

Future Directions for SysML v2

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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

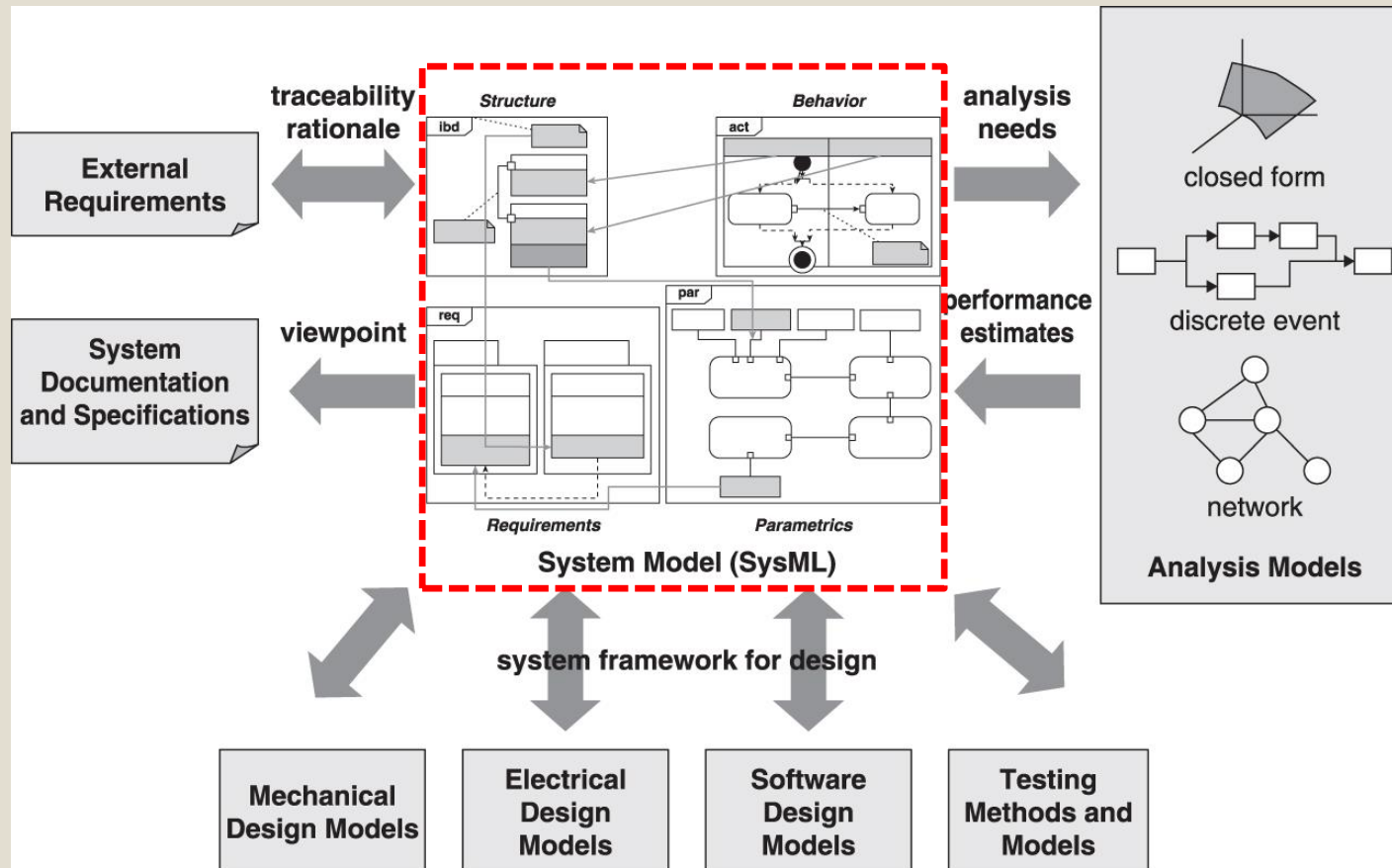


Figure 18.1

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

System Modeling Environment (SME)

