OMG Systems Modeling Language™ Version 2 (SysML® v2) Requirements Support Document

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Table of Contents

1 Introduction 5
1.1 Document Purpose 5
1.2 Background 5
1.3 Organization of this Document 8
1.4 Summary Changes from SysML v1 9
2 System Modeling Environment (SME) Overview 9
2.1 Role of System Modeling Environment in a Model-Based Engineering Environment 9
2.2 SME Capabilities and Effectiveness Measures in Support of MBSE 11
2.3 SME Architecture 12
3 Specific Requirements on Proposals 15
3.1 Mandatory Language Requirements 15
3.1.1 Language Architecture and Formalism 15
3.1.2 Data Model 26
3.1.3 Reference Model and Model Libraries 93
3.1.4 Language Conformance 94
3.1.5 Other 95
3.2 Mandatory API and Services Requirements 98
3.2.1 API 98
3.2.2 Services 101
3.2.3 API and Services Conformance 102
3.3 Non-mandatory API and Services Features 103
3.3.1 Model Construction Services 103
3.3.2 Model Visualization Services 106
3.3.3 Model Analysis Services 109
3.3.4 Model Management Services 111
3.3.5 Workflow & Collaboration Services 115
3.3.6 Interoperability Services 117
Appendix A References & Glossary Specific to this RFP 118
A.1 References Specific to this RFP 118
A.2.1 Bibliographic Citation List 118
A.2.2 OMG Standards List 122
A.2.3 Other Standards List 124
A.2 Glossary Specific to this RFP 125
Appendix B General Reference and Glossary 156
B.1 General References 156
B.2 General Glossary 158

Table of Figures

Figure 1.1. SysML v2 Approach Diagram 7
Figure 2.1. The SME is part of the broader MBE environment that enables systems engineers to perform MBSE 10
Figure 2.2. The System Model (Source: A Practical Guide to SysML, 3rd Edition (Friedenthal, Moore, and Steiner 2014)) 11
Figure 2.3. System Modeling Environment-Logical Architecture 13
Figure 2.4. System Modeling Environment Layered Architecture 14
Figure 3.1. SysML v2 Models and Model Libraries 15
Figure 3.2. SysML v2 Metamodel and Profile 16
Figure 3.3. SysML v2 Model Interchange 17
Figure 3.4. SysML v2 Language Subsets 18
Figure 3.5. SysML v2 SMOF Mapping 19
Figure 3.6. Language Formalism and Uniform Interpretation 20
Figure 3.7. Core SEBoK Concepts (Extract from draft SECM-2015 Industry Reference. Used with permission) 27
Figure 3.8. Organization of SysML v2 Modeling Concepts 28
Figure 3.9. Root Concepts 29
Figure 3.10. Value Type and Definition Element 30
Figure 3.11. Component Definition and Item Definition 31
Figure 3.12. Component Definition and Item Definition-Elaborated 32
Figure 3.13. Function Definition and Constraint Definition 33
Figure 3.14. State Machine 34
Figure 3.15. Interface Definition 35
Figure 3.16. Configuration Element and Individual Element 36
Figure 3.17. State and Time History 37
Figure 3.18. Requirements 38
Figure 3.19. Analysis and Verification 39
Figure 3.20. Decision and Variant 40
Figure 3.21. View and Viewpoint 41
Figure 3.22. Cross-cutting Model Element Concepts 42
Figure 3.23. Cross-cutting Relationship Concepts 43
Figure 3.24. Variant Modeling Concepts 44
Figure 3.25. View and Viewpoints 45
Figure 3.26. Specifying an unambiguous system design configuration 59
Figure 3.27. Sample of Structure Modeling Concepts 60
Figure 3.28. SysML v2 Interface Concept 64
Figure 3.29. Interface Concepts 65
Figure 3.30. Top Level Behavior - Take Picture 71
Figure 3.31. Camera Context with Take Picture Functions 72
Figure 3.32. Camera Context with State Machine 73
Figure 3.33. Requirement Groups 78
Figure 3.34. Example Weight Requirement 79
Figure 3.35. Requirement Concepts 80
Figure 3.36. Verification Concepts 86

Figure 3.37. SysML v2 Analysis Concepts 89
Figure 3.38. Vehicle Weight & Acceleration Analysis 90
Figure 3.39. System Model Interoperability Concepts (Source: Alex Reichwein) 96
Figure 3.40. SysML v2 API Specification Approach 99
Figure 3.41. Model Visualization Concepts (Source: C. Schreiber, J. Feingold, and M. Sarrel) 107
Figure 3.42. Integrated System Model (ISM) Lifecycle Management Concepts (Source: SysML v2 RFP Model Management WG) 112
Figure 3.43. Workflow & Collaboration Concepts 116

1 Introduction

1.1 Document Purpose

The content of this document was developed by the Object Management Group (OMG) SysML v2 RFP Working Group. This document provides the draft requirements and supporting information for the SysML v2 Request for Proposals (RFP) that will be issued by the OMG that include the requirements for a SysML v2 RFP and a SysML v2 API and Services RFP. *The RFPs define the requirements that the specification for the next generation System Modeling Language (SysML®) called SysML v2 must satisfy.* The SysML v2 Specification and SysML v2 API and Services Specification, in turn, will be implemented by tool vendors in their modeling tools to enable practitioners to perform their model-based systems engineering (MBSE) activities. The requirements in this document are expected to continue to be updated based on inputs from further review and requirements analysis. The requirements are included in tables at the end of the subsections in Section 3 of this document, and are also captured in a separate excel table with additional supporting information.

Reviewers of this document are encouraged to read Sections 1 and 2 to understand the context for these requirements, and refer to the Glossary in Section 4 for clarification of terms.

1.2 Background

The following extract is from the two previous INCOSE INSIGHT articles that provide background on this effort.

- INCOSE INSIGHT Article in August 2015 entitled "**Evolving SysML and the System Modeling Environment to Support MBSE** (Friedenthal and Burkhart 2015)"
- INCOSE INSIGHT article in December 2016 entitled "**Evolving SysML and the System Modeling Environment to Support MBSE-Part 2** (Friedenthal 2016)"

The need for a standard systems modeling language. The transition to a MBSE approach is essential for systems engineering to meet the demands of increasing system complexity, productivity and quality, and shorter design cycles. Many other engineering disciplines, such as mechanical, electrical, and controls engineering, utilize models as an integral part of their practice. Models have long been important for systems engineering as well to support systems analysis and design, but MBSE emphasizes the need to create a coherent model of the system architecture that helps integrate other aspects of the design, including electrical, mechanical, and software.

The system model provides a shared view of the system that can enhance communication and coordination across the system development lifecycle. This model represents an authoritative source of information that is maintained to ensure consistency and traceability between requirements, design, analysis, and verification. The model-based approach contrasts with the traditional document-based approach in which information is captured independently in many different documents using common applications such as Word, Visio, Excel, and PowerPoint. To

take full advantage of a model-based approach, the system model must be maintained as part of the technical baseline, and integrated with other engineering models and tools.

The capability to express system concepts in the form of models can result in quality improvements by reducing downstream design errors, and in productivity improvements through reuse of models throughout the lifecycle and across projects. Systems engineers realize other benefits, such as the ability to automate tasks like change impact analysis, and auto-generation of reports and documentation with increased confidence that the information is valid, complete, and consistent.

A systems modeling language enables systems engineers to express fundamental concepts about the system such as system composition, interconnection and interfaces, functional and state-based behavior, parametric aspects, and traceability relationships between requirements, design, analysis, and verification. The modeling language is an essential capability to specify and architect increasingly complex systems. A standard systems modeling language can help overcome the informational "Tower of Babel" by providing a means to express these concepts in a standard and precise way that enables communications between engineers and tools.

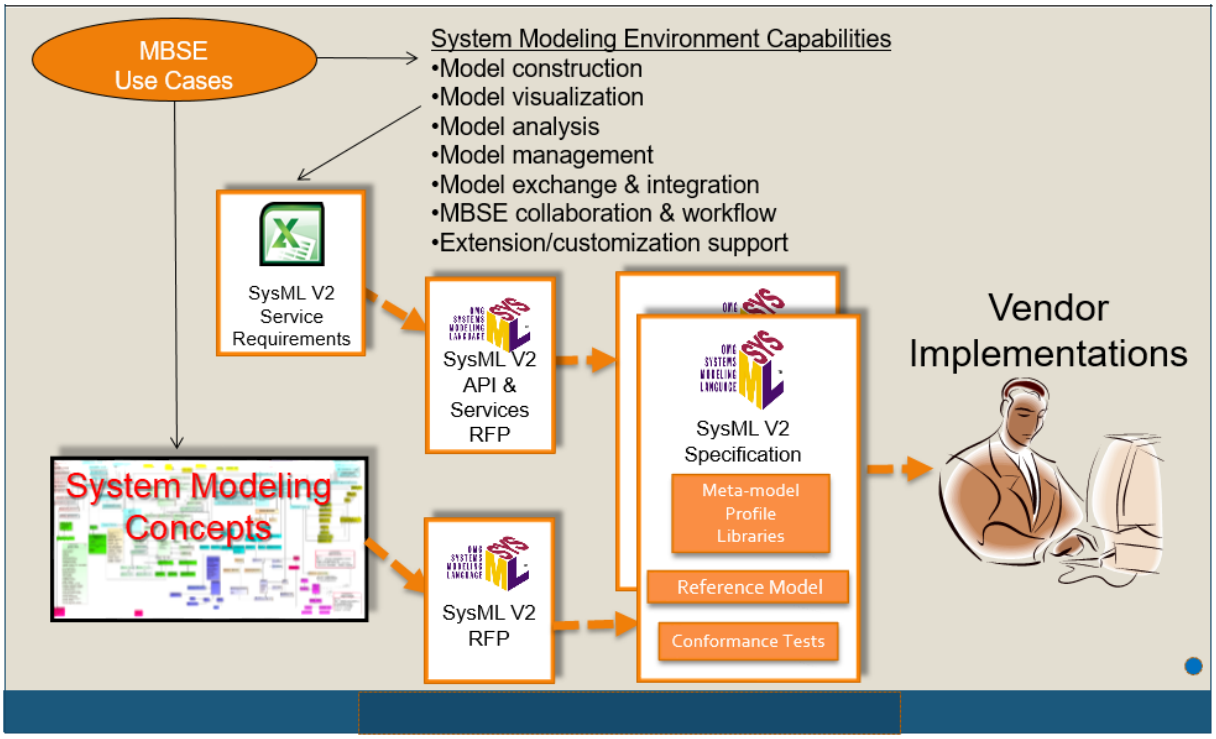
SysML background. The Object Management Group (OMG) adopted the OMG Systems Modeling Language ™ (www.omgsysml.org) specification in 2006 and version 1 was available in 2007. The SysML specification resulted from a collaborative effort between INCOSE, the OMG, and the ISO STEP AP-233 Working Group (WG) to develop the requirements for the language, and then develop the system modeling language solution in response to those requirements.

SysML is a general-purpose graphical modeling language for specifying, analyzing, designing, and verifying complex systems that may include hardware, software, information, personnel, procedures, and facilities. The language provides graphical representations with a semantic foundation for modeling system requirements, behavior, structure, and constraints.

Since its adoption, SysML enabled broad recognition and increased adoption of model-based systems engineering practices across industry. Systems engineers, tool vendors, and academia have learned much from this experience, including both the strengths and weaknesses of SysML as a language, and the benefits and challenges of adopting and applying MBSE with SysML.

Based on these experiences, the OMG SysML v2 RFP Working Group was initiated on July 23, 2016 at the OMG meeting in Orlando, Florida and began working on the requirements for SysML v2. This followed an approximately year-long effort to establish a baseline concept for a System Modeling Environment (SME). The SME is the environment that systems engineers interact with to perform model-based systems engineering activities, and the MBSE use cases and the SME concept are used to help derive requirements for SysML v2 as shown in the figure below.

Figure 1.1. SysML v2 Approach Diagram



The initial high-level requirements for the SME are documented in the August 2015 edition of the INCOSE INSIGHT. The article is entitled *'Evolving SysML and the System Modeling Environment to Support MBSE'* and defines 7 capabilities, 8 measures of effectiveness (moe's), and 11 driving requirements for the SME to support the specification, design, analysis, and verification of systems. A second article was published in the December, 2016 edition of the INCOSE INSIGHT entitled *'Evolving SysML and the System Modeling Environment to Support MBSE - Part 2'*. This article summarizes the baseline SME Concept in response to the requirements in the earlier article. Both articles are available in final draft form under the Articles section of the SysML v2 RFP Working Group Wiki at:

http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:sysml_assessment_and_roadmap_working_group

The requirements contained in this document are incorporated into two separate SysML v2 RFPs, and are used to define the requirements for two SysML v2 specifications, which will then be implemented by tool vendors. The SysML v2 RFP specifies the requirements on the language, and the SysML v2 API and Services RFP specifies the requirements for the standard API and services.

The overarching objectives for SysML v2 are to facilitate increased adoption and effectiveness of MBSE over SysML v1. This is accomplished by enhancing support for MBSE with improved precision, expressiveness, and integration among the language concepts, and improved

interoperability with other engineering models and tools. SysML is also intended to facilitate improved usability by model developers and consumers.

The requirements in the SysML v2 RFP reflects lessons learned from experiences with SysML v1. The SysML v2 RFP includes refined requirements to represent the SysML v1 concepts (e.g., structure, behavior, parametrics, requirements), and requirements for additional system modeling concepts. The SysML v2 API and Services RFP also includes requirements for a standard API and services that support model construction, model visualization, model analysis, model management, and workflow and collaboration. Service requirements were not included in the RFP for SysML v1.

Submission teams will develop the SysML v2 Specification and the SysML v2 API and Services Specification in response to the requirements in both RFPs. Tool vendors will then implement these specifications.

The modeling concepts and associated requirements will be satisfied in the SysML v2 Specification, which will specify both a SysML metamodel and a profile of UML. A vendor can choose to implement the metamodel or profile or both. The combination of a metamodel and a profile enable a broader range of vendor implementations. The metamodel supports implementation of the system concepts without some of the constraints imposed by UML, while the profile supports implementation of the system concepts that is more closely aligned with SysML v1 implementations. The SysML v2 Specification is also intended to provide foundational concepts and extension mechanisms to facilitate integrations with other domain specific languages such as safety, reliability, security, and testing, and to maintain continuity with other related OMG modeling standards such as UAF and UML.

The API and service requirements will be satisfied in the SysML v2 API and Services Specification. The standard API facilitates interoperability by enabling external tools, plug-ins, and user interfaces to access the system model using standard service requests. The SysML v2 API and Services Specification is intended to be implemented by multiple types of tools that are part of a System Modeling Environment.

1.3 Organization of this Document

This document is organized into the following sections.

1. **Introduction.** This section includes the purpose, background, and organization of this document.
2. **System Modeling Environment (SME) Overview.** This section provides an overview of the System Modeling Environment.
3. **Specific Requirements on Proposal.** This section is organized into subsections for each logical grouping of requirements. Each subsection includes relevant concepts that reflect systems modeling needs to motivate the requirements, and a summary of key issues with SysML v1 in terms of its support for these concepts. In some cases, motivating examples are provided to further illustrate the concept and/or highlight SysML v1 issues. The requirements are then included in tables at the end of each subsection.

4. **References & Glossary Specific to Document.** This section includes a glossary of terms that are used to represent the concepts and requirements in this document, related standards, and a list of references used in this document.
5. **General Reference and Glossary.** This section includes a glossary of more general terms that apply to OMG standards, and references to other more general OMG standards that may have been used or are intended to be used in support of these requirements.

1.4 Summary Changes from SysML v1

The API and Services requirements are additional scope for SysML v2 over SysML v1. The requirements in this RFP will include mandatory requirements for a small number of mandatory service requirements that include a query service and extension service. The remaining service requirements are optional requirements, which means the submission team can choose which optional service requirements to specify.

The language requirements generally include the scope of the original UML for SE RFP that was used to specify SysML v1. However, many of the requirements are refined based on lessons learned. A summary of SysML v2 concepts are contained in the Data Model section of this document.

The original requirement was for a profile only, whereas in SysML v2 we are requiring the specification as both a profile and a metamodel. In addition, there is emphasis on establishing a more precise semantics. There is additional scope to ensure more effective tool neutral model interchange beyond what was provided with the XMI.

The SysML v2 requirements are also captured in a separate spreadsheet at "SysML v2 RFP Related Documents", which includes columns with additional information that is not included in this document. In particular, the spreadsheet includes columns that contain the following information for each requirement.

- The extent to which a SysML v1 construct satisfies the requirement (none, partial, full)
- The corresponding SysML v1 construct that addresses the requirement (partial or full only)

This spreadsheet can be used to further evaluate how SysML v2 compares with SysML v1. It is also expected that a similar spreadsheet will be used to show traceability between the SysML v2 constructs and the SysML v2 requirements.

2 System Modeling Environment (SME) Overview

2.1 Role of System Modeling Environment in a Model-Based Engineering Environment

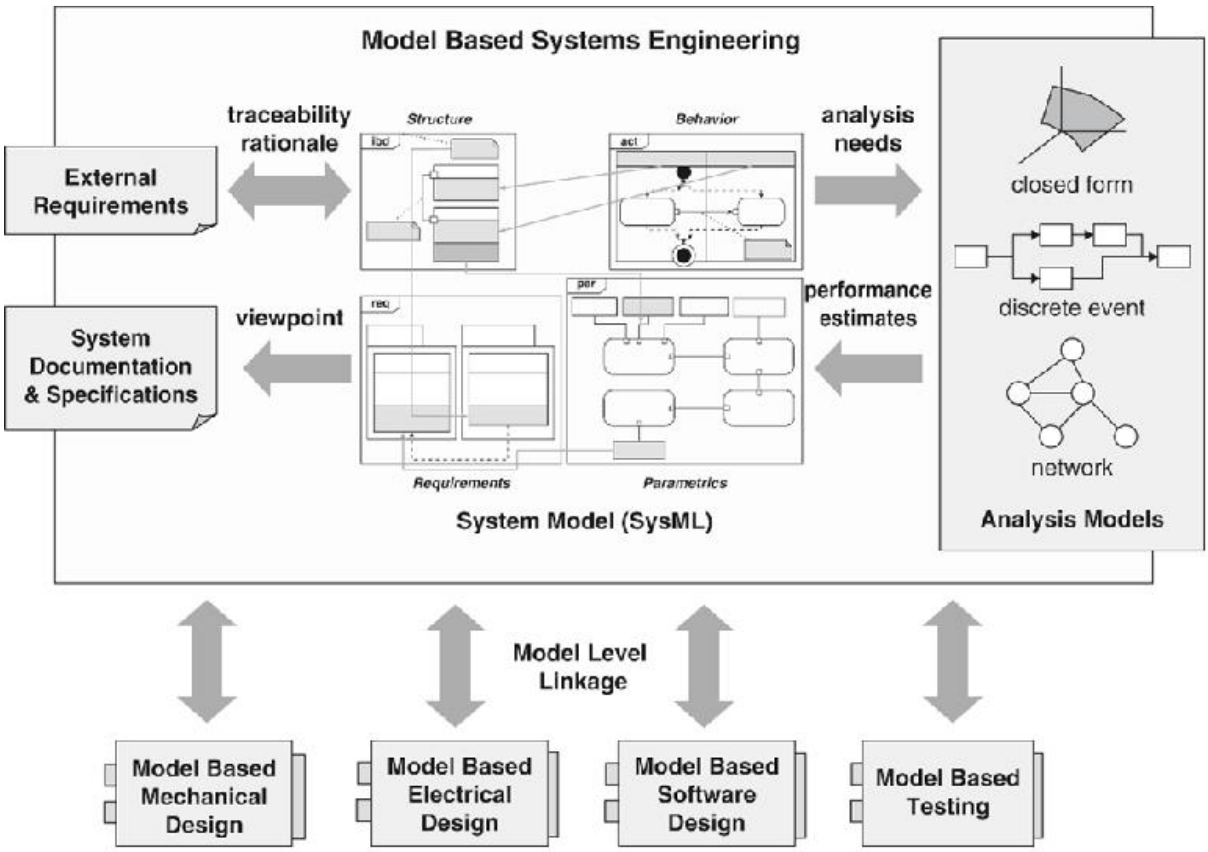
In the figure below, each of the disciplines contributes to the development of the technical baseline of the system as part of a Model-Based Engineering (MBE) approach. Each member of

the development team use their discipline-specific models to capture and analyze different aspects of the design. The MBE environment is the overall set of tools that all disciplines use to implement a MBE approach. The System Modeling Environment (SME) is the part of the overall MBE environment that systems engineers use to perform MBSE and interact with other members of the development team. (Note: The focus for the SME is limited to SysML v2 modeling, but it is recognized that the SME can include many other kinds of system models and data.)

Figure 2.1. The SME is part of the broader MBE environment that enables systems engineers to perform MBSE

The system model provides an overall description of the system that facilitates integration with the other engineering models and tools as shown in the figure below.

Figure 2.2. The System Model (Source: A Practical Guide to SysML, 3rd Edition (Friedenthal, Moore, and Steiner 2014))



The systems engineer and others use the SME System Modeling Environment to perform model-based systems engineering as part of an overall development process to flow requirements from the mission/enterprise level to systems, subsystems, and components, and verify the components, subsystems, system, and mission requirements are satisfied. This process continues throughout the development lifecycle, with the aim of delivering systems and products that meet the stakeholder needs. Typical MBSE use cases were defined as part of the requirements development, including a detailed change management scenario that are available at http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:use_case_working_group.

2.2 SME Capabilities and Effectiveness Measures in Support of MBSE

The definition of the initial SME capabilities and driving requirements are identified in the August 2015 INCOSE INSIGHT article (Friedenthal and Burkhart). This article defines 7 capabilities, 8 measures of effectiveness (moe's), and 11 driving requirements the SME should support. These capabilities enable the systems engineer to perform MBSE as part of a broader model-based engineering effort, and include:

- Model construction
- Model visualization
- Model analysis
- Model management
- Model interoperability
- MBSE workflow and collaboration
- Extension/customization support

The effectiveness measures for the SME are used to evaluate how effectively the SME supports the above capabilities. Some of these measures are difficult to quantify, and will require further refinement. The set of effectiveness measures include:

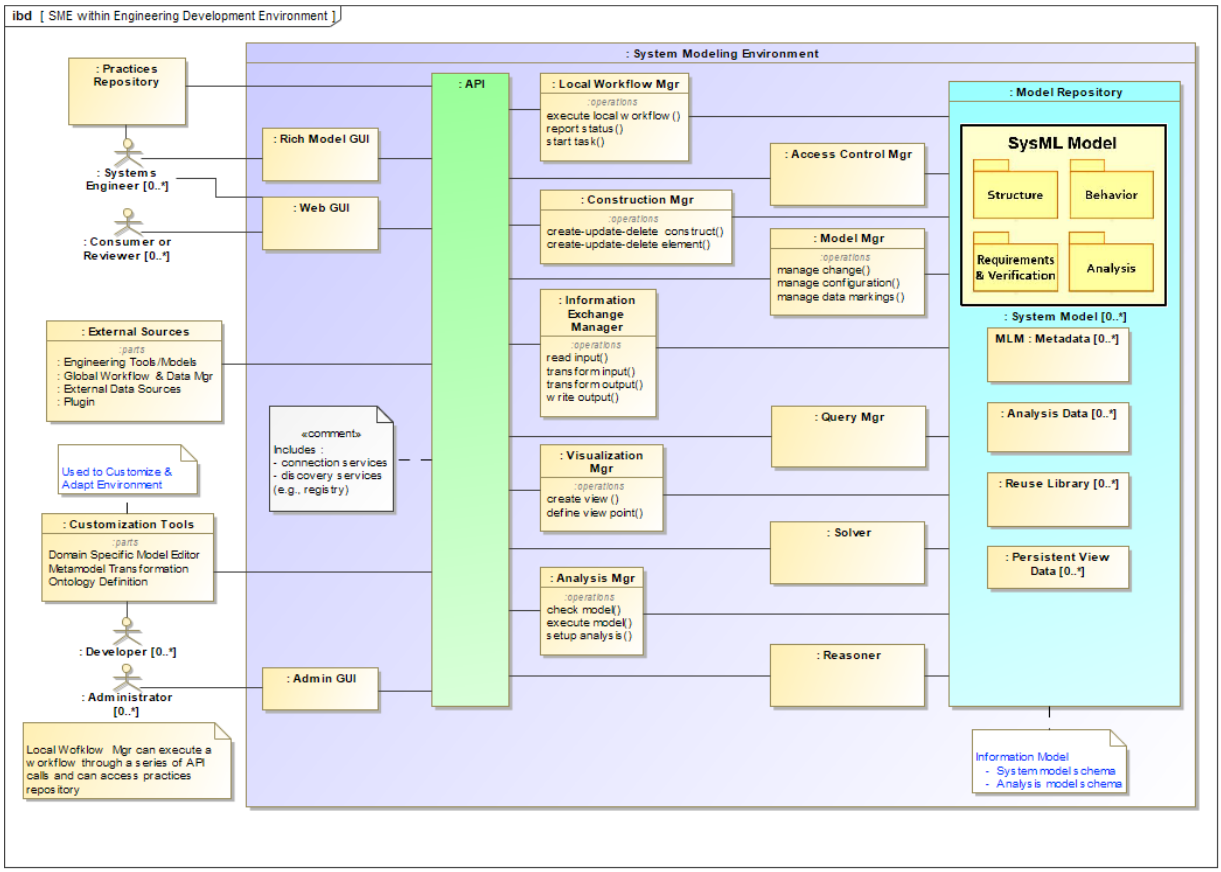
- **Expressive:** Ability to express the system concepts
- **Precision:** Syntax and semantics are unambiguous and concise
- **Consistency/integrity**: Level of integration of concepts to ensure consistency and integrity of the language
- **Presentation/communication**: Ability to effectively support communications with diverse stakeholders that includes support for generating technical baseline documentation (e.g., specifications, design descriptions, and interface definitions).
- **Model construction:** Ability to efficiently and intuitively construct models
- **Interoperable:** Ability to exchange data with other SysML models, other engineering models and tools, and structured data sources.
- **Manageable:** Ability to efficiently manage change to models
- **Secure:** Ability to protect all relevant data from threats
- **Usable:** Ability for stakeholders to efficiently and intuitively create, maintain, interpret, and use the model
- **Adaptable/Customizable:** Ability to extend models to support domain-specific needs
- **Scalable:** Ability to scale from small to medium to large models

2.3 SME Architecture

The SME must provide the functionality needed to enable systems engineers and others to evolve the system model throughout the life cycle. The diagram below is a view of the logical architecture of the SME. The model repository contains the data about the system, including the system model, analysis data, metadata, and reuse libraries. This repository is shown as a single logical repository, but may be federated across multiple physical repositories.

The diagram shows the systems engineer using a rich model graphical user interface that provides the full functionality of the SME to create, maintain, and use the system model and other data in the model repository. The systems engineer and other disciplines can also interact with the SME using a web interface that provides the functionality needed to use and/or review the system model and other data. The user interface can present different views of the model to address different stakeholder needs and concerns. For example, a power subsystem engineer may view the power interfaces, and a mechanical engineer may view the system breakdown and mass allocation.

Figure 2.3. System Modeling Environment-Logical Architecture



The SME also enables other engineering tools and models and plug-ins to access the repository. The graphical user interfaces and the external tools access the model repository by requesting standard services through an application program interface (API). The API provides the interface to the model repository and supports the SME modeling capabilities described above that include model construction, model visualization, model analysis, model management, and workflow and collaboration services.

Applications external to the SME that provide global workflow and data management, can interact with the SME and other discipline-specific environments to control the configuration and manage change across the overall MBE environment, and across the system life cycle. This includes synchronization tasks via notifications as the engineering work products change state. The combination of the PLM capability and the integrated system model facilitate a collaborative engineering environment.

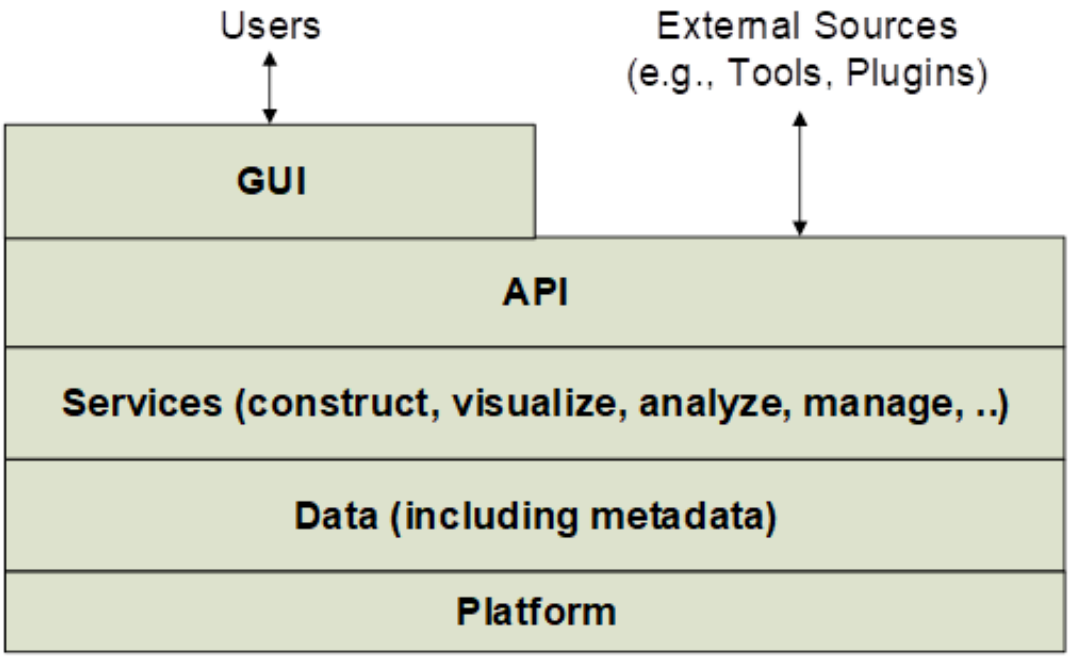
In addition, the logical architecture includes Customization Tools to further extend and customize the SME to support different domain and program needs, and ensure the customized environment continues to be interoperable with the rest of the MBE environment.

Finally, there is a practices repository that stores the systems engineering and modeling practices that are implemented by the users of the SME. The local workflow manager is intended to facilitate the systems engineer and others to perform these practices.

