendor Implementations
## SysML v2 Requirements Summary

<table>
<thead>
<tr>
<th>Requirement Category</th>
<th>Number of Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SysML v2 Language req’ts</strong></td>
<td>167 (+38 requirement groups)</td>
</tr>
<tr>
<td>Language &amp; Formalism req’ts</td>
<td>23 (+7 for conformance)</td>
</tr>
<tr>
<td>Data Model req’ts</td>
<td>137</td>
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</table>

Number fully, partially, and not addressed by SysML v1:
- Fully addressed: 42
- Partially addressed by: 59
- Not addressed: 66

The scope of the SysML v2 data model requirements is similar in scope to the original SysML v1 mandatory and optional requirements:

<table>
<thead>
<tr>
<th>Requirement Category</th>
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<tbody>
<tr>
<td><strong>SysML v1 Language req’ts</strong></td>
<td>190</td>
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<tr>
<td>Mandatory req’ts</td>
<td>163</td>
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<tr>
<td>Optional req’ts</td>
<td>27</td>
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</table>
SysML v2 Approach

SysML v2 profile and metamodel
Similar in scope to SysML v1.x
Based on industry standards for systems engineering
Grounded in logical formalisms
SysML v2 profile facilitates transition for current SysML vendors
SysML v2 metamodel not constrained by UML
Language Formalism and Uniform Interpretation

Source: Derived from SysML Formalism WG Presentation dated March 21, 2017
Semantics Requirements

- SysML v2 semantics shall be grounded in a declarative semantics expressed using mathematical logic.
  - Semantics are defined formally to reduce ambiguity.
  - Declarative semantics enable reasoning with mathematical proofs.
  - This contrasts with operational semantics that requires execution in order to determine correctness.

- SysML v2 semantics shall be modeled with SysML v2 model libraries.
  - Simplifies the language when model libraries are used to extend the base declarative semantics without additional abstract syntax.
  - Enables SysML to be improved and extended more easily by changes and additions to model libraries, rather than always through abstract syntax.
Conformance Tests

The RFP will require submitters to provide
- a conformance test suite with test cases traced to SysML v2 language feature requirements
- a reference model demonstrating substantive use of SysML v2 features

Submitters will be expected to provide a pilot implementation that satisfies all conformance tests and can manage the reference model.
<table>
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<th>Event or Activity</th>
<th>Date</th>
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<tbody>
<tr>
<td>Letter of Intent (LOI) deadline</td>
<td>24 September, 2018</td>
</tr>
<tr>
<td>Initial Submission deadline</td>
<td>4 November, 2019</td>
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<tr>
<td>Voter registration closes</td>
<td>25 November, 2019</td>
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<tr>
<td>Initial Submission presentations</td>
<td>2 December, 2019</td>
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<tr>
<td>Revised Submission deadline</td>
<td>9 November, 2020</td>
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<tr>
<td>Revised Submission presentations</td>
<td>7 December, 2020</td>
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Objective – SysML v2 API and Services RFP

Specifies the requirements for an Application Programming Interface (API) that includes services to operate on SysML v2 models, and Connect SysML v2 models with models in other disciplines

API shall be implemented by SysML v2 modeling environments and shall support a wide range of operations related to model query, model construction, model view/viewpoint management, model analysis, model management, and model transformation for SysML v2 models.

Complements the SysML v2 RFP (language RFP)
Fundamental problems that motivate
SysML v2 API and Services RFP

**Problem 1**: Standard approach for programmatically interacting with a SysML model
  XMI (Import/Export), Non-standardized native APIs

**Problem 2**: Portability of your applications (apps)
  Rewriting your app for each SysML environment -> less time improving app

**Problem 3**: Enterprise-ready services for wider SysML deployment
  File-based to service-based, Import/export -> APIs, Scaling up (users, model size, etc.)

**Problem 4**: Building an integrated system model (aka “digital twin”)
  Connecting SysML models to other models and repositories, bi-directional compare and synchronization services
What is an API?

API stands for Application Programming Interface

API = Interface for software/services to communicate with each other

For any software, we will typically have

GUI = Interface for humans to interact

API = Interface for other software/services to interact
Why does SysML v2 need an API?

We have always needed to access system model and automate
  Document generation
  Model validation
  Model generation/transformations
  Analysis and reasoning, and many such tasks…

Today
  We write plugins / scripts for a specific SysML tool
  Application logic subject to tool-specific implementation of SysML / UML

SysML 2 API will make it possible to
  Write application (business) logic using standard services independent of a specific tool
  Deploy the application for each SysML Modeling Environments
  Focus on business logic and not portability
Scope of SysML v2 API and Services RFP

(1) and (2) are in scope, (3) is out of scope
SysML v2 API and Services Architecture

PIM and PSM

Logical API Model

Service Definition
Services and Operations

Platform Independent

Platform-specific API
(language/protocol)

Example API bindings include: Java, .NET, REST/HTTP, OSLC, and others

API 1

API 2

API 3

...others

implements

API implementation by SysML tools

SysML Tool 1
File-based

SysML Tool 2
3-Tier architecture

SysML Tool 3
Federated architecture

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Leveraging other open standards

OMG standards / RFPs

- SysML 2 RFP – defines the meta-model for SysML 2 API and Services I/O
- MOF/SMOF
- [API4KB] Application Programming Interfaces (API) to Knowledge Bases (KB) RFP
- [DOL] Distributed Ontology, Model, and Specification Language
- [MOFVD] Versioning and Development Lifecycle TM (MOFVDTM)
- [QVT] Query View Transformation TM (QVTTM)
- [SPMS] Structured Patterns Metamodel Standard (SPMS™)
- [UTP] UML Testing Profile

Non-OMG standards

- OpenAPI (Open API Initiative)
- ISO 10303 (STEP)
- OSLC

...
RFP submission for review at OMG Boston

Document: ad/2018-05-01

Mandatory Requirements
- API and Services Architecture and Conformance
- Service Scope, Conditions, and Response
- Model Navigation, Creation, Update, Deletion Services
- External Relationship Management Service

Non-Mandatory Requirements
- Model Query Service
- Advanced Model Construction Services
- Model Visualization Services
- Model Analysis Services
- Model Management Services
- Model Transformation Services
- General Services – Timestamp and UUID generation, API Call Back
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<td>Letter of Intent (LOI) deadline</td>
<td>10 December 2018</td>
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<tr>
<td>Initial Submission deadline</td>
<td>4 weeks before Mar 2020 OMG Meeting (date TBD)</td>
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<tr>
<td>Voter registration closes</td>
<td>2 weeks before Mar 2020 OMG Meeting (date TBD)</td>
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<tr>
<td>Initial Submission presentations</td>
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Questions