INCOSE SE Vision 2025

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FROM

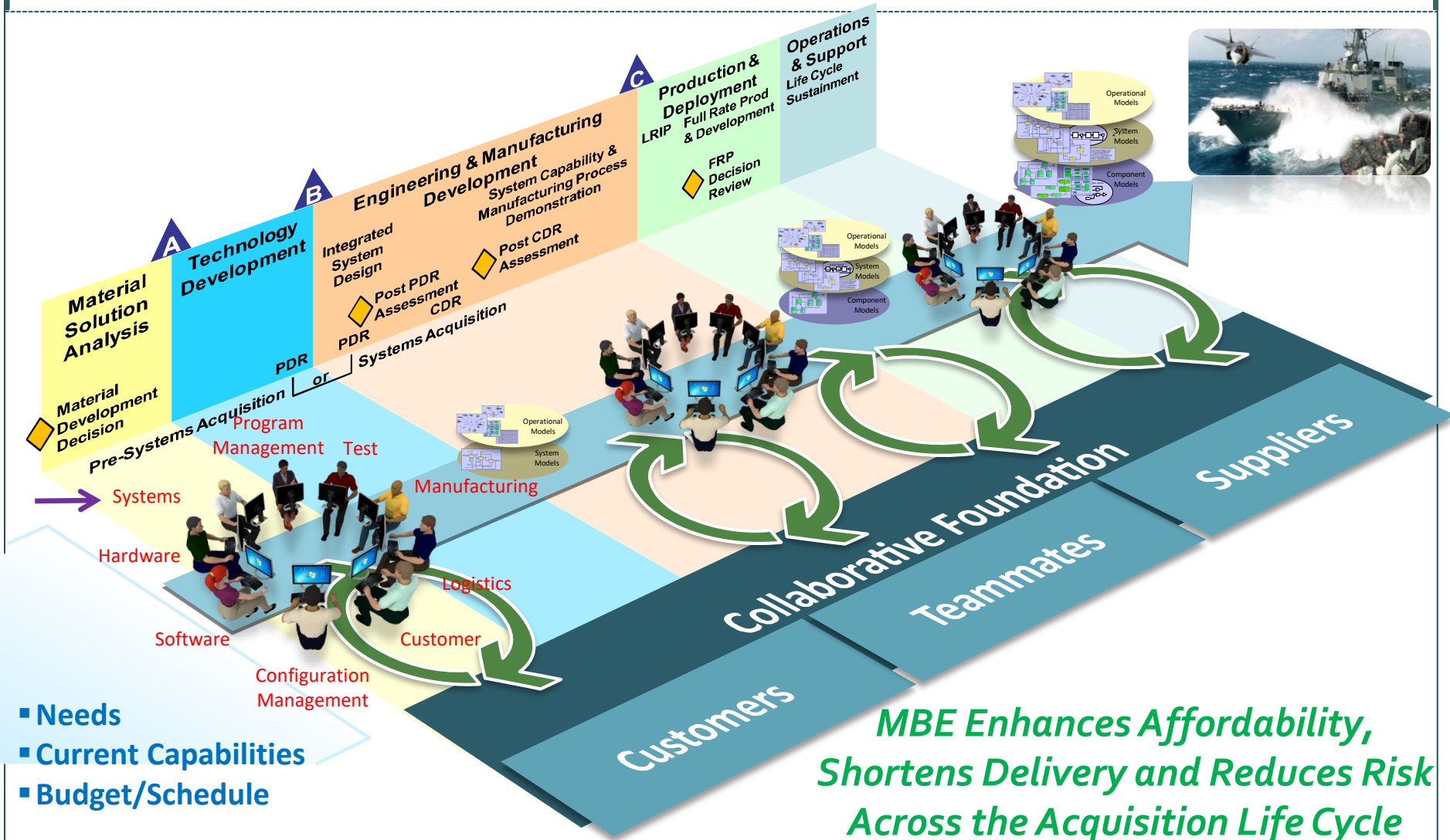
- Model-based systems engineering has grown in popularity as a way to deal with the limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/CAE.

