



Model Driven Solutions
Where Business Meets Technology

Building a major modeling language standard

Reflections on how we got to SysML v2 and where we are going

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Supports the specification, analysis, design, and verification and validation of complex systems that may include hardware, software, information, processes, personnel, and facilities

SysML v1.0 adopted in 2006
Standard profile of UML v2.1

Current version is SysML v1.7 beta (December 2022)
v1.7 is the last for SysML v1

SysML v2
Language RFP: December 2017
API and Services RFP: June 2018



SysML v2 Submission Team (SST)

Formed December 2017

Leads: Sandy Friedenthal, Ed Seidewitz

A broad team of end users, vendors,
academics, and government liaisons
Grew to 200+ members from 80+ organizations

Developed submissions to both RFPs
Final submission: February 2023



SST Participating Organizations

- Aerospace Corp
- Airbus
- ANSYS medini
- Aras
- Army Aviation & Missile Center
- Army CBRND
- BAE
- BigLever Software
- Boeing
- U.S. Army DEVCOM Armaments Center
- CalTech CTME
- CEA
- Contact Software
- Defence Science and Technology Group
- DEKonsult
- Delligatti Associates
- Draper Lab
- ESTACA
- Ford
- Fraunhofer FOKUS
- General Motors
- George Mason University
- GfSE
- Georgia Tech/GTRI
- IBM
- Idaho National Laboratory
- IncQuery Labs
- Intercax
- Itemis
- Jet Propulsion Lab
- John Deere
- Kenntnis
- KTH Royal Institute of Technology
- LieberLieber
- Lightstreet Consulting
- Lincoln Lab
- Lockheed Martin
- MathWorks
- Maplesoft
- Mercury Systems
- Mgnite Inc
- MID
- MITRE
- ModelAlchemy Consulting
- Model Driven Solutions
- Model Foundry
- NIST
- No Magic/Dassault Systemes
- OAR
- Obeo
- OOSE
- Ostfold University College
- Phoenix Integration/ANSYS
- PTC
- Qualtech Systems, Inc (QSI)
- Raytheon
- Rolls Royce
- Saab Aeronautics
- SAF Consulting *
- SAIC
- Siemens
- Sierra Nevada Corporation
- Simula
- Space Cooperative
- Sodius Willert
- System Strategy *
- Tata Consultancy Services
- Thales
- Thematix
- Tom Sawyer
- Twingineer
- UFRPE
- University of Western Switzerland (Rosas Center)
- University of Cantabria
- University of Alabama in Huntsville
- University of Detroit Mercy
- University of Kaiserslautern / VPE
- Vera C. Rubin Observatory
- Vitech
- 88solutions



Second-System Effect

"The tendency of small, elegant, and successful systems to be succeeded by over-engineered, bloated systems, due to inflated expectations and overconfidence."

https://en.wikipedia.org/wiki/Second-system_effect

<http://catb.org/jargon/html/S/second-system-effect.html>

Fred Brooks, *The Mythical Man-Month*, Chapter 5



And SysML v2 *is* bigger than SysML v1

New functionality
Variants, analysis, geometry, ...

Textual in addition to graphical notation
Including a full expression sublanguage

New standard API and interchange format
Based on JSON, allowing project interchange



But...It wasn't really the "second system"