The SME can be implemented by multiple vendors. A systems engineer should be able to request a service of the SME through the standard API to access the model repository without regard for where the model data resides or what SME implementation provides the access to the model.

The logical components from the SME Logical Architecture are allocated to different layers of the SME architecture as shown in the SME Layered Architecture in the diagram below. The platform layer provides the basic computing infrastructure. The data layer stores the model data in the repository. The services layer contains a set of applications that implement the services needed to support the SME capabilities (for example: model construction, visualization, analysis, management). An application program interface (API) provides the interface to request these services. The graphical user interface (GUI) provides the interface for the users. The GUI and other tools request the services through the API. The API also enables the Customization Tools to modify and extend the data model and other aspects of the environment.

Figure 2.4. System Modeling Environment Layered Architecture



3 Specific Requirements on Proposals

3.1 Mandatory Language Requirements

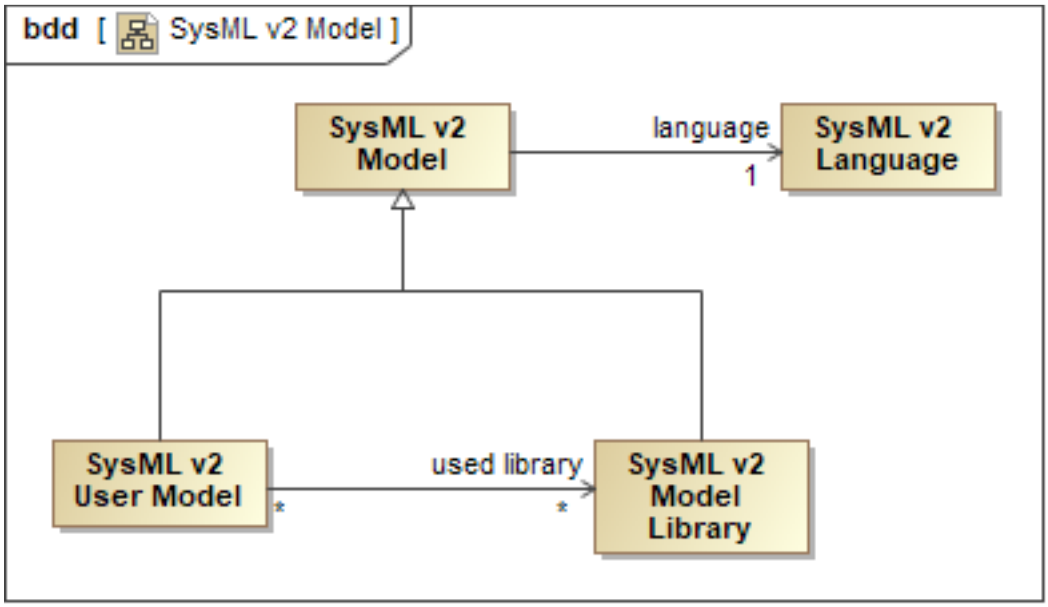
The mandatory requirements for SysML v2 are intended to support the MBSE use cases and SME concept as described above. This section is organized into logical groupings of requirements. Each subsection contains key concepts that reflect the system modeling needs and issues with SysML v1, and some motivating examples to highlight the concepts and/or issues. The set of requirements applicable to each section is included at the end of each subsection.

3.1.1 Language Architecture and Formalism

3.1.1.1 Language Architecture

SysML v2 is a modeling language used to represent SysML v2 models. As shown in the figure below, SysML v2 models include both models created by SysML v2 end users and model libraries containing reusable modeling components that may be used in the creation of user models. In particular, some of the SysML v2 language requirements may be implemented in the SysML v2 specification as user-level model libraries.

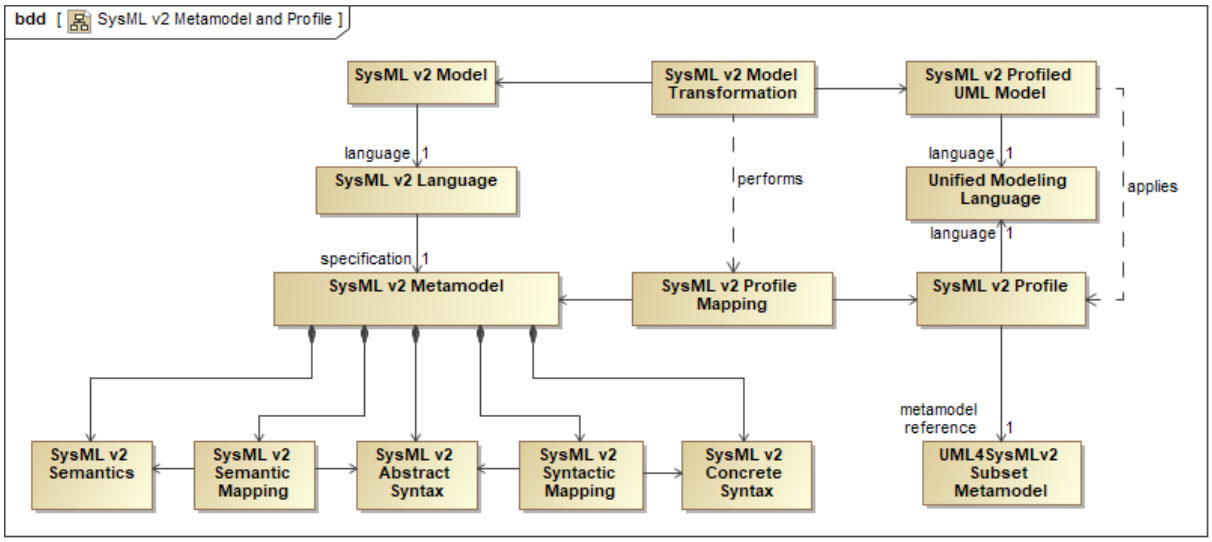
Figure 3.1. SysML v2 Models and Model Libraries



The SysML v2 language is specified using a SysML v2 metamodel that defines the language's semantics, abstract syntax and concrete syntax, and the relationships between them, as shown in the figure below. The language also provides mechanisms to support further customization to

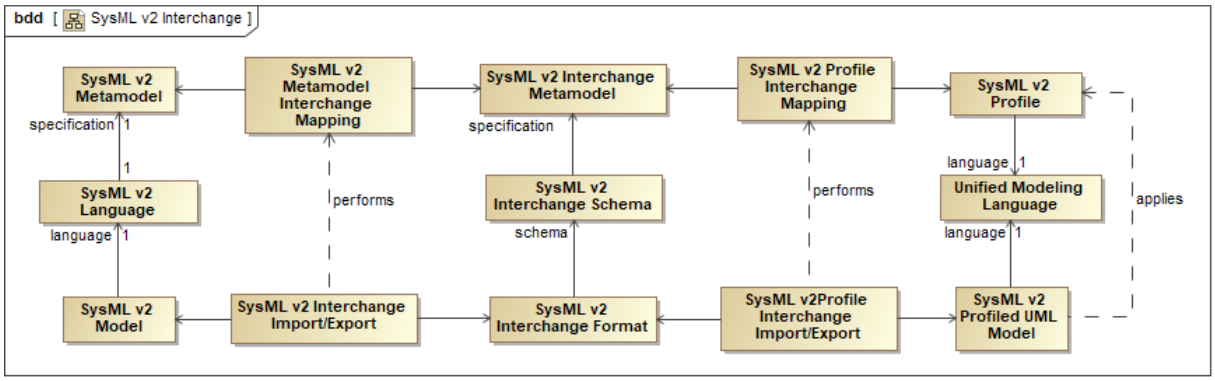
reflect domain specific concepts. In addition, the SysML v2 metamodel is mapped to a SysML v2 profile. This allows a SysML v2 model to also be represented as an extension of a UML model, using the profile to adapt UML syntax and semantics to those of SysML v2. The combination of a metamodel and a profile enable a broader range of vendor implementations. The metamodel supports implementation of the system concepts without some of the constraints imposed by UML, while the profile supports implementation of the system concepts in a way that is more closely aligned with SysML v1 implementations.

Figure 3.2. SysML v2 Metamodel and Profile



Having the SysML v2 metamodel aligned with the SysML v2 profile also allows for the specification of a SysML v2 format for interchanging models between tools, usable by both metamodel and profile-based tools. As shown in the figure below, this is done by defining mappings from both the SysML v2 metamodel and the SysML v2 profile to a common SysML v2 interchange metamodel, consistent with the mapping between the SysML v2 metamodel and the SysML v2 profile. That is, a SysML v2 models based on the metamodel and profile are related by the SysML v2 metamodel-to-profile mapping and represented in the same way for the purposes of tool interchange. This allows a SysML v2 model exported from a metamodel-based tool to be imported into a profile-based tool, and vice versa. Furthermore, the SysML v2 interchange format enables interchange of both the abstract syntax representation of a SysML v2 model and the concrete syntax representation of views of that model.

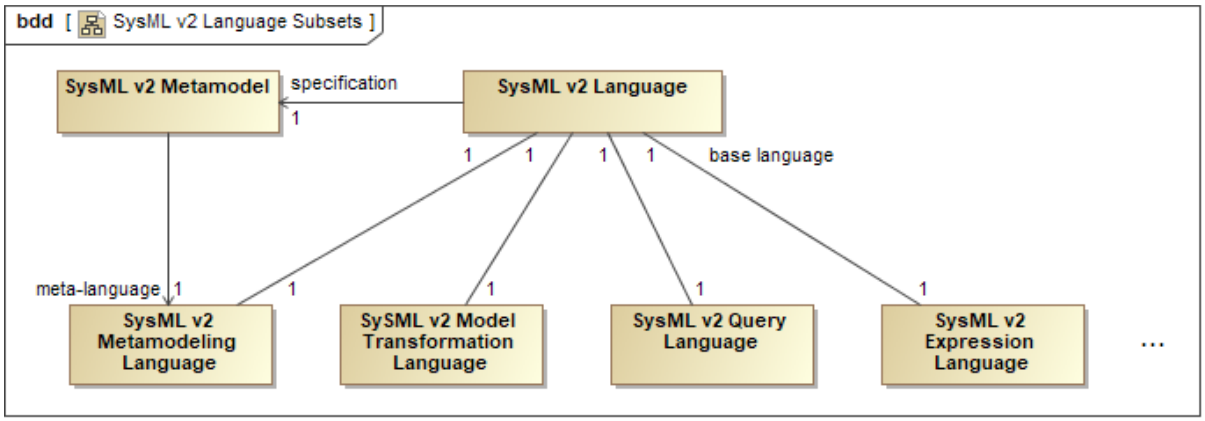
Figure 3.3. SysML v2 Model Interchange



SysML v2 is a general language for modeling systems. However, it will also be possible to identify a number of distinct sub-languages within SysML v2, each covering a well-defined subset of capabilities of the overall SysML v2 language. As shown in the following figure, these include model-transformation, query and expression languages, though this list is by no means intended to be exhaustive. Such sub-languages may represent existing languages within SysML, so that models using them can be fully integrated and exchanged as part of the System Modeling Environment.

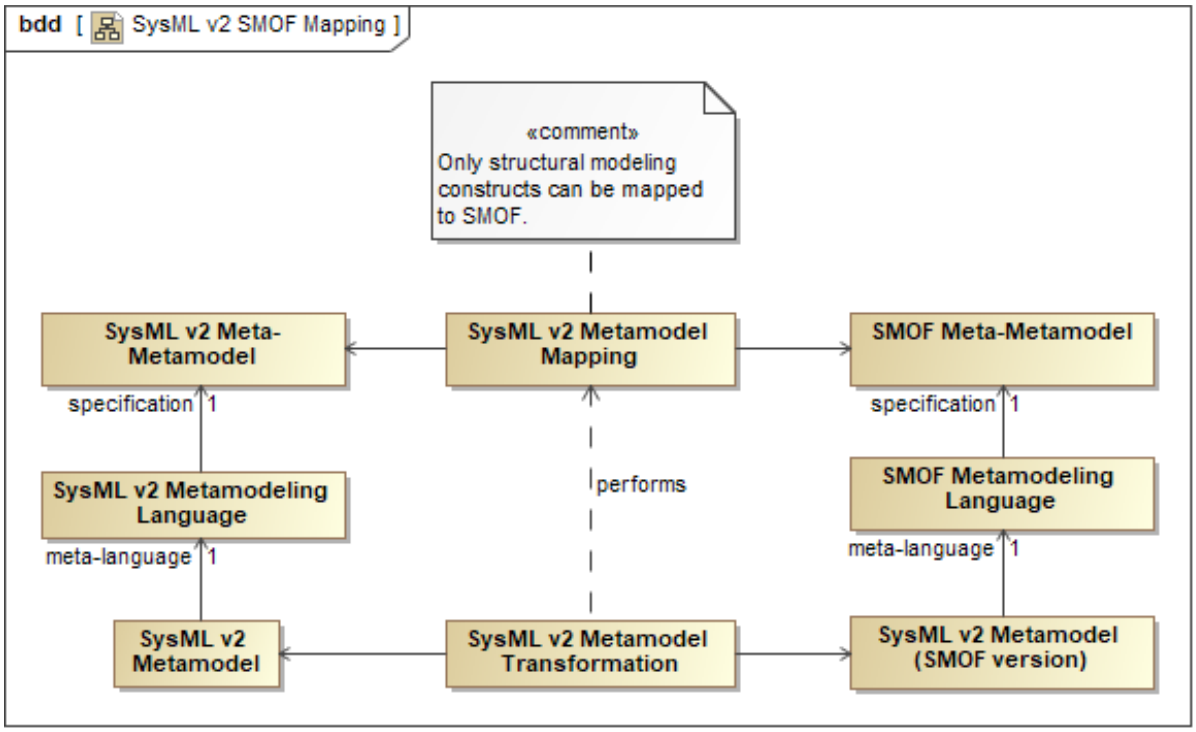
SysML v2 will also include a sub-language focused on representing metamodels. This SysML v2 metamodeling language will then be used to represent the SysML v2 metamodel itself. This circularity of specifying SysML v2 in itself stops at a root level that is defined by a foundational subset of the language using a separate declarative formalism (as described further in the section on Formalism below). It is not expected that any additional features will need to be added to SysML v2 to support metamodeling. The SysML v2 metamodeling language will simply be a subset of SysML v2 language features already needed to satisfy other SysML v2 requirements, such as for structural and behavioral modeling, but which also apply to metamodeling.

Figure 3.4. SysML v2 Language Subsets



Since the SysML v2 metamodeling language is a sub-language of SysML v2, it is specified by a subset of the SysML v2 metamodel. As shown in the following figure, this metamodel subset is known as the SysML v2 meta-metamodel, since it is essentially a model of the meta-modeling language. The SysML v2 meta-metamodel also provides the basis for mapping to the OMG-standard Semantic Meta-Object Facility (SMOF) meta-model (SMOF is an extension of the base MOF specification). Using this mapping, the SysML v2 metamodel may be represented using a metamodel conformant with the SMOF standard, allowing integration with existing MOF and SMOF-based tooling. Note, however, that, like MOF, SMOF only provides support for structural modeling of the syntactic constructs of a modeling language, so it will likely not be possible to fully map the SysML v2 semantics portion of the SysML v2 metamodel to a SMOF-based representation. This semantic gap can be filled by other OMG standards such as those used in the precise semantics of UML.

Figure 3.5. SysML v2 SMOF Mapping



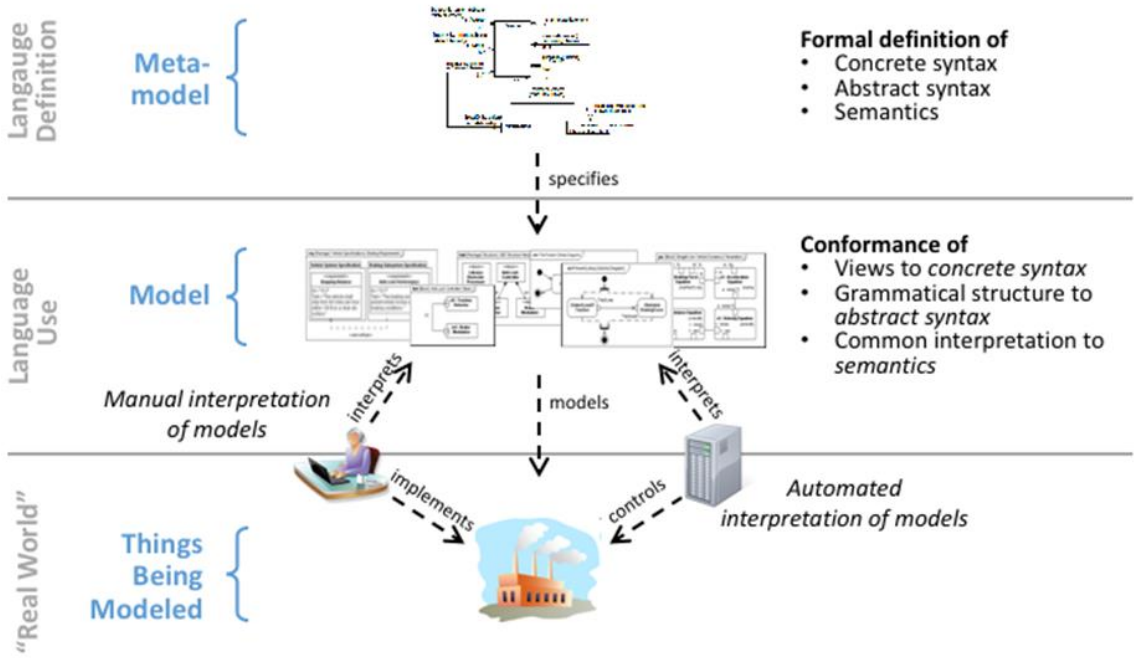
3.1.1.2 Formalism

A formalism is used to specify the SysML v2 language. In mathematics and logic, formalism has to do with how something is structured and expressed, as opposed to the actual content of what is being expressed. Formalism aims to express content in a well-defined form, such that this expression can be given a uniform interpretation. A formalism may also extend to rules for the consistent manipulation of the form of expression, such as the ability to construct formal proofs using deduction rules based on given axioms and to reason about the system being represented.

For SysML, the formalism defines how the language itself is specified in terms of its syntax and semantics, as opposed to what is in the language. This includes: the abstract syntax that specifies the grammar of the language, including the basic constructs of the language analogous to verbs and nouns, and the rules for constructing legal sentences (i.e., statements); the concrete syntax that specifies the symbols (textual, graphical and diagrammatic) that define how grammatical constructs in the language can be presented; and the semantics that specify the meaning of the constructs so that they can be interpreted in the domain that the model is intended to represent. The specification of how models are interchanged can also be considered part of the formalism. The rigorous specification of the abstract syntax, concrete syntax, semantics, and interchange format is intended to ensure the precision and integrity of the language.

The figure below shows the relationship between the language formalism and the things being modeled. The goal of a formal specification for SysML is to provide a uniform syntactic and semantic interpretation for the language. That is, a SysML model should be interpreted in a consistent way and subject to an objective evaluation as to whether it conforms to the SysML v2 Specification, whether this interpretation is done by a human that interprets a view of the model or a machine that interprets the model.

Figure 3.6. Language Formalism and Uniform Interpretation



SysML v1 is specified using the formalism of UML 2 profiles. A UML profile is an extended subset of the UML metamodel, which is itself specified using the formalism provided by the Meta Object Facility (MOF). The SysML v1 specification defines the abstract syntax of SysML as a profile of UML that extends the subset of UML abstract syntax using stereotypes, extends the concrete syntax of UML diagrams, and adopts and adapts UML semantics as appropriate.

There are some significant limitations of the formalism used for SysML v1 that result in ambiguities of interpretation. For example, SysML v1 does not include a complete formal mapping between the concrete syntax and the abstract syntax, which can result in ambiguity in how a SysML diagram conforms to the rules of the grammar. In addition, the semantics of SysML v1 are often defined in English rather than a more precise formal representation, which can result in ambiguity of meaning.

In contrast, SysML v2 will have a more formal specification of its abstract syntax, concrete syntax and semantics, and the mappings between them. To maximize the flexibility of this specification, the required approach is to specify a small set of foundational concepts and their

base semantics using a mathematical *declarative* semantics. Then, model libraries written in SysML itself, grounded in the base semantics, are used to further extend the concepts of the language and their associated semantics. These extensions will represent the core domain concepts for the SysML v2 language. SysML v2 is also intended to include additional user-level model libraries that extend these core concepts, and provide a mechanism to further customize the language.

The advantage of grounding SysML semantics in a declarative approach is that well-known techniques of mathematical logic can then be used to make formal deductions based on the assertions made in a model, in order to prove things that are true or not about the system or domain that is being modeled. Declarative semantics contrast with the operational semantics which specify how a model executes, such that the execution results are evaluated to determine how the system will behave. It is expected that the full semantics for SysML v2 will include both declarative and operational components.

As an example of how the semantics of SysML v2 could be built up from a declarative base, consider the case of the semantics of control nodes used in activity diagrams. Currently (in UML and, so, SysML v1), each type of control node such as a fork node, join node, decision node, or merge node is defined with its own unique semantics. In SysML v2, the general concept of a control node might be specified along with its base semantics. The specific semantics for fork, join, decision and merge nodes could then be specified in the core model library, specializing the base control node semantics. The language formalism would include rules for how this could be done in an unambiguous, rigorous way. A formal mathematically-based language does not have to be difficult to use. The usability of the language will be emphasized using graphical, textual and tabular notations appropriate for a practicing systems engineer.

3.1.1.3 Language Architecture and Formalism Requirements

The language architecture and formalism requirements are included in the table below. These requirements are about how the abstract syntax, concrete syntax, and semantics are to be specified for SysML v2, and include requirements related to extending the language and interchanging and transforming models.

Table 3.1. Language Architecture and Formalism Requirements

ID	Name	Requirement Text	SysML v1.x Construct
LNG 1	Language Architecture and Formalism Requirements Group	This group specifies how the language is structured and defined. **Supporting information:** Some concepts may be implemented as user-level model libraries.	
LNG 1.1	Metamodel and Profile Group		

ID	Name	Requirement Text	SysML v1.x Construct
LNG 1.1.1	SysML Metamodel	SysML v2 shall be specified using a metamodel that includes abstract syntax, concrete syntax, semantics, and the relationships between them.	
LNG 1.1.2	Metamodel Mapping	The SysML v2 specification shall provide or reference a mapping between the subset of SysML v2 used to define SysML v2, MOF and SMOF.	
LNG 1.1.3	SysML Profile	SysML v2 shall be specified as a SysML v2 profile of UML that includes, as a minimum, the functional capabilities of the SysML v1.x profile, and a mapping to the SysML v2 metamodel. **Supporting information:** Equivalent functional capability demonstrated by mapping the UML metaclasses and SysML stereotypes from SysML v2 to SysML v1 to demonstrate coverage.	SysML v1.x Profile
LNG 1.2	Semantics Group		
LNG 1.2.1	Semantic Model Libraries	SysML v2 semantics shall be modeled with SysML v2 model libraries. **Supporting Information:** 1. Simplifies the language when model libraries are used to extend the base declarative semantics without additional abstract syntax. 2. Enables SysML to be improved and extended more easily by changes and additions to model libraries, rather than always through abstract syntax.	
LNG 1.2.2	Declarative Semantics	SysML v2 models shall be grounded in a declarative semantics expressed using mathematical logic. **Supporting Information:** Semantics are defined formally to reduce ambiguity. Declarative semantics enable reasoning with mathematical proofs. This contrasts with operational semantics that requires execution in order to determine correctness.	Semantics of UML and SysML

ID	Name	Requirement Text	SysML v1.x Construct
		The semantics provide the meaning to the concepts defined in the language, and enable the ability to reason about the entity being represented by the models.	
LNG 1.2.3	Reasoning Capability	SysML v2 shall provide a subset of its semantics that is complete and decidable. **Supporting Information:** This enables the ability to reason about the entity being modeled by querying the model, and returning results that satisfy the specified set of constraints. As an example, a query could return valid vehicle configurations that satisfy vehicle mass<2kg AND vehicle has a sunroof.	
LNG 1.3	Abstract Syntax Group		
LNG 1.3.1	Syntax Specification	SysML v2 abstract and concrete syntax shall be specified entirely using a subset of SysML v2 (including constraints on syntactic structure). **Supporting Information:** Expressing the syntax formally using a single consistent language which is more understandable to the user.	
LNG 1.3.2	View Independent Abstract Syntax	The SysML v2 abstract syntax representation of SysML v2 models shall be independent of all views of the models. **Supporting Information:** Rationale This is intended to define the concept independent of how it is presented. This enables a consistent representation of concepts with common semantics across a diverse range of views, including graphical, tabular, and other textual representations. It also allows more consistent implementation of services on models (e.g., model checking, execution, and analysis) independent of specific views of those models.	

ID	Name	Requirement Text	SysML v1.x Construct
LNG 1.4	Concrete Syntax Group		
LNG 1.4.1	Concrete Syntax to Abstract Syntax Mapping	The SysML v2 concrete syntax representation of all views of a SysML model shall be separate from, and mapped to the abstract syntax representation of that model (including the ability to map to one or more images or snippets of images). **Supporting Information:** Enables views to provide unambiguous concrete representation of the abstract syntax of the model. Enables views to be rendered in a consistent way across tools.	Diagram Definition
LNG 1.4.2	Graphical and Textual Concrete Syntax	SysML v2 shall provide a standard graphical and human readable textual concrete syntax. **Supporting information:** Graphical and textual concrete syntax representations can be used in combination to more efficiently and effectively present the model. Refer to Alf as an example of a textual notation.	Graphical syntax only
LNG 1.4.3	Syntax Examples	All examples of model views in the SysML v2 specification shall include the concrete syntax of the view, and the mapping to the abstract syntax representation of the parts of the models being viewed. **Supporting Information:** Experience has shown that the mapping of examples to the concrete and abstract syntax is not always obvious. Making these mappings explicit helps clarify their formal specification.	
LNG 1.5	Extensibility Group		
LNG 1.5.1	Extension Mechanisms	SysML v2 syntax and semantics shall include mechanisms to extend the language. **Supporting Information:** This is essential to enable further customization of the language. SysML v1	Stereotype, Profile

ID	Name	Requirement Text	SysML v1.x Construct
		includes a stereotype and profile mechanism to extend the language. It should also enable extension of metadata, e.g. data owner, model protection data, model precision	
LNG 1.5.2	Extensibility Consistency	All SysML v2 extension mechanisms shall be applicable to SysML v2 syntax (concrete and abstract) and semantics, and be consistent with how these are specified in SysML v2. **Supporting Information:** The SysML v2 Specification includes syntax, semantics, and vocabulary, so extending the language requires all of these to be extensible.	
LNG 1.6	Model Interchange, Mapping, and Transformations Group		
LNG 1.6.1	Model Interchange	SysML v2 shall provide a tool-neutral format for unambiguously interchanging the abstract syntax representation of a model and the concrete syntax representation of views of the model. **Supporting Information:** The interchange should facilitate long term retention, file exchange, and version upgrades. Consider consistency with related interchange standards, such as AP233. For the concrete syntax, consider consistency with Diagram Definition and Diagram Interchange.	XMI
LNG 1.6.2	Model Mappings and Transformations	SysML v2 shall provide a capability to specify model mappings and transformations. **Supporting Information**: SysML may be used to represent the metamodel of other languages to enable transformation between SysML models and models in other languages. These languages include languages for queries, validation rules, expressions, viewpoint methods, and transformations.	

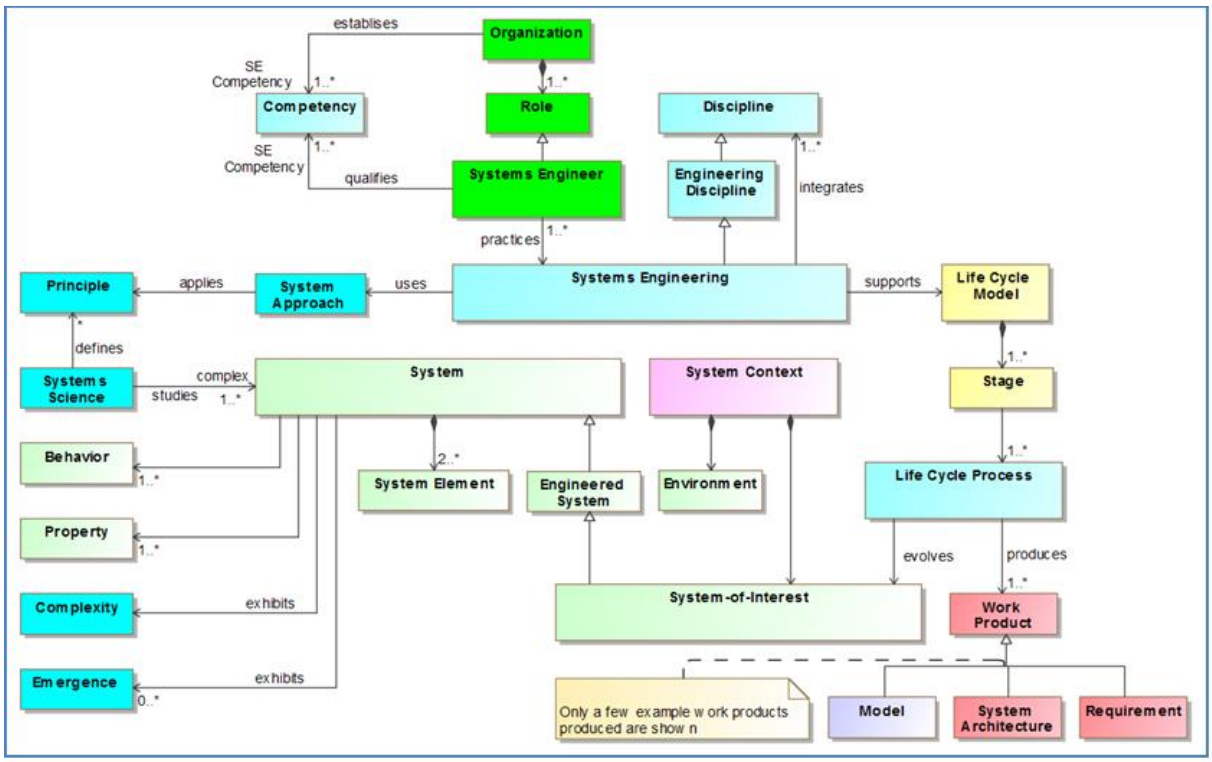
ID	Name	Requirement Text	SysML v1.x Construct
LNG 1.6.3	UML Interoperability	SysML v2 shall provide the capability to map shared concepts between SysML and UML.	SysML Profile of UML

3.1.2 Data Model

Systems Engineering Concept Model (SECM). SysML v2 is intended to provide the capability to model systems with a precisely defined systems engineering vocabulary. A Systems Engineering Concept Model (SECM) is used to capture the key concepts to represent systems, and is a primary input to help specify the requirements for the SysML v2 metamodel, profile, and model libraries. *The SECM is used as part of the analysis to derive the SysML v2 requirements, but is not considered part of the mandatory requirements in the SysML v2 RFP*.