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



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

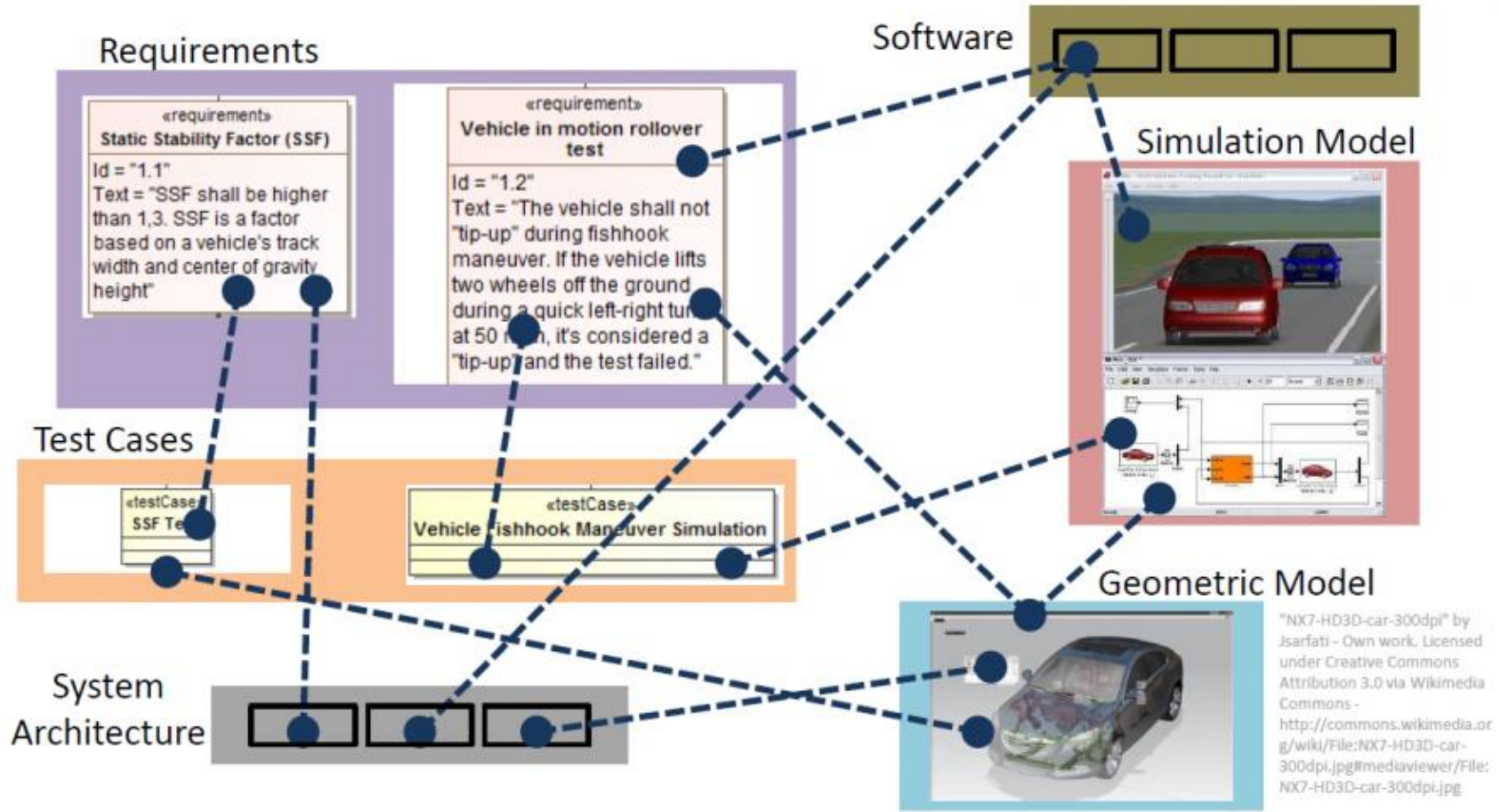


System Modeling Environment

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

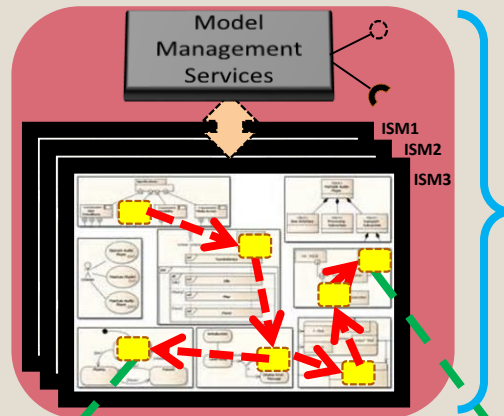
SysML v2 Model Interoperability & Standard API Requirements

System Model Management Concept

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

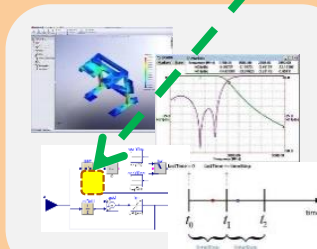
Model Management services for the *Integrated System Model (ISM)*

- Versioning
- Configuration control
- Controls & permissions
- Change process
- Change history
- Branching & merging
- Model differencing

