

# Future Directions for SysML v2

**INCOSE, Chesapeake Chapter**  
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# Agenda

- Background
- SysML v2 Requirements Approach
- Summary

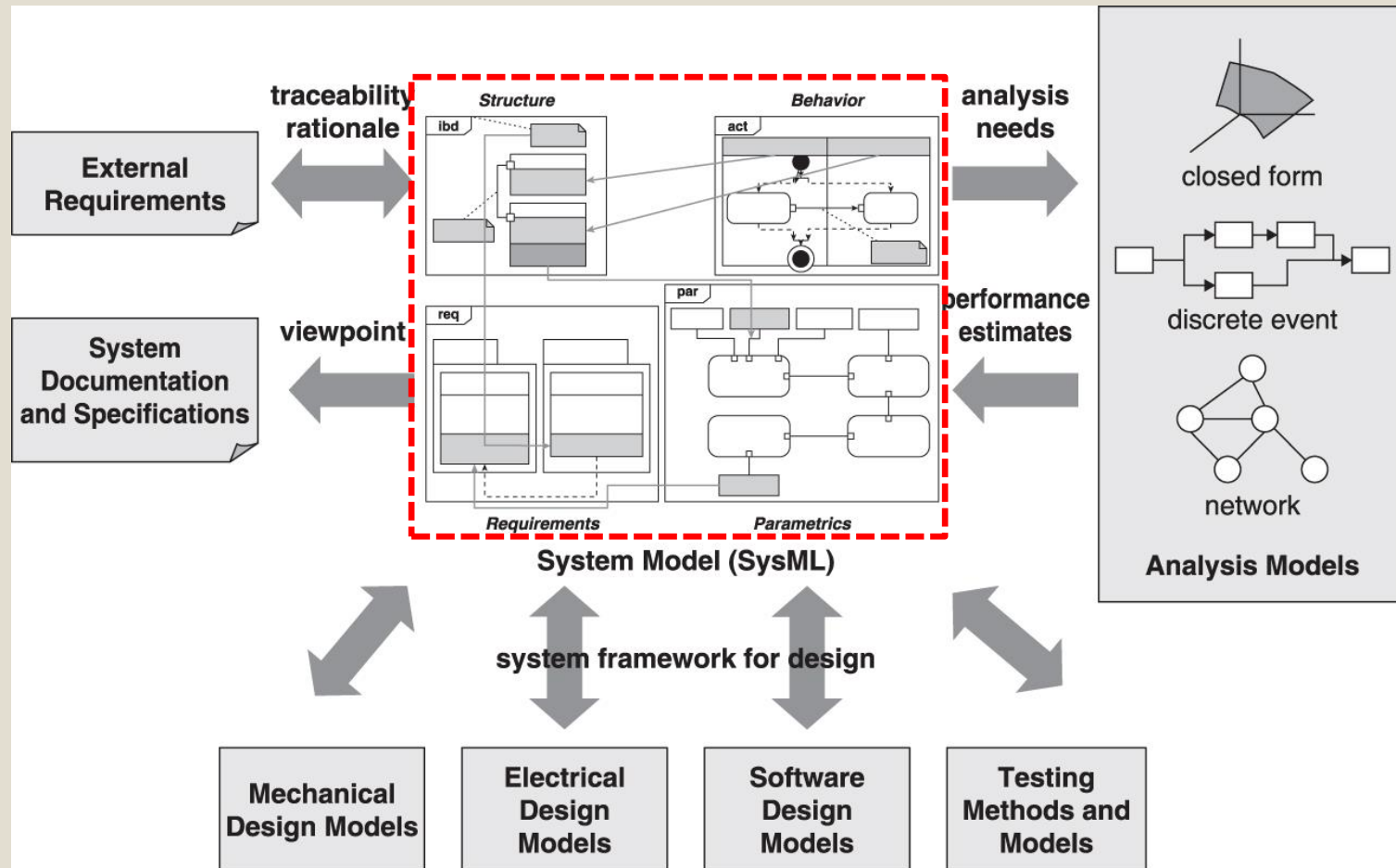
# Background

# SysML Background

- SysML v1 adopted in 2006
- Continued evolution to address user and vendor needs
  - SysML v1.5: current version
  - SysML v1.6: in process
- Facilitated awareness and adoption of MBSE
- Much learned from applications of MBSE using SysML

