

# Future Directions for SysML v2

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**INCOSE IW  
MBSE Workshop  
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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

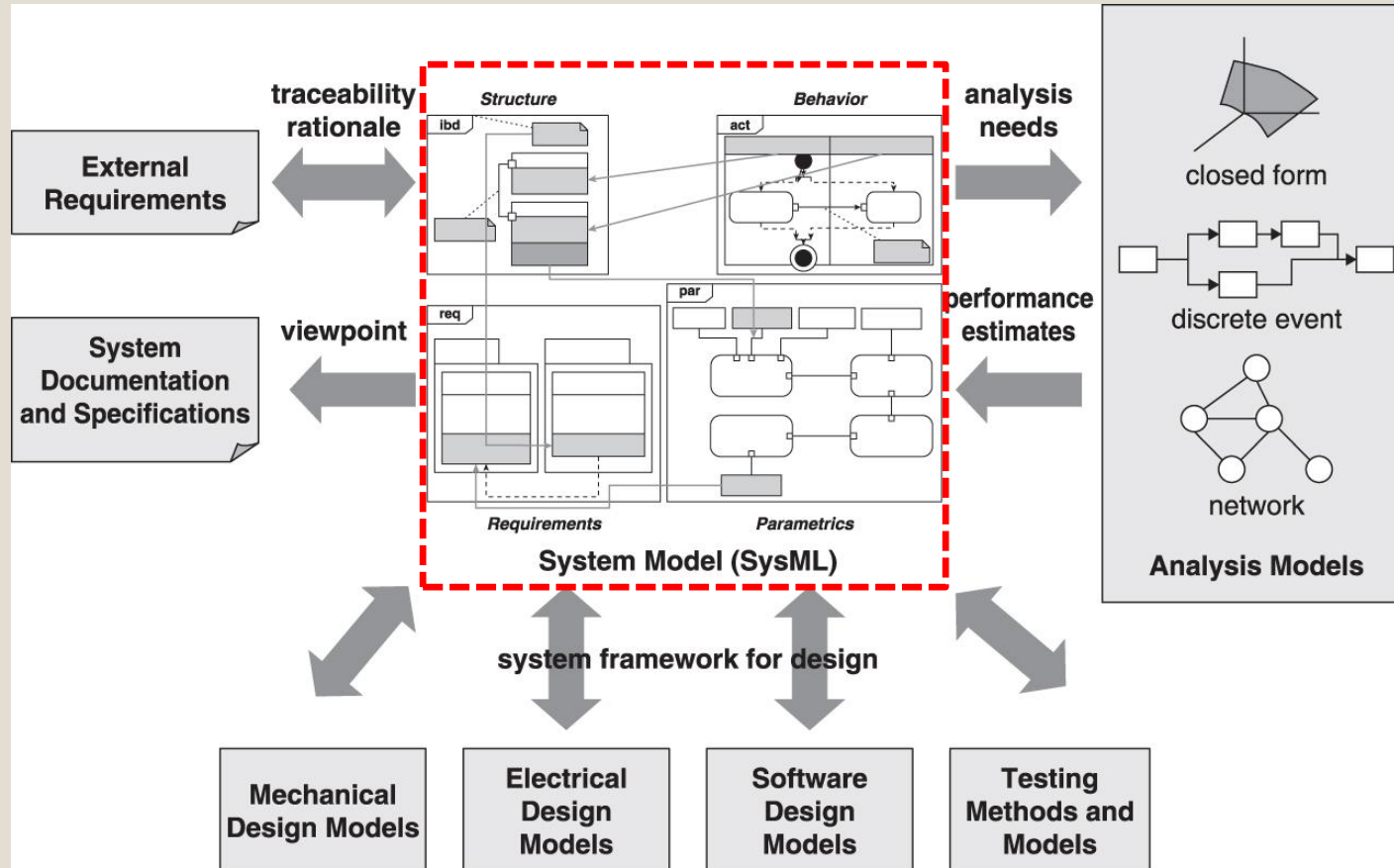


Figure 18.1

# 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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## **F R O M**

- 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.