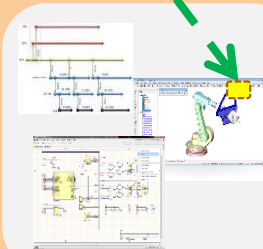


ISM:
System Model
+ Reference Links

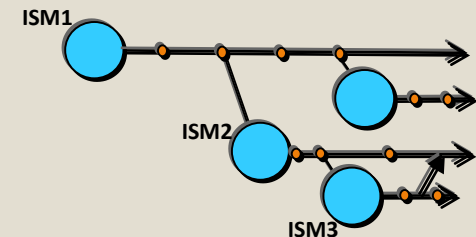
Analytic Model
Version X



CAD Model
Version Y



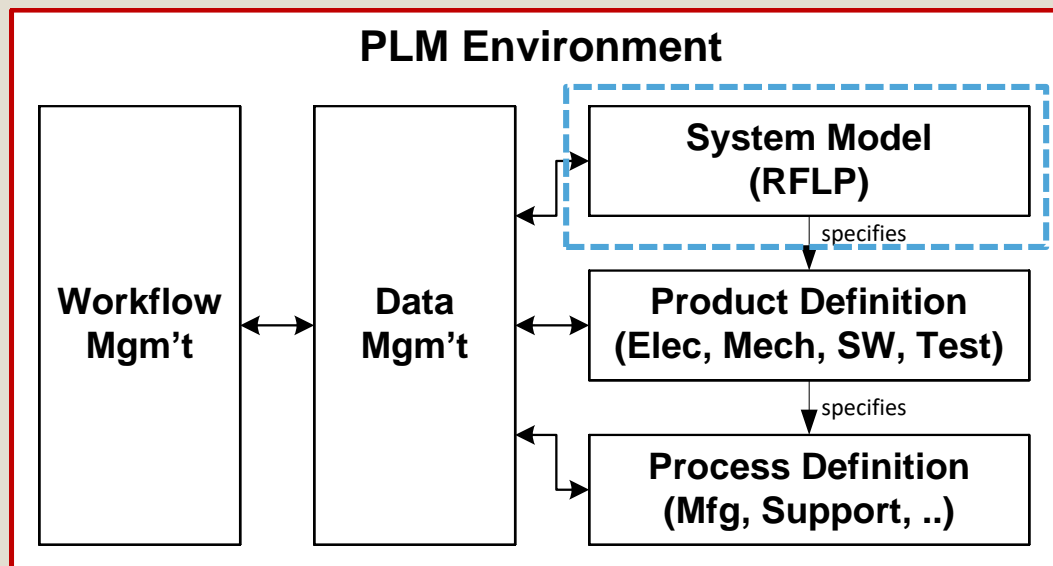
Model Evolution



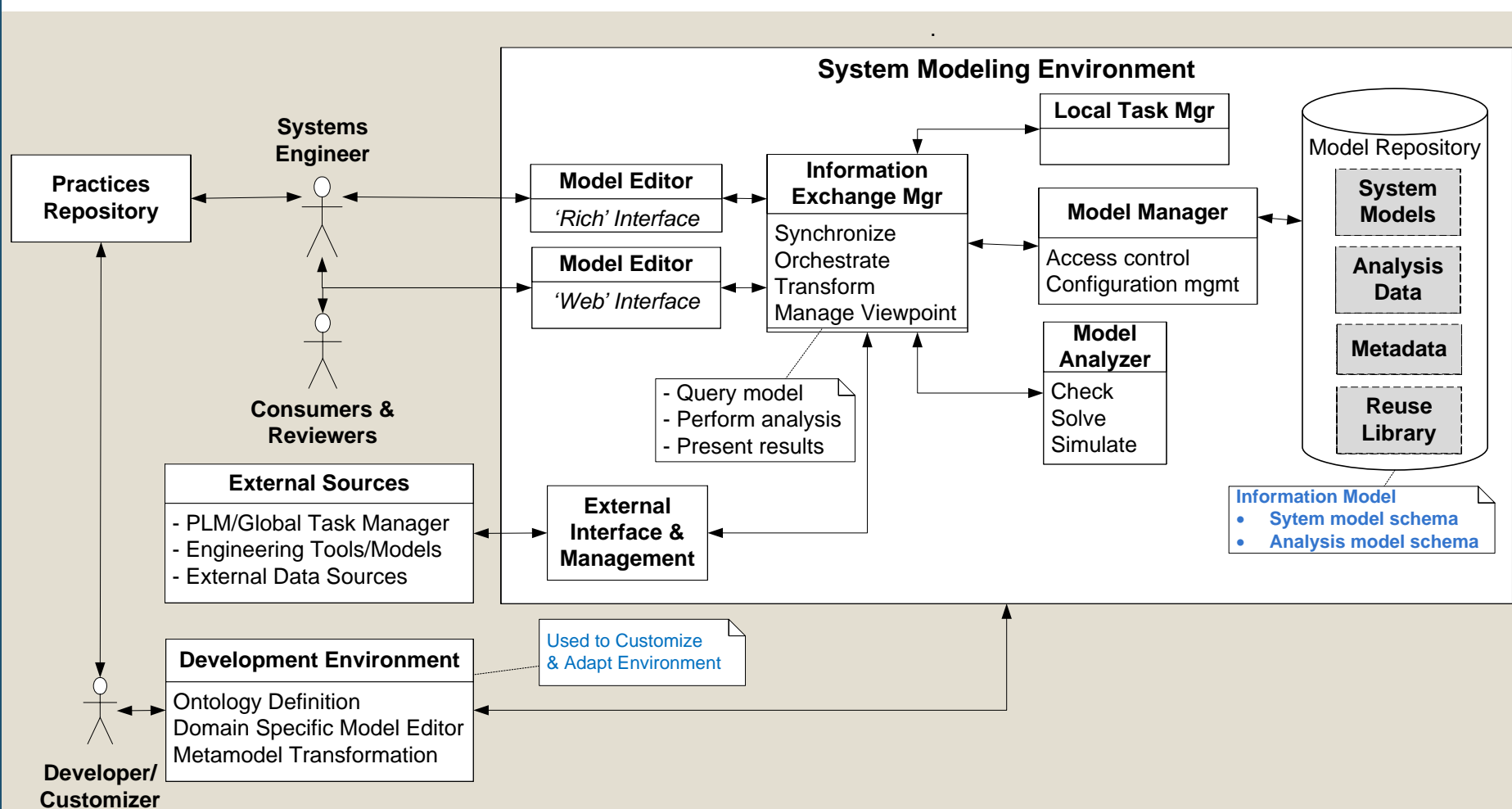
Each version of model
contains model elements
with different versions.