The high-level concepts in the SECM are intended to be consistent with industry standards for systems engineering that include the Systems Engineering Body of Knowledge (SEBoK), the ISO standard for Systems and Software Engineering -- System lifecycle processes (ISO/IEC/IEEE 15288:2015), and the INCOSE Systems Engineering Handbook v4. These sources and others provide high-level concepts which can be further elaborated to support the requirements for SysML v2. The figure below is an extract from the SECM-2015 Industry Reference showing some of the core concepts in the SEBoK. There are many other concepts in the industry reference model beyond what is shown in this Figure.

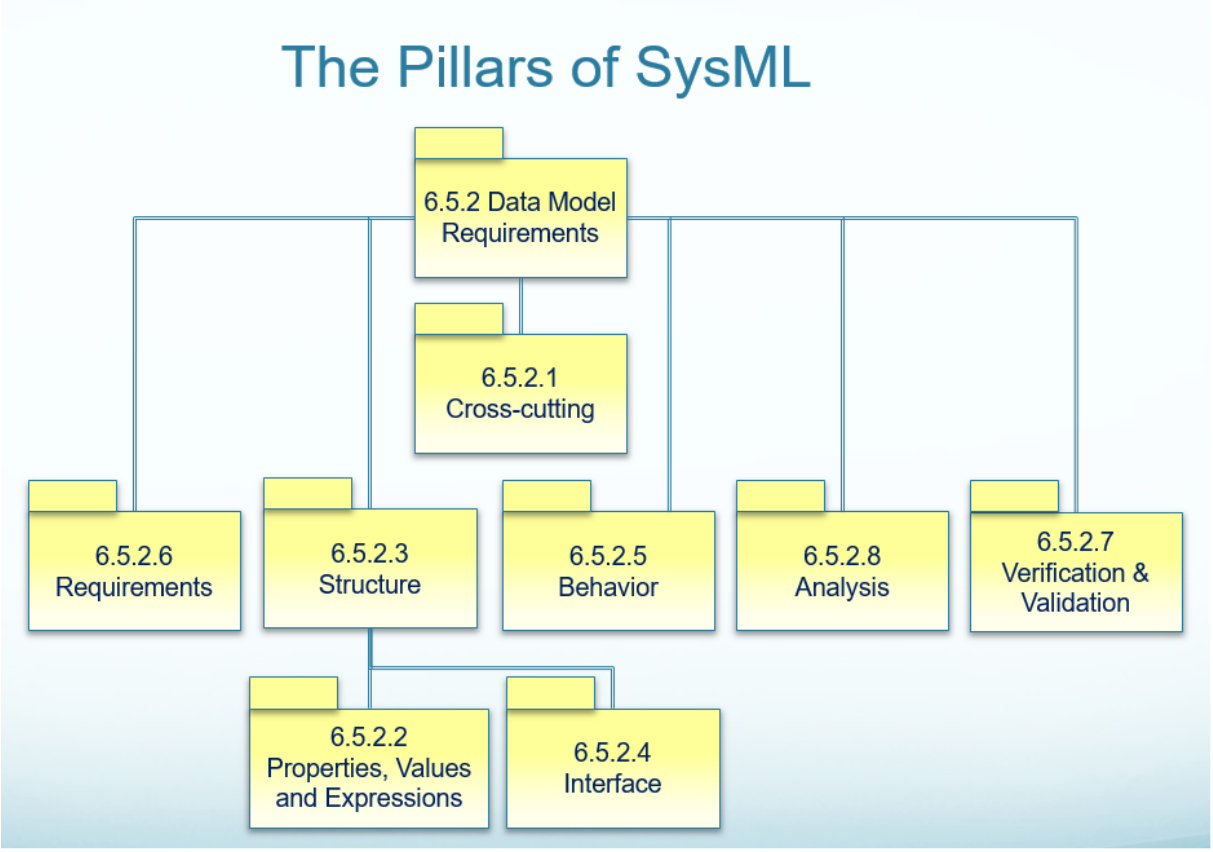
Figure 3.7. Core SEBoK Concepts (Extract from draft SECM-2015 Industry Reference. Used with permission)



SysML v2 includes concepts directly related to the specification, design, analysis, and verification of systems. The SysML v2 concepts are intended to align with the industry standards, but the scope of SysML v2 is not intended to address the full scope of the industry reference model. At the same time, SysML v2 may include additional concepts that are not explicitly referred to in the industry reference model.

Data model requirements. The scope of SysML v2 system modeling concepts includes the scope of SysML v1, which includes support for modeling structure, behavior, parametric, and requirements, often referred to as the 4 pillars of SysML. The SysML v2 concepts also include additional concepts related to verification, analysis, and other concepts beyond what is in SysML v1. The organization of the system modeling concepts are indicated in the figure below.

Figure 3.8. Organization of SysML v2 Modeling Concepts



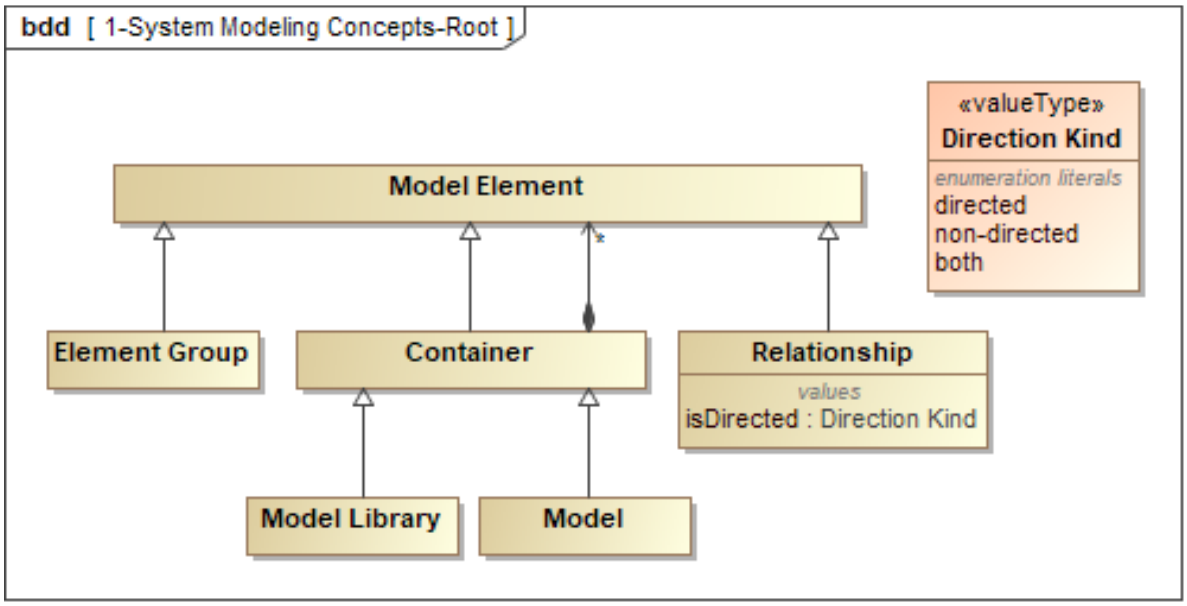
In addition to extending the SysML v1 concepts, a major emphasis for SysML v2 is to ensure integration of these concepts. This is in part accomplished by defining a core set of concepts and patterns, and then applying them consistently to define other concepts. For example, the concept of decomposition can be applied consistently to structure and behavior, and the concept of precedence can be applied consistently in different behavior representations, such as activities and state machines. Logical expressions such as AND, OR, XOR, and NOT can also be applied consistently throughout the language.

The following is a brief introduction to the SysML v2 modeling concepts that reflect the intent of many of the requirements. This summary level is an abstraction of the more comprehensive SECM that includes consider more detail. The SECM is captured in a model that will be provided as an input to the Submission Teams to provide context for the requirements. Although many of the concepts may be similar to those in UML and SysML, the terms are often different to avoid the implication of a particular implementation.

Root concepts. The root concepts that are reflected in the cross cutting requirements are included in Figure 3.9. A Model Element is the root element. A Container contains other model elements, and is analogous to a package in SysML. An Element Group establishes criteria for

Model Elements to be members of a group, but is not a Container. Model and Model Library are kinds of Containers, where a Model is a top-level Container and a Model Library contains elements that are designated to be reused. Finally, the Relationship relates 2 model elements, and can be directed, non-directed, or both. All other relationships are specialized from this more general relationship.

Figure 3.9. Root Concepts

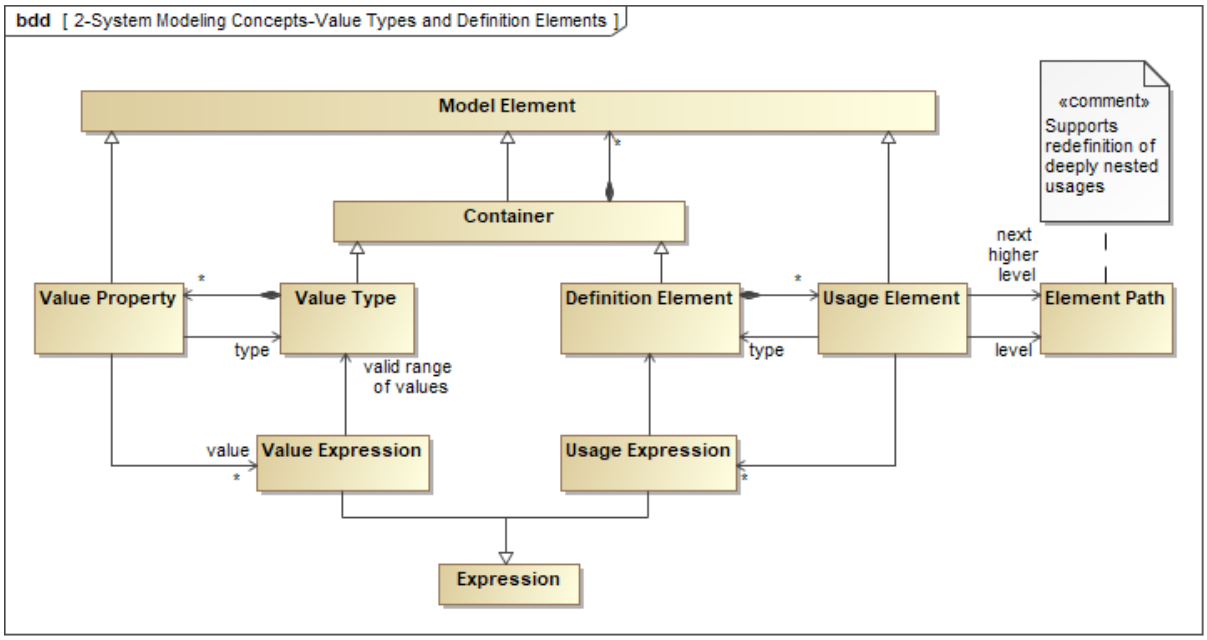


Value Type and Definition Element. The two important kinds of Containers shown in Figure 3.10 are Value Types and Definition Elements. A Value Type is used to represent data structures with units and quantity kinds. A Value Property is typed by a Value Type to represent quantitative properties, and a Value Expression establishes the value for a Value Property. A Value Type can contain other Value Properties. The kinds of Value Types have been significantly expanded beyond the primitive Value Types in SysML v1 to include vectors and other more complex data structures.

The concepts of definition and usage, such as block and part, are core concepts in SysML v1 that also apply to many of the SysML v2 language concepts. The Definition Element and Usage Element provide the ability to define a concept one time, and then reuse it in many different contexts. Usage Elements represent many concepts that are referred to as structural and behavioural features in UML and SysML. A Usage Element is typed by a Definition Element, and a Definition Element can contain other Usage Elements. An Element Path can unambiguously refer to a deeply nested usage element, and over-ride the definition for a particular localized usage (Note: analogous to SysML redefinition). This concept is further elaborated in the SECM. The Usage Expression allows the representation of logical expressions

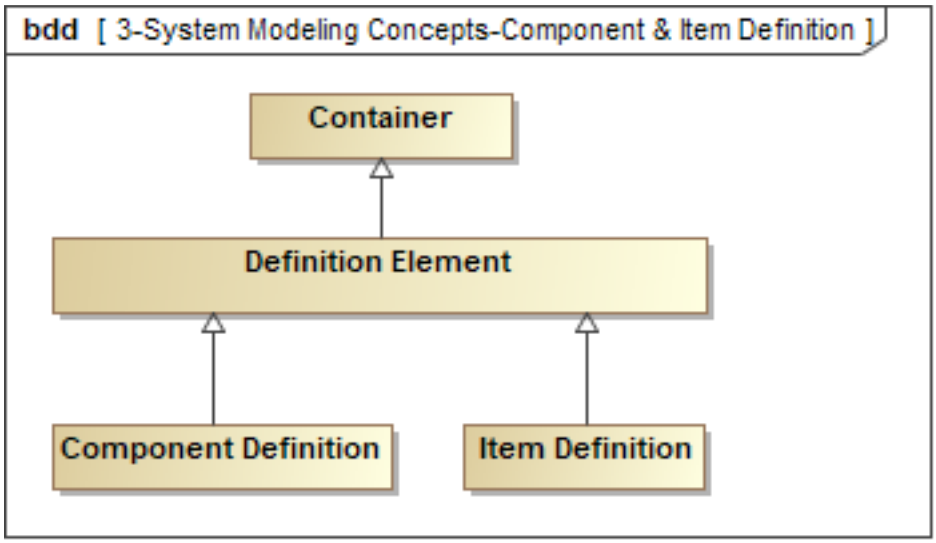
such as {(Usage Element A AND Usage Element B) OR (Usage Element C AND Usage Element D)}.

Figure 3.10. Value Type and Definition Element



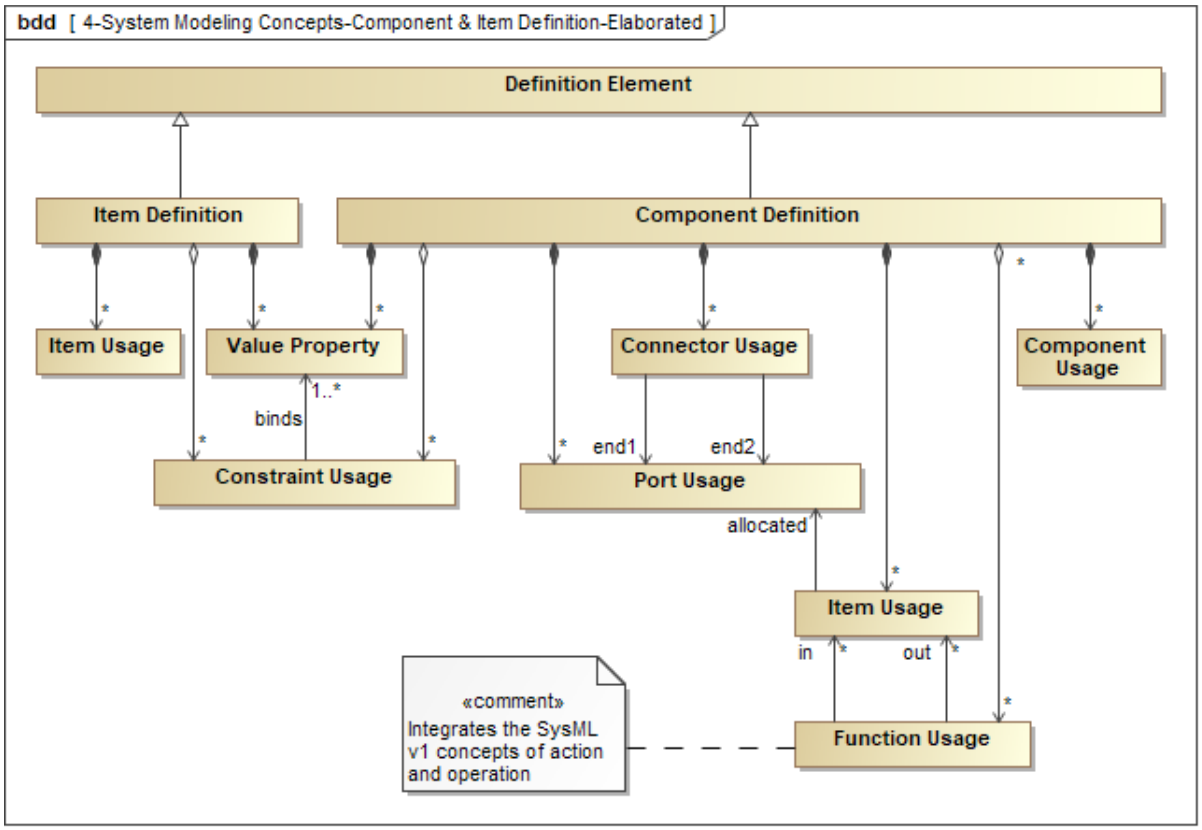
Component Definition and Item Definition. Two particular types of Definition Elements that represent structural elements of a system and items that flow across a system are Component Definition and Item Definition respectively as shown in Figure 3.11. A simple example of a Component is a Pump and an Item is Water that flows in and out of the Pump. Both of these can be represented in SysML v1 as a Block to represent a modular unit of Structure. SysML v1 also includes various concepts to represent items that flow such as flow properties and item properties.

Figure 3.11. Component Definition and Item Definition



Component Definition and Item Definition-Elaborated. The Component Definition and Item Definition are further elaborated in Figure 3.12 to show the kinds of usage elements and value properties that they contain. The Item Definition includes Value Properties and Constraint Usages to constrain its properties, and Item Usages to create nested item structures. The Component Definition contains Value Properties and Constraint Usages similar to Item Definitions, and Component Usages to define nested component structures. It also contains Port Usages and Connector Usages to connect Component Usages. Component Definition also contains Function Usages that is analogous to an Operation of a Block, but represents an action that the Block performs to transform inputs to outputs or change its state. The input and output Item Usages are allocated to ports.

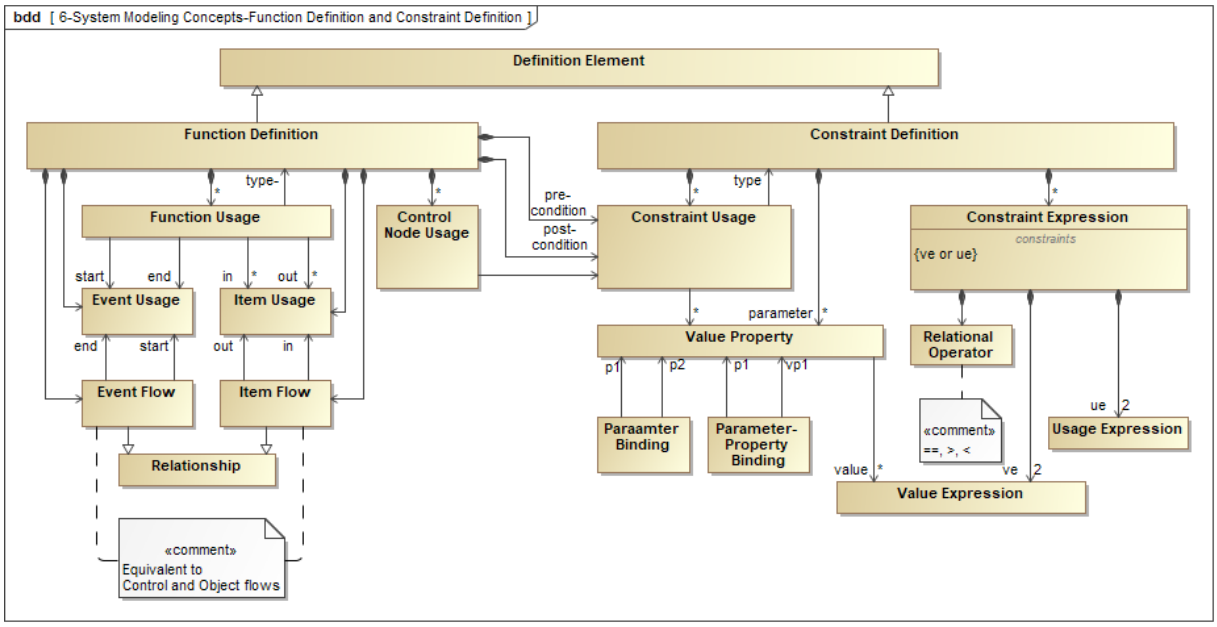
Figure 3.12. Component Definition and Item Definition-Elaborated



Function Definition and Constraint Definition. As noted in the previous figure, both a Component Definition and Item Definition contain Constraint Usages, and a Component Definition can contain Function Usages. The Constraint Definition and Function Definition are also Definition Elements as shown in Figure 3.13. They both use the standard pattern that enable the Definition Element to decompose into Usage Elements and the Usage Elements are typed by the Definition Element, enabling a nested tree of usages. The Constraint Definition contains Constraint Expressions that constrain the parameters of the expressions similar to SysML v1 Constraint Blocks.

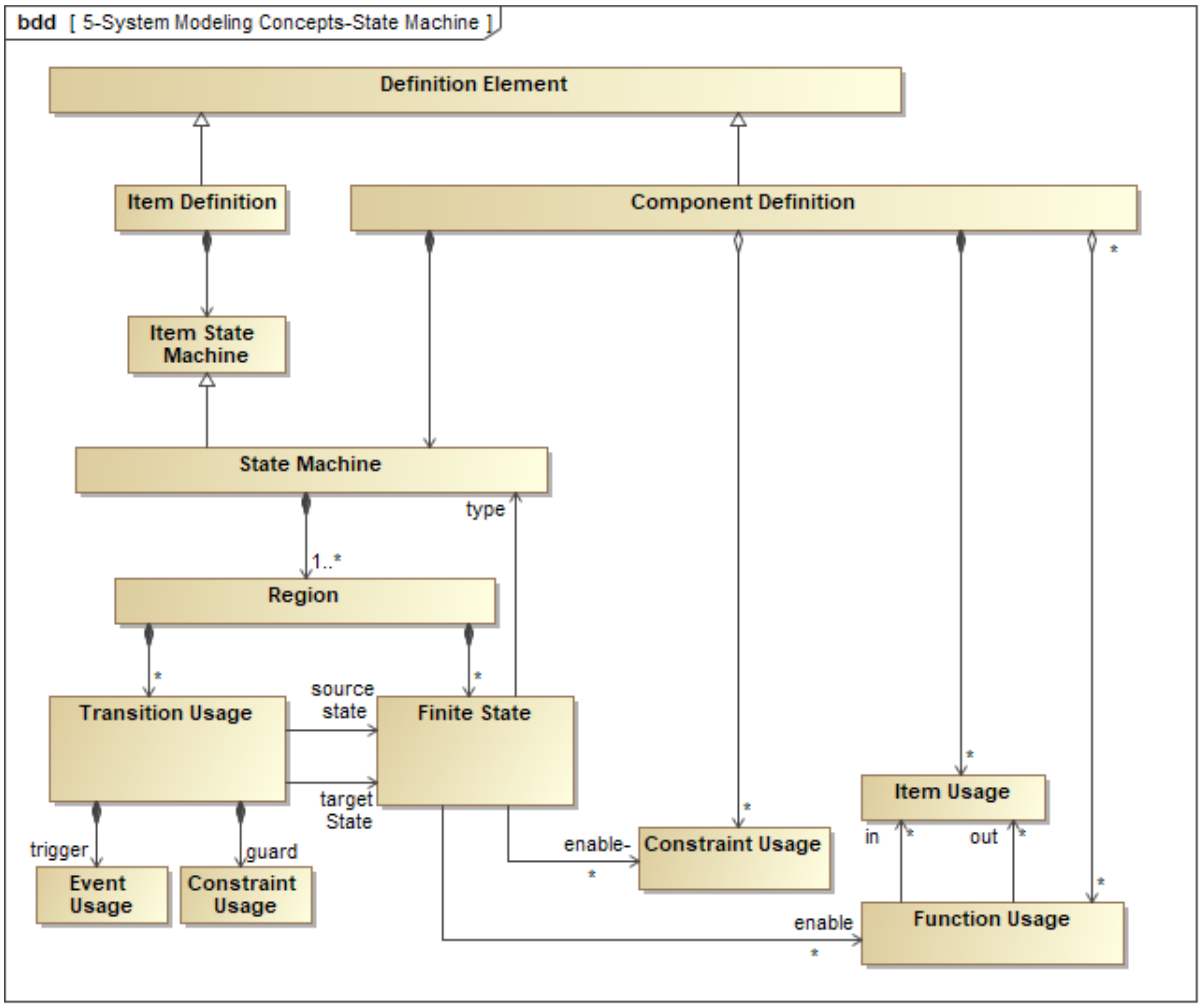
The Function Definition contains Function Usages and Control Node Usages which are analogous to actions and control nodes in SysML v1. Function Usages can include both inputs and outputs (i.e., Item Usages), and start and end events (i.e., Event Usages). An Output from one Function Usage is connected to the input of another Function Usage by an Item Flow, and the end event of one Function Usage is connected to the start event of another Function Usage by an Event Flow. Item Flow and Event Flow are analogous to Object Flow and Control Flow in SysML v1. Although not shown, these flows can also connect Control Node Usages. A Control Node Usage refers to a Constraint Usage. This is similar to a join specification in SysML v1. Finally, Function Definitions can include pre-conditions and post-conditions.

Figure 3.13. Function Definition and Constraint Definition



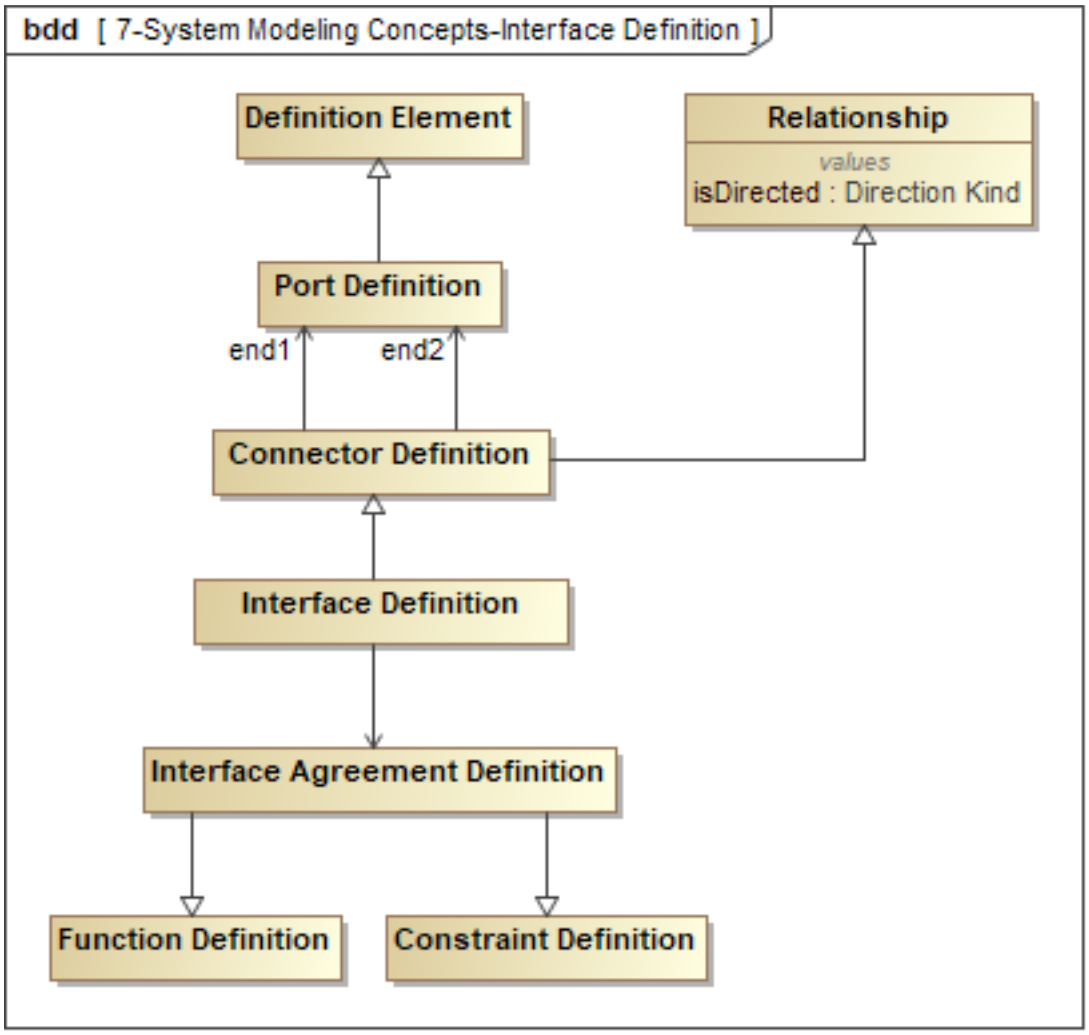
State Machine. The State Machine of a Component Definition and Item Definition specify its finite (i.e., discrete) states and the transitions between them as shown in Figure 3.14. The State Machine is a Definition Element which enables a Finite State to be typed by a State Machine. A Finite State can enable Constraint Usages and Function Usages in response to an event and guard condition. A State Machine can define the discrete states for an Item Definition such as a solid, liquid, and gas states of Water. A State Machine for an Item Definition can enable Constraint Usages, but does not enable Function Usages.

Figure 3.14. State Machine



Interface Definition. An Interface definition in SysML v2 constrain the physical and functional interaction between structural elements. The Interface includes two ends, the connection between them, and the constraints on the connection. As shown in Figure 3.15, the Interface Definition is a subclass of a Connector Definition, which corresponds to a SysML v1 association block. The Connector Definition includes Port Definitions (aka Interface End Definitions) on either end, and includes an Interface Agreement Definition which constrains the connection. The two types of Interface Agreements include both a Function Definition and Constraint Definition. Function Definitions are generally used to constrain the exchange of Items, such as with a communication protocol, and Constraint Definitions are generally used to constrain physical interactions such as voltage and current (i.e., Across and Through Variables). Although not shown in the Figure, a special type of component called in Interface Medium enables connection between other components, such as a pipe, network, cable. Interfaces also support nested ports and layered interfaces.