Goal: Develop next generation of SysML to support MBSE over next 10+ years

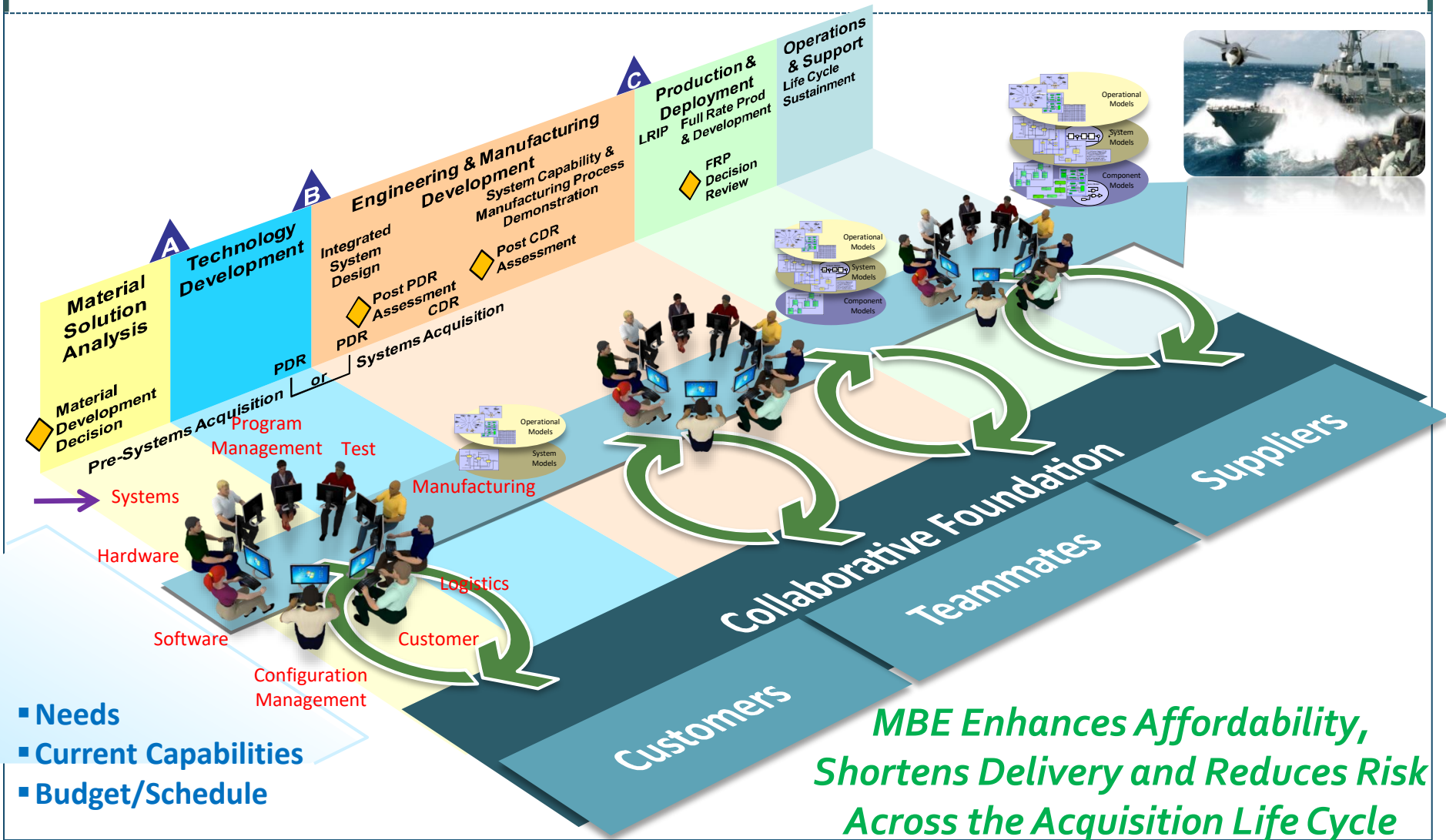
# Using SysML Model as an Integration Framework



Source: A Practical Guide to SysML 3<sup>rd</sup> Ed: Figure 18.1

# MBE To-Be State

Source: NDIA MBE Final Report dated February 2011



# System Modeling Environment (SME)

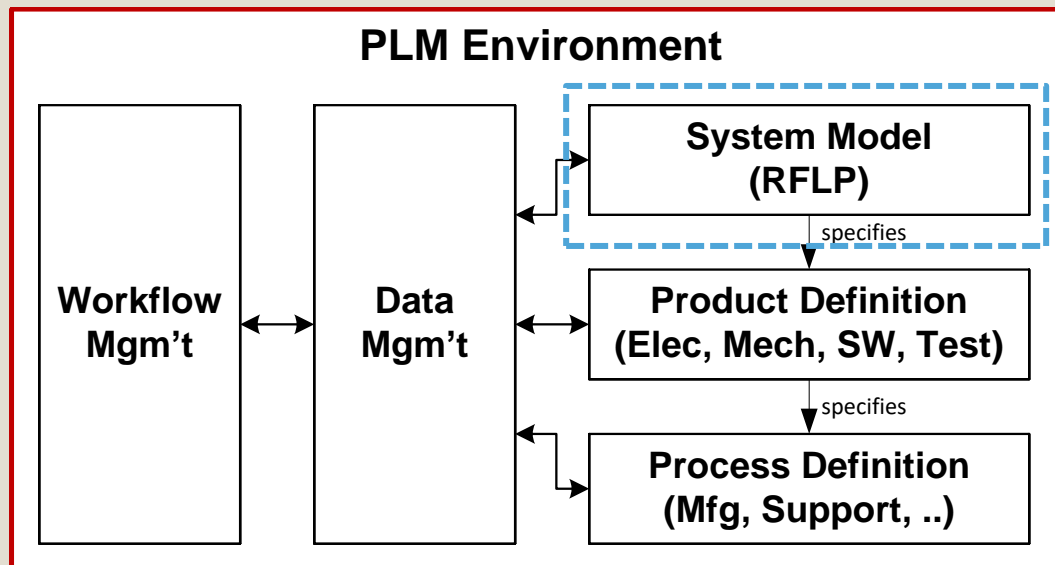
## Purpose & Scope

- 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
  - Model libraries (e.g., systems, components, interfaces, units,...)
  - Integrations with other engineering models and tools
  - Extension and customization tools