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)



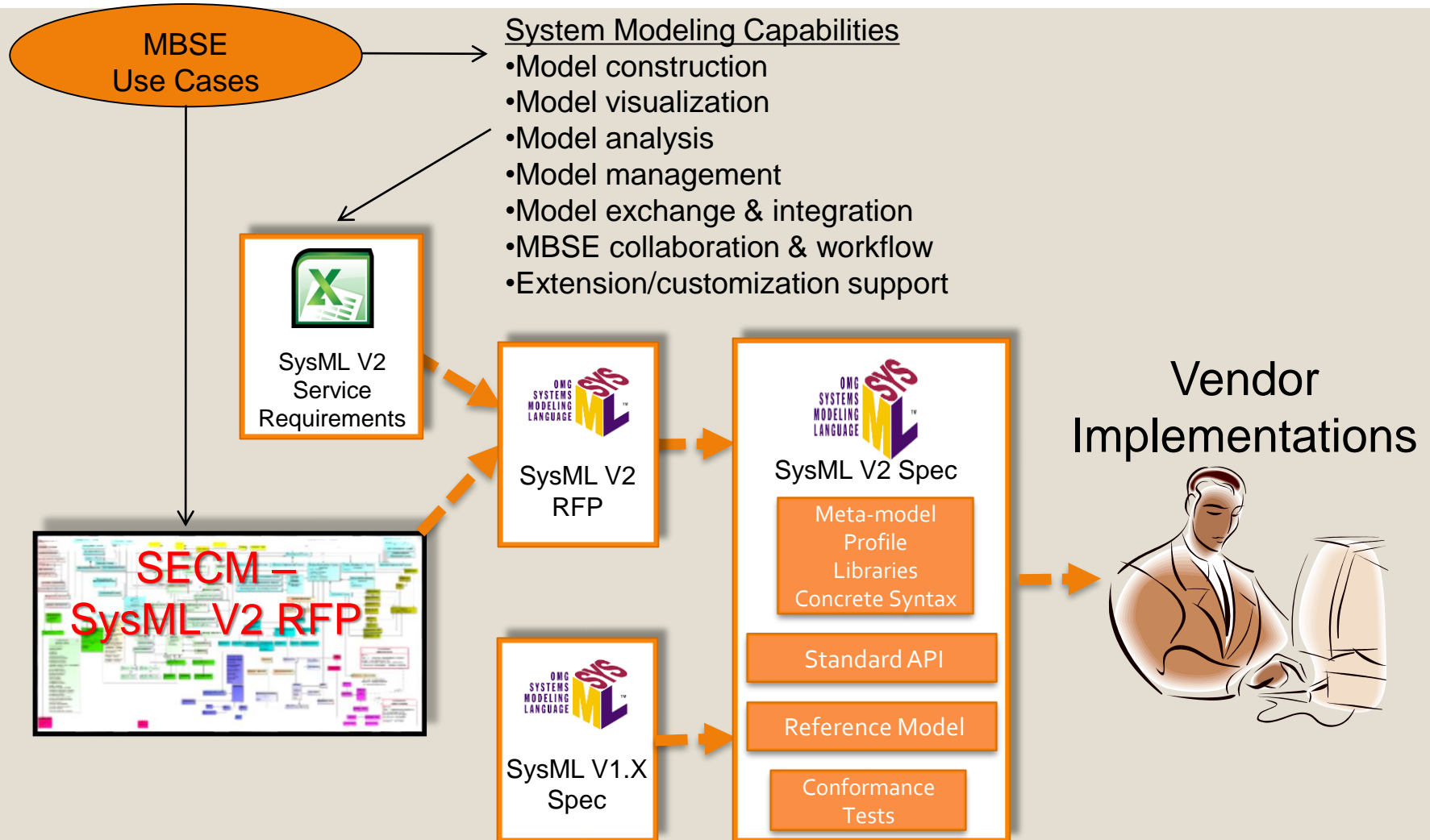
Systems Modeling Environment Logical Architecture



09/18/16

SysML v2 Requirements

SysML v2 Specification Development



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

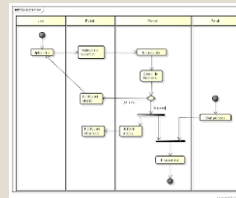
Visualization Concept (cont.)