Figure 3.15. Interface Definition



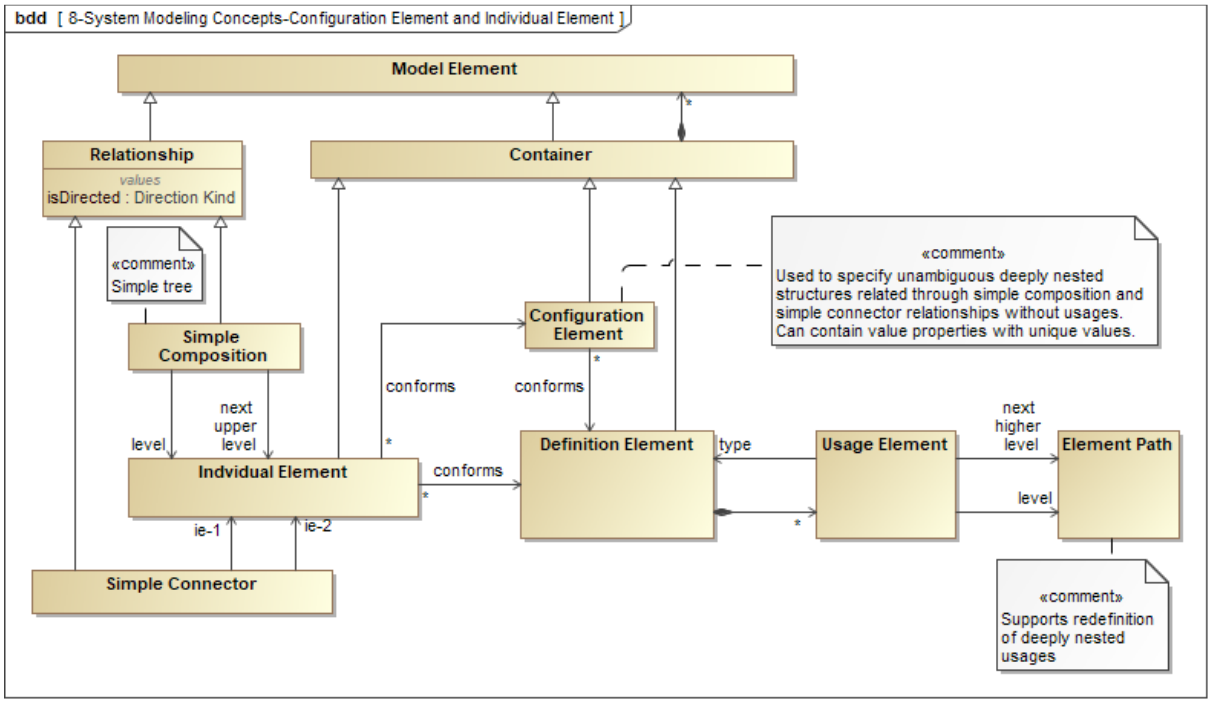
Configuration Element and Individual Element. A Definition Element can be decomposed into a tree of Usage Elements as noted before. However, SysML v2 requires a mechanism to define an unambiguous deeply nested structure using Configuration Elements which provides a straight forward way to specify a design configuration. A simple example is a vehicle that has 4 wheels, and each wheel has several lug bolts. The design configuration would enable the definition of an unambiguous product structure where each lug bolt on each wheel is clearly identified, and the torque value for each lug bolt can also be uniquely defined.

An Individual Element represents a model of a particular element that is uniquely identified, such as a model of a particular Vehicle on the factory floor with a Vehicle Identification Number (VIN). The structure of an Individual Element can be modified, such as replacing its wheels with a new kind of wheel and tire. A Simple Composition and Simple Connector is used to define a

tree of Configuration or Individual Elements and connect the Configuration or Individual Elements.

A Configuration Element can conform to a Definition Element such as a Component Definition, and an Individual Element can conform to a Configuration Element. However, they can be defined independently.

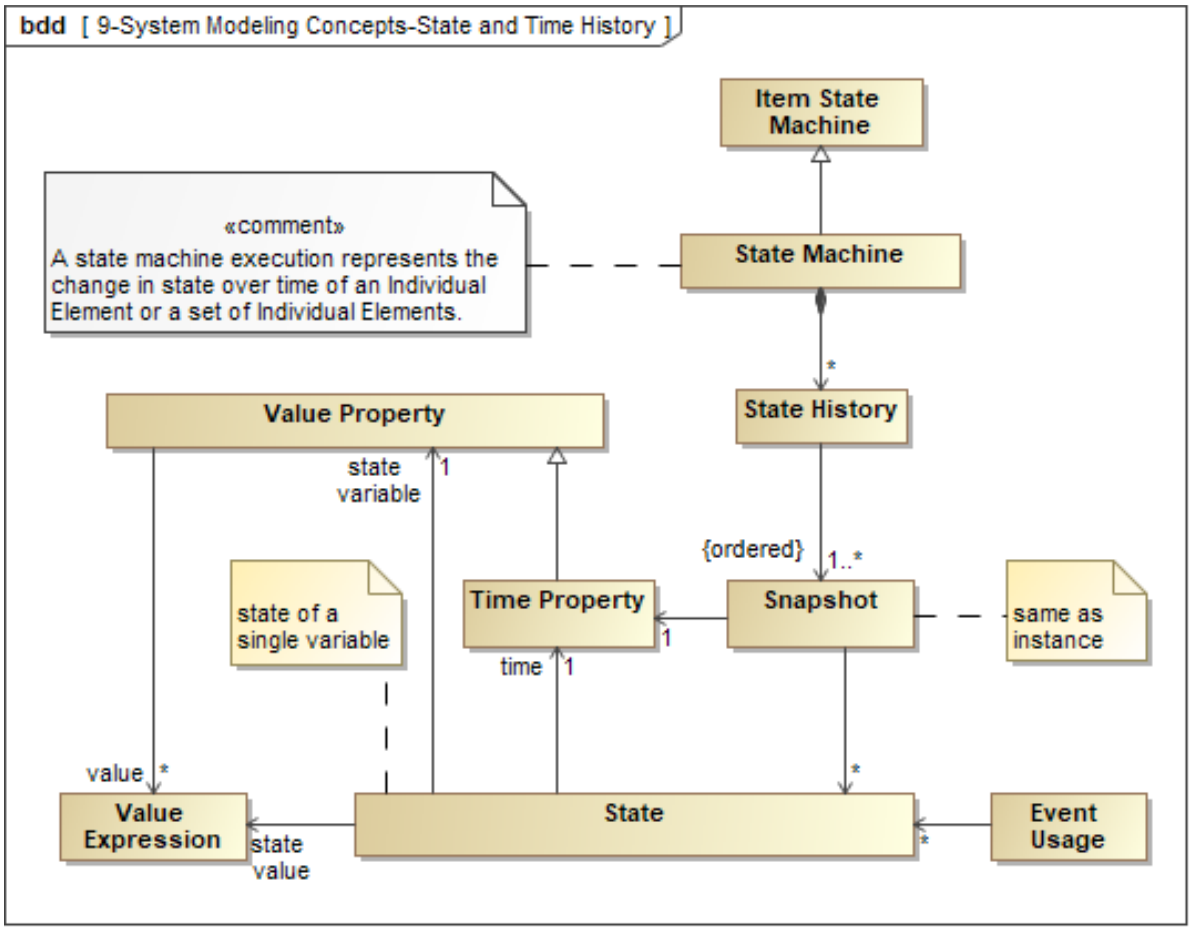
Figure 3.16. Configuration Element and Individual Element



State and Time History. An Individual Element can have a state and time history. The state history is defined as a series of ordered Snapshots of an Individual Element, where each Snapshot represents the state of the Individual Element at a point in time. An Individual Element such as an Engine may have several value properties, such as its temperature and torque, whose values change over time. These are referred to as state variables. The Snapshot represents the values of each of these state variables at a particular point in time.

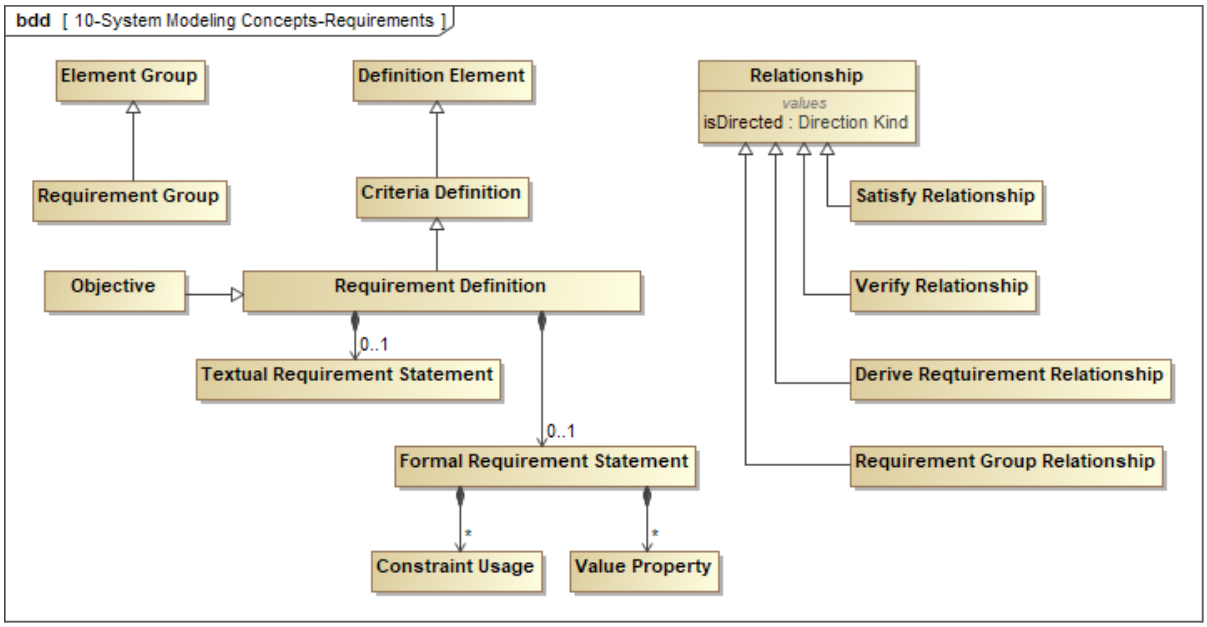
Each State Machine can contain multiple State Histories, where each State History can represent a distinct estimate of the Individual Elements change in state over time. A State History for a State Machine for a Component Definition implies that each conforming Individual Element will have this State History.

Figure 3.17. State and Time History



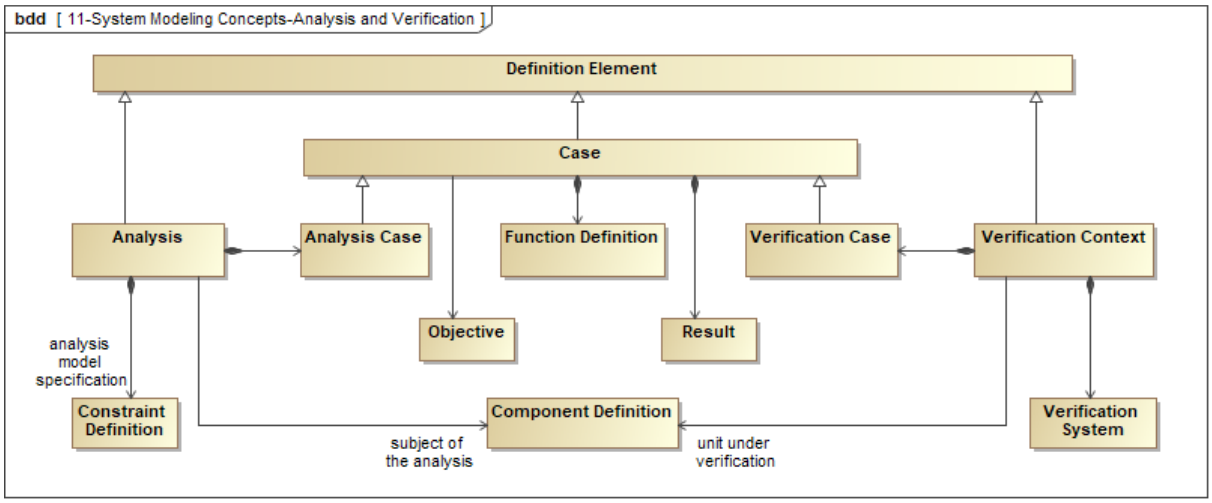
Requirements. A Requirement in SysML v2 will extend the SysML v1.5 Requirement which includes the ability to more precisely specify a requirement with a Formal Requirement Statement in addition to a Text Requirement Statement. The Formal Requirement Statement is specified by constraints. Requirements can be grouped into Requirement Groups, and can be related to other elements using requirements relationships such as Satisfy, Verify, Derive, and others, similar to SysML v1.

Figure 3.18. Requirements



Analysis and Verification. SysML v2 includes additional concepts to support Analysis and Verification. Both Analysis and Verification can apply similar patterns to represent an Analysis or Verification Context that include the Component Definition, Configuration, or Individual being analyzed or verified, the analysis models or verification system use to perform the verification or analysis, and the Analysis Case or Verification Case used to define how the analysis or verification is performed. The concept of Case is a common concept that is specialized to define an Analysis Case and Verification Case.

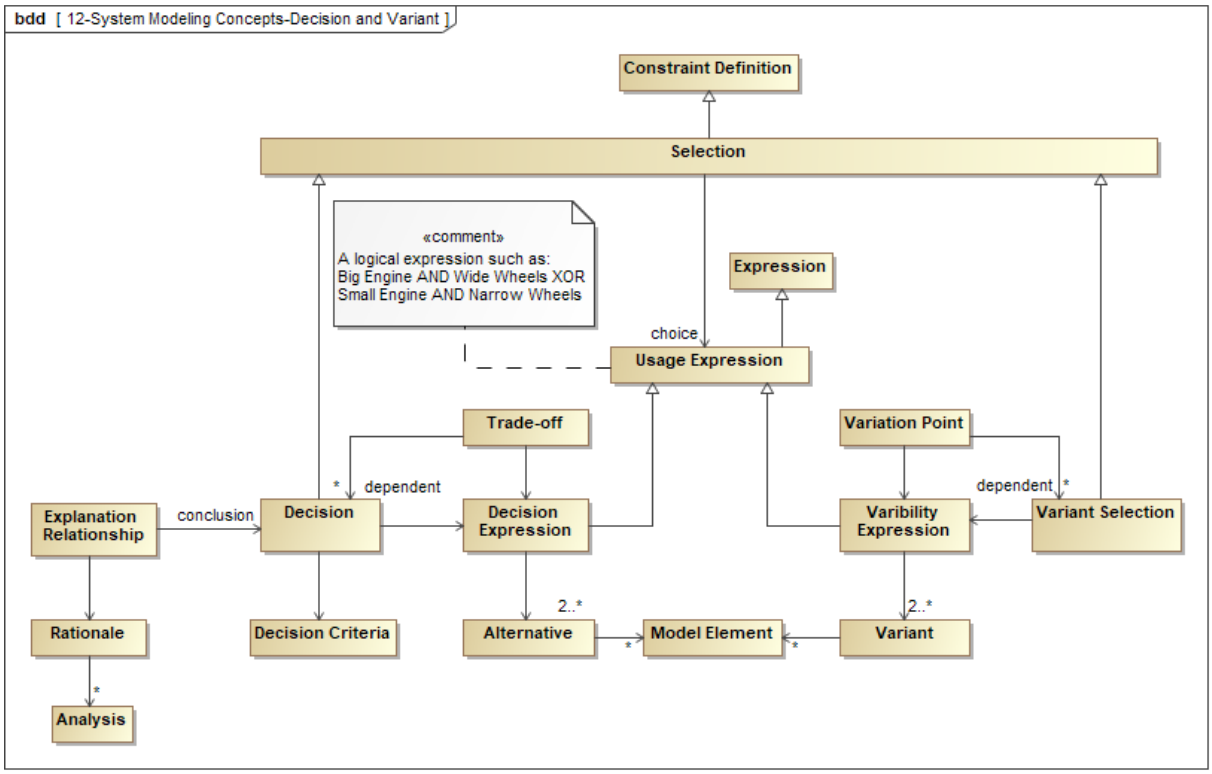
Figure 3.19. Analysis and Verification



Decision and Variant. SysML v2 requires additional concepts to support decisions analysis, such as trade studies, and variant modeling. Some common patterns for these concepts are noted in Figure 3.20. In particular, both a Decision and Variants involve a set of choices, called Alternative and Variant**,** respectively. An Expression can be used to define the choices such as A or B or C. The name for the set of choices is called a Trade-off and a Variation Point for the Decision and Variants respectively. A Selection is made among choices and called a Decision and a Variant Selection respectively. The available choices may be dependent on other Selections.

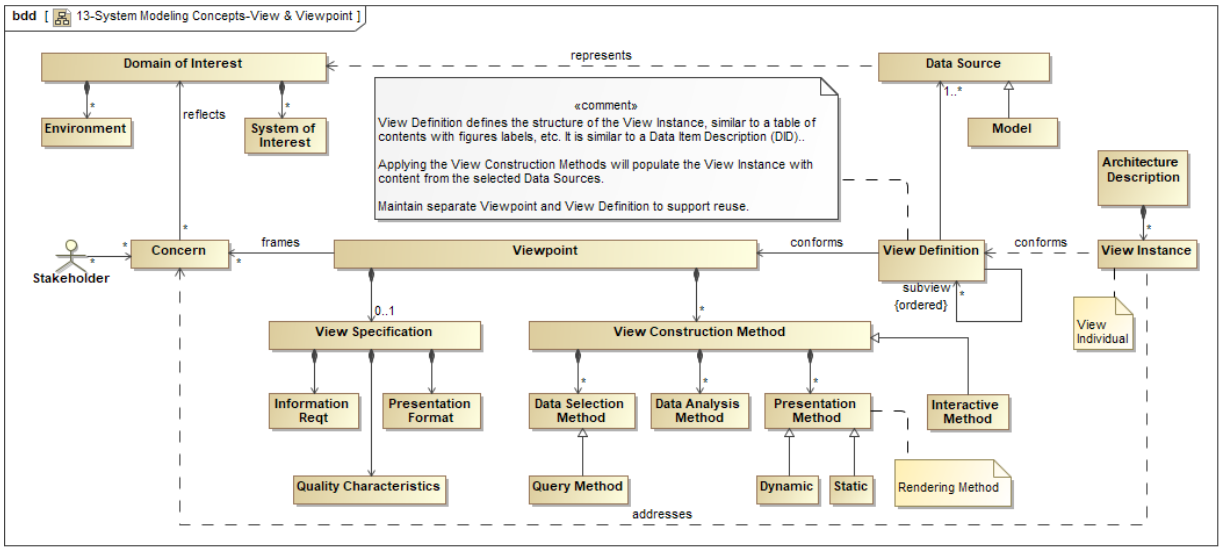
The Explanation Relationship relates the Decision to the Rationale which in turn refers to the Supporting Analysis. The Rationale concepts can be applied more generally to any conclusion.

Figure 3.20. Decision and Variant



View and Viewpoint. SysML v2 includes concepts to enable the generation of Views of the system or Domain of Interest that address diverse Stakeholder Concerns. Views can include diagrams, tables, and total documents that are presented to Stakeholders. The Model is treated as a Data Source. The View Definition defines the structure of the artifact that is presented, such as a Table of Contents for a document. The View is generated by applying Viewpoint Methods to query the model and render the results. The Viewpoint contains the Viewpoint Method and a specification of View in terms of the type of information and the format of the presentation.

Figure 3.21. View and Viewpoint



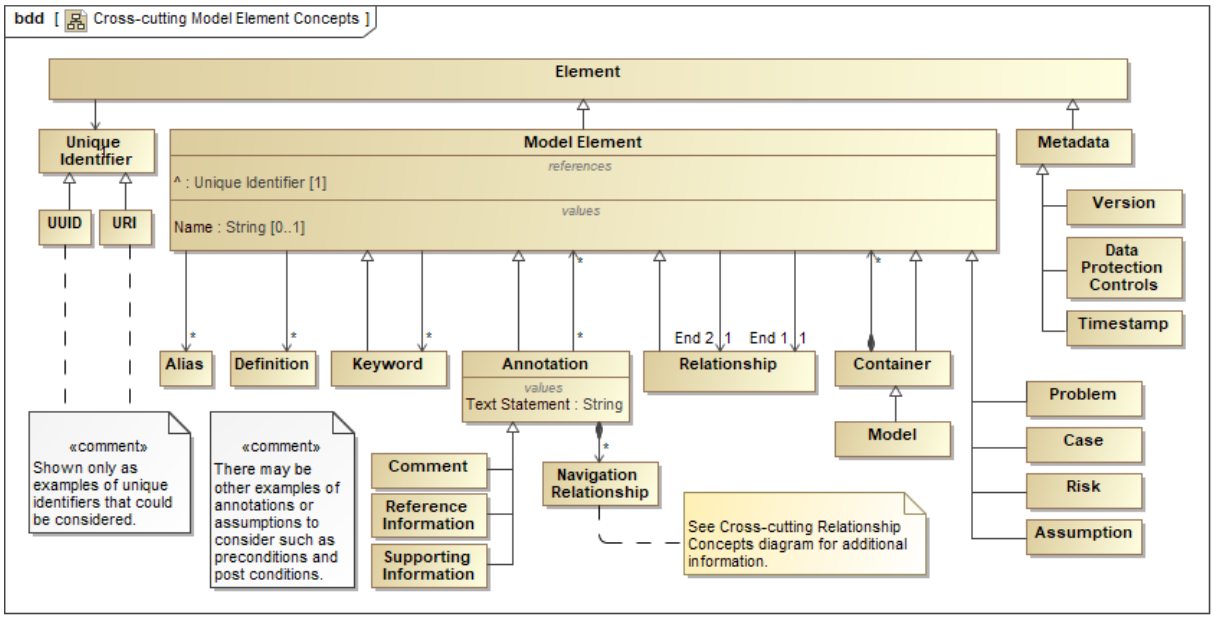
3.1.2.1 Cross-cutting

3.1.2.1.1 Cross-cutting Introduction

The Cross-cutting concepts and associated requirements apply to all model elements. A model element is the most general element in the model, and includes features that are common to all other kinds of model elements that are specified in the language.

As shown in the figure below, a model element contains certain properties such as unique id, name, alias, and definition. An annotation is a sub-class of model element that can refer to other model elements.

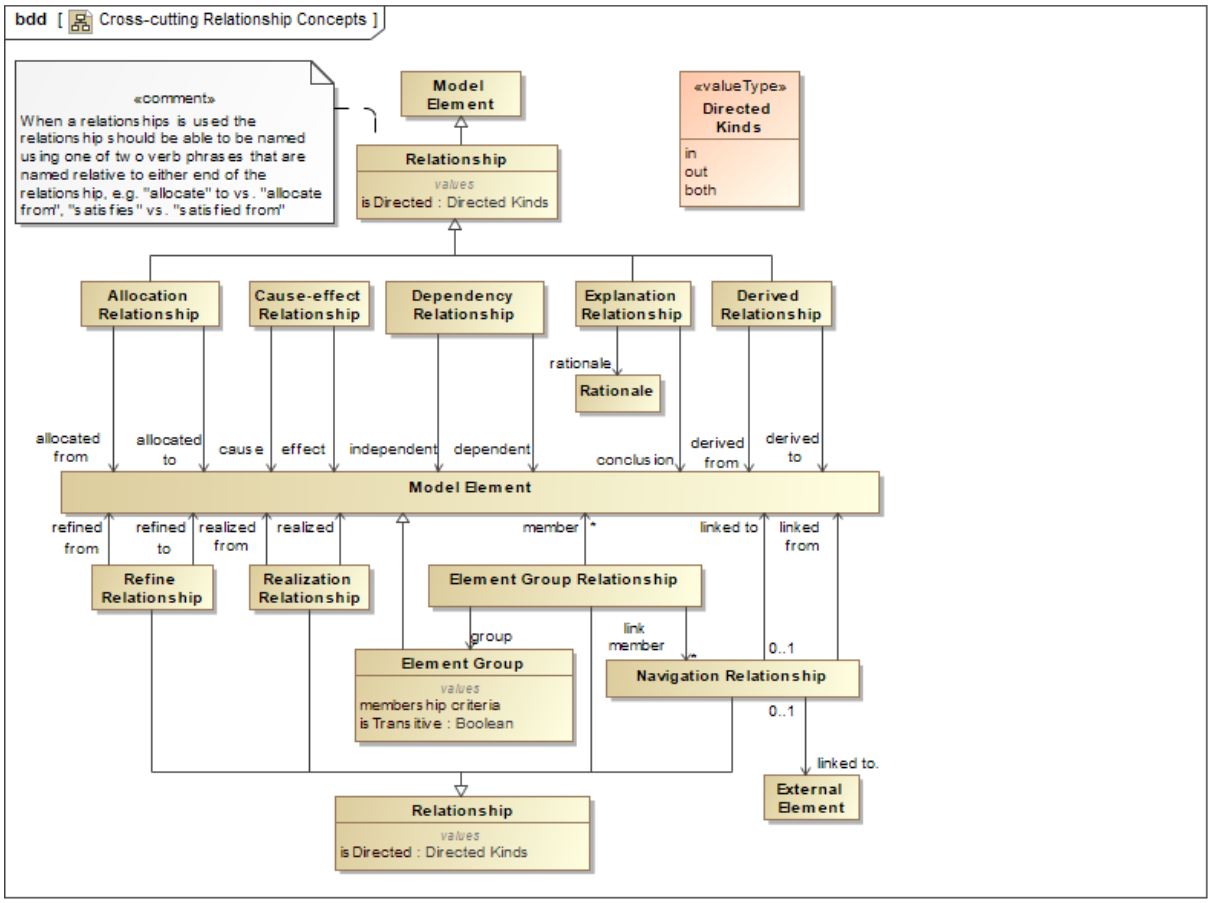
Figure 3.22. Cross-cutting Model Element Concepts



A container is a kind of model element that contains other model elements and applies scoping rules such as namespace rules to the contained elements. A Model is top-level container, and a Model Library is a kind of container designated to contain reusable model elements.

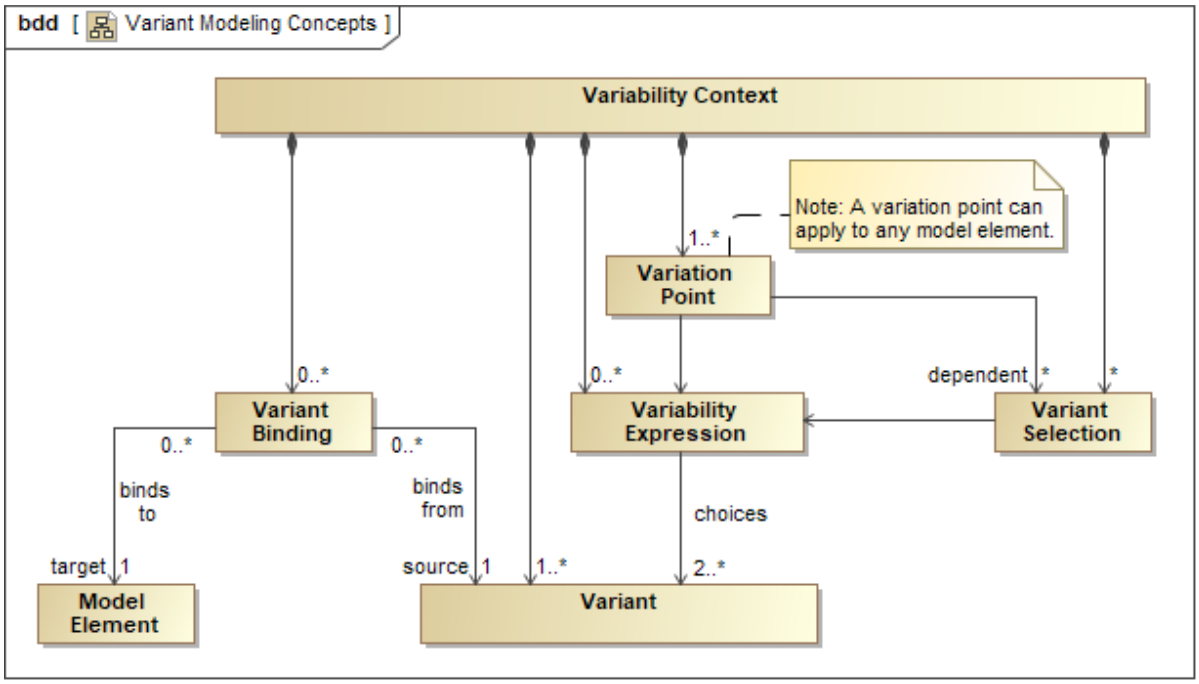
In addition, a model element can have a relationship with other model elements. The Relationship can relate any kind of model element. This relationship be used directly or further specialized into more specific relationships. This includes the dependency, allocation, cause-effect, explanation, and element group relationships that can have any model element on one end of the relationship but may constrain the other end to specific kinds of model elements.