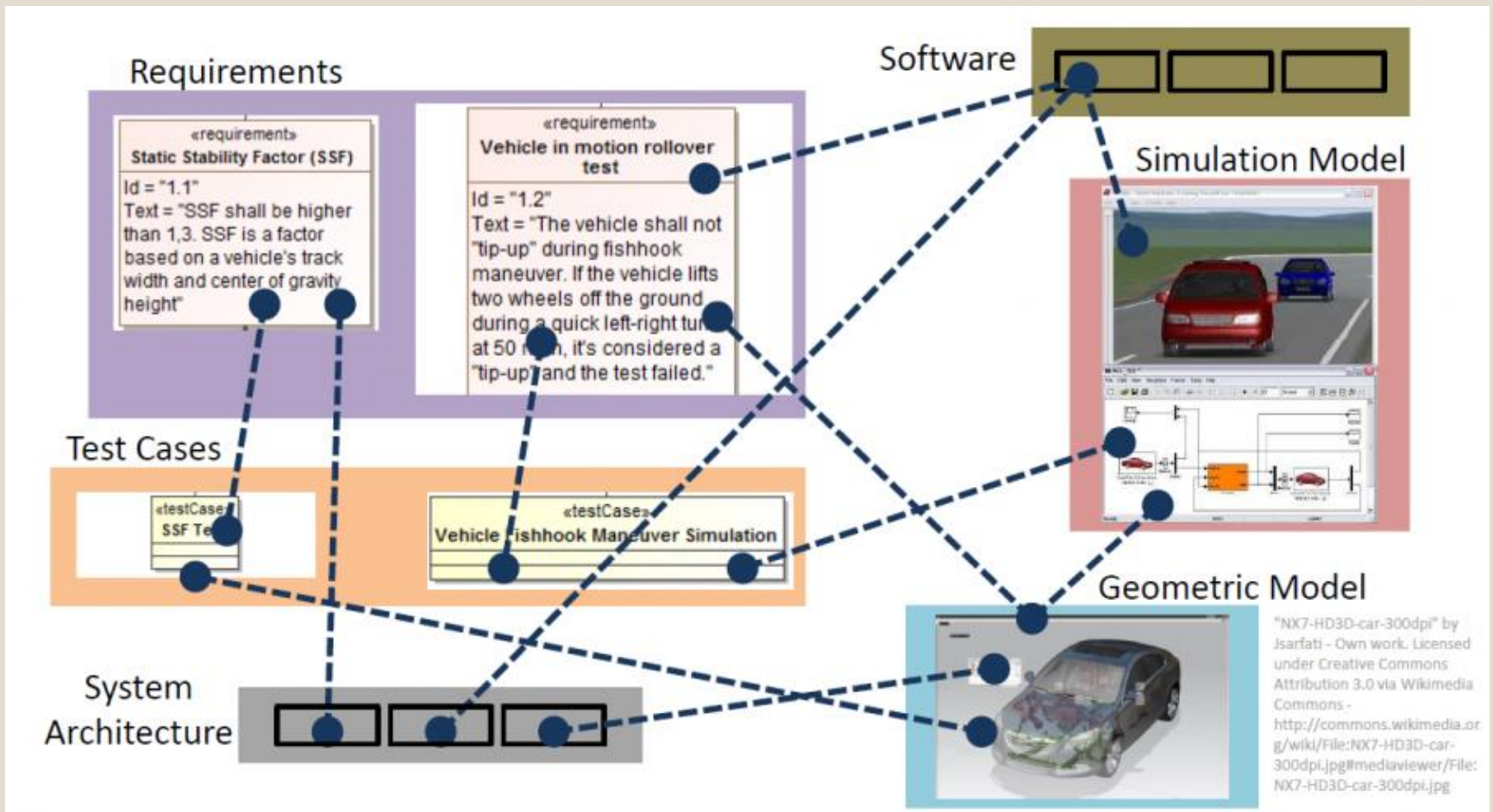
# System Model & PLM

- 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)





# System Model Interoperability



Source: Axel Reichwein

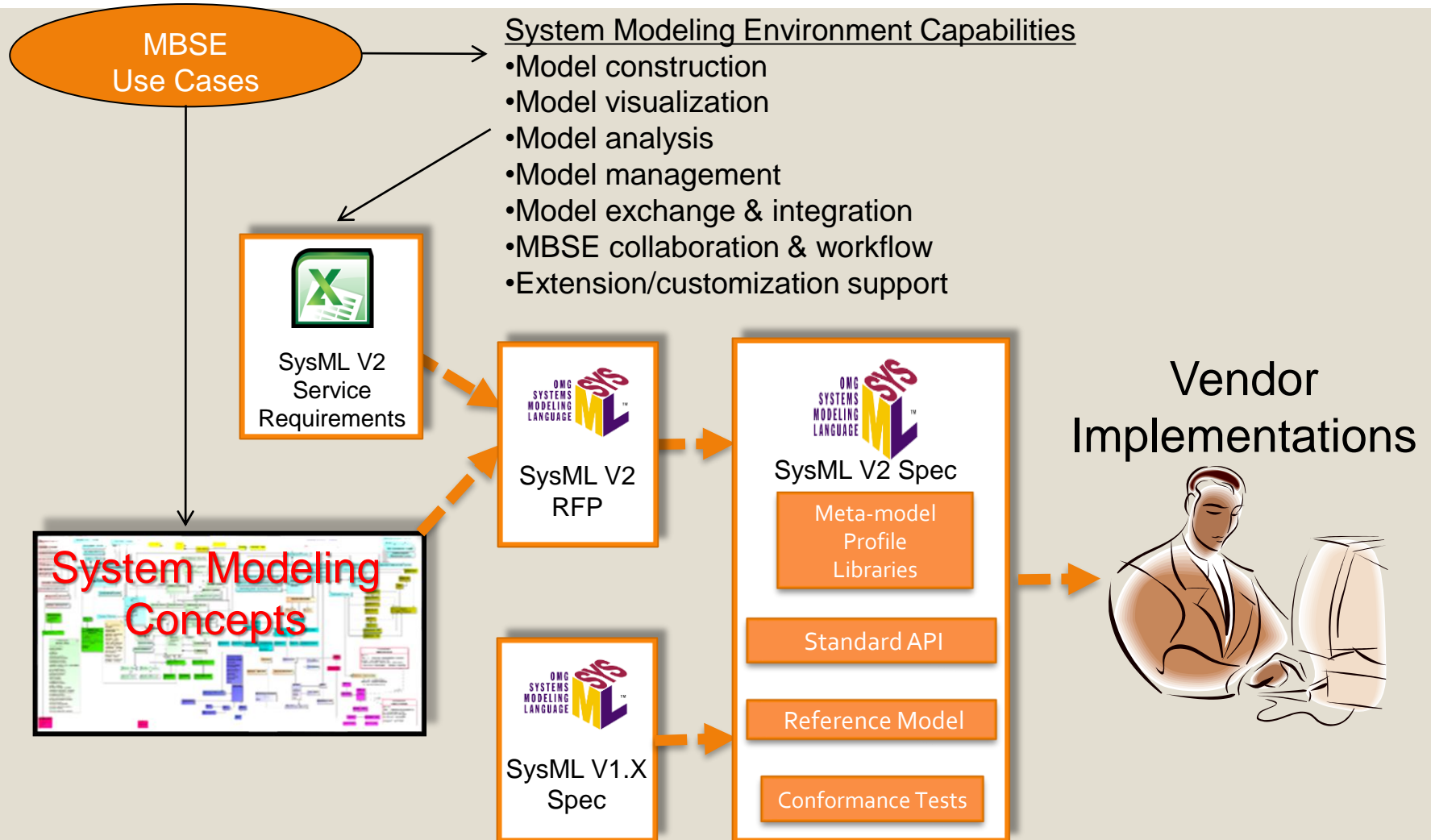
SysML v2 Model Interoperability & Standard API Requirements