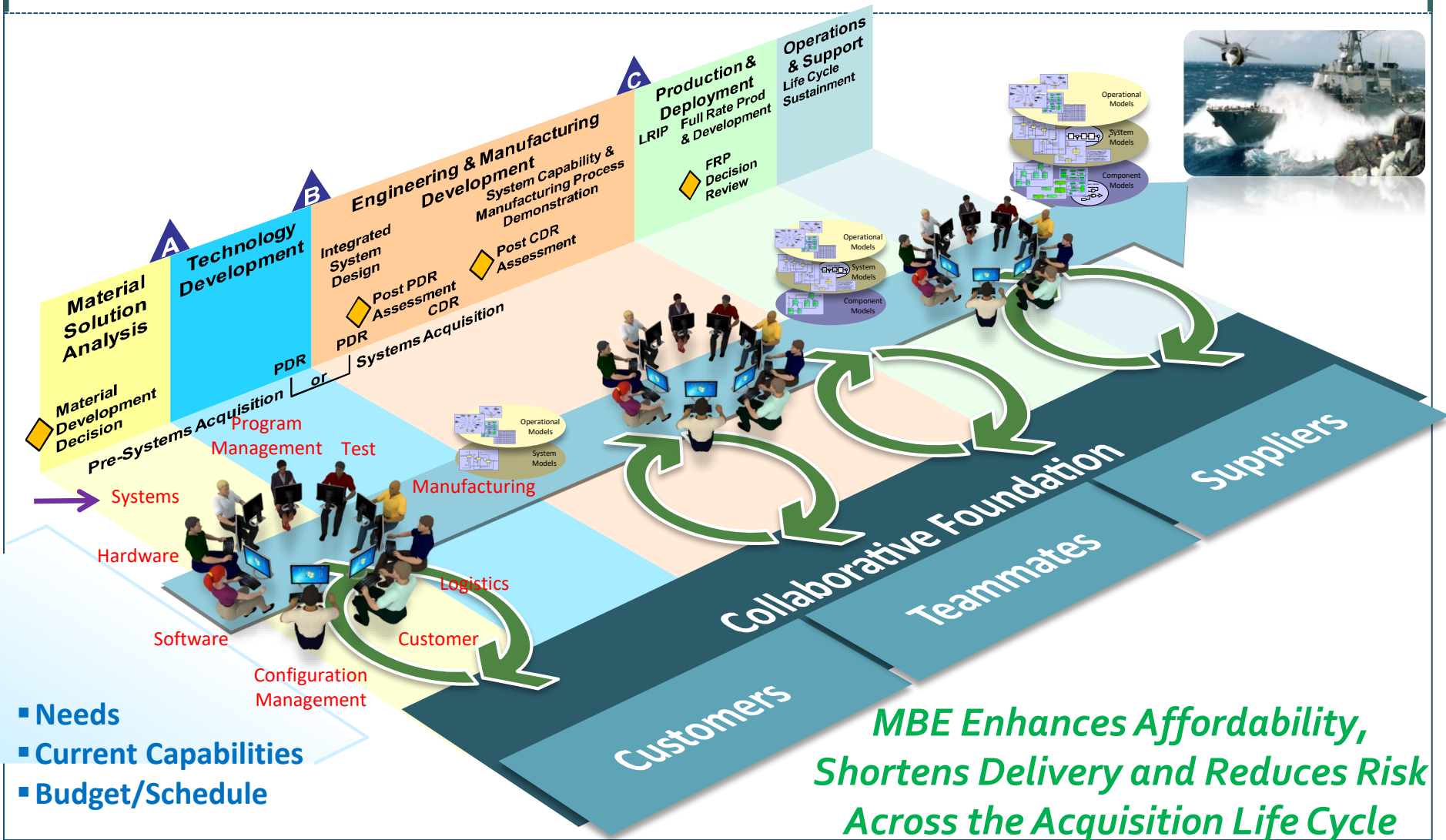
## **T O**

- 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 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