Figure 3.23. Cross-cutting Relationship Concepts



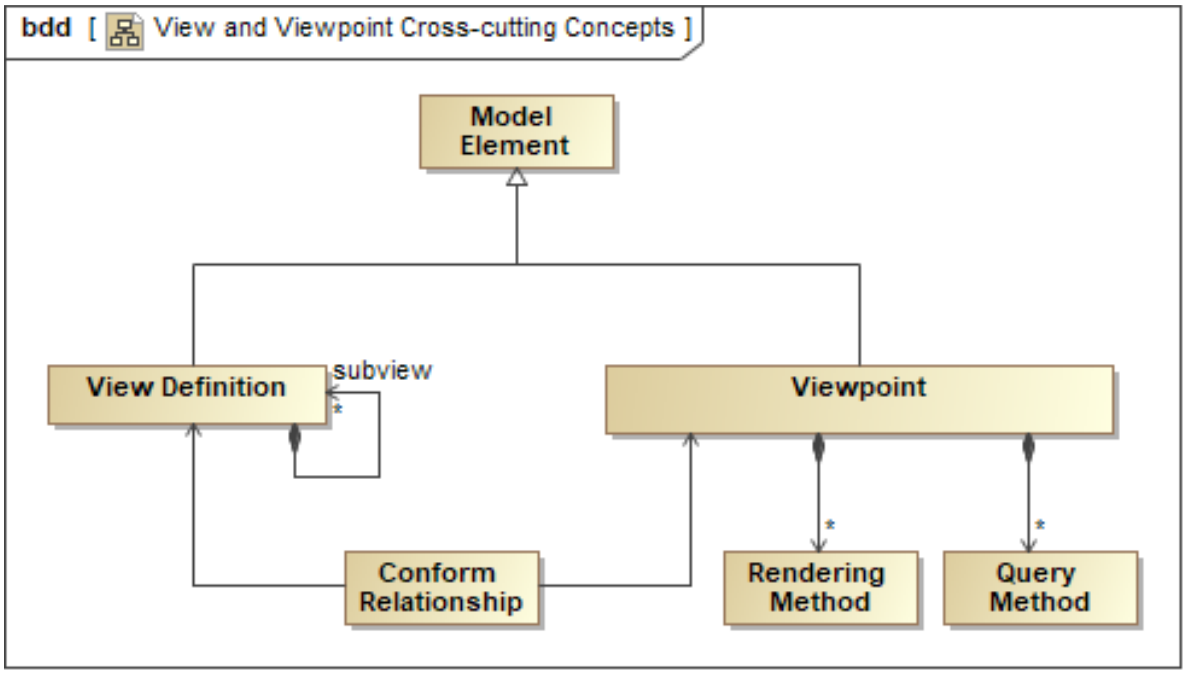
The following figure shows the concepts of variability that can be applied to any model element. These include the concept of a variation point that identifies some part of the model that can vary, and a variant that identifies the specific choices. For example, *wheel size* can be a variation point, and *narrow* wheel and *wide* wheel are variants. Variability constraints can be defined to constrain the valid choices (i.e., variants) for one or more variation points. A variant binding concept is also included to enable a separate variant model to represent the variant concepts and refer to the base model elements in the SysML model.

Figure 3.24. Variant Modeling Concepts



The concepts of View and Viewpoint are also included as Cross-cutting Concepts and are illustrated in the figure below. These concepts are used by the required Visualization services described in the Services section below to generate Views that conform to Viewpoints.

Figure 3.25. View and Viewpoints



3.1.2.1.2 Cross-cutting Requirements

Table 3.2. Cross-cutting Requirements

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1	Cross-cutting Requirements Group	The following specify the requirements that apply to all model elements.	
CRC 1.1	Model and Model Library Group		
CRC 1.1.1	Model	SysML v2 shall include a capability to represent a model (aka system model) that contains a set of uniquely identifiable model elements. **Supporting Information:** This is intended to be a kind of Container or Namespace.	Model

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1.1.2	Model Library	SysML v2 shall include a capability to represent a Model Library that contains a set of model elements that are intended to support reuse. **Supporting Information:** This is intended to be a kind of Container or Namespace.	Model Library
CRC 1.1.3	Container	SysML v2 shall include the capability to represent a Container that is a model element that contains other model elements. **Supporting Information:** This provides a way to organize the model and should include considerations for rules to uniquely identify the content of a container. Containers can contain other containers.	Package
CRC 1.2	Model Element Group		
CRC 1.2.1	Model Element	SysML v2 shall include a root element that contains features that apply to all other kinds of elements in the model.	Model Element
CRC 1.2.10	Risk	SysML v2 shall include a capability to represent a Risk that identifies the kind of risk (e.g., cost, schedule, technical), and the likelihood of occurrence, and the potential impact.	
CRC 1.2.2	Unique Identifier	SysML v2 shall include a capability to represent a single unique identifier for each model element that cannot be changed.	UUID is part of the XMI specification
CRC 1.2.3	Name and Aliases	SysML v2 shall include a capability to represent a name and one or more aliases for any named model element. **Supporting Information:** Aliases enable users to assign more than one name for the same element, such as a shortened name. Selected kinds of model elements may not require a name (e.g. dependency), or the name may be optional, but still should be distinguishable within a namespace. A common use of aliases is the use of an abbreviated or shortened name.	Named Element

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1.2.4	Keyword	SysML v2 shall include a capability to assign a key word to any model element as a lightweight extension mechanism. **Supporting Information:** This is intended to be an inheritable feature such that any sub-class will inherit this keyword. It is similar to a very lightweight usage of a stereotype at the user model level and not at the metamodel level.	Stereotypes
CRC 1.2.5	Definition / Description	SysML v2 shall include a capability to represent one or more definitions and/or descriptions for each model element and select those that apply.	Owned Comment
CRC 1.2.6	Annotation	SysML v2 shall include a capability to represent an annotation of one or more model elements that includes a text string and/or link that refers to a Navigation relationship.	Comment
CRC 1.2.7	Element Group	SysML v2 shall include a capability to represent a group of model elements that can be ordered and can satisfy user-defined criteria for membership in the group. **Supporting Information:** 1. A query can be used to dynamically update the members of the group. 2. A relationship between an element group and another element applies to each member of the element group. 3. A member of an element group is not intended to impose ownership constraints on the members. 4. Element group is expected to be specialized for different kinds of members, such as contain requirements, functions, and structural elements, which may impose additional constraints on its members.	Element Group

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1.2.8	Problem	SysML v2 shall include a capability to represent a problem that causes an undesired affect from a particular stakeholder. **Supporting Information:** A problem is often represented as a cause in a cause-effect relationship.	Problem
CRC 1.2.9	Case	SysML v2 shall include the capability to represent a case that can be specialized into a use case, analysis case, verification case, and domain specific cases, such as safety case and assurance case. **Supporting Information:** A case is sometimes defined as a systematic investigation or study that produces a result or conclusion, which can be represented as a behavior.	
CRC 1.3	Model Element Relationships Requirements Group		
CRC 1.3.01	Relationship	SysML v2 shall include a capability to represent a Relationship between any two model elements that may have a name and direction, and can be used concretely or sub-classed.	Relationship
CRC 1.3.02	Derived Relationship	SysML v2 shall include a capability to represent a relationship that is derived from other relationships. **Supporting Information:** An example is a derived relationship from a transitive relationship where B relates to A and C relates to B, then C relates to A. Another example is a connector between two composite parts that is derived from a connector between their nested parts.	
CRC 1.3.03	Dependency Relationship	SysML v2 shall include a capability to represent a Dependency Relationship where one side of the relationship refers to the independent element and	Dependency

ID	Name	Requirement Text	SysML v1.x Construct
		the other side of the relationship refers to the dependent element.	
CRC 1.3.04	Cause-Effect Relationship	SysML v2 shall include a capability to represent a Cause-Effect Relationship where one side of the relationship refers to the cause and the other side of the relationship refers to the effect.	
CRC 1.3.05	Explanation Relationship	SysML v2 shall include a capability to represent an Explanation Relationship where one side of the relationship refers to the rationale and the other side of the relationship refers to the element being explained (i.e. what is concluded).	Anchor on a rationale
CRC 1.3.06	Refine Relationship	SysML v2 shall include a capability to represent a Refine Relationship where the refined side of the relationships refers to the more precisely specified element.	RefineReqt
CRC 1.3.07	Realization Relationship	SysML v2 shall include a capability to represent a Realization Relationship where one side of the relationship refers to the more abstract element, and the other side of the relationship refers to the more concrete element. **Supporting information:** Generalization constrains this relationship with the ability to inherit features. It is also restricted to relating classifiers.	Realization
CRC 1.3.08	Allocation Relationship	SysML v2 shall include a capability to represent an Allocation Relationship where one side of the relationship refers to the allocated from, and the other side of the relationship refers to the allocated to.	Allocate
CRC 1.3.09	Element Group Relationship	SysML v2 shall include a capability to represent an Element Group Relationship where one side of the relationship refers to the member, and the other side of the relationship refers to the Element Group.	Anchor
CRC 1.3.10	Navigation Relationship	SysML v2 shall include a capability to represent a Navigation Relationship between a model element and another model element or an external element, similar to a hyperlink, where one side of the relationship refers to the linked to, and the other side of the relationship refers to the linked from.	Some tools support navigation links, but not in a standard way.

ID	Name	Requirement Text	SysML v1.x Construct
		The external element can be a data element and/or a file. **Supporting information:** This is a navigation aid that standardizes what many tools already do. The navigation can specify the ability to navigate from either end of the relationship.	
CRC 1.4	Variability Modeling Group	The requirements in this group should accommodate approaches to model variants as choices among design options. The modeling approaches may include a separate variability model to identify the design choices. **Supporting information:** refer to ISO/IEC 26550:2015	
CRC 1.4.1	Variation Point	SysML v2 shall include a capability to model variation points that identify features that can vary across a set of variants (e.g., vehicles with manual or automatic transmission, variable number of axles, or variable wheel size).	
CRC 1.4.2	Variant	SysML v2 shall include a capability to model variants that correspond to particular selections for a variation point.	
CRC 1.4.3	Variability Expression and Constraints	SysML v2 shall include a capability to model variability expressions that can be used to select variants among a set of possible variant choices (e.g., 3 axles plus large wheel size or 2 axles plus small wheel size), and where one selection may be dependent on another selection (e.g., number of axles and wheel size is dependent on selection of load size).	
CRC 1.4.4	Variant Binding	SysML v2 shall include a capability to model the binding between a variant and the model elements that vary. **Supporting Information:** The binding is intended to enable a variability model to define variation in different kinds of models such as a SysML model, simulation model, and a CAD model.	

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1.5	View and Viewpoint Group	The following specify the requirements associated with View and Viewpoint. These concepts are used by the Visualization Services to generate Views of a Model.	
CRC 1.5.1	View Definition	SysML v2 shall include a capability to represent the structure of an artifact that is presented to a stakeholder. **Supporting Information:** An individual View is intended to be a specific artifact, such as a document, diagram, or table that is presented to a stakeholder. A View Definition can be thought of as a table of contents for a document and the list of figures and tables that can be specialized, decomposed into sub-views, and ordered. The View is generated when the Viewpoint Method is applied to the View Definition to populate the contents. The View Definition is intended to be reused with different Viewpoint methods.	View
CRC 1.5.2	Viewpoint	SysML v2 shall include a capability to represent a Viewpoint to address a set of stakeholders and their concerns. It specifies the requirements a View must satisfy and the set of methods needed to generate a particular View that can be presented to a stakeholder. **Supporting Information:** The Viewpoint method enables query of the model and rendering of the query results to present to the stakeholder. The stakeholder and their concerns should be represented in the model.	Viewpoint
CRC 1.6	Metadata Group	The requirements in this group identify metadata that can apply to each model element or to another element that refers to a model element (e.g., a model configuration item).	
CRC 1.6.1	Version	SysML v2 shall include a capability to represent the version of one or more model elements or of another element that refers to one or more model elements.	

ID	Name	Requirement Text	SysML v1.x Construct
CRC 1.6.2	Time Stamp	SysML v2 shall include a capability to represent a model management time stamp for one or more elements or for another element that refers to one or more model elements.	
CRC 1.6.3	Data Protection Controls	SysML v2 shall include a capability to represent Data Protection Controls for one or more model elements or for another element that refers to one or more elements. **Supporting Information:** This can include markings such as ITAR, proprietary or security classifications	

3.1.2.2 Properties, Values & Expressions

3.1.2.2.1 Properties, Values & Expressions Introduction

The foundation concepts in SysML v1 for specifying quantitative and qualitative characteristics and supporting engineering analysis are value properties and value types, and the usage of constraint blocks that capture reusable equations and parameters in parametric diagrams, and a rich non-normative model for representing quantities and units. SysML v2 will extend these concepts to include a more comprehensive set of value types such as arrays, vectors, and a discretely sampled function that captures discrete functions that are often specified as tabular data. SysML v2 also includes concepts related to coordinate transformations and geometric shapes to enable representation of basic geometry. SysML v2 provides improved support for probability concepts, quantities, units and scales, as well as a selection of a default expression language that can be applied to any feature or property.

3.1.2.2.2 Properties, Values & Expressions Requirements

Table 3.3. Properties, Values & Expressions Requirements

ID	Name	Requirement Text	SysML v1.x Construct
PRP 1	Properties, Values and Expressions Requirements Group	The requirements in this group provide a unified representation of the type of properties, variables, constants, operation parameters and return types as well as literal values and value expressions. This includes types to represent variable size collections, compound value types, and measurement units and scales.	

ID	Name	Requirement Text	SysML v1.x Construct
PRP 1.01	Unified Representation of Values	SysML v2 shall include a capability to represent any value-based characteristic such as a value property, a constant, a variable in an expression, as well as a formal parameter and the return type of an operation in a unified way. **Supporting Information:** Consider distinguishing between a fundamental physical or mathematical constant (i.e., Pi) from a constant value within the context of a particular model or model execution (i.e., amplifier gain).	Value Property, Value Specification, Formal Parameter of an Operation
PRP 1.02	Value Type	SysML v2 shall include a capability to represent a Value Type as a named definition of the essential semantics and structure of the set of possible values of a value-based characteristic.	Value Type
PRP 1.03	Value Expression	SysML v2 shall include a capability to represent a value as a literal or through a reusable Value Expression that is stated in an expression language that includes the capability to represent opaque expressions.	Opaque and OCL expressions
PRP 1.04	Logical Expressions	SysML v2 shall include a capability to represent, as part of the Expression language, logical expressions that support as a minimum the standard boolean operators AND, OR, XOR, NOT, and conditional expressions like IF-THEN-ELSE and IF-AND-ONLY-IF, in which symbols bound to any characteristics (e.g. value properties or usage features) may be used.	
PRP 1.05	Unification of Expression and Constraint Definition	SysML v2 shall include a capability to represent a reusable constraint definition in the form of an equality or inequality which can be evaluated to true or false, and where the left and right-hand sides of the constraint definition are Value Expressions.	Constraint Block
PRP 1.06	Intended Use of Value	SysML v2 shall include a capability to convey the intended use of a Value	Default, Static, Initial Value

ID	Name	Requirement Text	SysML v1.x Construct
		Property as a default (static, invariant) value, and initial value.	
PRP 1.07	System of Quantities	SysML v2 shall include a capability to represent a named system of quantities that support definition of numerical Value Types in accordance with the ISO/IEC 80000 standard. **Supporting Information:** The typical Systems of Quantities is the ISO/IEC 80000 International System of Quantities (ISQ) with seven base quantities: length, mass, time, electric current, thermodynamic temperature, amount of substance and luminous intensity.	SystemOfQuantities in Annex E.5 QUDV
PRP 1.08	System of Units and Scales	SysML v2 shall include a capability to represent a named system of measurement units and scales to define the precise semantics of numerical Value Types in accordance with the [ISO/IEC 80000] standard. **Supporting Information:** Similar to SysML v1 QUDV, SysML v2 should include model libraries representing the [ISO/IEC 80000] units, as well as the conversion to US Customary Units defined in [NIST SP 811] Appendix B.	SystemOfUnits in Annex E.5 QUDV
PRP 1.09	Range Restriction for Numerical Values	SysML v2 shall include a capability to represent a value range restriction for any numerical Value Type. **Supporting Information:** This requirement allows further restriction of the range of values beyond what is specified by its type. A simple example is a planar angle typed by a real number Value Type and a degree measurement scale. However, the value range may be further restricted from 0 to 360 degrees for positioning a rotational knob. This can also include the definition of optional lower and upper bounds on an associated measurement scale.	

ID	Name	Requirement Text	SysML v1.x Construct
PRP 1.10	Automated Quantity Value Conversion	SysML v2 shall include a capability to represent all information necessary to perform automated conversion of the value of a quantity (typed by a numerical Value Type) expressed in one measurement scale to the value expressed in another compatible measurement scale with the same quantity kind. **Supporting Information:** This capability is needed to rebase a set of (smaller) system models coming from various contributors on a single coherent set of measurement scales, so that an integrated (larger) system model can be consistently constructed and analyzed.	Most concepts are defined in Annex E.5 QUDV, but measurement scales are lacking detail to fully automate value conversions.
PRP 1.11	Primitive Data Types	SysML v2 shall include a capability to represent the following primitive data types as a minimum: signed and unsigned integer, signed and unsigned real, string, boolean, enumeration type, ISO 8601 date and time, and complex.	Primitive ValueType Library
PRP 1.12	Variable Length Collection Value Types	SysML v2 shall include a capability to represent variable length value collections where all items are typed by a particular Value Type and are referable by index, and where the collection may be one of the established collection types: sequence (ordered, non-unique), set (unordered, unique), ordered set (ordered, unique) or bag (unordered, non-unique).	
PRP 1.13	Compound Value Type	SysML v2 shall include a capability to represent both scalar and compound Value Types, where a scalar Value Type represents elements with a single value, and compound Value Type represents elements with a fixed number of component values, where each component value is typed in turn by a scalar Value Type or another compound Value Type.	ValueType

ID	Name	Requirement Text	SysML v1.x Construct
		Supporting Information: Such compound Value Types are needed to support the representation of vector, matrix, higher order tensor, computer data record, complex number, quaternion, and other richer Value Types.	
PRP 1.14	Discretely Sampled Function Value Type	SysML v2 shall include a capability to represent variable length sets of values that constitute discrete time series data, frequency spectra, temperature dependent material properties, and any other datasets that can be represented through a discretely sampled mathematical function. **Supporting Information:** Such a discretely sampled function can be defined by a tuple of one or more Value Types that prescribe the type of the domain (independent) variables, and a tuple of one or more Value Types that prescribe the range (dependent) variables, as well as a variable length sequence of tuples that represent the actual set of sampled values.	
PRP 1.15	Discretely Sampled Function Interpolation	SysML v2 shall include a capability to represent an interpolation scheme for a Discretely Sampled Function Value Type for derivation of the function's range values for domain values that are in-between sampled values.	
PRP 1.16	Probabilistic Value Distributions	SysML v2 shall include a capability to represent the value of a quantity with a probabilistic value distribution, including an extensible mechanism to detail the kind of distribution, i.e. the probability density function for continuous random variables, or the probability mass function for discrete random variables.	Annex E.7 Distribution Extensions

ID	Name	Requirement Text	SysML v1.x Construct
PRP 1.17	System Simulation Models	SysML v2 shall include a capability to represent signal flow graph models and lumped parameter models as well as combinations thereof. **Supporting Information:** See [SysPISF] for details.	
PRP 1.18	Across and Through Value Properties	SysML v2 shall include a capability to define across and through properties of flows on Interface Ends that participate in representing physical interactions in lumped parameter models. **Supporting Information:** Typically the across and through properties are defined together as a pair, where the across property does not conserve energy and the through property does. For example, in a lumped parameter model of an electric circuit, the across and through properties are voltage and current respectively. See [SysPISF] for details.	
PRP 1.19	Basic Geometry	SysML v2 shall include a capability to represent basic two- and three-dimensional geometry of a structural element, including a base coordinate frame as well as relative orientation and placement of shapes through nested coordinate frame transformations, where the basic shape definitions are provided in a model library. **Supporting Information:** These capabilities are intended to provide basic geometry and coordinate frame representations to support specification of physical envelopes. The intent is that each block or equivalent will have its own reference coordinate system, and transformations can be applied between coordinate systems of different blocks. The shape of a block is defined in its reference coordinate system. Consider	

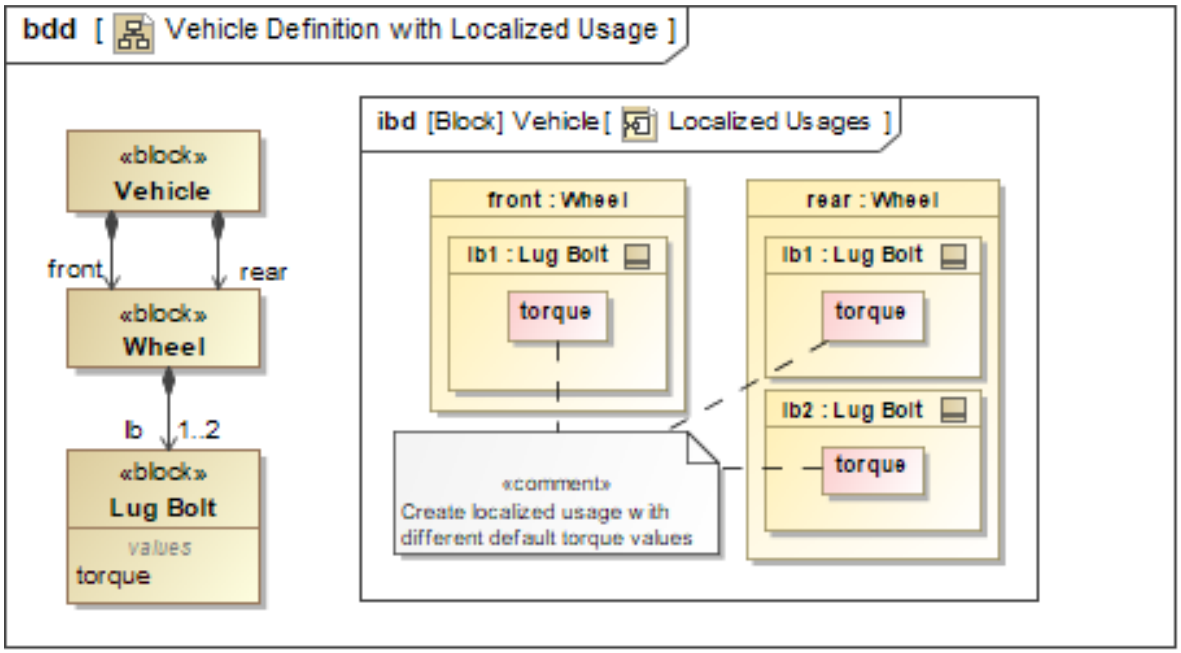
ID	Name	Requirement Text	SysML v1.x Construct
		references to standard formats (e.g., ISO 10303 (STEP), IGES)	
PRP 1.20	Materials with Properties	SysML v2 shall include a capability to represent named materials with their material properties in a model library and assignment of such materials to structural elements. **Supporting information:** This requirement is intended to specify a model library with a generic material kind that has generic material properties that can be further specialized.	

3.1.2.3 Structure

3.1.2.3.1 Structure Introduction

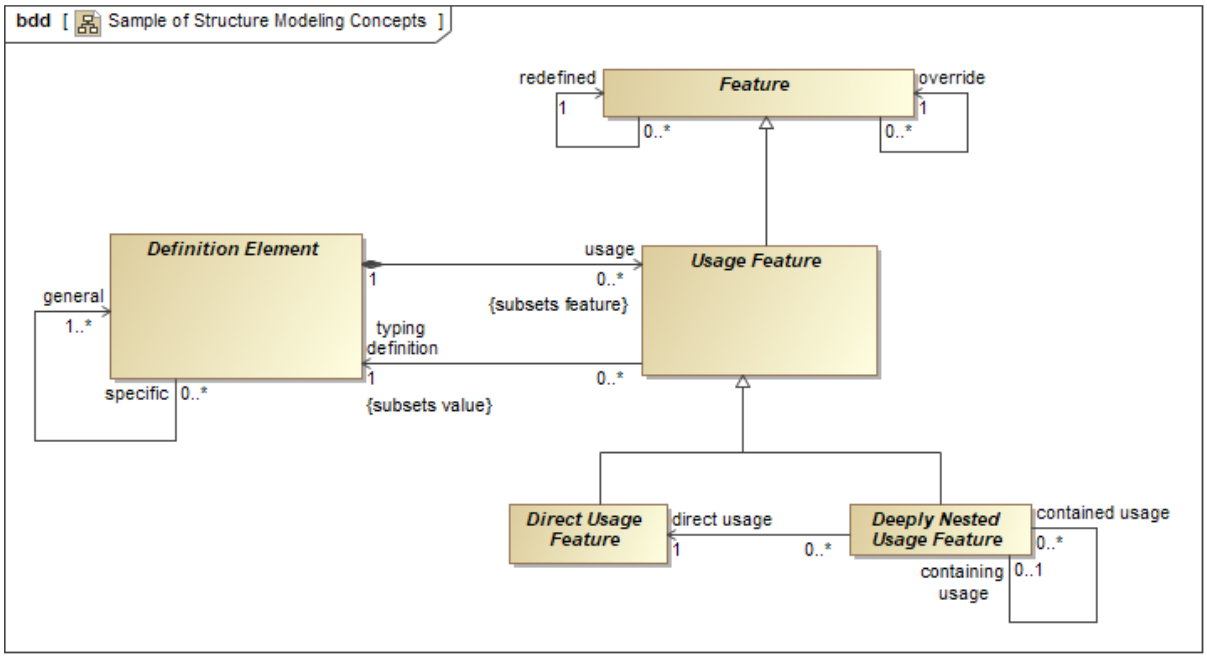
The structure modeling concepts are intended to facilitate modeling of deeply nested elements of a system or other composite structure and their interconnection. A limitation of SysML v1 is highlighted in the figure below showing a nested structure of Lug Bolts that are part of Wheels that are part of a Vehicle. The challenge in SysML v1 is the ability to easily represent the structures corresponding to a specific design configuration that have localized values. For example, in the internal block diagram in the figure below, the torque on the 2nd lug bolt on the rear wheel should be clearly distinguishable from the torque on the 1st lug bolt. This can be done in SysML v1 but may require the use of advanced features such as property specific types, redefinition, subsetting, and bound references.

Figure 3.26. Specifying an unambiguous system design configuration



Modeling structure in SysML v2 builds on SysML v1 concepts of definition and usage (e.g., blocks and parts), but adds the concept of a deeply nested part as shown in the figure below to facilitate modeling of deeply nested structures.

Figure 3.27. Sample of Structure Modeling Concepts



Like SysML v1, SysML v2 can also model structure with variabilities that may be represented with part multiplicity and component sub-classes. In SysML v2, additional concepts are provided to model system design configurations with the variation in the system structure removed. The system design configuration can include property values that over-ride the values in the more general definition, such as the torque values on the lug bolts in the example above.

Another limitation of SysML v1 is the ability to model an as-built system that has measured values that over-ride the as-designed values associated with the system design configuration. This can be done in SysML v1 by creating an instance. However, once this is done, there can be no further changes to the structure of the system, which limits the ability to model a system across its lifecycle. For example, the replacement of a component in the as-built system is not easily represented by an instance.

SysML v2 includes the concept of a model of an individual system, such as an as-built system on the factory floor with a serial number. The individual system can include property values corresponding to its measured values that further over-ride the property values of the system design configuration. The individual model has its own lifetime where its structure can change over time, and its property values can change over time.

The structure concepts are intended to be applied to other parts of the language such as behavior to establish a consistent approach to define how elements are decomposed.

3.1.2.3.2 Structure Requirements

Table 3.4. Structure Requirements

ID	Name	Requirement Text	SysML v1.x Construct
STC 1	Structure Requirements Group	This group of requirements is intended to represent composable, deeply nested, connectible structure with and without variants, and models of individual elements that are uniquely identified.	
STC 1.01	Modular Unit of Structure	SysML v2 shall include a capability to represent a modular unit of structure - called a Definition Element - that defines its characteristics through value properties, interface ends (ports), constraints, and behavioral features. **Supporting Information:** Such modular units of structure can be regarded as the fundamental and uniquely identifiable, named building blocks from which system representations, i.e. architectures, can be constructed. The capability enables modeling of all kinds of systems that include hardware, software, people, facilities, and natural objects at the enterprise, system-of system, subsystem, and component levels.	Block
STC 1.02	Usage Feature	SysML v2 shall include a capability to represent the containment of a usage of another Definition Element - called a Usage Feature - in order to support modular, deeply nested hierarchical composition structures. **Supporting Information:** In the SECM this is referred to as a Constituent Feature.	Structural Feature, Behavioral Feature, ElementPropertyPath, NestedConnectorEnd
STC 1.03	Generic Hierarchical Structure	SysML v2 shall include a capability to represent hierarchical composition structure between Definition Elements.	Composite Association

ID	Name	Requirement Text	SysML v1.x Construct
STC 1.04	Reference Feature	SysML v2 shall include a capability to represent a reference from one element to any other element within a shared scope.	Reference Property, Reference Association
STC 1.05	Multiplicity of Usage	SysML v2 shall include a capability to define the multiplicity of any particular Usage Feature or Reference Feature as an integer range (i.e., lower bound and upper bound). **Supporting Information:** Multiplicity refers to the number of Individual Elements.	Multiplicity on properties.
STC 1.06	Definition Element Specialization	SysML v2 shall include a capability to represent a specialization from a more general Definition Element into a more specific Definition Element, where the more specific element inherits all features of the more general element.	Generalization/Specialization
STC 1.07	Unambiguous Deeply Nested Structure	SysML v2 shall support a capability to represent and unambiguously identify deeply nested Usage Features in a way that is fully integrated with direct (one level deep) Usage Features. **Supporting Information:** Deeply nested Usage Features may be defined only when needed for specific localized typing or interface representation.	ElementPropertyPath, NestedConnectorEnd, Redefinition, Subsetting
STC 1.08	Structure With Variability	SysML v2 shall include a capability to represent multiple possible variant configurations of a system-of-interest through a single collection of Definition Elements and Usage Features - called a Definition Model - where at each usage level in the (de)composition, a Variant selection	Multiplicity of property, specialization of classifiers Redefined property, Subsetted property

ID	Name	Requirement Text	SysML v1.x Construct
		from different possible Variant choices can be defined. **Supporting Information:** A Structure With Variability enables the definition of a product line architecture, see e.g. ISO 26550. Some common variant choices are defined by multiplicity range. sub-classes, and different values of a value property.	
STC 1.09	Structure Resolved to a Single Variant	SysML v2 shall include a capability to represent a single variant of a system-of-interest - called a Configuration Model composed of Configuration Elements - that establishes a fully expanded hierarchical (de)composition conforming to an associated Structure with Variability where for each Variability Choice a single selection is made. **Supporting Information:** A SysML v2 implementation should support auto-generation of Configuration Models from a Definition Model based on a set of rules. A SysML v2 implementation should ideally also provide a capability to semi-automatically generate a Definition Model from one or more Configuration Models.	Sub-class with Redefinition, Subsetting, Property Specific Type
STC 1.10	Structure of an Individual	SysML v2 shall include a capability to represent a hierarchical structural (de)composition of an individual system or product - called an Individual Model composed of Individual Elements - that actually or potentially exists in the real world, and that conforms to an associated Structure resolved to a Single Variant.	Instance Specification

ID	Name	Requirement Text	SysML v1.x Construct
		Supporting Information: Such a digital representation of a real-world system is sometimes called a 'digital twin'. The elements in a Structure of an Individual are typically designated by a unique serial number, a batch number or an effectivity code.	
STC 1.11	Usage Specific Localized Type	SysML v2 shall include a capability to represent local override, redefinition, or addition of features with respect to the features defined by its more general type. **Supporting Information:** The more-general to more-specific type chain is: Definition Element - direct Usage Feature - deeply nested Usage Feature - Configuration Element - Individual Element.	PropertySpecificType Redefinition, Subsetting

3.1.2.4 Interfaces

3.1.2.4.1 Interface Introduction

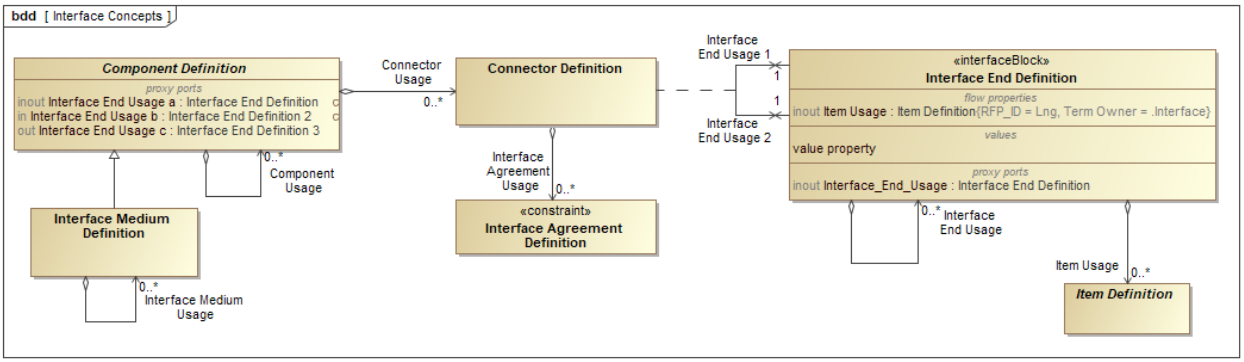
The goals for interface modeling include the ability to model a diverse range of interfaces (e.g., electrical, mechanical, software, user). The core concept of an interface includes 2 interface ends, an interface connection and any constraints related to connecting the ends as shown below.