# SysML v2 Requirements Approach

# SysML v2 Objectives & Approach

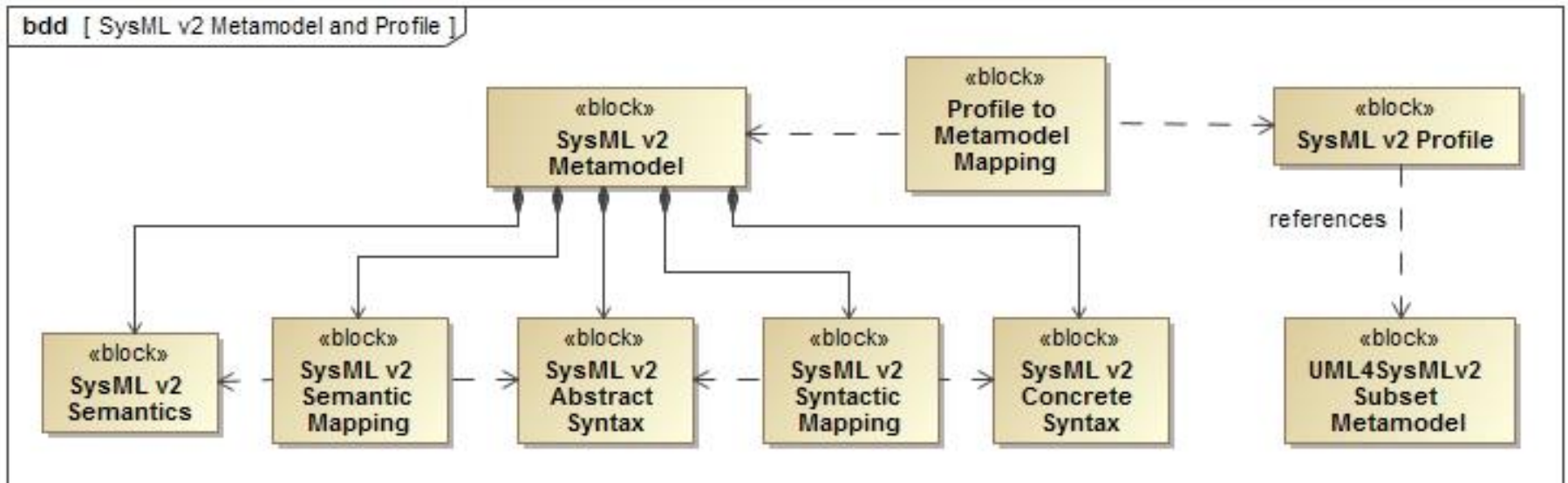
- Facilitate increased adoption and effectiveness of MBSE over SysML v1 through enhanced:
  - Precision & expressiveness
  - Interoperability with other engineering models and tools
  - Usability by model developers and consumers
- Approach
  - Improved data model with similar scope as SysML v1.x
    - Based on industry standards for systems engineering
    - Not constrained by UML data model
    - Grounded in logical formalisms
  - Enhanced model construction and visualization capabilities
  - Standard API to improve interoperability and model access