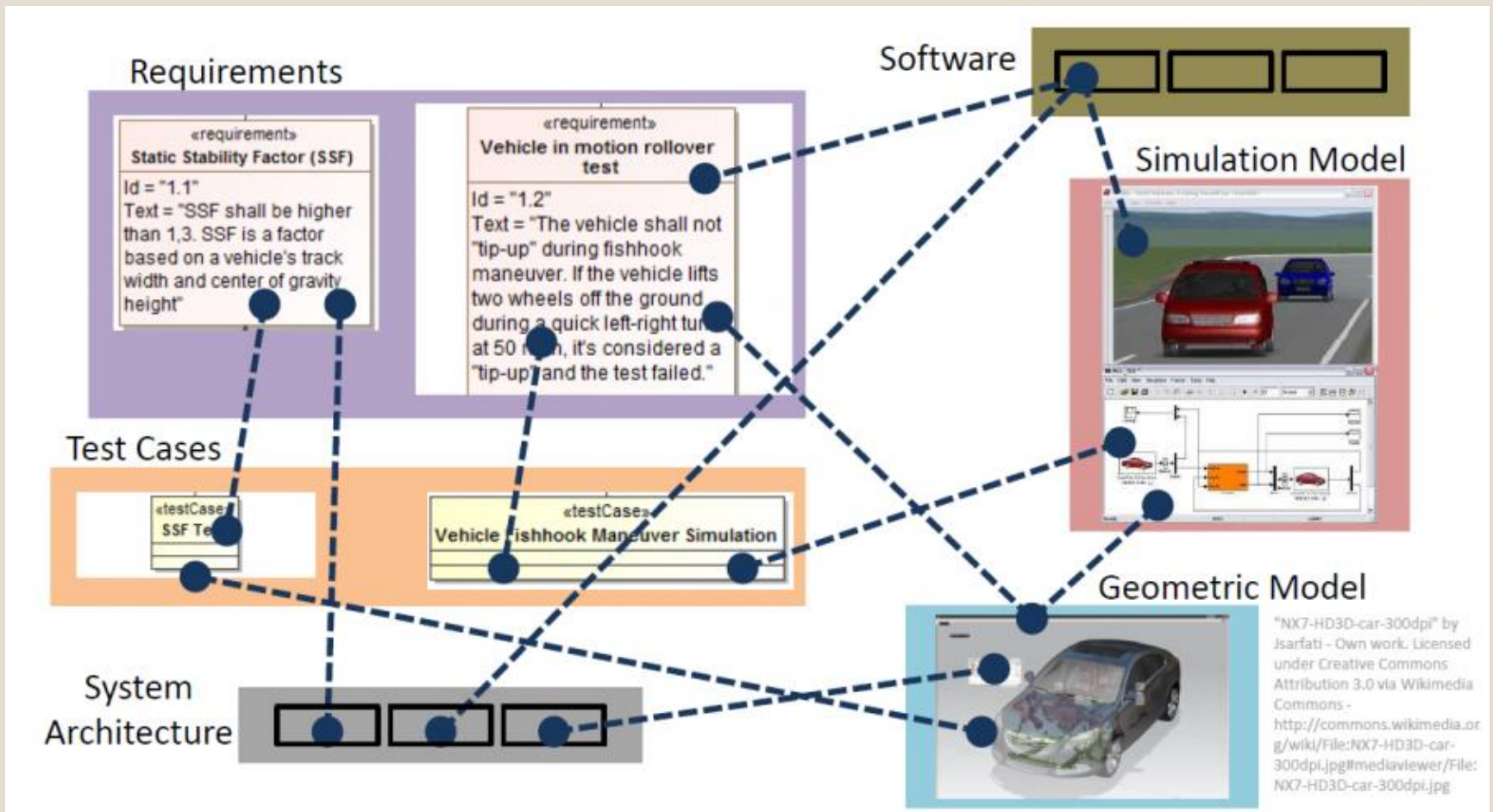


# System Modeling Environment

## 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

# System Model Interoperability



Source: Axel Reichwein

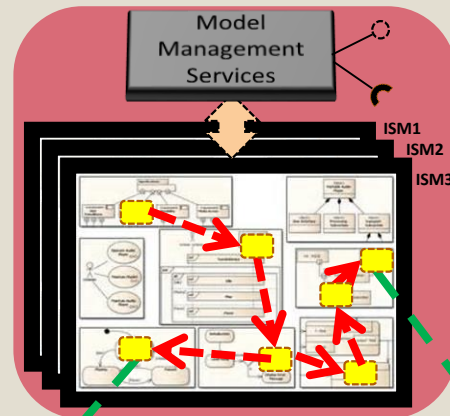
SysML v2 Model Interoperability & Standard API Requirements

# System Model Management Concept

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

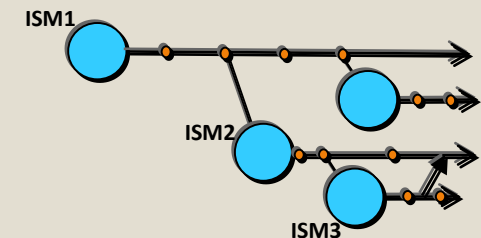
## Model Management services for the *Integrated System Model (ISM)*

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



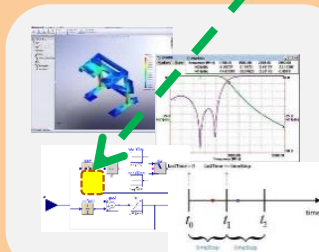
**ISM:**  
*System Model*  
**+ Reference Links**

## Model Evolution

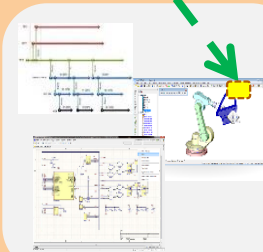


Each version of model contains model elements with different versions.

