



2019
Annual **INCOSE**
international workshop
Torrance, CA, USA
January 26 - 29, 2019

SysML v2 Submission Team (SST)

SysML v2 Update



Presentation Purpose

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- 1 Year after RFP Issued and SysML v2 Submission Team Established
 - Share preliminary progress & directions with broader community
 - Highlight some differences and benefits relative to SysML v1
- Slides derived in part from previous presentations:
 - SysML v2 Overview and Demo to OMG SE DSIG 2018-12-11 – Friedenthal/Seidewitz
 - SysML v2 and MBSE: The Next Ten Years 2018-10-16 Models Conference - Seidewitz
 - Future Directions for MBSE with SysML 2018-05-22 No Magic Symposium - Friedenthal



Systems Modeling Language™ (SysML®)

SST

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

- SysML has evolved to address user and vendor needs
 - v1.0, adopted in 2006; v1.5, current version; v1.6, in process
- SysML has facilitated awareness and adoption of MBSE
- Much has been learned from using SysML for MBSE



SysML v2 Objectives

SST

Increase adoption and effectiveness of MBSE
by enhancing...

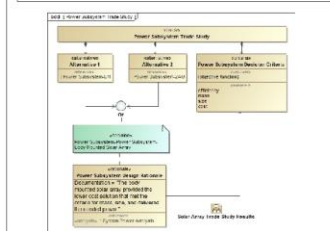
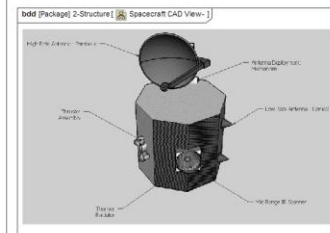
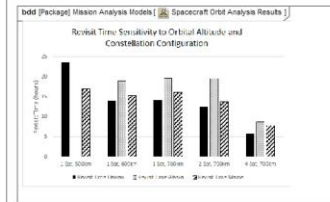
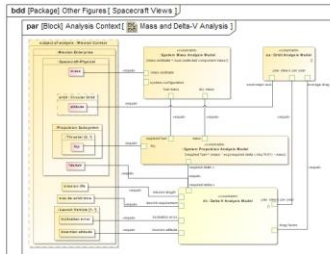
- Precision and expressiveness of the language
- Consistency and integration among language concepts
- Interoperability with other engineering models and tools
- Usability by model developers and consumers



SysML v2 Functional Enhancements

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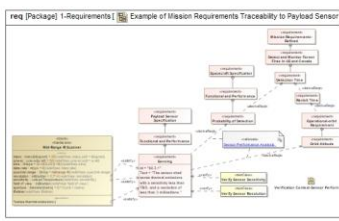
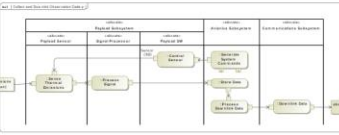
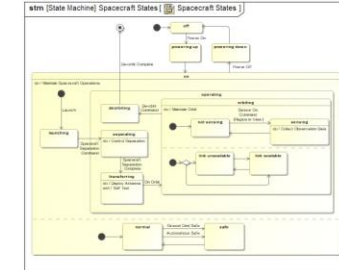
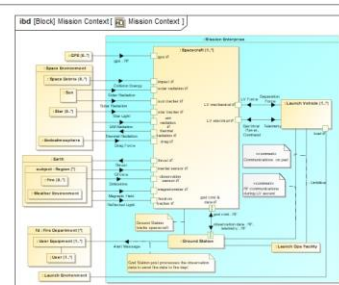
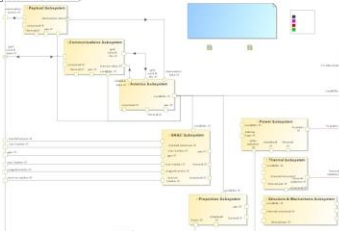
Improved integration with analysis