# SysML v2 Specification Development



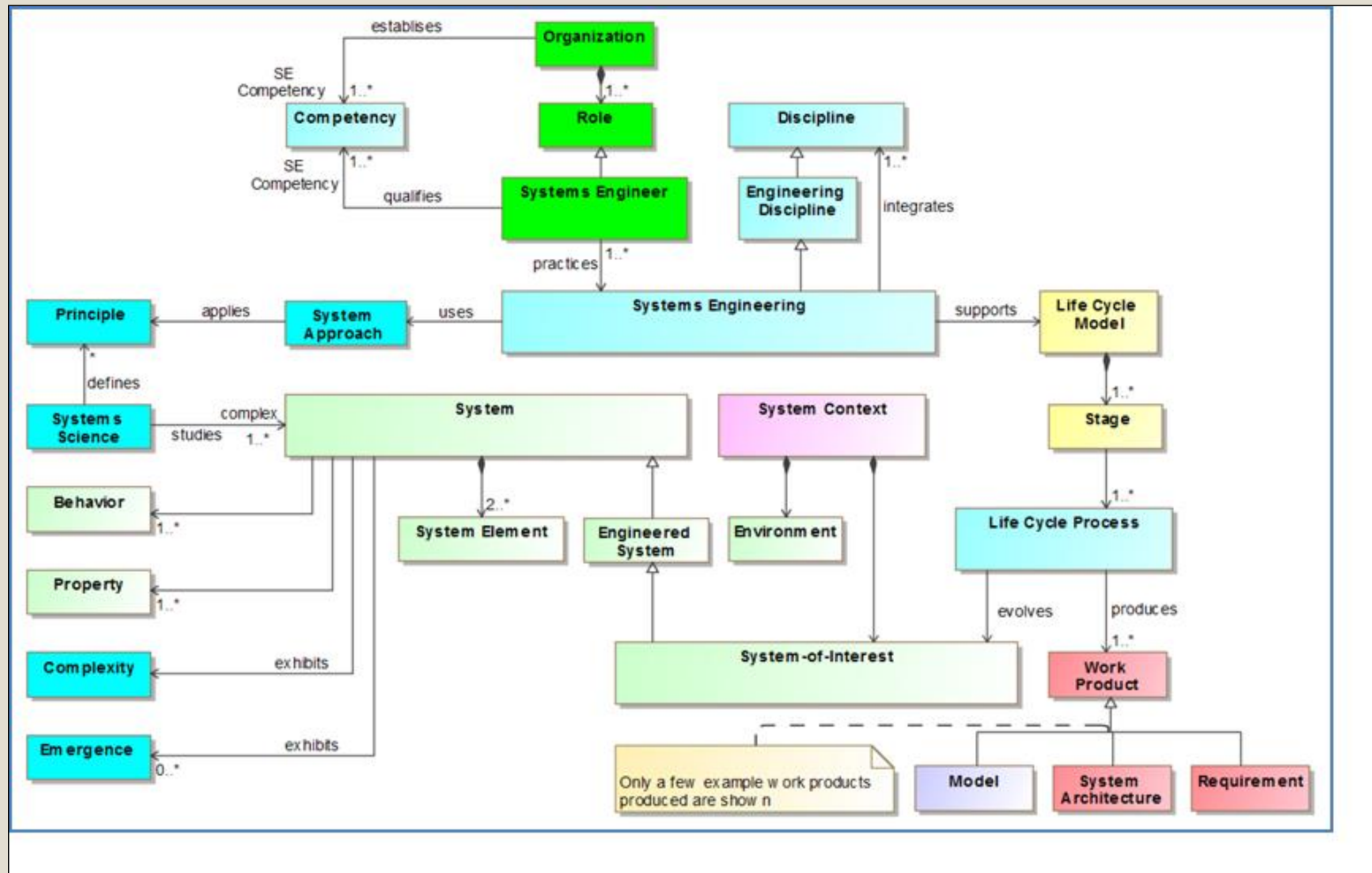
# Language Specification Metamodel and Profile

- SysML v2 profile facilitates transition for current SysML vendors
- SysML v2 metamodel not constrained by UML



# Core SEBoK Concepts

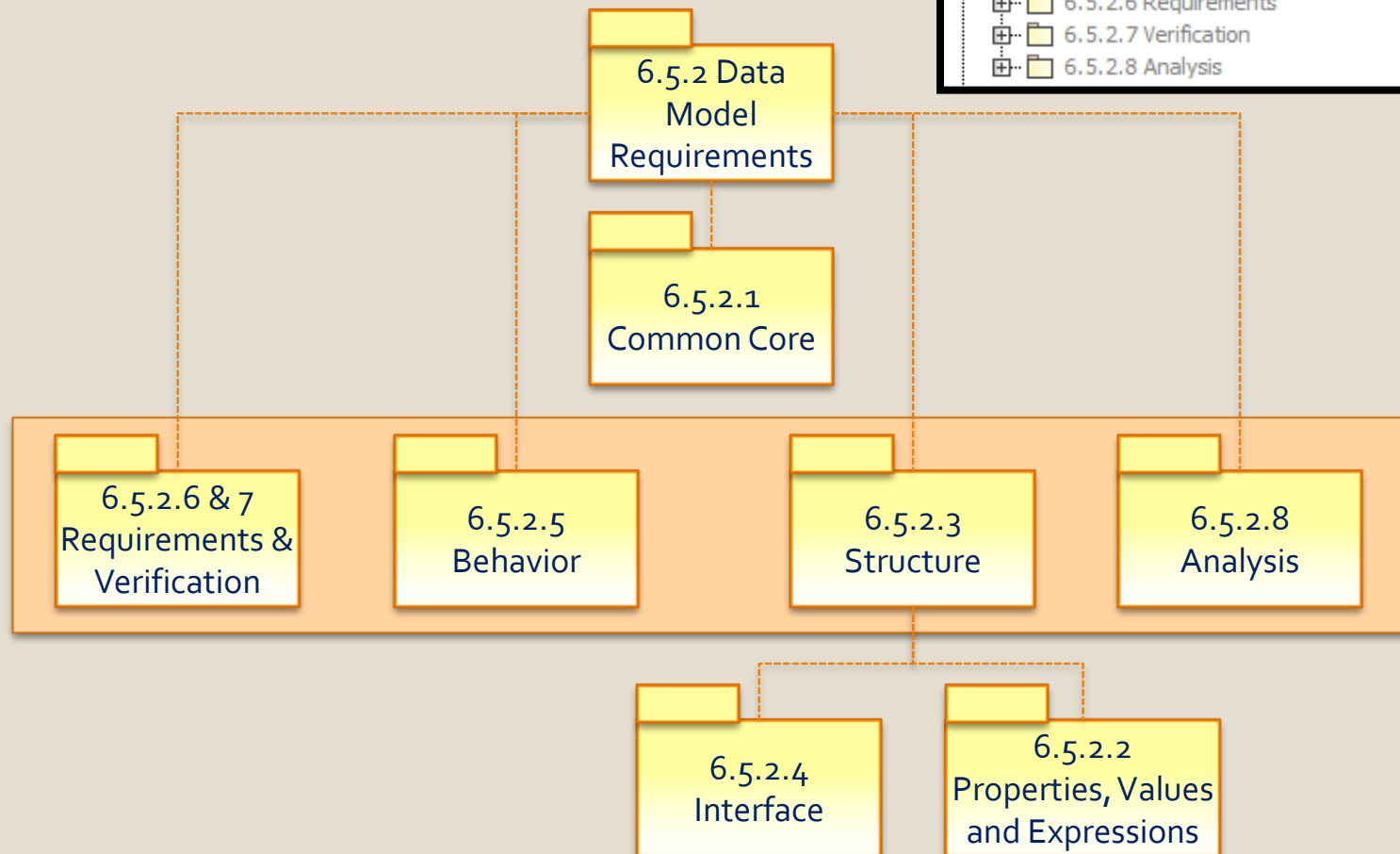
(Extract from draft SECM-2015 Industry Reference. Used with permission)