## Analytic Model Version X

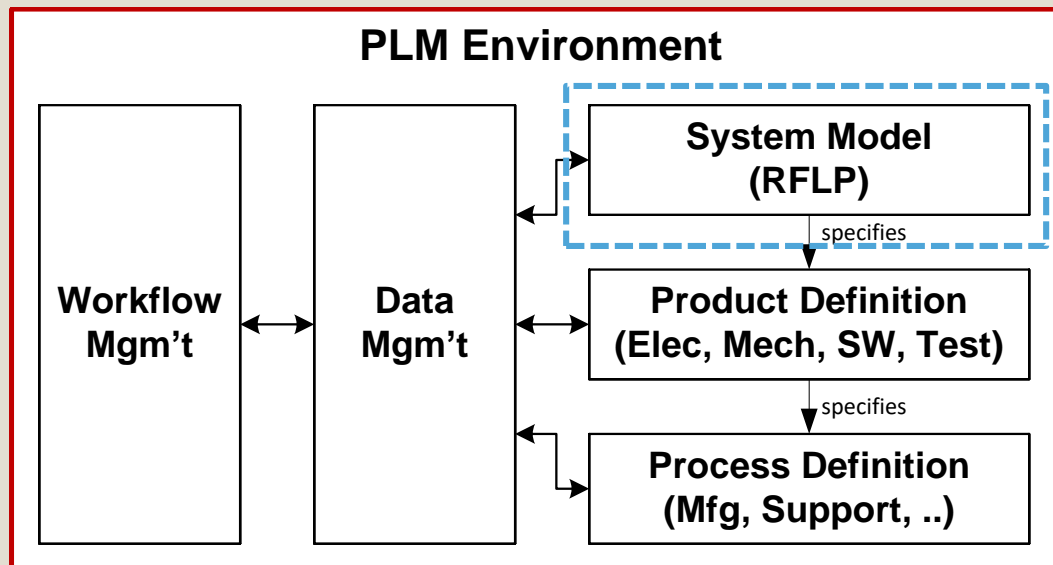


## CAD Model Version Y

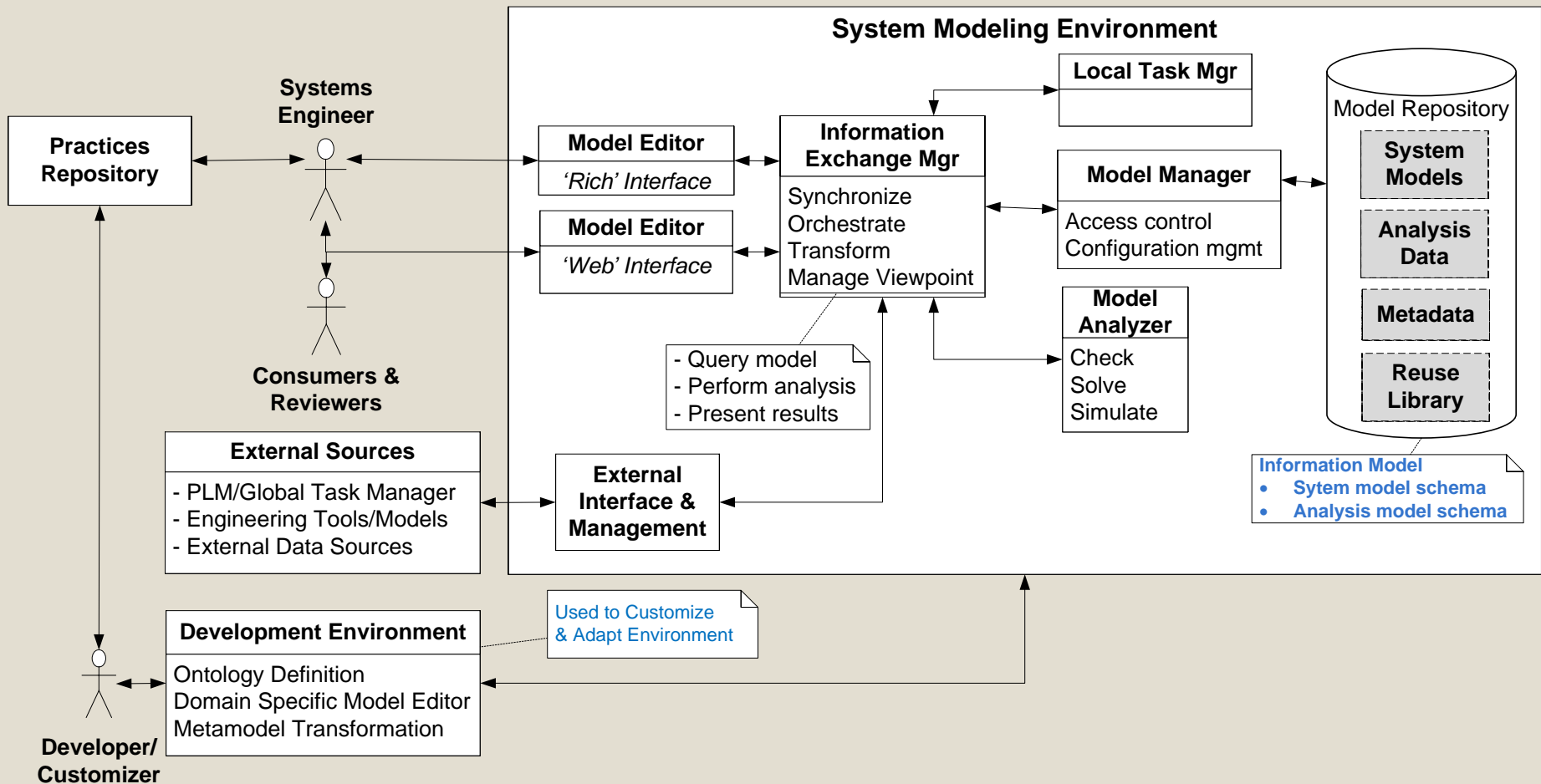


# System Model & PLM

- 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