Geometric View

Trade Studies

| # | Req ID | Req No | Text |
|----|--------|--------|---|
| 1 | 1.1 | 1.1.1 | Power System shall provide 100W to 200W |
| 2 | 1.1 | 1.1.2 | Power System shall provide 100W to 200W |
| 3 | 1.1 | 1.1.3 | Power System shall provide 100W to 200W |
| 4 | 1.1 | 1.1.4 | Power System shall provide 100W to 200W |
| 5 | 1.1 | 1.1.5 | Power System shall provide 100W to 200W |
| 6 | 1.1 | 1.1.6 | Power System shall provide 100W to 200W |
| 7 | 1.1 | 1.1.7 | Power System shall provide 100W to 200W |
| 8 | 1.1 | 1.1.8 | Power System shall provide 100W to 200W |
| 9 | 1.1 | 1.1.9 | Power System shall provide 100W to 200W |
| 10 | 1.1 | 1.1.10 | Power System shall provide 100W to 200W |
| 11 | 1.1 | 1.1.11 | Power System shall provide 100W to 200W |
| 12 | 1.1 | 1.1.12 | Power System shall provide 100W to 200W |
| 13 | 1.1 | 1.1.13 | Power System shall provide 100W to 200W |
| 14 | 1.1 | 1.1.14 | Power System shall provide 100W to 200W |
| 15 | 1.1 | 1.1.15 | Power System shall provide 100W to 200W |
| 16 | 1.1 | 1.1.16 | Power System shall provide 100W to 200W |
| 17 | 1.1 | 1.1.17 | Power System shall provide 100W to 200W |
| 18 | 1.1 | 1.1.18 | Power System shall provide 100W to 200W |
| 19 | 1.1 | 1.1.19 | Power System shall provide 100W to 200W |
| 20 | 1.1 | 1.1.20 | Power System shall provide 100W to 200W |
| 21 | 1.1 | 1.1.21 | Power System shall provide 100W to 200W |
| 22 | 1.1 | 1.1.22 | Power System shall provide 100W to 200W |
| 23 | 1.1 | 1.1.23 | Power System shall provide 100W to 200W |
| 24 | 1.1 | 1.1.24 | Power System shall provide 100W to 200W |
| 25 | 1.1 | 1.1.25 | Power System shall provide 100W to 200W |
| 26 | 1.1 | 1.1.26 | Power System shall provide 100W to 200W |
| 27 | 1.1 | 1.1.27 | Power System shall provide 100W to 200W |
| 28 | 1.1 | 1.1.28 | Power System shall provide 100W to 200W |
| 29 | 1.1 | 1.1.29 | Power System shall provide 100W to 200W |
| 30 | 1.1 | 1.1.30 | Power System shall provide 100W to 200W |



Variant Modeling & Design Configurations

Improved integration between Behavior & Structure

Property-based requirements

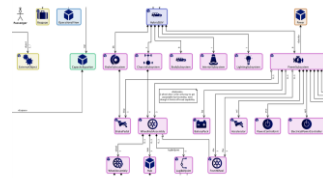
SysML models must support flexible visualizations

Text

```

part vehicle_C1: VehicleDefinitions.Vehicle {
  part frontAssembly: AxleAssembly {
    part frontWheel: Wheel[2];
    part frontAxle: Axle;
  }
  part rearAssembly: AxleAssembly {
    part rearWheel: Wheel[2];
    part rearAxle: Axle;
  }
}
    
```