# SysML v2 Modeling Concepts

- 6.5.2 Data Model Requirements
  - 6.5.2.1 Common Core
  - 6.5.2.2 Properties, Values & Expressions
  - 6.5.2.3 Structure
  - 6.5.2.4 Interfaces
  - 6.5.2.5 Behavior
  - 6.5.2.6 Requirements
  - 6.5.2.7 Verification
  - 6.5.2.8 Analysis

## The Four Pillars of SysML



# Data Model Improvement Areas (Partial)

- Property-based requirements
- Integration between structure and behavior modeling
- Timelines
- Improved integration with analysis
- Geometric concepts
- Variant modeling concepts
- Metadata for element id, version, status
- ...

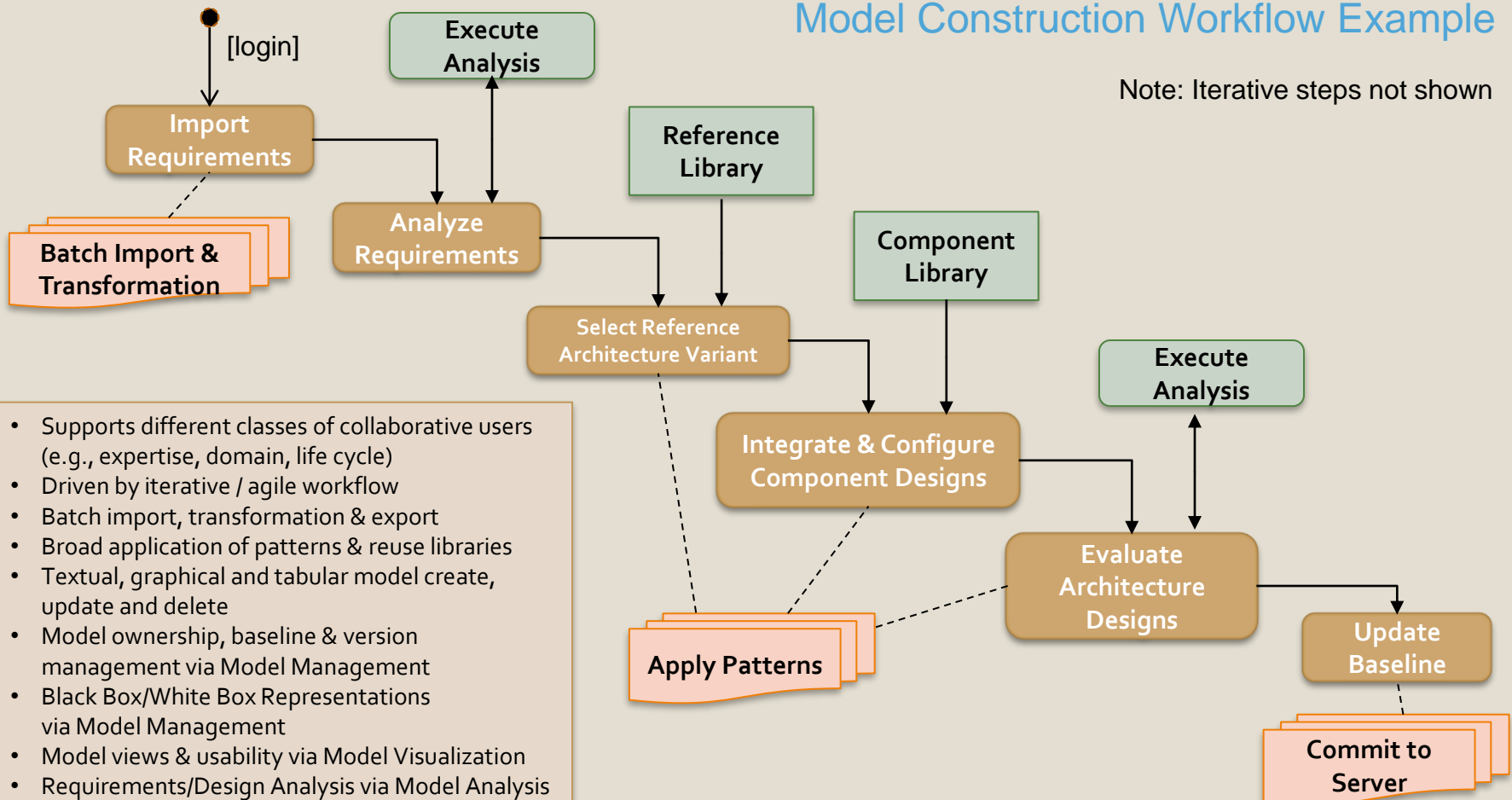


# Model Construction Concept

Source: R. Williamson

## Model Construction Workflow Example

Note: Iterative steps not shown



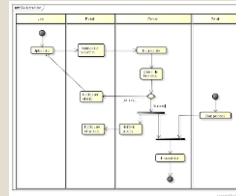
# Visualization Concept (cont.)