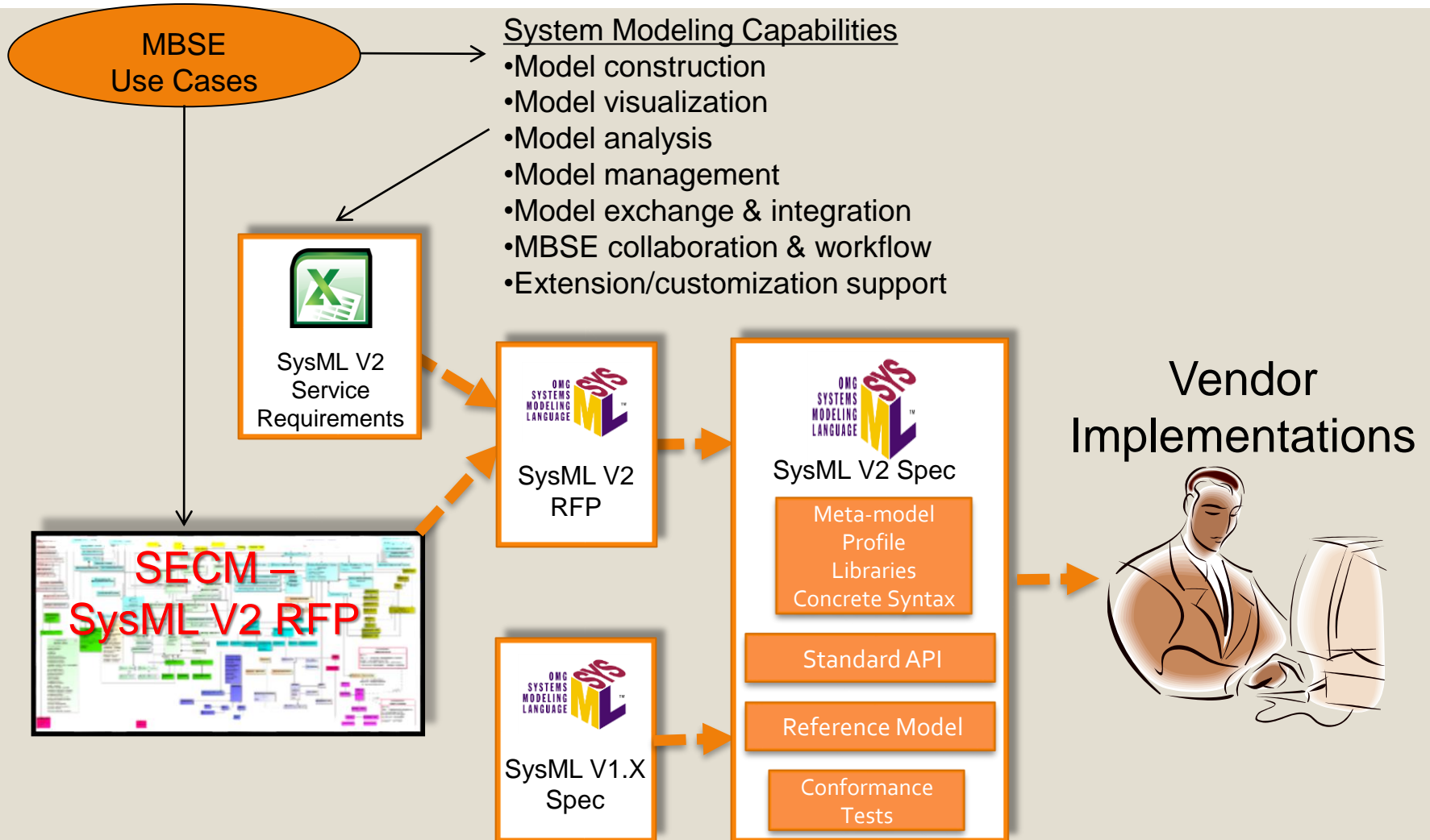


09/18/16

# 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

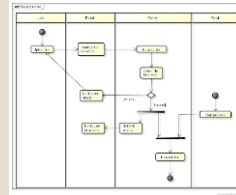
# Visualization Concept (cont.)