Figure 3.28. SysML v2 Interface Concept

The concepts of definition and usage apply to the interface ends and interface connection consistent with SysML v1 (e.g., proxy port typed by interface block and full port typed by block). These concepts are being aligned with the structure modeling concepts described above

to allow multiple levels of nested interfaces. SysML v2 also requires support for layered interfaces such as when modeling an Open Systems Interconnection (OSI) stack with application layers down to physical layers. Another important concept is an interface agreement, which can be used to specify and constrain the connection, interface ends, and any items that are exchanged. The interface agreement can specify behavioral constraints on the exchange of messages consistent with a defined protocol, and can specify physical constraints associated with a physical layer, such as the torque and angular rate constraints for a motor to gear interface. The interface concepts are highlighted in the figure below. An interface medium is a kind of component that provides interconnections that enable other components to interact. Examples include an electrical harness, a communication network, or a pipe to connect fluid flows.

Figure 3.29. Interface Concepts



One of the key issues with SysML v1 is the inability to readily support views of different abstraction levels of complex interfaces. For example, a desired view of a detailed multi-layer interface may show one layer of a stack and hide others. Another view may show highly detailed pinouts between electrical connectors. This ability to view different abstraction levels is being addressed by the visualization service requirements to facilitate the generation of views that support different stakeholder viewpoints, such as a software view of the application layer or a hardware view of the physical layer.

Similarly, it is often desirable to create an interface in the model, and then add more detail over time. Early in the design, the model may only represent a simple connector between two parts. Later, ports may be added, then data flows, interface agreements and intermediate systems such as networks. The requirements needed to address this issue are addressed by the model construction service requirements.

3.1.2.4.2 Interface Requirements

Table 3.5. Interface Requirements

ID	Name	Requirement Text	SysML v1.x Construct
INF 1	Interface Requirements Group	SysML v2 is intended to provide a robust capability to model interfaces that constrain the physical and functional interaction between structural elements. An interface in SysML v2 includes two (2) interface ends, the connection between them, and any constraints on the interaction. An interface should support the following: 1. Different levels of abstraction that include logical and physical interfaces, nested interfaces, and interface layers; 2. Diverse domains that include a combination of electrical, mechanical, software, and user interfaces; 3. Reuse of interfaces in different contexts; 4. Generation of interface control documents and interface specifications **Supporting Information:** The ability to construct and visualize different views of interfaces, including different abstraction levels, are addressed by the visualization and construction services.	
INF 1.01	Interface Usage	SysML v2 shall provide the capability to represent an interface that constrains the interaction between any two (2) structural elements.	Ports, Connectors, Parts
INF 1.02	Interface Definition and Reuse	SysML v2 shall provide the capability to define an interface that can be used in different contexts that includes the definition of the interface ends, the interface connections, and the constraints on the interaction.	Port Definitions including Interface Blocks and Blocks, Association and Association Blocks used to type Connectors, Item Flows, Constraints

ID	Name	Requirement Text	SysML v1.x Construct
		Supporting Information: Interfaces must conform to the structural concepts of definition and usage. The constraints can include physical constraints and/or functional constraints on exchanged items.	
INF 1.03	Interface Decomposition	SysML v2 shall provide the capability to represent nested interfaces, such as when modeling two electrical connectors with pin to pin connections.	Nested ports
INF 1.04	Interface End Definitions	SysML v2 shall provide the capability to represent an Interface End whose features constrain the interaction that it can participate in, including items that can be exchanged and their direction, behavioral features, and constraints on properties.	Interface Blocks with flow properties, value properties, and behavioral features
INF 1.05	Conjugate Interface Ends	SysML v2 shall provide the capability to reverse the direction of the items that are exchanged in an Interface End.	Conjugate Ports
INF 1.06	Item Definition	SysML v2 shall provide the capability to represent the kind of items that can be exchanged between Interface Ends. **Supporting Information:** The items represent the type of things such as water or electrical signals that may have physical characteristics such as mass, energy, charge, and force, and logical characteristics such as those associated with information. Item Definitions must conform to the structural concepts of definition and usage. The rate at which a usage of an Item Definition is updated may be marked with an update rate that is continuous or discrete valued. (Refer to Behavior Requirement called "Discrete and Continuous Time Behavior")	Blocks, Signal

ID	Name	Requirement Text	SysML v1.x Construct
INF 1.07	Interface Agreement Group		
INF 1.07.1	Item Exchange Constraints	SysML v2 shall provide the capability to constrain the interaction between the interface ends that includes constraints on the items to be exchanged, the allowable sequences and directions of those items, timing of the exchange and other characteristics. The items exchanged shall be consistent with the type and direction of the items specified in the connected Interface Ends.	Activities, state machines and sequence diagrams in an association block with participant properties
INF 1.07.2	Property Constraints	SysML v2 shall provide the capability to constrain the interaction between the interface ends that include mathematical constraints on the properties exposed by the Interface Ends. **Supporting Information:** The value properties may further be marked as Across or Through variables consistent with standard usage of the terms (e.g. across and through variables, for specifying properties that are constrained by conservation laws). Refer to Properties, Values and Expression requirement called "Across and Through Value Properties"	Parametric diagrams that specify constraints on the ends of an association block with participant properties.
INF 1.07.3	Geometric Constraints	SysML v2 shall provide the capability to constrain the interaction between the interface ends that include geometrical constraints on either Interface End. **Supporting Information:** An example are the geometric constraints associated with connecting a plug and socket.	
INF 1.08	Interface Medium	SysML v2 shall include a capability to represent an Interface Medium that enable 2 or more components to interact. **Supporting Information:** The Interface Medium may represent either an abstract or	Property typed by block with user-defined stereotype indicating its special function.

ID	Name	Requirement Text	SysML v1.x Construct
		physical element that connects elements to enable interactions. Examples of an interface medium included an electrical harness, a communications network, a fluid pipe, the atmosphere, or even empty space. The interface medium may connect one to many components, which include support for peer-to-peer, multi-cast, and broadcast communications. Consider replacing the term Interface Medium with Transport Medium.	Also, connector typed by Association Block that has part properties, e.g. hotwater:Pipe and coldwater:Pipe.
INF 1.09	Interface Layers	SysML v2 shall provide the capability to represent interfaces between structural elements that represent a specified layer of an interface stack, and connections between structural elements in adjacent layers of an interface stack. **Supporting Information:** An upper layer in a stack transforms the data to match the input to the next lower layer, performing the exchange at that lower layer. The transformation can be represented by an Over Relationship. In order for the layered interface stack to perform properly, each layer must satisfy its requirements.	Complex combination of the ports and flow concepts.
INF 1.10	Allocating Functional Exchange to Interfaces	SysML v2 shall provide the capability to allocate or bind the outputs and inputs of a functional exchange to interface ends, and validate the consistency between the functional exchange and the interface.	On Port metaproperty.

3.1.2.5 Behavior

3.1.2.5.1 Behavior Introduction

Behavior modeling concepts describe the interaction between individual structural elements and their change of state over time.

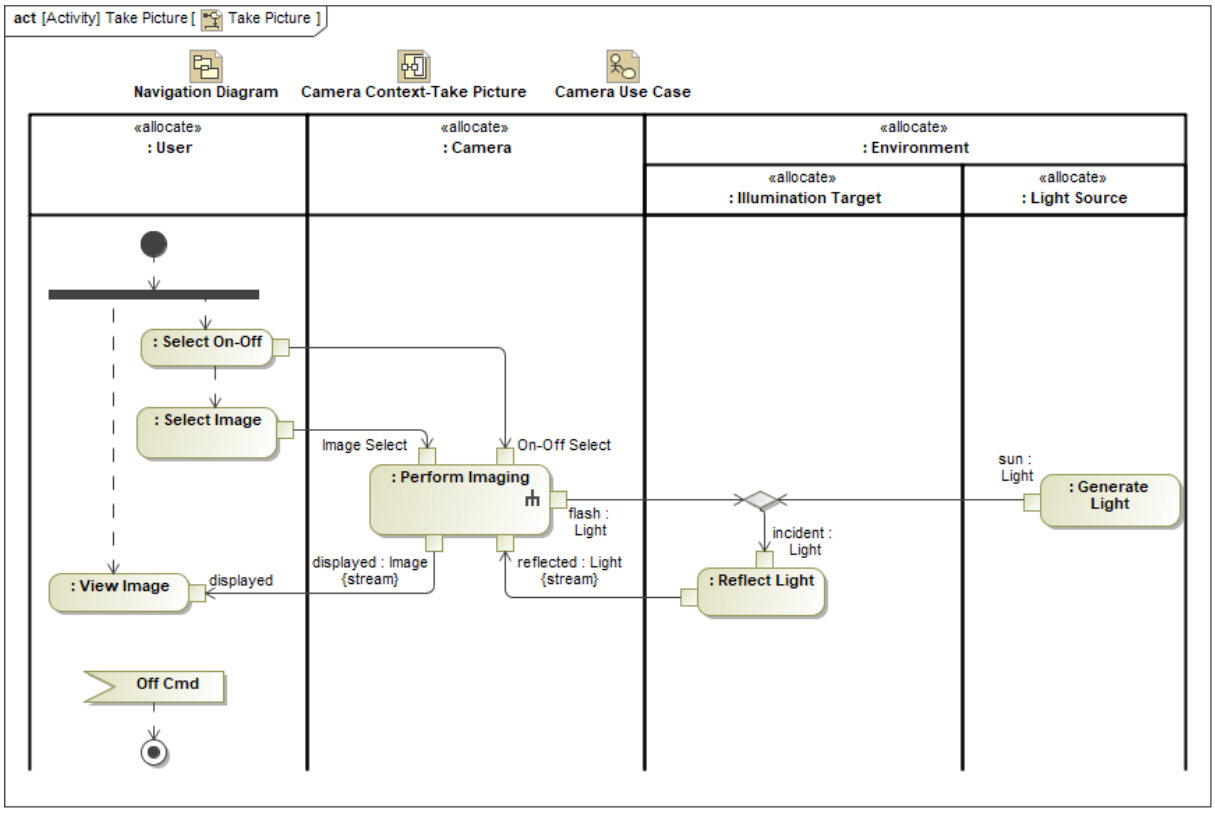
Some of the SysML v1 issues that should be addressed by SysML v2 behavior models include:

- Lack of integration between structure and behavior (e.g., action inputs and outputs, flow properties, item flows, input/output of do/behavior)
- Lack of integration between different kinds of behavior (seq, act, stm, uc, timing)
- Improved support for continuous flow semantics
- Inability to decompose inputs and outputs I/O and how they are input to or output from different actions and/or activities
- Lack of representation of timelines
- Inability to easily have actions that create and destroy relationships such as connectors
- More flexible and expressive pre/post conditions
- Support for software architecture concepts such as threads
- Complexity of the relationship between operations and actions/activities
- Inability to represent a reference activity that spans activity partitions in an activity diagram similar to reference interactions in a sequence diagram

As noted above, one of the critical issues in SysML v1 is the limitations associated with integrating behavior and structure with respect to input and outputs of activities, item flows on connectors, and flow properties on ports. The key requirement for SysML v2 is to seamlessly integrate behavior and structure by integrating the behavior inputs and outputs with component interfaces.

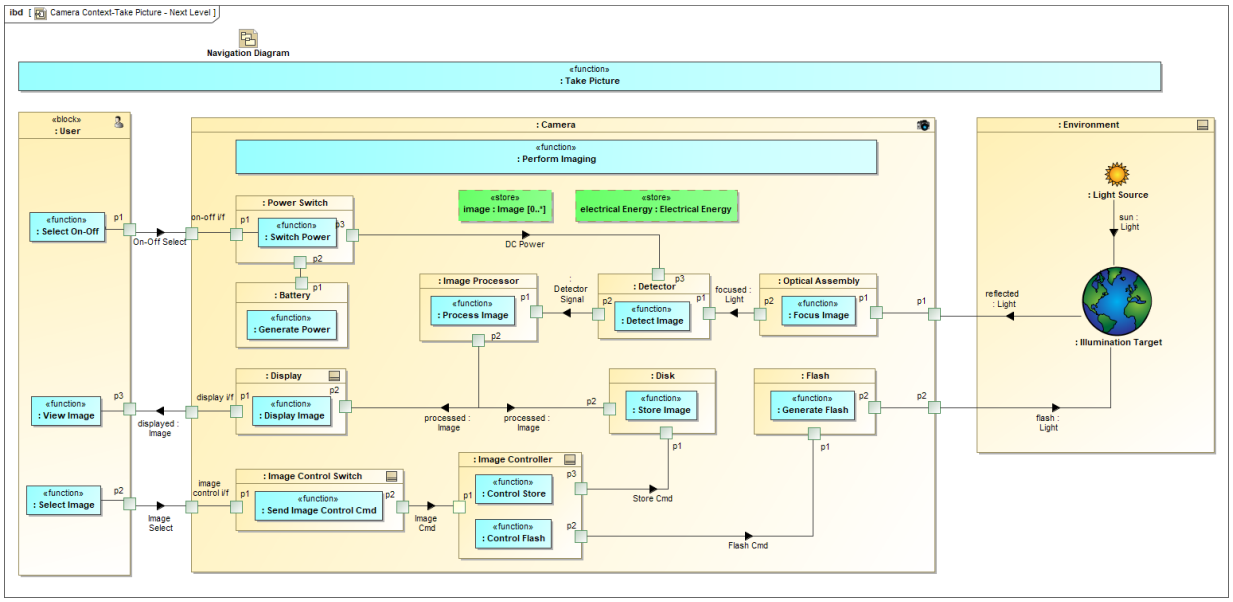
The Camera model example below illustrates the need for this integration. In the first figure, the Take Picture activity integrates structure and behavior by representing the actions that the User, Camera, and Environment perform to take a picture. The Camera accepts Light as an input from the Environment and the User inputs, and executes the Perform Imaging action to produce an Image to present to the User and store in the Camera (not shown).

Figure 3.30. Top Level Behavior - Take Picture



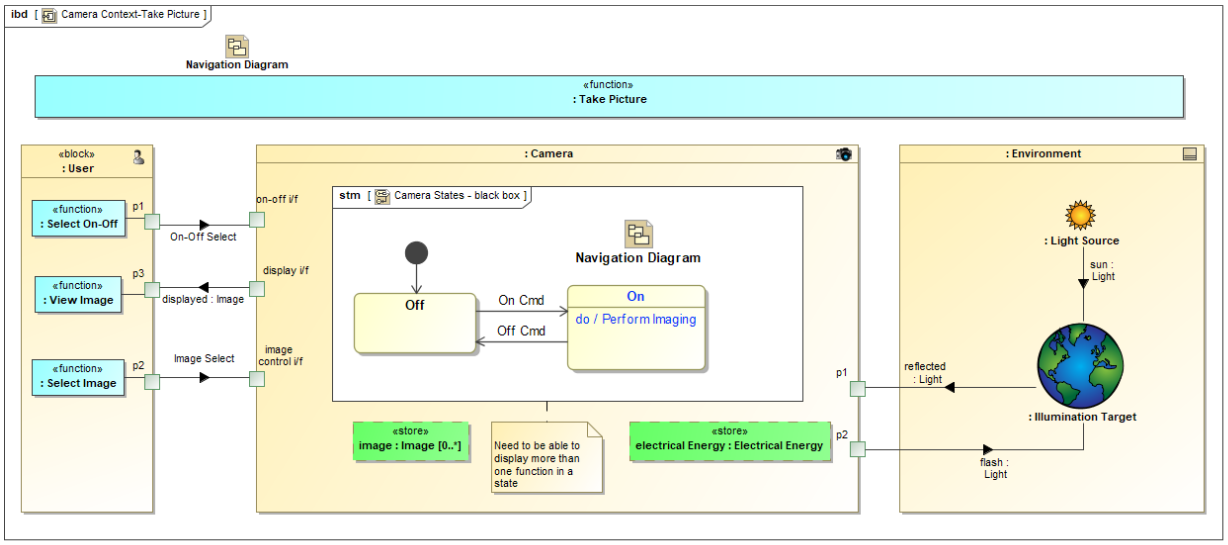
In the figure below, the internal block diagram highlights the interconnection of the parts of the camera with their allocated actions (i.e., functions). SysML v2 must enable the straightforward construction and presentation of different views of the model while maintaining consistency between the activities, their inputs and outputs, the flow properties on the ports (not shown), and the item flows on the connectors.

Figure 3.31. Camera Context with Take Picture Functions



Another important view is the decomposition of the activities without representing the flow of control and flow of inputs and outputs. SysML v1 supports this capability, but does require an additional concept called an adjunct property to establish correspondence between the activity decomposition and the actions in an activity diagram. In SysML v2, behavior decomposition should apply the same modeling concepts that apply to structure decomposition to simplify and integrate the language. Another limitation in SysML v1 is that a do-behavior of a state machine, such as the Perform Imaging activity in the figure below, can only accept inputs and produce outputs by sending and receiving signals and by performing read/write actions to properties of the owning block. SysML v2 must ensure that activities are not constrained as to how they use state machines to integrate with activity inputs and outputs.

Figure 3.32. Camera Context with State Machine



3.1.2.5.2 Behavior Requirements

Table 3.6. Behavior Requirements

ID	Name	Requirement Text	SysML v1.x Construct
BHV 1	Behavior Requirements Group		
BHV 1.01	Behavior	SysML v2 shall include the capability to model a Behavior that represents the interaction between individual structural elements and their change of state over time.	Activity, State Machine, Interaction, Simple Time
BHV 1.02	Behavior Decomposition	SysML v2 shall include the capability to decompose a behavior to any level of decomposition. **Supporting Information:** This should include the equivalent capability to decompose a SysML v1 activity on a BDD, and the ability to decompose actions on a structured activity node.	Composited Association of Behavior Classifiers with Adjunct Properties
BHV 1.03	Function-based Behavior Group		

ID	Name	Requirement Text	SysML v1.x Construct
BHV 1.03.1	Function-based Behavior	SysML v2 shall include the capability to represent a controlled sequence of actions (or functions) that can transform a set of inputs to a set of outputs. **Supporting Information:** This is analogous to activity diagrams. It may be addressed by an integrated approach to specify both activities and sequence diagrams.	Activity
BHV 1.03.2	Opaque Behavior	SysML v2 shall include the capability to represent a behavior that embeds the definition in a language such as a programming language.	Opaque Behavior
BHV 1.03.3	Behavior Library	SysML v2 shall include a library that can be populated with commonly used behaviors.	FUML actions library
BHV 1.03.4	Structure Modification Behavior	SysML v2 shall include the capability to represent changes in a structural element over time, such as the creation and destruction of interconnections and composition.	Primitive Actions
BHV 1.04	State-based Behavior Group		
BHV 1.04.1	Regions, States, and Transitions	SysML v2 shall include the capability to represent the discrete-state behavior of a structural element in terms of its concurrent regions with mutually exclusive states, and transition between discrete states.	State Machine
BHV 1.04.2	Integration of Function-based Behavior with State-based Behavior	SysML v2 shall include the capability to model function-based behavior both on transitions between states, and upon entry, exit, and while in a discrete state.	Entry, Exit, Do Behavior and Transition effect
BHV 1.05	Composite Input and Output	SysML v2 shall include the capability to model composite inputs and outputs of behaviors with separate flows defined for the constituent inputs and outputs.	
BHV 1.06	Discrete and Continuous Time Behavior	SysML v2 shall include the capability to model behaviors whose inputs and outputs vary continuously as a function of time, or discretely as a function of time.	Continuous, streaming

ID	Name	Requirement Text	SysML v1.x Construct
BHV 1.07	Events	SysML v2 shall include the capability to model signal events, time events, and change events and their ordering. **Supporting Information:** The ordering of actions (i.e., functions) is accomplished through ordering of their start and completion events.	Triggering events on state machines, accept event actions, send signal actions
BHV 1.08	Control Nodes	SysML v2 shall include the capability to model control nodes that specify a logical expression of conditions and events to enable a flow. **Supporting Information:** For Example: {Inputs A < a1 AND B>=b2 OR C AND NOT D} must be true).	Join, Fork, Merge, Decision
BHV 1.09	Behavior Constraints	SysML v2 shall include the capability to model constraints on a behavior that include a declarative specification in terms of its pre conditions and its post conditions and/or any invariants.	Pre and post conditions
BHV 1.10	Time Constraints	SysML v2 shall include the capability to specify the time associated with any event that includes start events, completion events, and duration constraints between events to represent the time-line of a behavior. **Supporting Information:** Time is a property typed by a Value Type whose quantity kind and units are specified as part of QUDV.	Simple Time
BHV 1.11	State History	SysML v2 shall provide the capability to represent a state history as a sequence of snapshots of state variables. The state history should contain a reference time scale consistent with QUDV, and can include a start time, end time, and time step.	
BHV 1.12	Behavior Execution	SysML v2 shall include the capability to execute behavior of an individual element in a standard way that specifies the sequence of events, and flow of inputs and outputs, in	FUML

ID	Name	Requirement Text	SysML v1.x Construct
		accordance with the behavior and time constraints. **Supporting Information:** The behavior of a Definition Element or Configuration Element represent the default behavior of the conforming Individual Elements.	
BHV 1.13	Integration between Structure and Behavior		
BHV 1.13.1	Allocation of Behavior to Structure	SysML v2 shall include the capability to represent the behavior of one or more structural elements. **Supporting Information:** This should support the ability to define a state machine of a structural element, with discrete states that enable actions (i.e., functions) and constraints. In addition, this should support the ability to specify the actions performed by a component, and the applicable constraints, without specifying the discrete state that enables them. The representation should allow more than one structural element to perform a single function on an activity diagram or equivalent, such as when two people carry a load. The presentation could be analogous to a reference interaction in a SysML v1 sequence diagram that spans multiple lifelines and displays the participating lifelines. The reference interaction refers to another sequence diagram. It should also allow presentation of the equivalent of structured activity nodes.	Allocate, Allocated Activity Partition, Structured Activity Node, Reference Interaction
BHV 1.13.2	Integration of Control Flow and Input/Output Flow	SysML v2 shall ensure that inputs, outputs, and events can seamlessly integrate with structural elements and interfaces.	Adjunct properties, On Port

3.1.2.6 Requirements

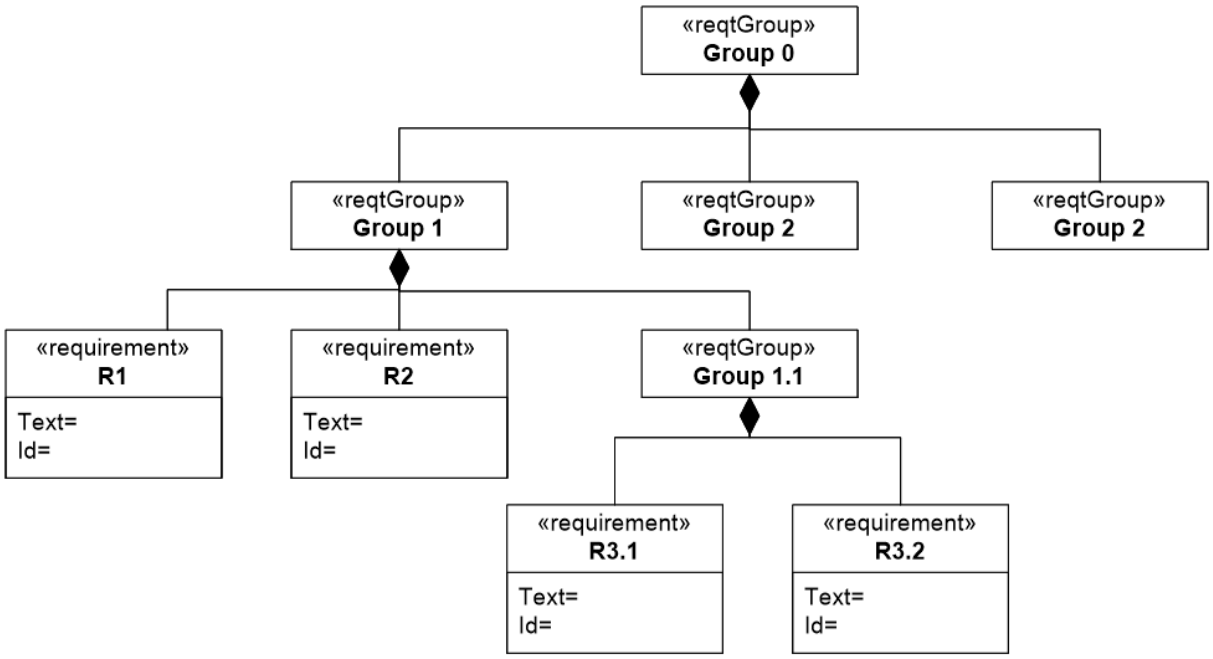
3.1.2.6.1 Requirement Introduction

SysML v1 includes text-based requirements and requirements relationships with other requirements, design, analysis, and verification elements. It also provides a means to construct requirements hierarchies that correspond to the requirements in a specification. Some of the limitations associated with SysML v1 requirements include the inability to automatically verify a text requirement by analysis (although this is being done in a non-standard way), the ability to group requirements, and the ability to easily reuse a requirement. In addition, the standard attributes of requirements are limited to text and id, and do not include many commonly used requirements attributes and categories.

SysML v2 will include a Requirement Group as a container for requirements that can include additional context information for the requirements contained in the group. The Requirement Group does not contain a "shall statement". In the figure below, Group 1 contains requirements R1 and R2 and Group 1.1 contains requirements R3.1 and R3.2. A logical expression can be applied to the members of a Group. For example, Group 1 can contain R1 AND R2 AND (R3.1 OR R3.2). A requirement can also be contained in more than one Requirement Group to enable reuse of the requirement.

In SysML v1, a requirement can be decomposed into other requirements. In SysML v2, the requirement group is used to decompose requirements. A compound text requirement is decomposed into multiple individual requirements by defining a requirement group that contains the individual requirements. The original compound requirement is refined by the requirement group that contains the individual requirements.

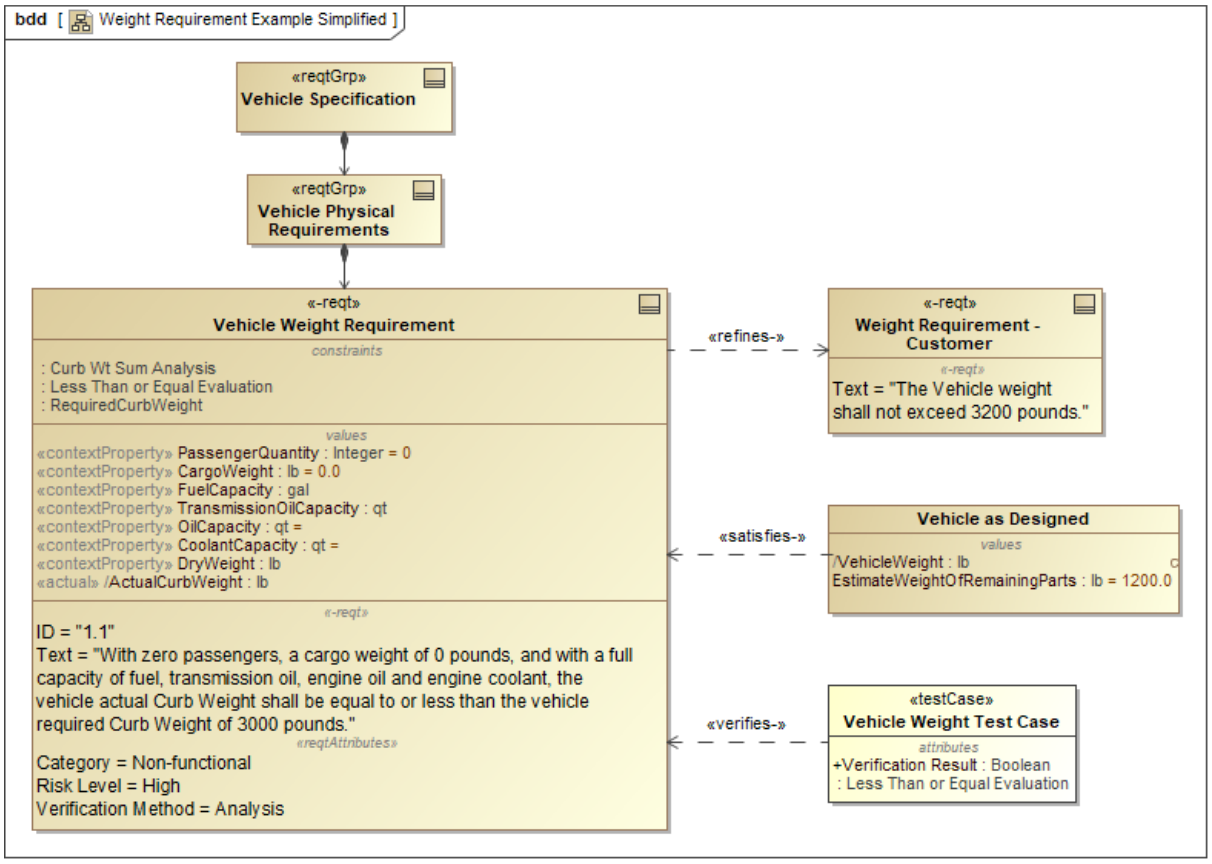
Figure 3.33. Requirement Groups



Text requirements can easily be misinterpreted. In SysML v1.5, the SysML requirement was refactored to enable both text based requirements and more precise statements of requirements, commonly referred to as property based requirements. SysML v2, is intended to represent property-based requirements by enabling requirements to contain formal expressions that constrain property values, such as weightActual<1000 kilograms. More complex expressions can also be specified to impose constraints on design solutions such as the required vehicle stopping distance as a function of speed and road conditions.