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>
  <Urgency> High </Urgency>
</Incidents>
  <Incident>
    <IncidentNumber> 50001 </IncidentNumber>
    <Subject> Daily Backup Failure </Subject>
    <Symptom> Backup failed on server </Symptom>
  </Incidents>
</Problem>
```

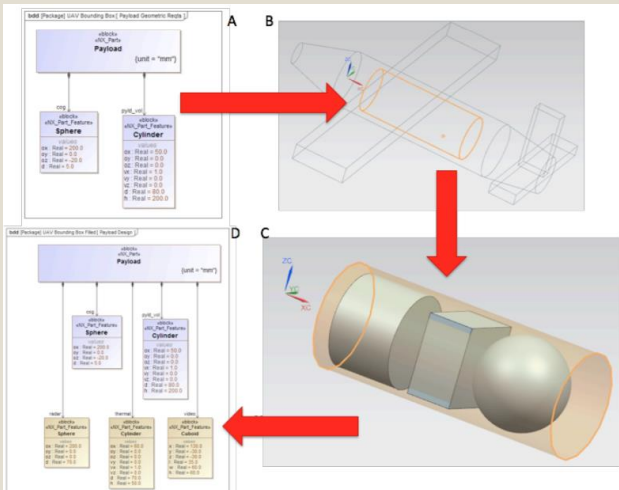
## SysML Diagrammatic



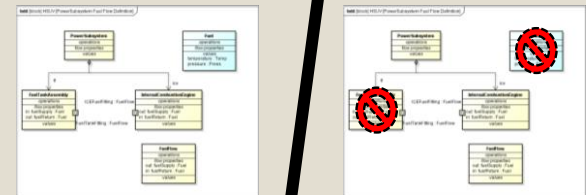
## Tabular Data View

Name	Thread (min)	Minor (mm)	Nominal diameter (mm)	Head shape	Price per 100 screws	Available at factory	Number in stock	Flat or Profile head?
M4	0.7	4g	4	Pan	\$10.08	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	Pan	\$11.98	No	298	Phillips
M10	1.5	6g	10	Round	\$16.74	Yes	488	Phillips
M12	1.75	7g	12	Pan	\$16.36	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	Pan	\$26.09	Yes	496	Both
M24	2.56	8g	24	Round	\$33.01	Yes	862	Phillips
M28	2.7	10g	28	Button	\$33.66	No	1067	Phillips
M36	3.2	12g	36	Pan	\$41.32	No	434	Both
M50	4.5	15g	50	Pan	\$44.72	No	740	Flat

## Architecture Geometry



## Diagram Differencing



## Semantic Zoom



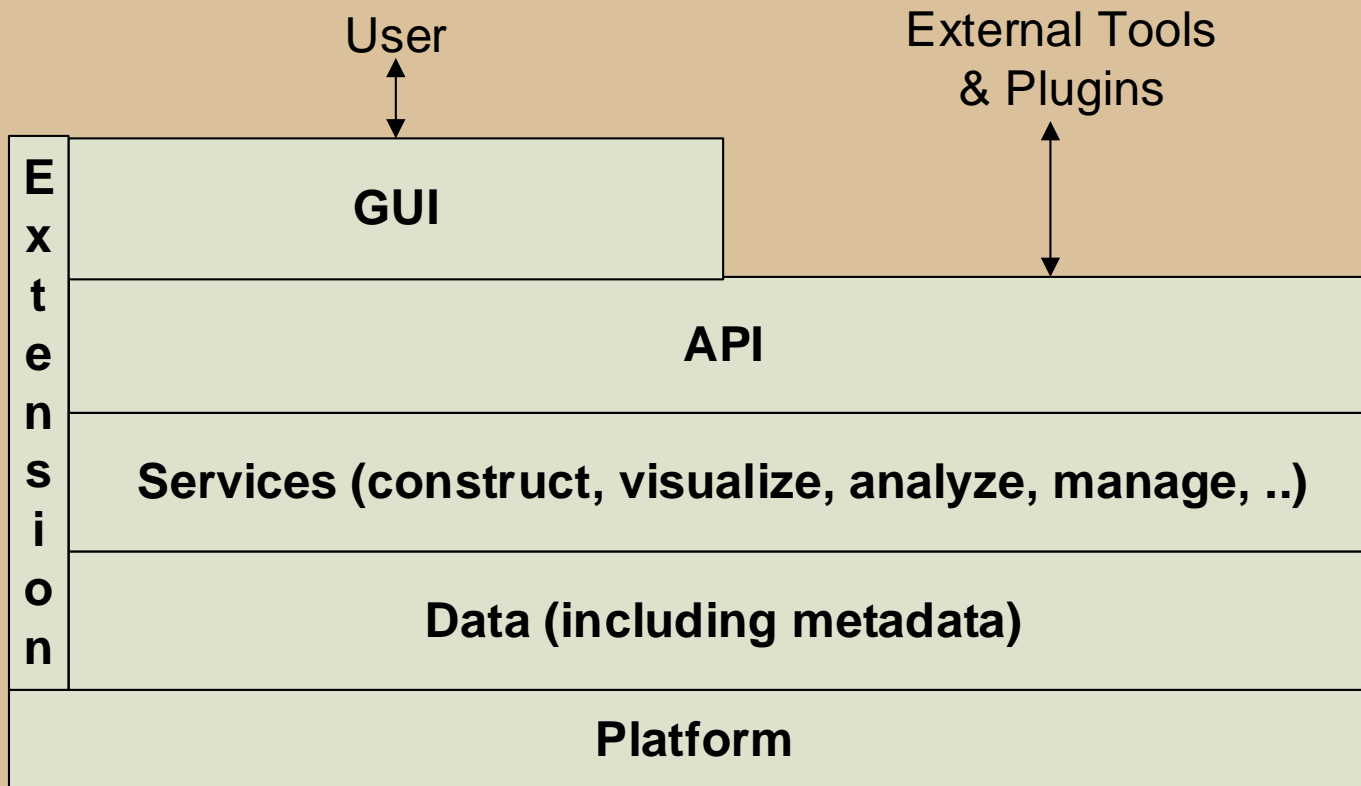
## Dynamic Visualization



# Usability Criteria

- Address different classes of users
  - Model developers – beginners
  - Model developers – experienced
  - Model consumers
- Usability goals
  - Reduce the learning curve for new users
  - Improve productivity for constructing models for new & experienced users
  - improve visualization capability and model interaction for a diverse set of model consumers (e.g., subsystem and discipline specific engineers, customers, ..)

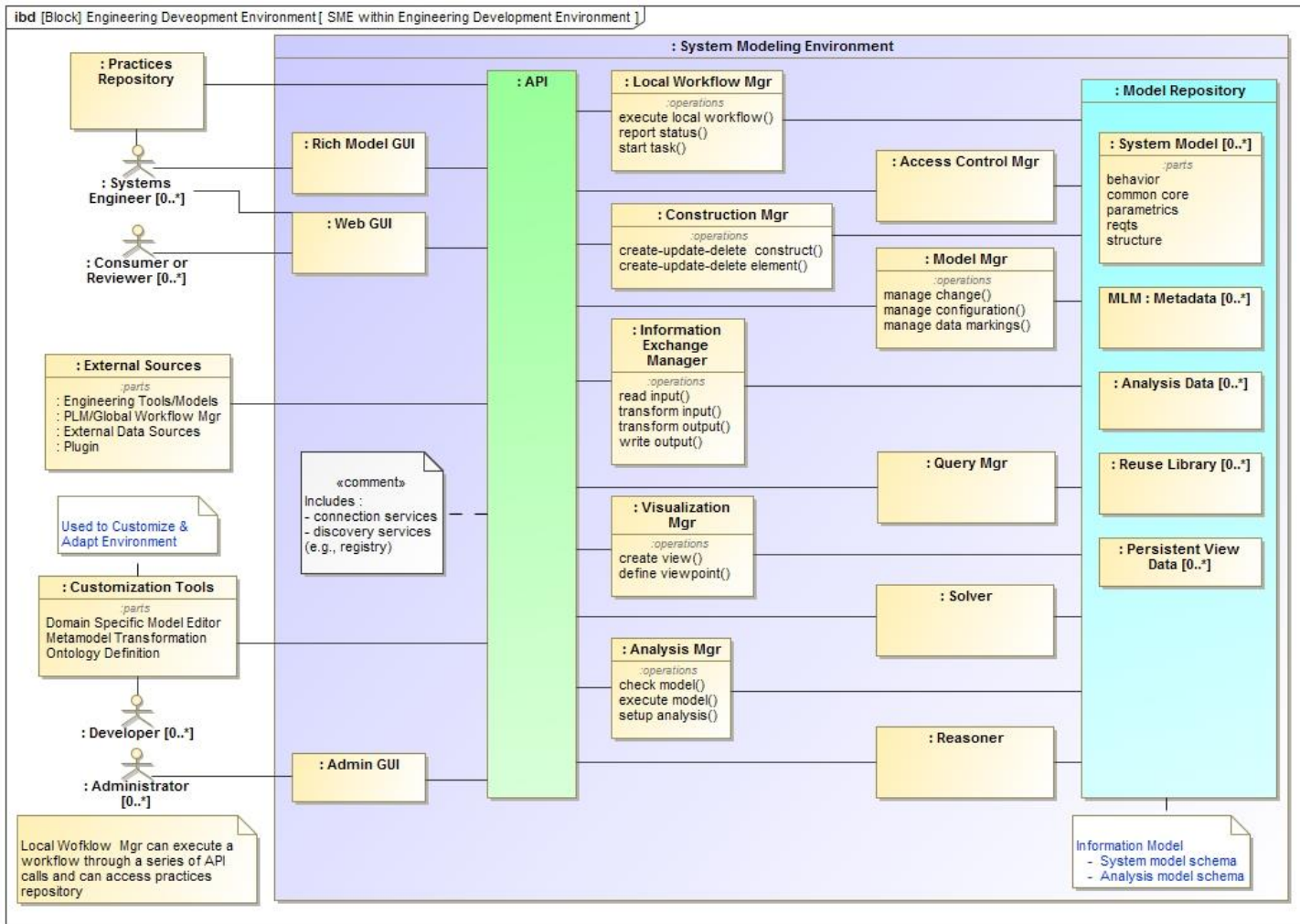
# Layered Architecture



Standard API enables interoperability and access to modeling services

# SME Logical Architecture

## Draft



# SysML v2 RFP

## Development Milestones

Aug 2015	Driving Requirements (INCOSE MBSE Themed Insight Article)