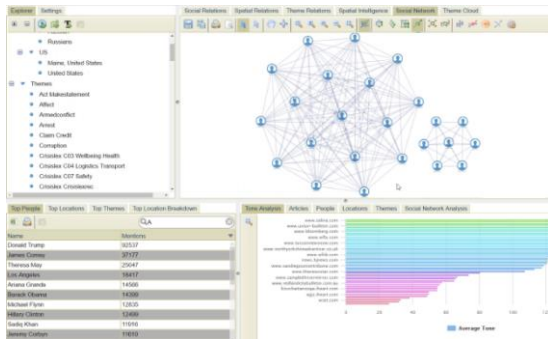
Diagram



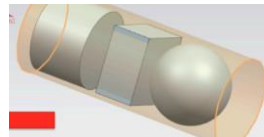
Table

| Name | Thread pitch (mm) | Minor diameter (mm) | Nominal diameter (mm) | Head shape | Price for 10 screws | Available at factory outlet | Number in stock | Flat or Phillips head? |
|------|-------------------|---------------------|-----------------------|------------|---------------------|-----------------------------|-----------------|------------------------|
| M4 | 0.7 | 4p | 4 | Pan | \$10.08 | Yes | 276 | Flat |
| M5 | 0.8 | 5p | 5 | Round | \$13.89 | Yes | 183 | Both |
| M6 | 1 | 6p | 6 | Button | \$10.42 | Yes | 1043 | Flat |
| M8 | 1.25 | 8p | 8 | Pan | \$11.38 | No | 238 | Phillips |
| M10 | 1.5 | 10p | 10 | Round | \$16.74 | Yes | 488 | Phillips |
| M12 | 1.75 | 12p | 12 | Pan | \$18.26 | No | 998 | Flat |
| M14 | 2 | 14p | 14 | Round | \$21.19 | No | 235 | Phillips |
| M16 | 2 | 16p | 16 | Button | \$23.57 | Yes | 292 | Both |
| M18 | 2.1 | 18p | 18 | Button | \$25.87 | No | 664 | Both |
| M20 | 2.4 | 20p | 20 | Pan | \$29.09 | Yes | 486 | Both |
| M24 | 2.55 | 24p | 24 | Round | \$33.01 | Yes | 982 | Phillips |
| M28 | 2.7 | 28p | 28 | Button | \$35.98 | No | 1007 | Phillips |
| M36 | 3.2 | 36p | 36 | Pan | \$41.32 | No | 434 | Both |
| M50 | 4.5 | 50p | 50 | Pan | \$44.72 | No | 740 | Flat |