The weight requirement in the figure below illustrates some of the requirements concepts including the requirement group, property based requirements, and requirement attributes and categories. The SysML v2 requirement contains the formal expression that are specified as constraints, the properties that are being constrained, along with the id and text statement. The SysML v2 requirement also includes the ability to specify assumptions, such as whether the weight of oil, gas, and other fluids are included in the vehicle weight requirement. The assumptions are represented by context properties that can have values assigned or constrained.

Figure 3.34. Example Weight Requirement

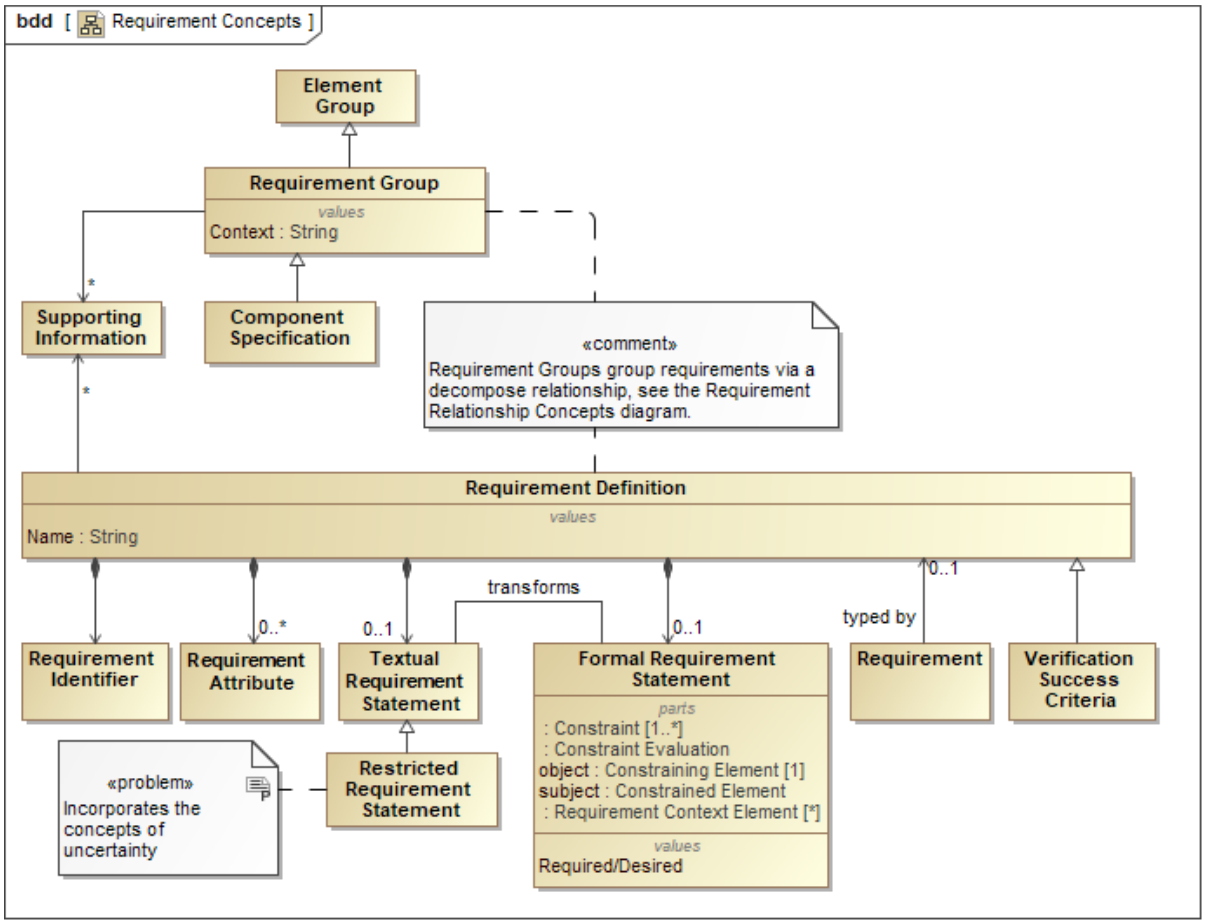


SysML v2 also supports the concept for restricted natural language text to specify requirements more precisely.

SysML v2 applies the structural concepts to both reuse requirements, and unambiguously define a tree of requirements. A generic structure of requirements can be defined using requirements groups that contain requirement definitions. An unambiguous hierarchy of requirements can be defined for a specific design configuration. A tree of individual requirements can specify an individual element.

The SysML v2 requirement will also include standard requirement attributes and requirement categories based on the INCOSE Handbook. Some of the SysML v1.2 requirements concepts are highlighted in the figure below.

Figure 3.35. Requirement Concepts



3.1.2.6.2 Requirements for Requirements

Table 3.7. Requirements for Requirements

ID	Name	Requirement Text	SysML v1.x Construct
RQT 1	Requirement Group		
RQT 1.1	Requirement Definition Group		
RQT 1.1.1	Requirement Definition Name	SysML v2 shall include a capability to represent a requirement definition that can be used to constrain a solution.	Requirement Name

ID	Name	Requirement Text	SysML v1.x Construct
RQT 1.1.2	Requirement Identifier	SysML v2 shall include a capability to represent a single identifier for each requirement that does not change over the requirement's lifetime and is adaptable to a user defined numbering scheme.	Requirement ID
RQT 1.1.3	Requirement Attributes	SysML v2 shall include a capability to represent the following optional requirement attributes for a requirement definition. • Requirement Identifier (conforms to a user specified naming and identifier production scheme) • Requirement Status Attribute • Priority Attribute • Risk Attribute • Originator/Author Attribute • Owner Attribute • User-defined Requirement Attributes (e.g., confidence level, uncertainty status, etc.) **Supporting Information:** These are derived from commonly used attributes as defined in the INCOSE Handbook and ReqIF and should be reconciled with other model element metadata and model element attributes that apply more generally.	Non Normative extensions
RQT 1.1.4	Textual Requirement Statement	SysML v2 shall include a capability to represent a requirement definition that contains an optional textual requirement statement.	Requirement text statement
RQT 1.1.5	Restricted Requirement Statement Group		
RQT 1.1.5.1	Restricted Requirement Statement	SysML v2 shall include a capability to represent a requirement definition that contains an optional restricted requirement statement which may include predefined key words and sentence structures.	
RQT 1.1.5.2	Restricted Requirement	SysML v2 shall include a capability to extend a restricted requirement statement	

ID	Name	Requirement Text	SysML v1.x Construct
	Statement Extensibility	with additional key words and sentence structures.	
RQT 1.1.5.3	Restricted Requirement Statement Transformation	SysML v2 will include a capability to maintain consistency between the restricted requirement statement and the textual requirement statement or the formal requirement statement.	
RQT 1.1.6	Formal Requirement Statement Group		
RQT 1.1.6.1	Formal Requirement Statement	SysML v2 shall include a capability to represent a requirement definition that contains an optional formal requirement statement that includes one or more constraints on an acceptable solution. **Supporting Information:** It is desired to also enable the element that is intended to satisfy the requirement.to contain the formal requirement statement. This can provide a more lightweight modeling style.	Non-normative extension for a property based requirement
RQT 1.1.6.2	Assumptions	SysML v2 shall include a capability to represent a formal requirement statement that includes one or more expressions to specify the assumptions and applicability conditions for acceptable solutions (e.g., the weight of a car includes the fuel weight)	
RQT 1.2	Groups of Requirements		
RQT 1.2.1	Requirement Group	SysML v2 shall provide the capability to model a group of requirements that are used to constrain a solution. **Supporting Information:** This is intended to be a sub-class of Element Group.	Requirement
RQT 1.2.2	Requirement Usage (localized)	SysML v2 shall include a capability to represent localized values of a requirement usage that can over-ride the values of its requirement definition.	

ID	Name	Requirement Text	SysML v1.x Construct
		Supporting Information: The structural concepts of definition, usage, configuration, and individuals is intended to apply to reuse requirements, and unambiguously define a tree of requirements that specify a design configuration or an individual element.	
RQT 1.2.3	Requirement Usage Identifier	SysML v2 shall include a capability to represent each requirement in a requirement group with a unique requirement identifier and a requirement definition.	Requirement ID
RQT 1.2.4	Requirement Ordering	SysML v2 shall include a capability to represent the order of each requirement in a requirement group that is not constrained by its requirement identifier. **Supporting Information:** This primarily allows the user to further organize the requirements, but it does not impact the meaning of the requirements. For example, there may be a requirement group with one requirement to open a value and another requirement to close a valve. The user may want to order the open requirement as the first requirement in the group.	
RQT 1.3	Requirement Relationships Group		
RQT 1.3.1	Specialization	SysML v2 shall include a capability to represent a generalization relationship that relates a specific requirement definition to a more general requirement definition.	
RQT 1.3.2	Requirement Satisfaction	SysML v2 shall include a capability to represent a satisfy relationship that relates a requirement to a model element that is asserted to satisfy it.	Satisfy
RQT 1.3.3	Requirement Verification	SysML v2 shall include a capability to represent a verify relationship that relates a verification case to the requirement it is intended to verify.	Verify
RQT 1.3.4	Requirement Derivation	SysML v2 shall include a capability to represent a derive relationship that relates a	DerivedRequirement

ID	Name	Requirement Text	SysML v1.x Construct
		derived requirement to a source requirement.	
RQT 1.3.5	Relationships to a Requirement Group	SysML v2 shall include a capability to apply any relationship with a requirement group to each member of the requirement group. **Supporting Information:** This applies more generally to element groups.	
RQT 1.3.6	Requirement Group Membership	SysML v2 shall include a capability to represent a relationship between a requirement group and the members of the group that can include either a requirement or another requirement group. **Supporting Information:** This relationship groups requirements into a shared context.	
RQT 1.4	Relationship Logical Constraint	SysML v2 shall include a capability to represent a logical expression (e.g. AND, OR, XOR, NOT, and conditional expressions like IF-THEN-ELSE and IF-AND-ONLY-IF) to one or more requirement relationships of the same kind, with an associated completeness property (e.g., complete satisfaction or partial satisfaction) and with a default expression of "And" for the logical expression. **Supporting Information:** As an example, two blocks that have a satisfy relationship with the same requirement are asserted to completely satisfy the requirement.	
RQT 1.5	Requirement Supporting Information	SysML v2 shall include a capability to represent supporting information for a requirement, requirement definition, and a requirement group. **Supporting Information:** This is a kind of annotation that applies more generally to any model element.	

ID	Name	Requirement Text	SysML v1.x Construct
RQT 1.6	Goals, Objectives, and Evaluation Criteria	SysML v2 shall include a capability to represent goals, objectives, and evaluation criteria. **Supporting Information:** Criteria can be viewed as a superclass of a requirement that does not constrain the values on the solution space. For example, a cost requirement may be to require the cost to be less than a certain value, where as a cost criteria may be to select a design with the lowest cost. Goals can be a type of criteria. For example, a goal of the system is to minimize the cost. An objective represents a desired end state. For example, the mission objective is to land a person on the moon and safely return them to earth. This can be thought of as a kind of requirement.	

3.1.2.7 Verification & Validation

3.1.2.7.1 Verification & Validation Introduction

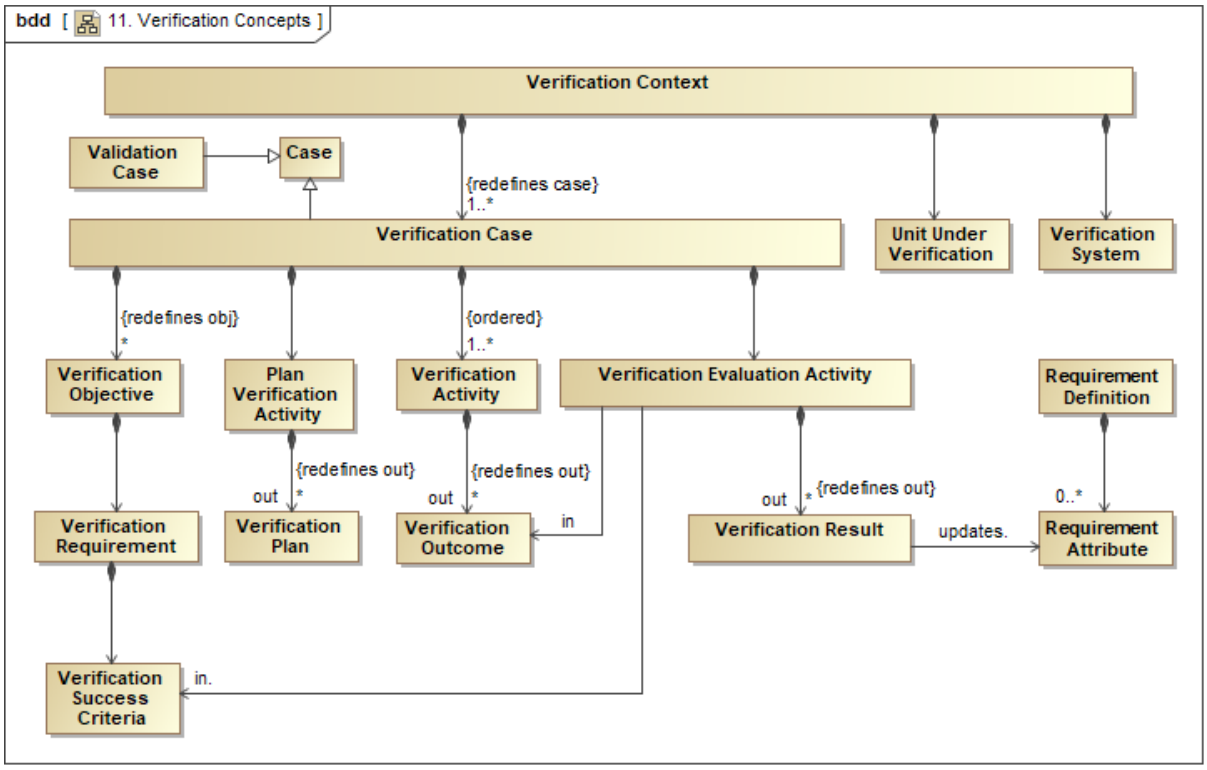
SysML v2 can be used to support verification planning and execution by modeling the verification system, and how the verification system is used to verify that the system and component requirements are satisfied. The verification concepts shown in the figure below are intended to integrate with the requirements concepts, and include verification objectives and criteria, a verification case, the verification system, the unit under verification, and the verification result.

Validation concepts are also intended to be similarly supported. Whereas verification is used to determine the extent to which a requirement is satisfied by the design, validation is used to determine the extent to which a requirement supports the need or a higher level requirement. Similar concepts can be applied to both. The intent is for the concepts to be adapted to support both verification and validation. For example, verification methods and validation methods can be defined.

A Verification Case (and Validation Case) generalizes the Test Case from SysML v1, and is used to specify how a requirement is satisfied (or validated). This Verification Case includes the Verification Activity that produces the Verification Outcome (e.g., test data). The Verification Evaluation Activity evaluates how the Verification Outcome satisfies the Verification Success

Criteria and associated requirements to produce a Verification Result (e.g., pass/fail). These concepts are generally specialized from other foundational concepts.

Figure 3.36. Verification Concepts



3.1.2.7.2 Verification & Validation Requirements

Table 3.8. Verification & Validation Requirements

ID	Name	Requirement Text	SysML v1.x Construct
VRF 1	Verification and Validation Requirements Group	The requirements in this group are generally assumed to be specialized from more foundational concepts, and are defined in user level model libraries. **Supporting Information:** The validation requirements are not called out explicitly, but are intended to be supported in a similar way as the verification requirements.	

ID	Name	Requirement Text	SysML v1.x Construct
VRF 1.1	Verification Context	SysML v2 shall include the capability to model a Verification Context that includes a Verification Case, a Verification System, and a Unit Under Verification.	
VRF 1.2	Verification Case Group		
VRF 1.2.1	Verification Case	SysML v2 shall include the capability to model a verification case to evaluate whether one or more requirements are satisfied by a unit under verification.	Test Case
VRF 1.2.2	Verification Objectives	The verification case shall include verification objectives to be implemented by the verification activities.	
VRF 1.2.3	Verification Success Criteria	The verification case shall include the criteria used to evaluate whether the verification objectives are met and the requirements are satisfied.	
VRF 1.2.4	Verification Methods	The verification case shall include the methods used to verify the requirements, including a library of different methods (i.e., inspection, analysis, demonstration, test, external verification, engineering reviews, and similarity) that can be applied. More than one method can be applied to verify a requirement. **Supporting information:** Verification method may include additional classification such as qualification test and acceptance test. An external verification is a method used in some industries, such as an Underwriters Labs.	
VRF 1.2.5	Verification Activity	The verification case shall include activities to produce the verification data, and include the ability to reference the data.	
VRF 1.2.6	Verification Evaluation Activity	The verification case shall include activities to evaluate the verification data and the verification success criteria and generate a verification result of how well the requirements are satisfied (e.g., pass/fail/unverified).	
VRF 1.3	Verification System	SysML v2 shall include the capability to model the system and associated environment that is used to verify the unit under verification. (Note: the verification system may include verification elements that are	

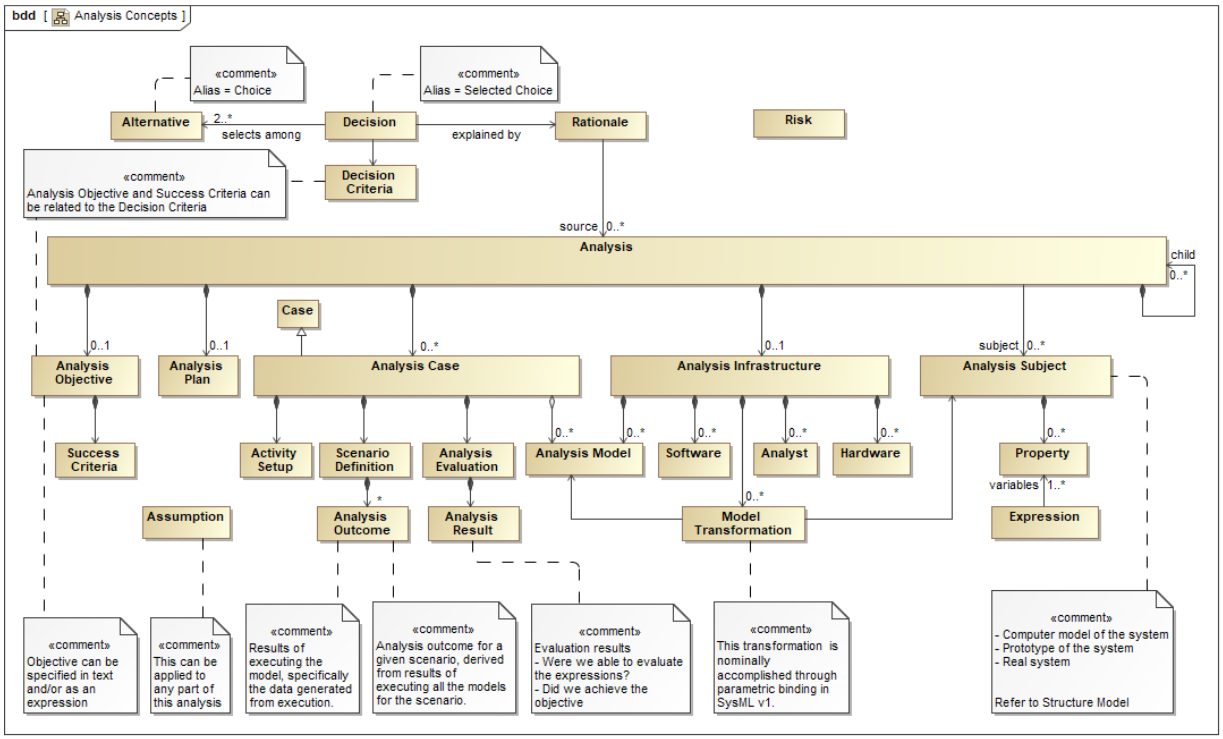
ID	Name	Requirement Text	SysML v1.x Construct
		combinations of operational and simulated hardware, software, people, and facilities.)	
VRF 1.4	Verification Relationships Group		
VRF 1.4.1	Verification Objectives to Verification Cases	SysML v2 shall include the capability to model relationship between the verification cases and their verification objectives.	
VRF 1.4.2	Validate Relationship	SysML v2 shall include the capability to model the relationship between the validation case and the model element being validated. **Supporting Information:** An element being validated may represent a requirement, design, as-built system, model, etc.	

3.1.2.8 Analysis

3.1.2.8.1 Analysis Introduction

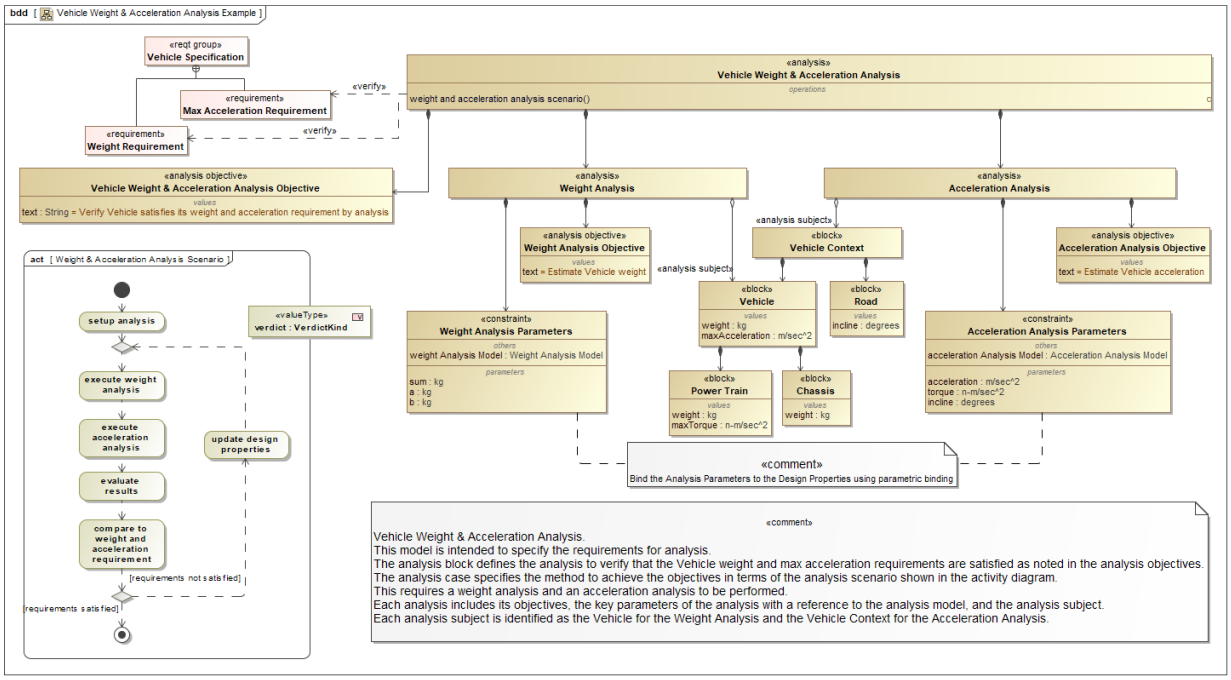
Although SysML v1 includes parametrics, it lacks some essential concepts to facilitate integration with analysis models. These concepts include concepts such as analysis, analysis case, analysis scenarios, analysis subject, analysis model, and analysis results. The analysis concepts for SysML v2 are shown in the figure below, and are similar to the verification concepts described in the previous section. Similar to the verification concepts, these concepts are generally specialized from other foundational concepts.

Figure 3.37. SysML v2 Analysis Concepts



The example in the figure below illustrates how these concepts can be applied to specify the requirements for the Vehicle weight and acceleration analysis. The analysis block contains the analysis objectives to verify that the Vehicle weight and acceleration satisfy its requirements. The analysis case specifies the analysis scenario in an activity diagram that can require the execution of multiple models to achieve the analysis objectives. The scenario in the figure requires a weight analysis and an acceleration analysis to be performed. Each of these analyses is part of the Vehicle Weight & Acceleration Analysis block, which include their objectives, the key parameters of the analysis, and the subject of the analysis. The subject of the analysis is identified as the Vehicle for the Weight Analysis, and the Vehicle Context for the Acceleration Analysis. The constraints contain the key parameters, and also include a reference to the analysis models that execute the analysis. These concepts are used to specify the analysis and integrate with the appropriate analysis models and tools to perform the analysis.

Figure 3.38. Vehicle Weight & Acceleration Analysis



SysML v2 also includes a set of analysis services that leverage the analysis concepts described in this section to further support integrating SysML with analysis. The analysis service requirements are described in the Services section below.

3.1.2.8.2 Analysis Requirements

Table 3.9. Analysis Requirements

ID	Name	Requirement Text	SysML v1.x Construct
ANL 1	Analysis Requirements Group	The requirements in this group are generally assumed to be specialized from more foundational concepts, and are defined in user level model libraries.	
ANL 1.01	Analysis	SysML v2 shall include the capability to specify an Analysis, including the subject of analysis (system), analysis objectives, analysis case, analysis models, and related infrastructure to perform the analysis.	
ANL 1.02	System of Interest	SysML v2 shall include the capability to model the relationship between analysis and the subject of the analysis (system being analyzed).	

ID	Name	Requirement Text	SysML v1.x Construct
ANL 1.03	Parameters of Interest	SysML v2 shall include the capability to identify the key parameters of interest, measures-of-effectiveness, and key performance parameters that are derived from the analysis.	Constraint Block
ANL 1.04	Analysis Objectives	SysML v2 shall include the capability to model the objective of the analysis being performed in text or as a mathematical formalism, e.g. math expression, so that it can be evaluated.	
ANL 1.05	Analysis Case	SysML v2 shall include the capability to model the analysis case to specify the scenario and analysis methods needed to achieve the analysis objectives.	
ANL 1.06	Analysis Scenarios	SysML v2 shall include the capability to model the scenarios that identify the models to executed, the conditions and assumptions, the analysis environment, and the configurations of the subject (system) that is being analyzed.	
ANL 1.07	Analysis Assumption	SysML v2 shall include the capability to model the assumptions of the analyses in a text or mathematical form, e.g. constraints and boundary conditions.	
ANL 1.08	Analysis Decomposition	SysML v2 shall include the capability to decompose an analysis into constituent analyses.	
ANL 1.09	Analysis Model	SysML v2 shall include the capability to relate analysis models to a given analysis or analysis scenarios. **Supporting Information:** Analysis models can be defined natively in SysML (e.g. parametric model or behavior model) or externally (e.g. equation-based math models, finite element analysis models, or computational fluid dynamics models).	
ANL 1.10	Analysis Model - System Model Transformation	SysML v2 shall include the capability to represent the transformation and the mapping between the analysis model and the system model. **Supporting Information:** This transformation will represent the algorithm or derivation process, if used, for generating analysis models from system model (or vice versa), and the mapping will provide a mechanism to verify and synchronize analysis models when system model changes (or vice versa).	

ID	Name	Requirement Text	SysML v1.x Construct
ANL 1.11	Analysis Result	SysML v2 shall include the capability to relate the results of executing analysis models to the analysis scenarios or the analysis. **Supporting Information:** The results may be stored in the SysML v2 model itself or an in an external store (e.g. CSV file or database). The results will be queried for evaluating analysis objectives and for supporting the rationale for decisions taken based on the analysis.	
ANL 1.12	Analysis - Decision	SysML v2 shall include the capability to model a Decision, which represents one or more selected choices among alternatives. **Supporting Information:** This Decision and Rationale are related through the Explanation relationship. The Rationale can includes references to the analysis.	
ANL 1.13	Analysis Infrastructure	SysML v2 shall include the capability to represent the hardware, software, and the personnel (analysis experts) required for performing the analysis.	
ANL 1.14	Analysis Metadata	SysML v2 shall include the capability to represent the following metadata for analysis-related model elements (common to all SysML v2 model elements), such as unique id, element type, name, version, author, creation date, and last modified date.	
ANL 1.15	Decision Group		
ANL 1.15.1	Alternative	SysML v2 shall include a capability to represent a set of alternatives.	
ANL 1.15.2	Decision	SysML v2 shall include a capability to represent a set of decision as one or more selections among alternatives.	
ANL 1.15.3	Decision Criteria	SysML v2 shall include a capability to represent decision criteria.	
ANL 1.15.4	Rationale	SysML v2 shall include a capability to represent rationale for a decision and/or to explain a conclusion.	Rationale

3.1.3 Reference Model and Model Libraries

3.1.3.1 Reference Model and Model Libraries Introduction

Over the many years of use of SysML v1, there has been strong demand to provide reusable assets that are broadly available across industry and within an organization. The language is quite flexible to enable users to apply the language using their own methods and modeling practices. This flexibility can result in models that are difficult to reuse across industry and organizations. The intent for SysML v2 will be to further encourage shared models through reuse libraries and application of common modelling patterns.

The SysML v2 specification will include a reference model that provides a robust example of the application of SysML to a broadly relevant domain such as an automobile that can serve to capture some of the common modelling patterns. The reference model can also be used to support conformance evaluation of vendor implementations, and can also be used to demonstrate SysML concepts and support various training needs. In addition, the generic elements for potential commonly used model libraries is also being requested to encourage the population of these libraries in a standard way.