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> Adale </Owner>
  <Urgency> Low </Urgency>
  <Incidents>
    <Incident>
      <IncidentNumber> 50001 </IncidentNumber>
      <Subject> Daily Backup Failure </Subject>
      <Symptom> Backup failed on server </Symptom>
    </Incident>
    <Incident>
      <IncidentNumber> 50002 </IncidentNumber>
      <Subject> Daily Backup Failure </Subject>
      <Symptom> Backup failed on server </Symptom>
    </Incident>
  </Incidents>
</Problem>
```

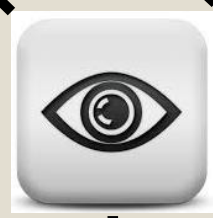
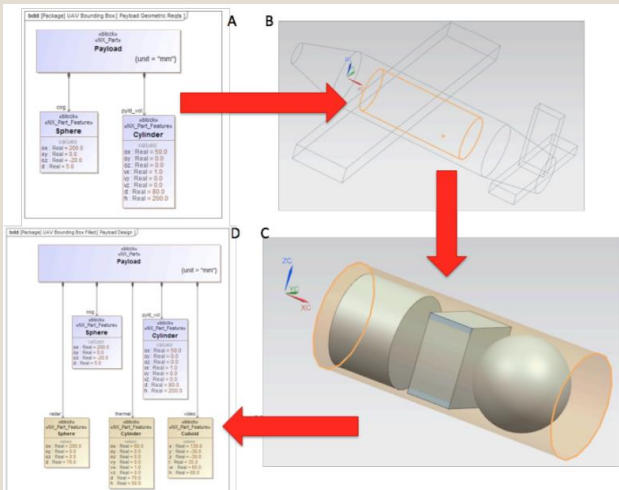