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

Structured File Extract

```
<?xml version="1.0" encoding="UTF-8"?>
<Problem>
  <ProblemNumber>1000002</ProblemNumber>
  <Subject>Update antivirus on AV servers</Subject>
  <ErrorMessage>Installation failed with error code: xxxxxx</ErrorMessage>
  <Description>The AV on the network security</Description>
  <Status>Active</Status>
  <Category>Accessibility</Category>
  <Source>Instant Message</Source>
  <OwnerTeam>Problem Management</OwnerTeam>
  <Owner>ADole</Owner>
  <Urgency>Low</Urgency>
  <Urgency>High</Urgency>
</Problem>
<Incidents>
  <Incident>
    <IncidentNumber>50001</IncidentNumber>
    <Subject>Daily backup failure</Subject>
    <Symptom>Backup failed on server</Symptom>
  </Incident>
</Incidents>
</Problem>
```

SysML Diagrammatic



Tabular Data View

Name	Thread (min)	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	4g	4	Flat	\$10.08	Yes	276	Flat
M5	0.8	4g	5	Round	\$10.39	Yes	153	Both
M6	1	5g	6	Button	\$10.42	Yes	1043	Flat
M8	1.25	5g	8	Flat	\$11.88	No	298	Phillips
M10	1.5	6g	10	Round	\$16.74	Yes	498	Phillips
M12	1.75	7g	12	Flat	\$18.26	No	898	Flat
M14	2	7g	14	Round	\$21.19	No	235	Phillips
M16	2	8g	16	Button	\$23.57	Yes	292	Both
M18	2.1	8g	18	Button	\$25.87	No	664	Both
M20	2.4	8g	20	Flat	\$28.09	Yes	496	Both
M24	2.55	8g	24	Round	\$33.01	Yes	982	Phillips
M28	2.7	10g	28	Button	\$35.66	No	1067	Phillips
M36	3.2	12g	36	Flat	\$41.32	No	434	Both
M50	4.5	15g	50	Flat	\$44.72	No	740	Flat

Architecture Geometry

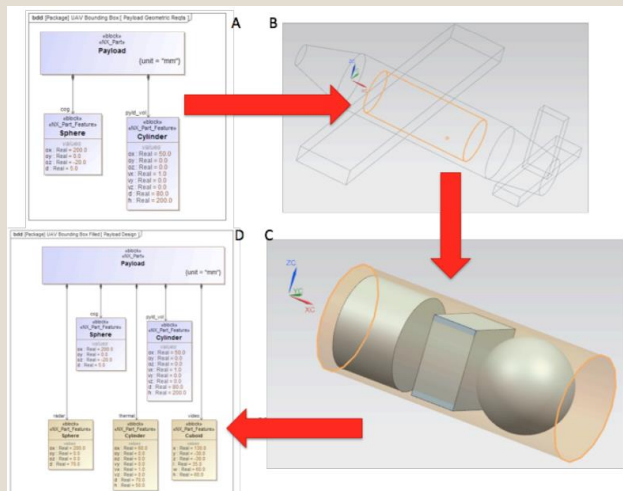
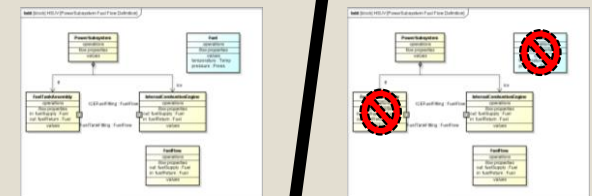