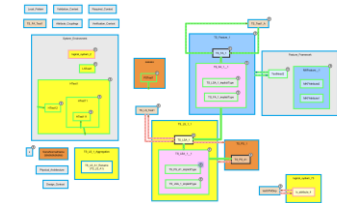
Dynamic Visualization



Physical Envelope



Model Differencing

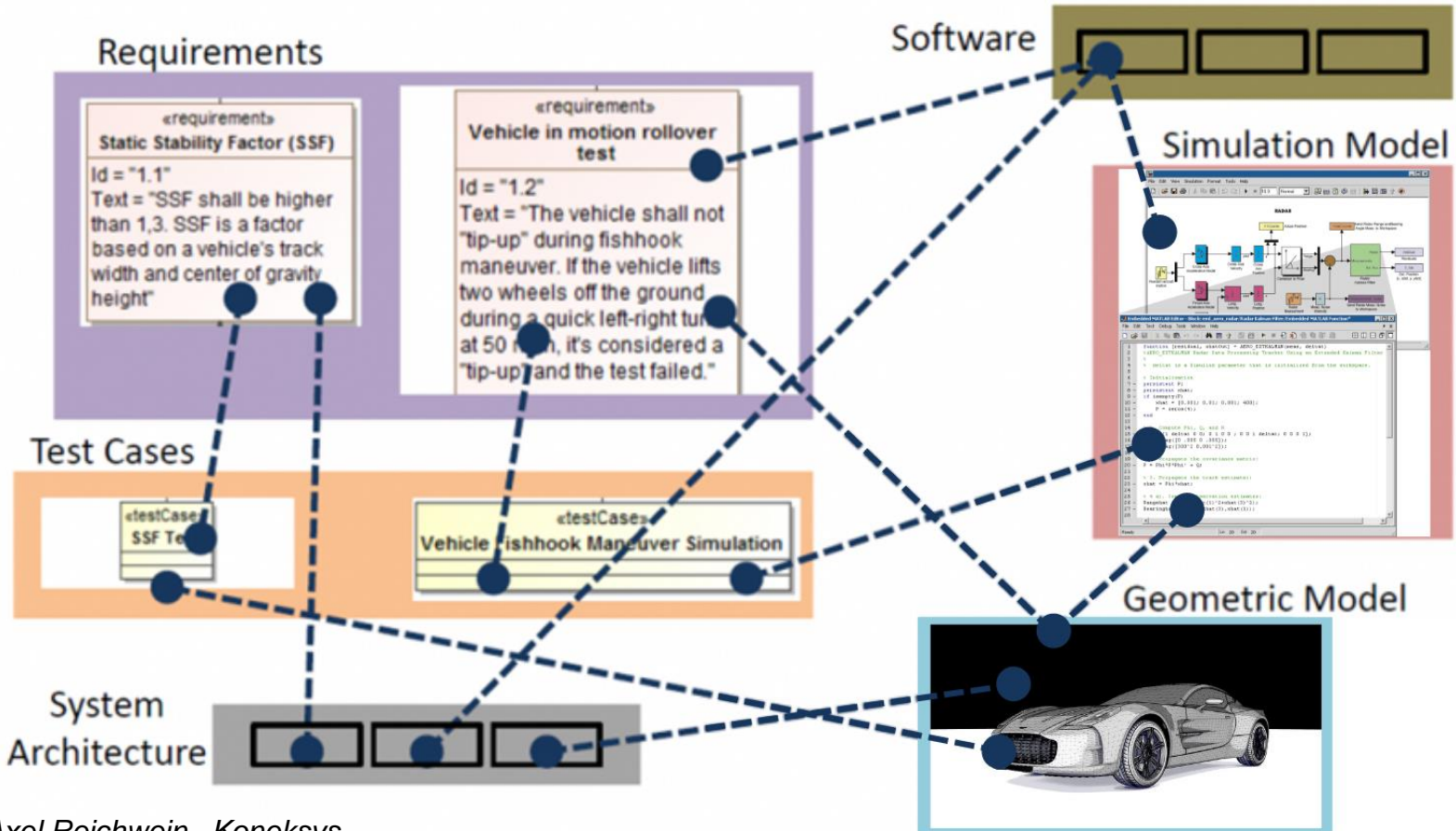


Interactive Display



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

SysML tooling must interoperate with other tools



Axel Reichwein , Koneksys
 SysML v2 Model Interoperability & Standard API Requirements



SysML v2 Requests for Proposals *SST*

- SysML v2 RFP issued December, 2017
 - Initial Submission: November, 2019
 - Revised (Final) Submission: November, 2020
- SysML v2 API & Services RFP issued June, 2018
 - Initial Submission: February, 2020
 - Revised (Final) Submission: February, 2021
- SysML v2 Submission Team (SST) formed December 2017
 - Leads: Sandy Friedenthal, Ed Seidewitz



SysML v2 Submission Team (SST) *SST*

- A broad team of end users, vendors, academics, and government liaisons
 - Currently 96 members from 60 organizations
- Developing submissions to both RFPs
- Driven by RFP requirements and user needs



SST Participating Organizations

SST

Academia/Research
End User

Tool Vendors
Government Rep

INCOSE rep *

- Aerospace Corp
- Airbus
- AIST
- ANSYS medini
- Aras
- ARDEC
- BAE
- BigLever Software
- Boeing
- CEA
- Christian Doppler Laboratory
- Contact Software
- Draper Lab
- Elbit Systems of America
- European Space Agency
- Ford
- Franhofer
- General Motors
- George Mason University
- GfSE
- GTRI/Georgia Tech
- IBM
- IncQuery Labs
- Innovative Decisions
- InterCax
- Jet Propulsion Lab
- John Deere
- Kenntnis
- Lieber Lieber
- Lightstreet Consulting
- Lockheed Martin
- LSST
- Maplesoft
- MITRE
- Model Driven Solutions
- Model Foundry
- NIST
- No Magic
- OOSE
- Ostfold University College
- Papyrus Industry Consortium (PIC)
- Phoenix Integration
- PTC
- Raytheon
- Rolls Royce
- SAF Consulting *
- SAIC
- Siemens
- Sierra Nevada Corporation
- Simula
- System Strategy *
- Tata Consultancy Services
- Thales
- Thematix
- Tom Sawyer
- University of Cantabria
- University of Alabama in Huntsville
- University of Detroit Mercy
- Vitech
- 88solutions