## SysML Diagrammatic



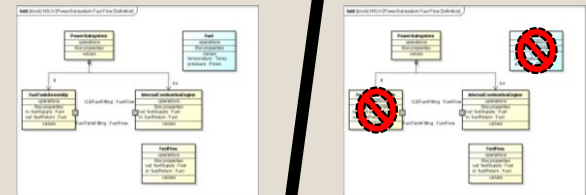
## Tabular Data View

Name	Thread (min)	Minor distance	Nominal (mm)	Head stage	Price for 100	Available at history	Number in stock	Fail or Probe head?
M4	0.7	4g	4	Pin	\$10.09	Yes	276	Flat
M5	0.8	4g	5	Round	\$13.39	Yes	133	Both
M6	1	5g	6	Button	\$10.42	Yes	1043	Flat
M8	1.25	5g	8	Pin	\$11.98	No	298	Phillips
M10	1.5	6g	10	Round	\$16.74	Yes	488	Phillips
M12	1.75	7g	12	Pin	\$18.36	No	398	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	Pin	\$28.09	Yes	496	Both
M24	2.56	9g	24	Round	\$33.01	Yes	862	Phillips
M28	2.7	10g	28	Button	\$33.66	No	1007	Phillips
M36	3.2	12g	36	Pin	\$41.32	No	434	Both
M50	4.5	15g	50	Pin	\$44.72	No	740	Flat

## Architecture Geometry



## Diagram Differencing



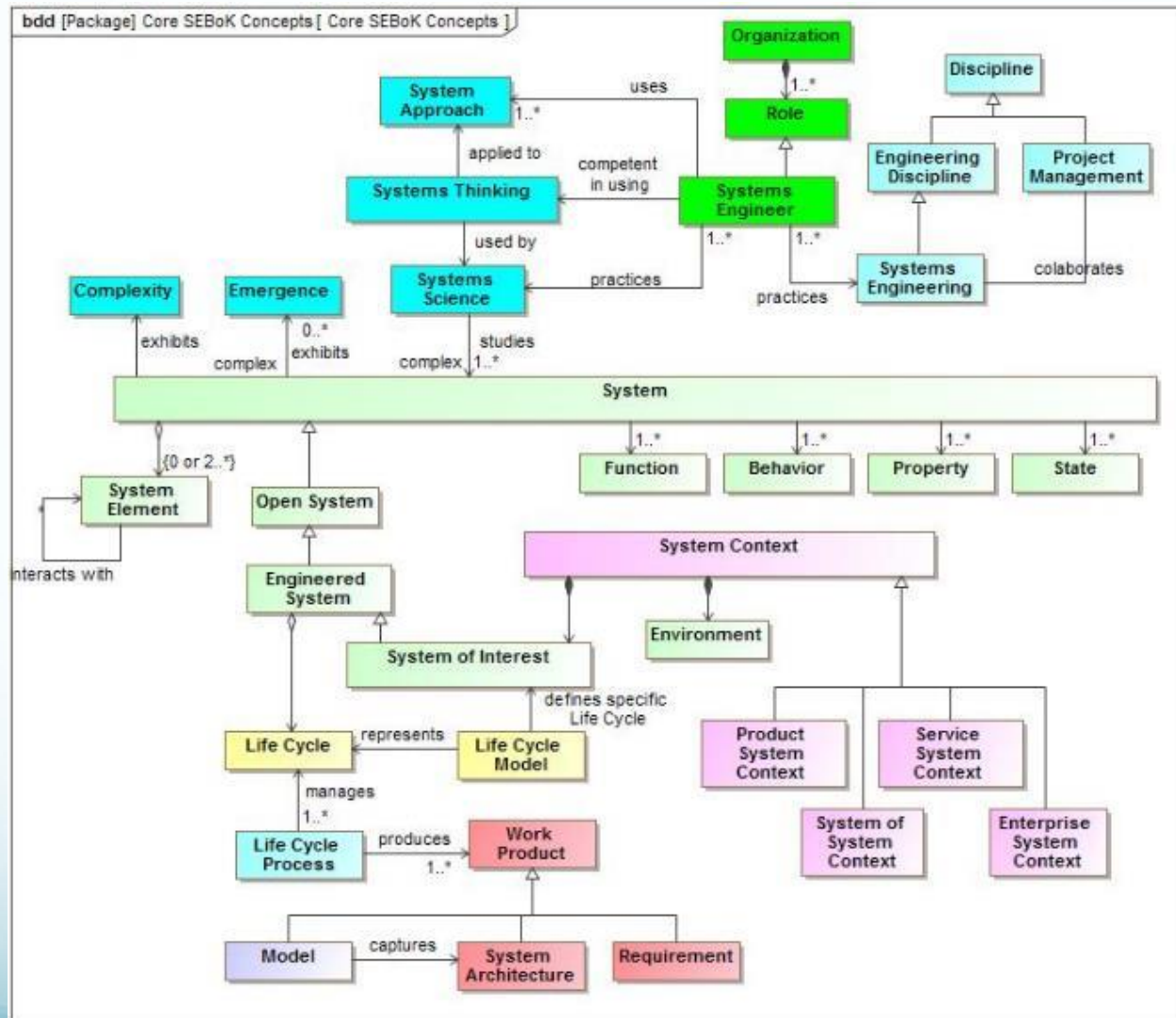
## Semantic Zoom



## Dynamic Visualization

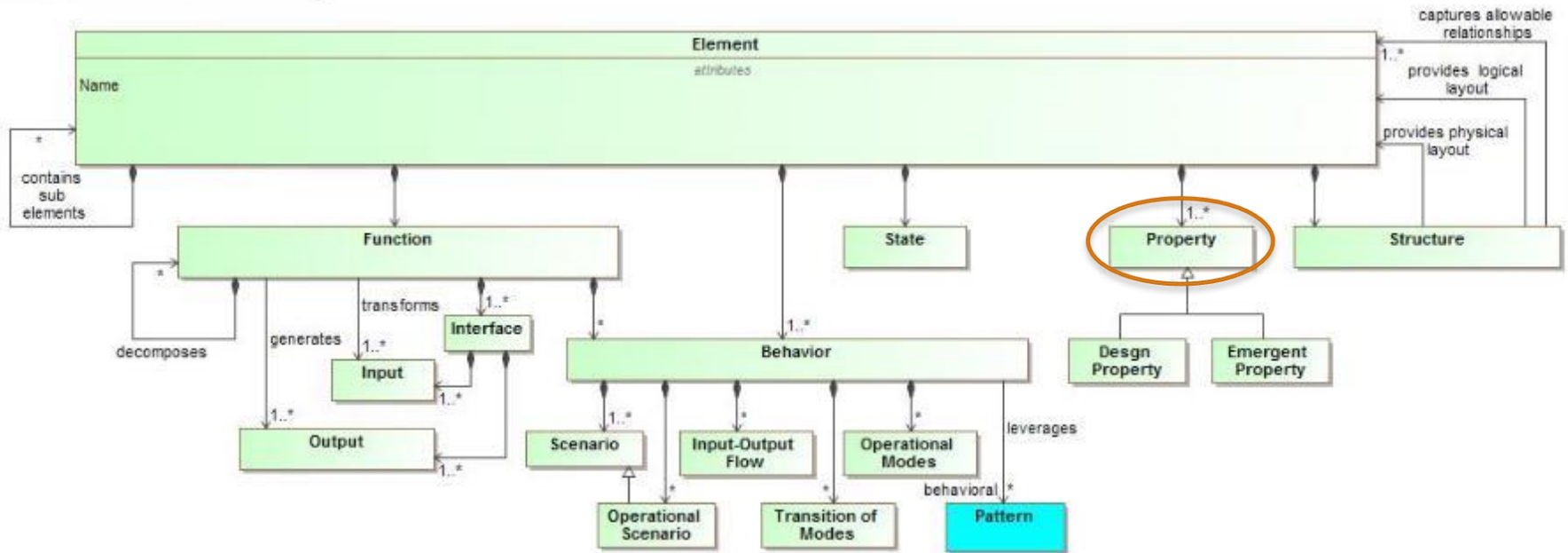


# Selected Core SE Concepts from Industry Reference Model



# Element Concept from Industry Reference Model

bdd [Package] SEBoK Diagrams [ SEBoK - Element ]

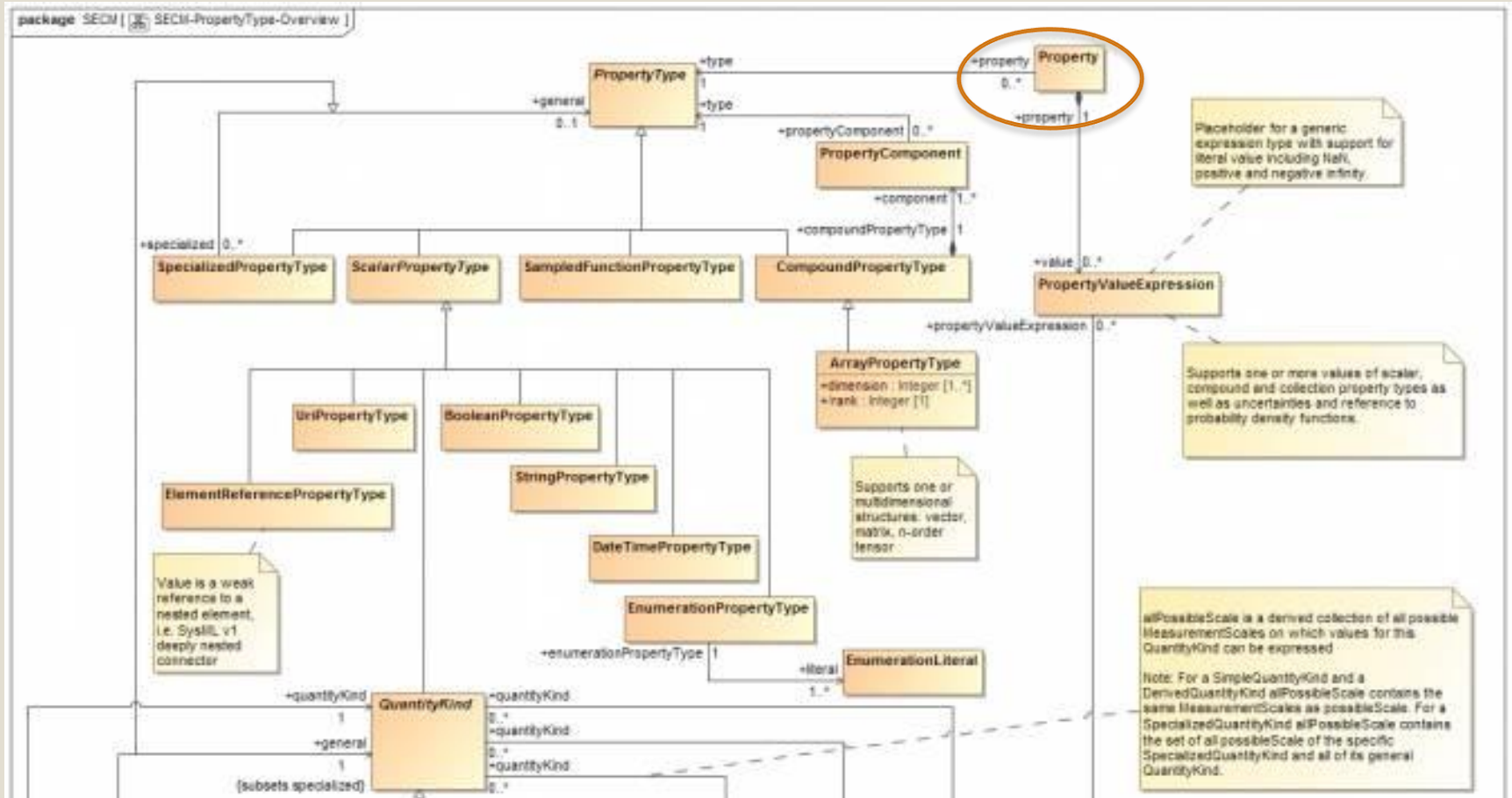


Extract from John Watson presentation  
to SEBoK team at INCOSE IW on 1/30/2016

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

Questions ?