Arguably 3rd or 4th or ... for team leadership

SysML v1 + UML 2 was not really that
"small and elegant" to begin with

SST adopted a user-driven, agile approach



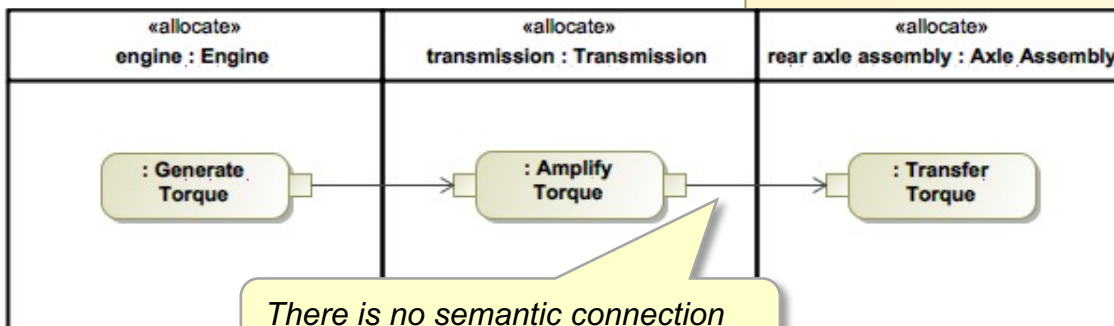
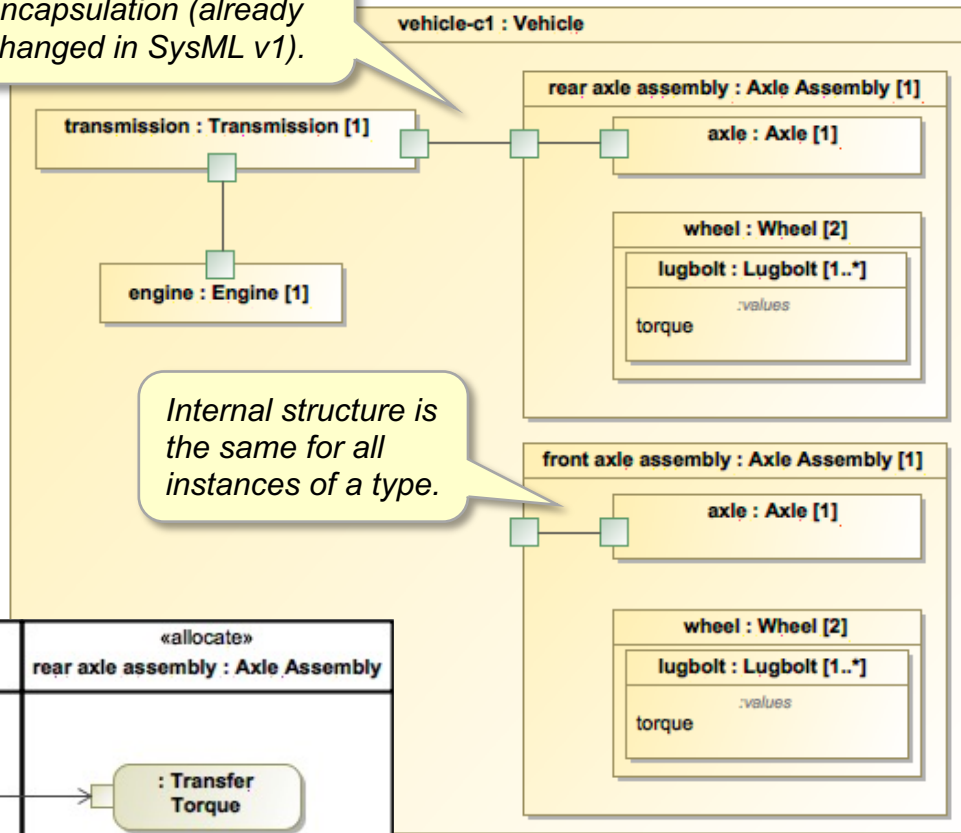
Language Design Limitations as a UML Profile

Can connections be deeply nested?

Can nested parts have different properties?

Can system behavior be related to subsystem structure?

UML requires encapsulation (already changed in SysML v1).



There is no semantic connection between flows and connectors.