Key Elements of SysML v2

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- New Metamodel that is not constrained by UML
 - Grounded in formal semantics
- Robust visualizations based on flexible view & viewpoint specification and execution
 - Graphical, Tabular, Textual
- Standardized API to access the model

Concrete Syntax (Textual Grammar)

NamespaceDefinition:
 PackageDefinition | ClassifierDefinition

PackageDefinition:
 PackageDeclaration "{" PackagedElement* "}"

PackagedElement: NamespaceDefinition | ...

ClassifierDefinition: ClassDefinition | ...

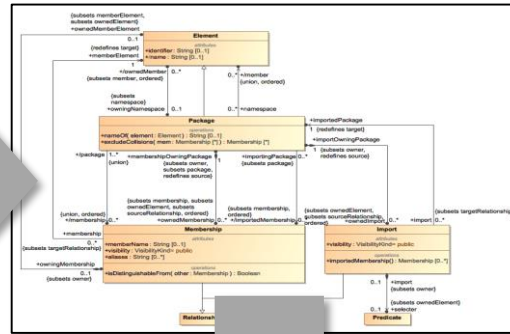
ClassDefinition:
 ClassDeclaration "{" ClassMember* "}"

ClassMember: FeatureDefinition | ...

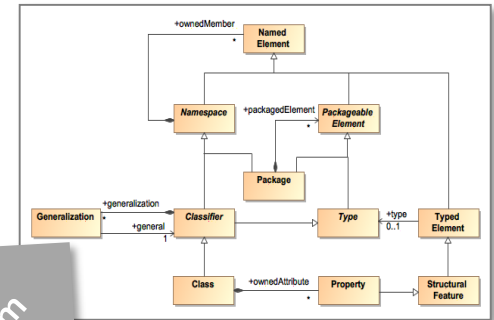
FeatureDefinition: AttributeDefinition | ...

AttributeDefinition:
 Visibility Name ":" QualifiedName

SysML Abstract Syntax



UML Abstract Syntax / Profile



Parse

Store

Transform

Visualization / Analysis

Guide

Repository

Services

Generate

Feedback

Export

Semantic Tooling / OWL

Requirements / User Needs



Initial SST Validation Cases

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- The following 11 validation cases capture initial required functionality in SysML v2
 - Parts Tree
 - Parts Interconnection
 - Function-based Behavior
 - Functional Allocation
 - State-based Behavior
 - Individuals and Snapshots
 - Variant Configuration
 - Requirements
 - Verification
 - Analysis & Trade Studies
 - View and Viewpoint