Diagram Differencing



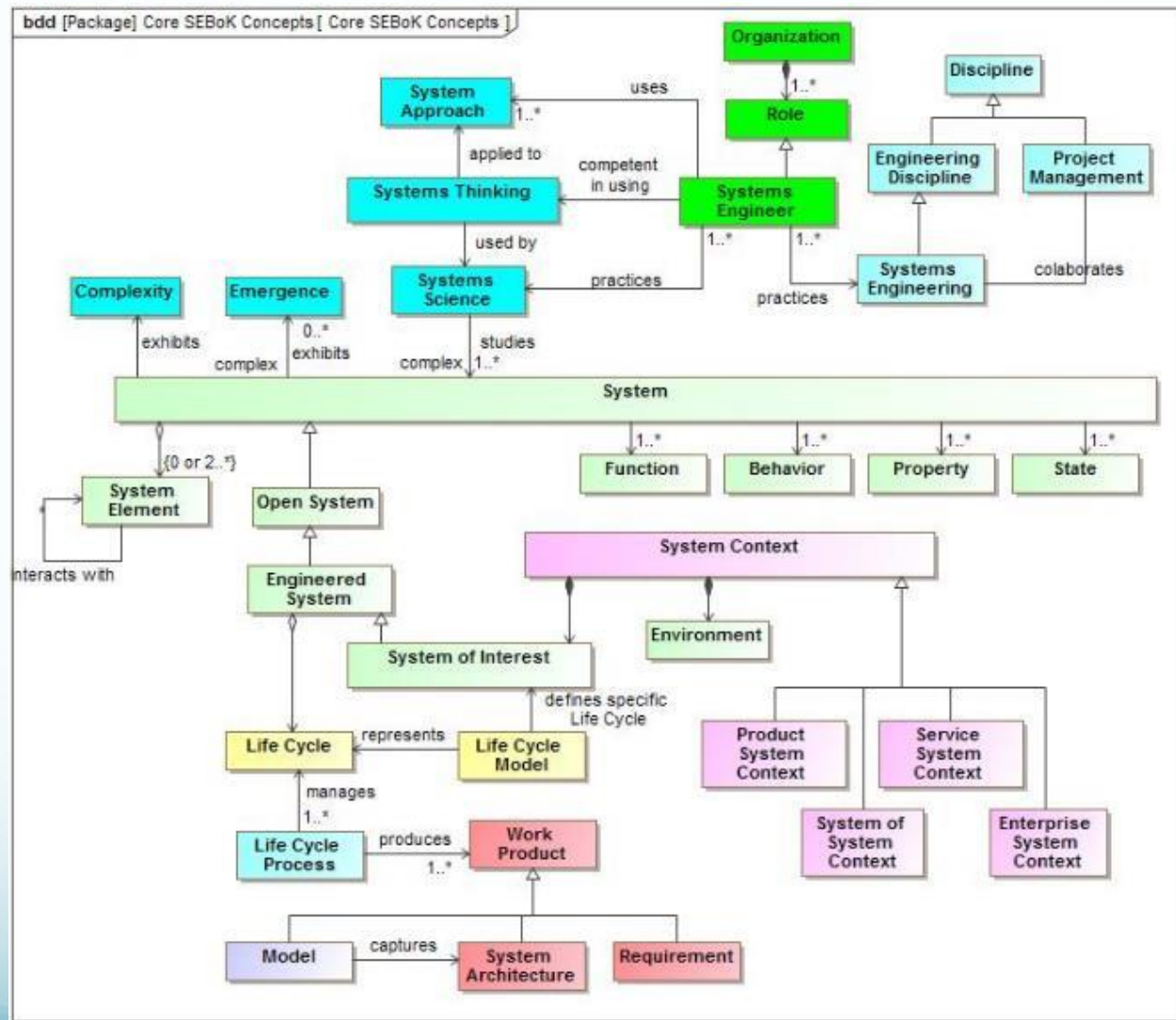
Semantic Zoom



Dynamic Visualization

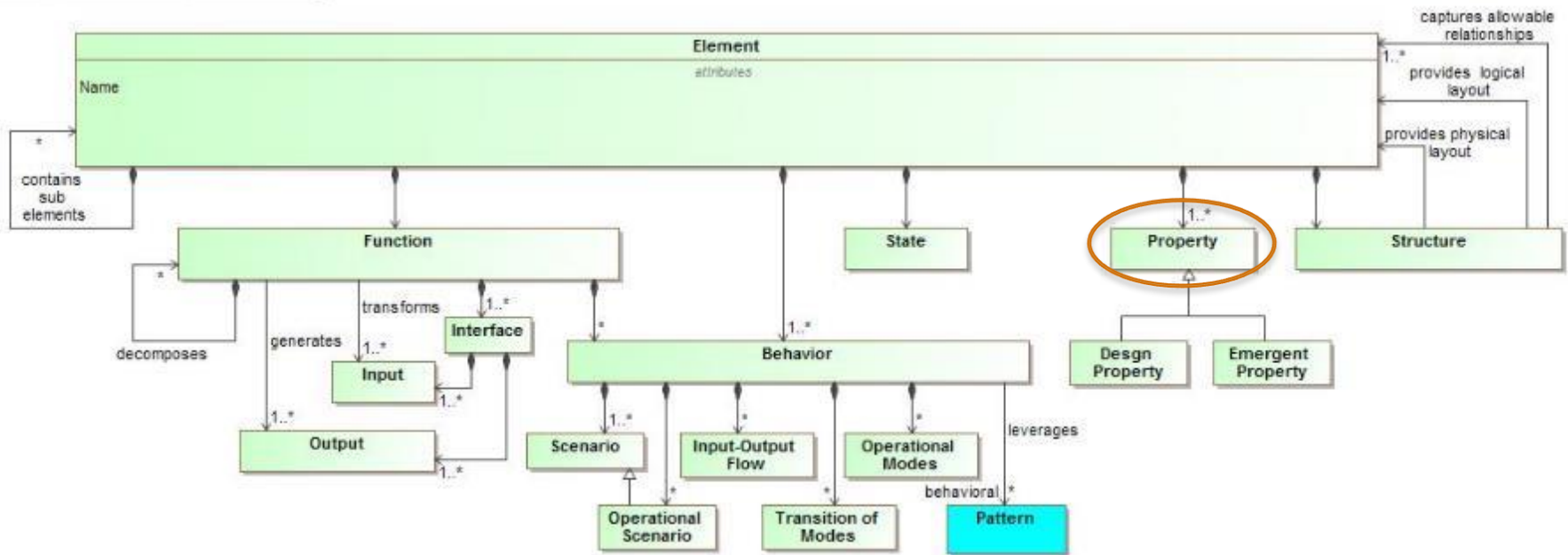


Selected Core SE Concepts from Industry Reference Model



Element Concept from Industry Reference Model

bdd [Package] SEBoK Diagrams [SEBoK - Element]