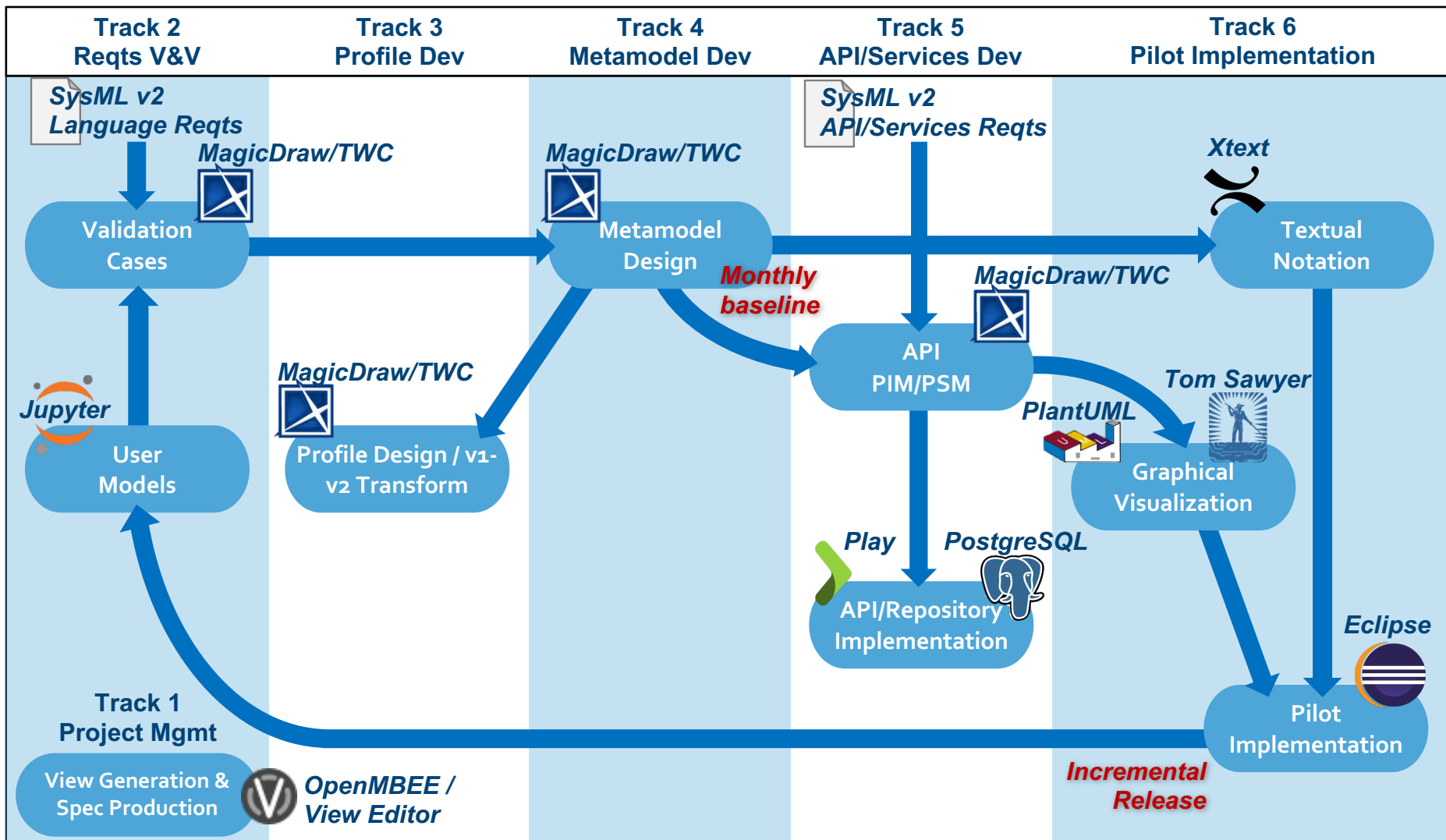


Other Desired Enhancements

- **Functional enhancements**
 - Improved integration with analysis, variant modeling, geometric modeling, etc.
- **Flexible visualization**
 - Textual, diagrammatic, tabular, dynamic, interactive, etc.
- **Improved interoperability**
 - Between SysML tools and with other tools



SST Incremental Approach





SST Milestones

December 2017	SysML v2 RFP issued; SST formed
June 2018	SysML v2 API & Services RFP issued
August 2019	Internal Review
August 2020	Initial Submission
February 2021	Stakeholder Review
August 2021	1st Revised Submission
November 2021	2nd Revised Submission
September 2022	Specification Review (2½ days)
November 2022	3rd Revised Submission
December 2022	Established Change Board
February 2023	Final Submission



SysML v2 vs. v1 Terminology (partial)

SysML v2	SysML v1
part / part def	part property / block
attribute / attribute def	value property / value type
port / port def	proxy port / interface block
action / action def	action / activity
state / state def	state / state machine
constraint / constraint def	constraint property / constraint block
connection / connection def	connector / association block
requirement / requirement def	requirement
view / view def	view



SysML v2 Objectives

Increase adoption and effectiveness of MBSE
by enhancing...

- Usability by model developers and consumers
- Precision and expressiveness of the language
- Consistency and integration among language concepts
- Extensibility to support domain specific applications
- Interoperability with other engineering models and tools



Contrasting SysML v1 with SysML v2

✓ **Simpler to learn and use**

- Systems engineering concepts designed into metamodel versus added-on
- Consistent definition and usage pattern
- More consistent terminology
- Ability to decompose parts, actions, ...
- More flexible model organization (unowned members, package filters)...

✓ **More precise**

- Textual syntax and expression language
- Formal semantic grounding
- Requirements as constraints
- Reified relationships (e.g., membership, annotation)

✓ **More expressive**

- Variant modeling
- Analysis case
- Trade-off analysis
- Individuals, snapshots, time slices
- More robust quantitative properties (e.g., vectors, ..)
- Simple geometry
- Query/filter expressions
- Metadata

✓ **More extensible**

- Simpler language extension capability
 - Based on model libraries

✓ **More interoperable**

- Standardized API



But...SysML v2 is harder to implement than v1

Re-implementation of v1-equivalent capabilities

plus

implementation of new capabilities

plus

re-implementation of former UML capabilities

Reification of relationships (graph structure) in abstract syntax

Textual as well as graphical notation

Inheritance everywhere



Nevertheless...Many Implementations in Progress!

Dassault/3DS

Cameo

IBM

Rhapsody

PTC

Windchill Modeler

Sparx

Enterprise Architect

Intercax

Syndeia

Siemens

Ansys



SysML v2 Finalization

March 2023	Formed Finalization Task Forces
June 2023	Publish Beta Specifications
September 2023	Establish Systems Modeling Community
December 1, 2023	Public Comment Deadline
March 2024	Deliver Finalized Specifications Establish Revision Task Forces
Mid 2024	Publish Formal Specifications



Potential Standards to Migrate to SysML v2

Unified Architecture Framework (UAF)

Risk Analysis and Assessment Modeling Language (RAAML)

SysML Extension for Physical Interaction and Signal Flow
(SysPhys)

Diagram Definition / Interchange

Unified Modeling Language (UML)



Conclusion: Not Bad for a "Second System"!

The SST ran for over 5 years

- No significant conflict, losing no participating organizations
- Pilot implementation released (almost) every month from November 2018 to February 2023.
- Submitted specifications met their objectives and about 90% of the RFP requirements.
- There is already a SysML v2 user community, and there is great interest in moving to SysML v2 in the wider MBSE community.

But...

- SysML v2 is not a simple evolution from SysML v1.
- SysML v2 is not easy to implement (even compared to SysML v1+UML).
- Nevertheless, it is being implemented!

Managing the transition from v1 to v2 will be critical!