Reflects approximately ½ of the SysML v2 RFP requirements



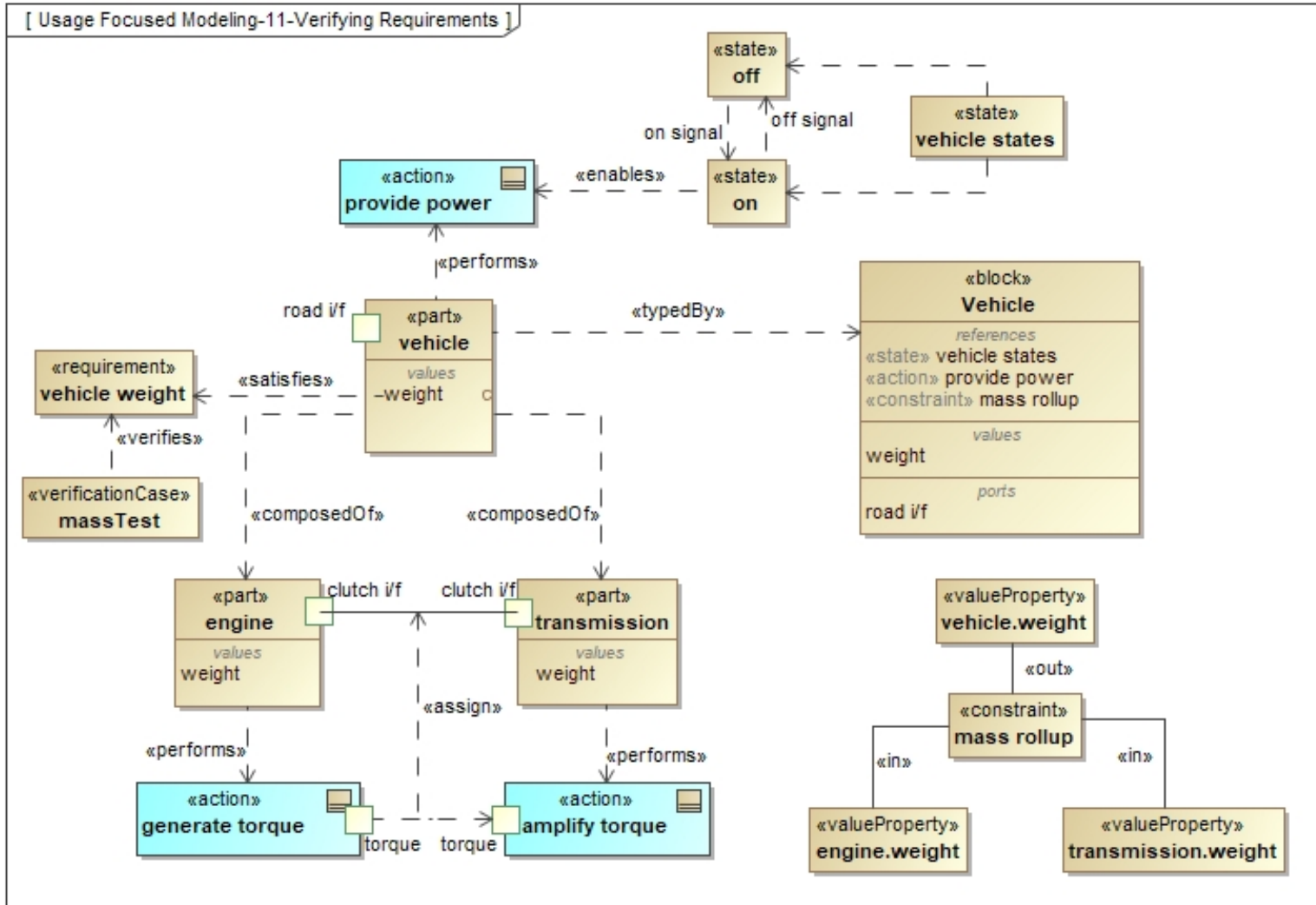
Usage Focused Modeling Approach

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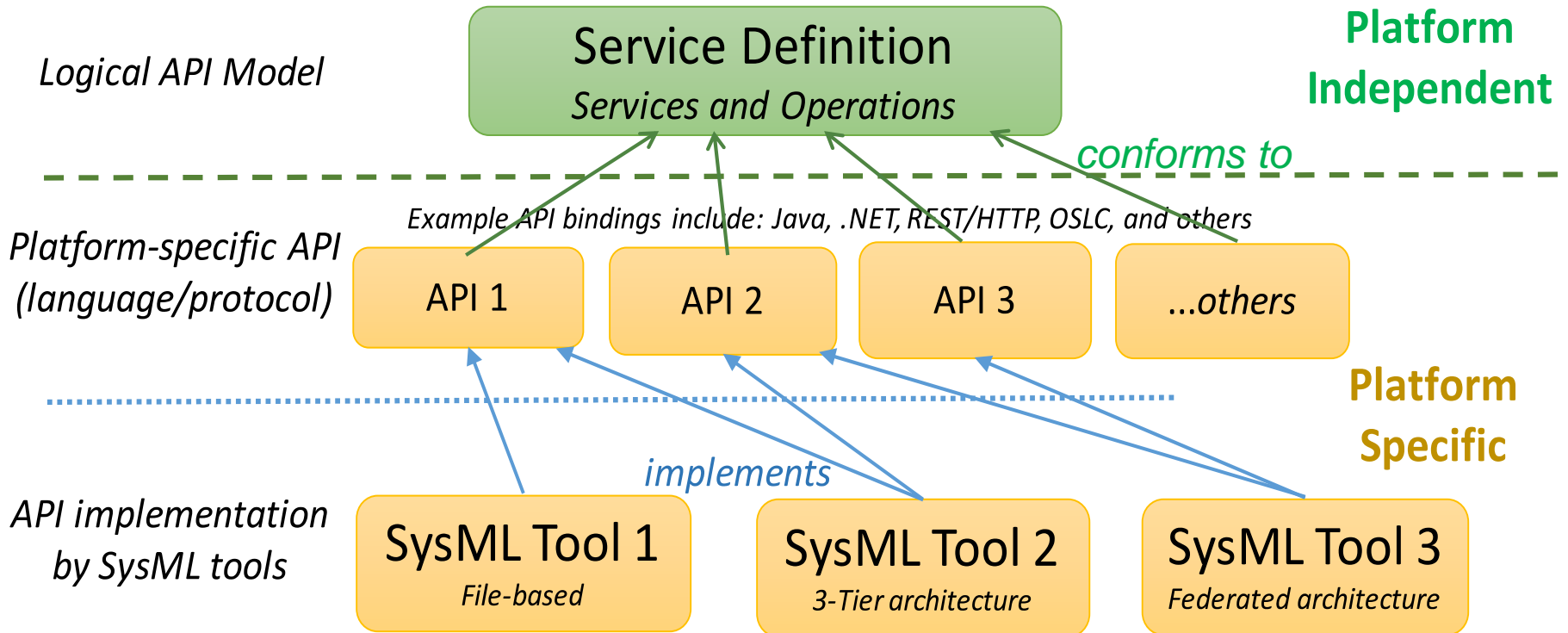
A paradigm shift to make SysML v2 more precise and intuitive to use

- Emphasizes modeling of *usages* (e.g., *parts on an ibd*)
 - Decompose, connect, relate, and group usages
- Supports other language requirements
 - variant design configurations, individuals, analysis, verification, ...

Graphical notation for illustrative purposes only



Standard APIs and services provide a mechanism for tool interoperability.



From: SysML v2 API & Services RFP



Summary

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- SST is addressing RFP requirements and issues associated with SysML v1 to improve
 - Precision and expressiveness
 - Consistency and integration among language concepts
 - Interoperability with other engineering models and tools
 - Usability by model developers and consumers
- Initial approach
 - SysML v2 metamodel that overcomes fundamental UML limitations
 - Flexible graphical notations and textual notation
 - Formal semantics
 - Standardized API for interoperability
- Working towards initial submission



OMG SysML v2 RFP

Requirements Development References

SST

- Friedenthal, S, Burkhart, R. Evolving SysML and the System Modeling Environment to Support MBSE, INCOSE INSIGHT, Model-Based Systems Engineering, August 2015 (*August 15 Volume 18 Issue 2, Pg 39-42*)
 - Capabilities, effectiveness measures, and driving requirements for a **system modeling environment (SME)** to support MBSE
- Friedenthal, S. Evolving SysML and the System Modeling Environment to Support MBSE-Part 2, INCOSE INSIGHT, (*December 16 Volume 19 Issue 4, Pg 76-80*)
 - Concept for a **system modeling environment (SME)** to support MBSE
- Friedenthal, S. Requirements for the Next Generation Systems Modeling Language (SysML® v2) INCOSE INSIGHT, (*March 18 Volume 21 Issue 1, Pg 21-25*)
 - SysML v2 RFP Requirements
- OMG SysML v2 RFP Working Group Wiki
 - http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:sysml_assessment_and_roadmap_working_group