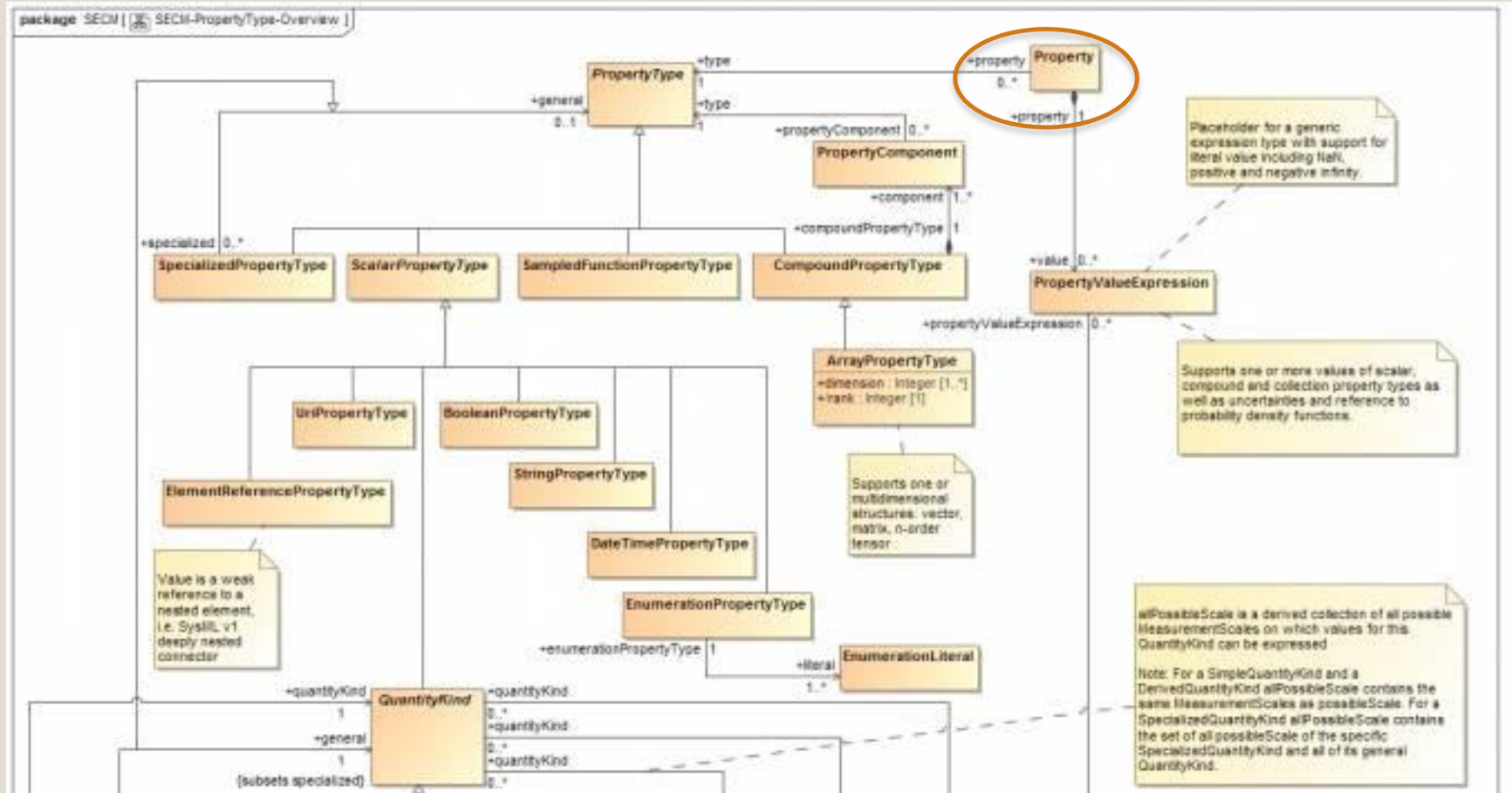


Extract from John Watson presentation
to SEBoK team at INCOSE IW on 1/30/2016

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 for improved visualization
 - Reference model & test cases to demonstrate vendor conformance levels
 - Migration from SysML v1 to SysML v2

Questions ?