June 2016	RFP Objectives, Scope, and Outline (Draft)
Dec 2016	SME Concept (INCOSE INSIGHT Article)
Jan 2017	Presentation at INCOSE IW
Mar 2017	Initial Draft Requirements (SECM, API, Formalism)
June 2017	<a href="#">Draft SysML v2 Requirements Review Document</a>
Sept 2017	Draft System SysML v2 RFP and Presentation to ADTF
Dec 2017	OMG Review Complete
Dec 2017	Issue SysML v2 RFP
Dec 2017	Form SysML v2 Submission Teams

# SysML v2 Requirements Review Document

## Mandatory Requirements

3.1 Language Architecture

3.2 Data Model

3.2.1 Common Core

3.2.2 Properties, Values, and Expressions

3.2.3 Structure

3.2.4 Interfaces

3.2.5 Behavior

3.2.6 Requirements

3.2.7 Verification

3.2.8 Analysis

3.3 API

3.4 Services

3.4.1 Model Construction Services

3.4.2 Model Visualization Services

3.4.3 Model Analysis Services

3.4.4 Model Management Services

3.4.5 Workflow and Collaboration Services

3.4.6 Interoperability Services

3.5 Other

3.5.1 Interoperability

3.5.2 Usability Introduction

3.5.3 Reference Model & Model Libraries

3.6 Conformance

# 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 over next 10 years:
  - Precision and expressiveness
  - Interoperability among engineering models and tools
  - Usability for diverse user base
- SysML v2 specification will include:
  - Meta-model, profile, model libraries
  - 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

# OMG SysML v2 Requirements References

- 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
- OMG SysML v2 RFP Working Group Wiki
  - [http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:sysml\\_assessment\\_and\\_roadmap\\_working\\_group](http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:sysml_assessment_and_roadmap_working_group)

Questions ?