3.1.3.2 Reference Model and Model Libraries Requirements

Table 3.10. Reference Model and Model Libraries Requirements

ID	Name	Requirement Text	SysML v1.x Construct
RML 1	Reference Model and Model Libraries Group		
RML 1.1	Reference Model	SysML v2 shall include a reference model that demonstrates the application of the SysML v2 language concepts to a commonly understood domain.	
RML 1.2	Model Libraries	SysML v2 shall include Model Libraries that contain generic elements that can be further specialized to define domain specific libraries in the following domain areas: • Primitive Value Types • Units and Quantity Kinds • Components • Natural environments • Interfaces • Behaviors • Requirements • Verification methods	

ID	Name	Requirement Text	SysML v1.x Construct
		• Analyses • Basic geometric shapes • Basic material kinds • Viewpoint methods • View definitions (i.e. different kinds of documents and other artifacts) • Domain-specific symbols **Supporting information:** The generic elements provide a common starting point for development of domain specific model libraries that can be subject to future RFPs and/or the open source community.	

3.1.4 Language Conformance

3.1.4.1 Language Conformance Introduction

The SysML v2 API and Services Specification will specify conformance tests to enable vendors and end users to evaluate their level of conformance with the SysML v2 Specification. This may include metamodel and profile conformance, concrete syntax conformance, API conformance, service conformance, and model interoperability conformance.

3.1.4.2 Language Conformance Requirements

Table 3.11. Language Conformance Requirements

ID	Name	Requirement Text	SysML v1.x Construct
CNF 1	Conformance Requirements Group	The conformance approach defines a set of test cases that requires a SysML v2 implementation to import a reference model, and provide a response to standard service requests. The service response is evaluated for conformance to the specification. The SysML v2 specification will specify the conformance levels for each conformance area below. Vendors are expected to identify specific levels of conformance their implementation is intended to support.	
CNF 1.1	Formalism Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification formalism requirements.	

ID	Name	Requirement Text	SysML v1.x Construct
CNF 1.2	Metamodel & Profile Conformance Group		
CNF 1.2.1	Metamodel Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification metamodel and profile requirements.	
CNF 1.2.2	Profile Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification profile requirements.	
CNF 1.3	Concrete Syntax Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification concrete syntax requirements.	
CNF 1.4	Model Interoperability Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification model interoperability requirements.	XMI

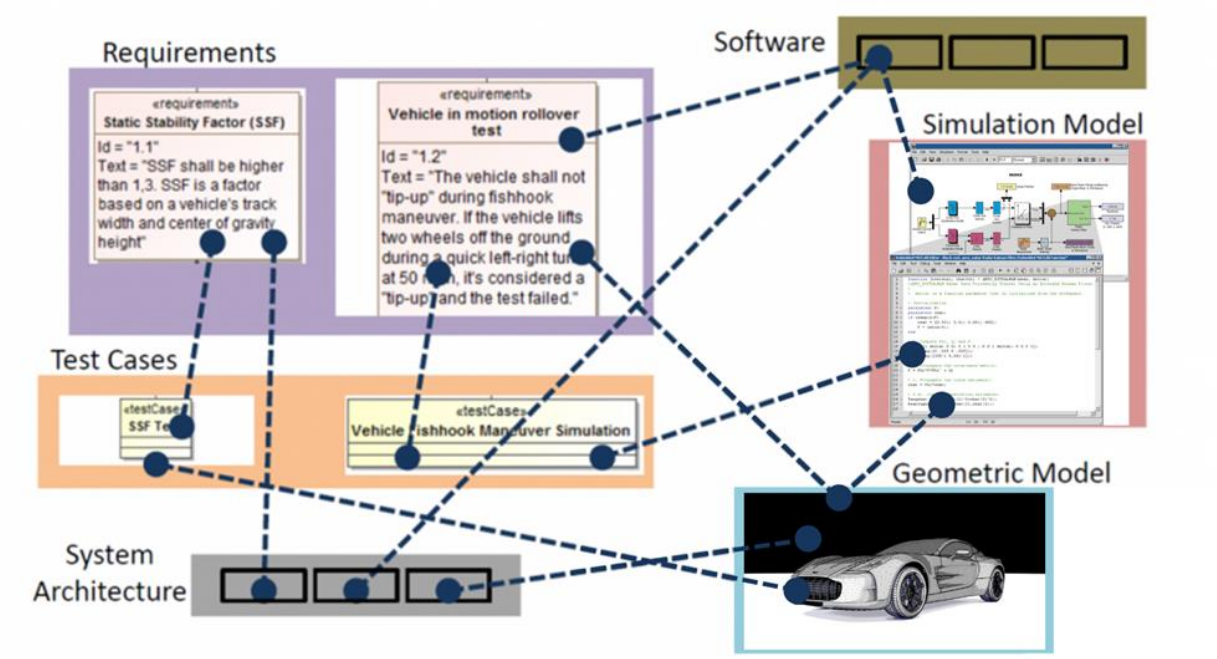
3.1.5 Other

3.1.5.1 Interoperability

3.1.5.1.1 Interoperability Introduction

A major emphasis for SysML v2 is to improve interoperability with other engineering models and tools, and other external data sources. In the figure below, interoperability implies relationships between model elements that span different models. In many cases, an element in the SysML model has a direct correspondence to an element in another model, such as when a component in the SysML model corresponds to a component in another model. However, the component in the SysML model may be an abstraction of the corresponding component in the other model. The corresponding element in the other model may add further detail such as the case when a component in the SysML model is represented by a component in a CAD model with detailed geometry. In this way, the SysML model is a specification of the detailed design or analysis model. The relationships between the SysML model and the other model must be defined and managed to ensure effective interoperability.

Figure 3.39. System Model Interoperability Concepts (Source: Alex Reichwein)



SysML v1 focused on interchange between SysML models in different vendor tools using the XMI standard. SysML v2 is intended to provide much broader support for interoperability that include requirements for:

- A standard API to enhance integration between SysML models and other models and tools
- A standard format to interchange SysML models that is not constrained to be XMI
- Services to import and export structured data that is defined in standard formats such as comma delimited data formats
- A capability to transform SysML models
- Migration of previous versions of SysML to current versions of SysML
- A mapping between the shared concepts between SysML and UML to facilitate semantic interoperability between the system and software model.

Some other standards that SysML v2 can leverage for interoperability include Open Services for Lifecycle Collaboration (OSCL), Functional Mockup Interface (FMI), and the series of STEP Application Protocols.

3.1.5.1.2 Interoperability Requirements

Table 3.12. Interoperability Requirements

ID	Name	Requirement Text	SysML v1.x Construct
OTR 1	Interoperability Requirements Group	Other requirements from other topic areas that also relate to interoperability include API 01, LNG 1.6, and the Interoperability Services Group, SVC 6.	

3.1.5.2 Usability

3.1.5.2.1 Usability Introduction

Usability is a critical driver to the ultimate acceptance and use of SysML v2, and is fundamental to enabling more cost-effective application of MBSE. In particular, the usability goals are to reduce the learning curve for new users, improve productivity for constructing models for new and experienced users, and improve the visualization capability and interaction with the model for a diverse set of stakeholders that consume the model data.

The SysML v2 RFP includes a requirement to specifically address these usability concerns. This includes the requirement for the SysML v2 specification to demonstrate how it addresses the usability criteria that are specified in this RFP for different classes of users.

Some ways in which SysML v2 implementations are expected to address usability concerns include:

- Model construction services that include the use of patterns and workflow support
- Model visualization services that support a highly flexible view and viewpoint
- Model construction, visualization, and model management services that facilitate uses across the development lifecycle from sketching capability to high fidelity models with rigorous model checking
- Customization and extensibility capabilities such as use of aliases, different native languages, domain specific symbol libraries concepts
- Consistency across language such as consistent terminology, symbols, shared concepts
- Consistent workflows, modeling patterns, and user interfaces
- Ability to quickly find relevant information within the current view
- Ability to quickly navigate to related information that is not in the current view
- Setting defaults to support common uses (e.g., default multiplicity of 1)
- Effective user documentation and support

3.1.5.2.2 Usability Requirements

Table 3.13. Usability Requirements

ID	Name	Requirement Text	SysML v1.x Construct
OTR 2	Usability Group	An objective for SysML v2 is to address SysML v1 usability issues, and enable systems engineers and others to perform MBSE more effectively. The following usability goals apply to a diverse class of SysML v2 users: 1. User understanding when creating or interpreting models 2. User engagement when creating or interpreting models (this particularly applies to consumers of the model data) 3. User productivity when creating models across the lifecycle	
OTR 2.1	Usability Evaluation	The SysML v2 submission shall demonstrate how the SysML v2 specification satisfies the following usability criteria to meet the usability goals for the different classes of users and goals. To be provided	

3.2 Mandatory API and Services Requirements

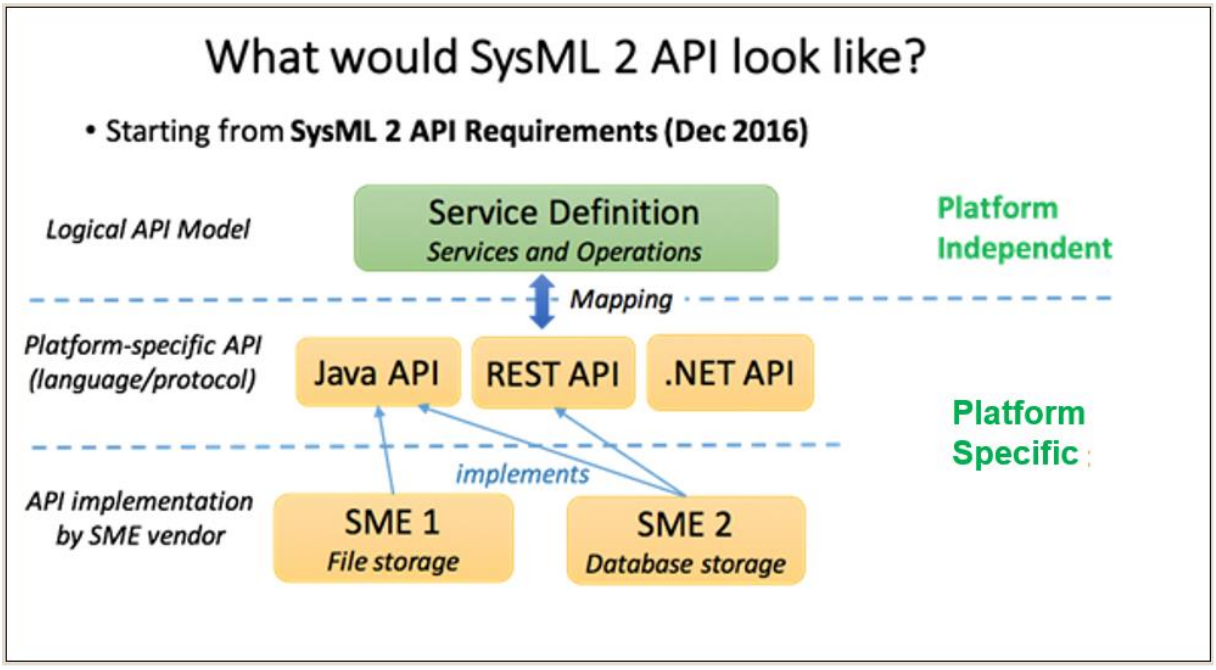
3.2.1 API

3.2.1.1 API Introduction

The SysML v2 RFP requires a standard way to request services through an API to support interoperability. SysML v2 will allow any client such as an external tool, plug-in, or user interface to request services to access the system model repository in a standard way. As highlighted in the figure below, the API requirement is to produce a platform-independent model (i.e., logical API model) with selected platform-specific bindings that are then implemented by modeling tools to enable access to the system model repository. The platform-independent model provides a service definition that is consistent with the information model. The platform-specific binding defines the services using a particular technology (e.g., Java, web services). A formal mapping is maintained between the platform-independent model and platform-specific bindings.

The API must also provide various infrastructure services to support connection to the model repository, service registries, and capabilities that enable a client of the API to request services that are implemented by a federated multi-vendor implementation.

Figure 3.40. SysML v2 API Specification Approach



3.2.1.2 API Requirements

Table 3.14. API Requirements

ID	Name	Requirement Text	SysML v1.x Construct
API 1	API Requirement Group	SysML v2 will include an API specification that will be implemented by SysML v2 vendors. Software application code written using this API specification will work with each conformant vendor implementation of this API specification without requiring any change in the code.	
API 1.1	API Scope	SysML v2 API shall support the SysML v2 service requirements.	
API 1.2	API Architecture	SysML v2 API shall provide: 1. A **platform-independent model** that defines the services and the operations provided by the API. Services are collections of operations. Inputs and outputs of each operation shall be defined. The model shall be defined using SysML.	

ID	Name	Requirement Text	SysML v1.x Construct
		2. **Mapping approach** to map the platform-independent model to platform-specific bindings. The mapping shall be formally represented using SysML. 3. **Platform-specific bindings** to two or more commonly used platforms (such as Java, .NET, or HTTP). The platform-specific bindings shall also include API documentation for each of the services and their operations. **Supporting Information:** The platform-independent model and the mapping approach should be complete and defined formally to allow for specifying other platform-specific bindings. See the SysML 2 API Prototype presentation [34, **Error! Hyperlink reference not valid.**] for an example of analysis services.	
API 1.3	API Conformance	SysML v2 API shall specify the conformance rules for an implementation of the platform-specific binding(s) of the API. SysML v2 API shall also provide a formal mechanism to evaluate and score the conformance level of a SME's implementation of the API specification.	
API 1.4	API Infrastructure Services	SysML v2 API shall provide the following infrastructure-level service specifications in addition to the systems engineering domain service specifications listed in *API Scope* requirement. SMEs that claim conformance to these services shall provide an implementation for the following. • Connection to model repository - Connect to SysML v2 data model repository managed by the SME • Service registry - Check if a SME provides a service registry, i.e. a collection of all SysML v2 API services offered by the SME. • Service discovery/lookup - Query of the service registry provided by the SME to lookup specific services. • Federated implementations - support a federated multi-vendor SME implementation where a client of the API can request services that are implemented by multiple vendors with their own model repositories.	

ID	Name	Requirement Text	SysML v1.x Construct
		Supporting Information: Refer to DDS [DDS] and CORBA [CORBA] as examples	
API 1.5	Design Constraints	The SysML v2 API shall meet the following design constraints: • Allow extensions of the platform-independent model and platform-specific bindings **Supporting Information:** Refer to DDS [DDS] and CORBA [CORBA] as examples	

3.2.2 Services

This section contains the mandatory service requirements for the SysML v2 specification service definitions.

3.2.2.1 Query Services

3.2.2.1.1 Query Services Introduction

The requirements in this group specify services related to accessing the information in a SysML model.

3.2.2.1.2 Query Services Requirements

Table 3.15. Query Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVM 1	Query Services Group	The requirements in this group specify services to create, update, delete, and execute queries of the SysML model, persist the results, and dynamically update the query results as the model is updated. **Supporting Information:** The query services are used by other services including visualization, analysis, applying patterns, and selecting members of element groups.	
SVM 1.1	CRUD Queries	SysML v2 shall specify services to provide the ability to create, read, update and delete queries.	

ID	Name	Requirement Text	SysML v1.x Construct
SVM 1.2	Query Model	SysML v2 shall specify services to provide the ability to query the information content in a SysML model.	
SVM 1.3	Persist Query Results	SysML v2 shall specify services to provide the ability to persist the results of a query.	

3.2.2.2 Extension Services

3.2.2.2.1 Extension Services Introduction

The Extension Services support the extension of the standard language to support domain specific customization.

3.2.2.2.2 Extension Services Requirements

Table 3.16. Extension Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVM 2	Extension Services Group	The requirements in this group specify services to extend the language to support domain-specific customizations consistent with the extension mechanisms in LNG 1.5.	
SVM 2.1	Create Extensions	SysML v2 shall specify services to create consistent extensions of the abstract syntax, concrete syntax, semantics and the mappings between them.	
SVM 2.2	Apply Extensions	SysML v2 shall specify services to apply the relevant extensions to a user model.	

3.2.3 API and Services Conformance

3.2.3.1 API and Services Conformance Introduction

The SysML specification will specify conformance tests to enable vendors and end users to evaluate their level of conformance with the SysML v2 API and Services specification.

3.2.3.2 API and Services Conformance Requirements

Table 3.17. API and Services Conformance Requirements

ID	Name	Requirement Text	SysML v1.x Construct
ACF 1	API and Services Conformance Requirement Group	Place Holder Requirement Group	
ACF 1.1	API Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification API requirements.	
ACF 1.2	Service Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation with the SysML v2 specification service requirements.	
ACF 1.3	Functional Thread Conformance	SysML v2 shall provide test cases to assess conformance of a SysML v2 implementation that support the following functional threads using a combination of services. • Change impact thread (requirements to design to analysis to verification) • Additional threads to show how the SysML v2 specification supports various MBSE use cases	

3.3 Non-mandatory API and Services Features

This section contains the optional service requirements for the SysML v2 specification service definitions in the API model described in the previous section. Optional means that the Submission Team can determine which requirements to incorporate into the specification.

3.3.1 Model Construction Services

3.3.1.1 Model Construction Services Introduction

The background that led to the model construction concept and requirements are described on the Model Construction Wiki. The model construction concept is intended to provide a more efficient, intuitive, and adaptable means for model development by users with a diverse range of experience and needs. The requirements reflect the need to create, update, and delete any model element or group of model elements using graphical, tabular, or textual entry. In addition, the requirements for model construction apply to other elements that are not model elements that include metadata, modeling patterns, model queries, expressions, validation scripts, viewpoint

methods, model transformations, and external links. Model construction is intended to be facilitated by mechanisms, such as patterns and wizards that enable a user to perform a specific systems engineering task or practice.

A user can construct models through a user interface that enables creating, updating, and deleting model elements, or by importing data from an external file, database or software application, and transforming the data to the corresponding SysML model elements. The model construction supports the definition and application of modeling patterns as a means for efficient and intuitive model construction.

Model updates can be completed successfully or rolled back to a prior consistent state. When deleting a model element, the services should ensure the deletion semantics are applied.

The requirements for model construction have interdependencies with other requirements related to model visualization, model management, workflow and collaboration, and model analysis.

3.3.1.2 Model Construction Services Requirements

Table 3.18. Model Construction Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 1	Model Construction Services Group	The requirements in this group specify services to construct model elements and other elements used to constructs models (i.e. model constructor).	
SVC 1.1	Read and Transform Input Group		
SVC 1.1.1	Read Input Data	SysML v2 shall specify a service to read data from an external data source that is available in the following formats. 1. Comma delimited data 2. Requirement interchange format 3. TBD	
SVC 1.1.2	Transform Input Data	SysML v2 shall specify a service to transform data from and an external data source to SysML v2 model elements in accordance with the mapping rules between the external data schema and the SysML v2 metamodel	
SVC 1.1.3	Maintain Source Identifier	SysML v2 shall maintain the element identifier of the source data if provided.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 1.2	Create Elements Group		
SVC 1.2.1	Create Model Elements and Model Constructors	SysML v2 shall specify a service to create model elements and other model constructors using textual, graphical, and/or tabular entry.	
SVC 1.2.2	Create Unique Identifier	SysML v2 shall create a unique identifier when creating a model element or other model constructors.	
SVC 1.3	Update Elements Group		
SVC 1.3.1	Update Model Elements and Model Constructors	SysML v2 shall specify a service to update model elements and other model constructors using textual, graphical, and/or tabular entry.	
SVC 1.4	Delete Elements Group		
SVC 1.4.1	Delete Model Elements and Model Constructors	SysML v2 shall specify a service to delete model elements and other model constructors in accordance with the deletion semantics.	
SVC 1.4.2	Preserve Unique Identifier	SysML v2 shall retain the unique identifier when deleting a model element or other model constructor for future reference to the deleted element, and to preclude reuse of this identifier by another model element or other model constructor.	
SVC 1.5	Patterns Group		
SVC 1.5.1	Create Pattern	SysML v2 shall specify a service to create a model pattern.	
SVC 1.5.2	Update Pattern	SysML v2 shall specify a service to update a model pattern.	
SVC 1.5.3	Delete Pattern	SysML v2 shall specify a service to delete a model pattern.	
SVC 1.5.4	Apply Pattern	SysML v2 shall specify a service to create, update, and delete model elements that conform to a defined model pattern.	
SVC 1.6	Model Metadata Services Group	This set of services supports the use of model element metadata associated with the model and model elements.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 1.6.1	Create Metadata	SysML v2 shall specify a service to create metadata using textual, graphical, and/or tabular entry.	
SVC 1.6.2	Update Metadata	SysML v2 shall specify a service to update metadata using textual, graphical, and/or tabular entry.	
SVC 1.6.3	Delete Metadata	SysML v2 shall specify a service to delete metadata using textual, graphical, and/or tabular entry.	
SVC 1.7	Crosscutting Group		
SVC 1.7.1	Abstraction Level Construction	SysML v2 shall consider how to construct models through elaboration and refinement to transition from one level of abstraction to another, while preserving the earlier abstraction. (Note: this may be considered a transformation of one abstraction level to another that can be viewed in different viewpoints.)	

3.3.2 Model Visualization Services

3.3.2.1 Model Visualization Services Introduction

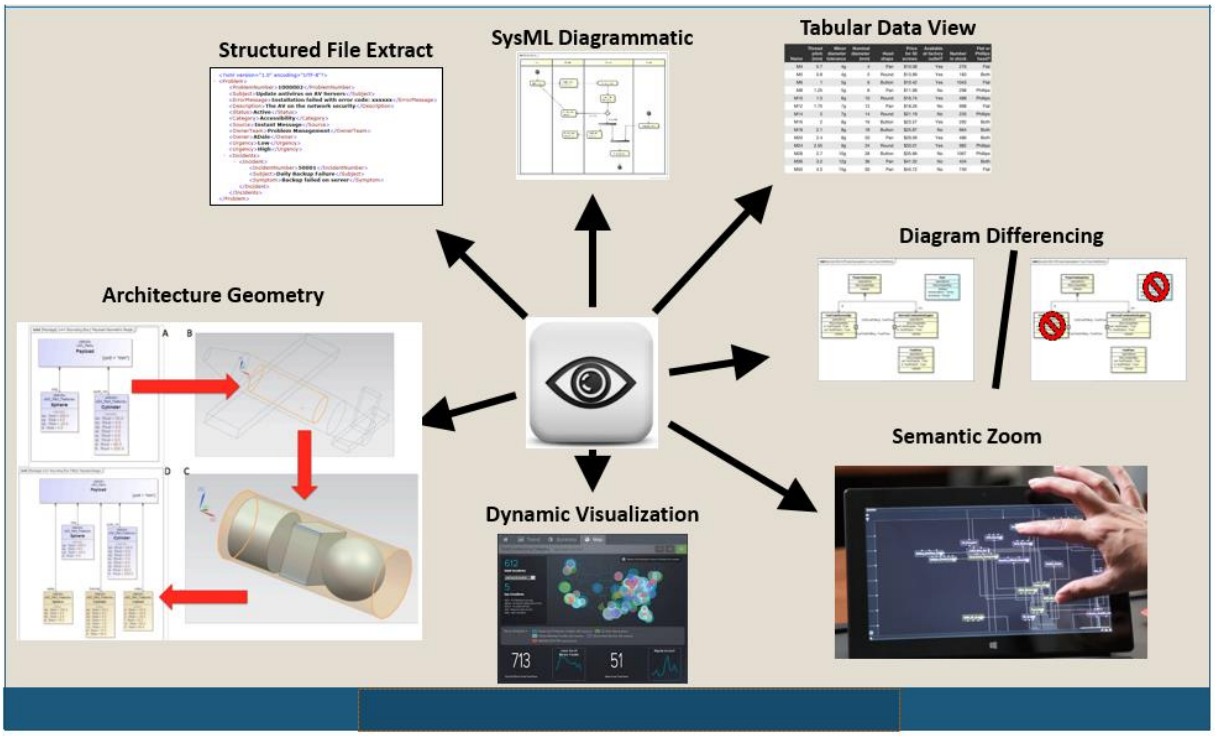
The background that led to the model visualization concept and requirements are described on the Model Visualization Working Group.

The concrete syntax requirements are included as part of the formalism requirements and the visualization requirements. These include requirements to define a view metamodel to formally define the symbols used in the language, and to establish a formal mapping between the view metamodel and the SysML metamodel. In addition, there is a requirement to specify a standard symbol set to support the standard SysML views, and for the concrete syntax to be customizable to support domain specific extensions.

The visualization concept reflects a model view controller paradigm where the controller is the viewpoint method. A primary driving service requirement is to create, read, update, delete, and execute viewpoints. Executing the viewpoint method includes querying the model and rendering the query results in a view. This concept supports dynamic visualization, semantic zoom and pan, diagram differencing, and the ability to provide diverse renderings including graphical, tabular, text, and geometric views of the model. The visualization requirements also include the requirement to map the model elements to the view elements and provide support for domain specific symbol libraries, including user defined images to represent any model element. Interactive viewpoints can be specified to enable the user to modify the view such as zoom, pan, and filter, and in some cases, provide updates to the model.

SysML v2 is required to support the standard SysML v1 diagrams and a geometric view. In addition, the viewpoint method is required to be highly flexible to address a diverse range of systems engineering visualization needs. The views must also be capable of being stored and retrieved.

Figure 3.41. Model Visualization Concepts (Source: C. Schreiber, J. Feingold, and M. Sarrel)



3.3.2.2 Model Visualization Services Requirements

Table 3.19. Model Visualization Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 2	Visualization Services Group	The requirements in this group specify services to enable visualization of the SysML v2 model.	
SVC 2.1	View Group	The following specify the requirements to render views that contain view elements.	
SVC 2.1.1	View Rendering Format	SysML v2 shall specify a service to render a view in diverse formats that include graphical, geometric, tabular, textual, and numerical formats.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 2.1.2	Manual and Automatic View Rendering	SysML v2 shall specify a service to render the layout of the view elements manually and automatically.	
SVC 2.1.3	View Filter, Zoom, and Layering	SysML v2 shall specify a service to filter, zoom, and layer the view elements.	
SVC 2.1.4	View Navigation	SysML v2 shall specify a service to navigate between views.	
SVC 2.1.5	Standard Views	SysML v2 shall specify a service to render the predefined SysML v1 diagrams and the following standard views. • Geometric view • Timing diagram	
SVC 2.1.6	Domain-Specific Symbol Libraries	SysML v2 shall specify a service to create, read, update, and delete domain-specific symbol libraries, including user-defined images that can be mapped to the abstract syntax.	
SVC 2.1.7	Persistent Views	SysML v2 shall specify a service to persist views and its mapping to the abstract syntax in a standard format and re-rendered in a view that is the same as the original view.	
SVC 2.1.8	View Interchange	SysML v2 shall specify a service to interchange view information so that the view can be rendered by a SysML v2 conformant tool using the model interchange format in LNG 1.6.1.	
SVC 2.1.9	View Management Service	SysML v2 shall specify a service to manage changes to persistent views that includes the ability to provide view differencing, and to control markings on views.	
SVC 2.2	Viewpoint Group	The following specify the requirements to specify viewpoints.	
SVC 2.2.1	Viewpoint Method	SysML v2 shall specify a service to create, read, update, delete, and execute viewpoint methods that query the model, and render the query results in a view based on the mapping between the abstract syntax and concrete syntax. **Supporting Information:** Include the ability to return derived relationships so that they can be rendered in a	

ID	Name	Requirement Text	SysML v1.x Construct
		view. Derived relationships are defined in the SysML v2 RFP.	
SVC 2.2.2	Interactive Viewpoint Method	SysML v2 shall specify a service to create, read, update, delete, and execute viewpoint methods that support interactive behavior between the user and the view, and the ability to update the model. **Supporting Information:** The ability to update the model is also a requirement on model construction.	
SVC 2.2.3	Interactive Viewpoint Method for Document Generation	SysML v2 shall specify a service to enable the generation and viewing of documents in a mode of what you see is what you get (WYSIWYG), and relate document text to model elements, insert selected views (e.g., diagrams, tables) into the document, and save text to the model, and optionally synchronize the text with the values in the model (e.g., name, number). **Supporting Information:** This is also a requirement on model construction.	
SVC 2.2.4	Composite Viewpoints	SysML v2 shall specify a service to compose viewpoints from other viewpoints that have conforming views that can be used to support document generation and other more complex views, such as panes with nested views.	
SVC 2.2.5	Viewpoint Library	SysML v2 shall specify a service to create, read, update, and delete viewpoint libraries that include predefined viewpoint methods (Note: this includes the methods to generate the SysML v2 standard views and support for standard role-based viewpoints to address different classes of users such as novice modelers, experience modelers, and model consumers.).	

3.3.3 Model Analysis Services

3.3.3.1 Model Analysis Services Introduction

The background that led to the model analysis concept and requirements are described on the Model Analysis Wiki. The goal for these services are to facilitate multi-domain and multi-disciplinary analysis of the system model. The services are intended to support full lifecycle analysis that includes both quantitative and qualitative (logical) analysis. This includes consistency checks, impact and coverage analysis, constraint solving, and simulation execution.

Model checking is performed to assess model well-formedness as an important first step prior to analysis to ensure the model results are meaningful. Quantitative analysis includes typical engineering analysis of performance and physical properties to support trade studies, design optimization, and verification. Logical analysis is used to reason about the system by performing queries of the model to get answers to questions such as what is the impact of a requirements change.

Some analysis can be performed by the SysML modeling tools that provide the analysis infrastructure, and other analysis require external solvers, simulation engines, and reasoners. When the analysis inputs are provided by the SysML model to the external analysis tool, the analysis results must be integrated back into the SysML model.

The primary analysis service requirements are to setup and execute the analysis, Store the analysis results, and Query the analysis. The analysis services must integrate with the analysis concepts, and the concepts for properties, values, and expressions, as well as the other service requirements related to model construction, model visualization, and model management. This includes the need to perform model transformations to support analysis.

3.3.3.2 Model Analysis Services Requirements

Table 3.20. Model Analysis Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 3	Analysis Services Group	The requirements in this group specify services to setup, execute, store, and query analysis models and artifacts.	
SVC 3.1	Analysis Setup	SysML v2 shall specify services to setup an analysis that includes the following: 1. Objectives, type, and fidelity of the analysis to be performed 2. Key metrics (MoEs, KPPs, PoIs) 3. The representation of the system which is being analyzed 4. The analysis case that defines the scenarios being considered 5. Analysis models for the analysis scenarios, including generation/derivation of analysis models from system model 6. Analysis infrastructure required to formulate and execute analysis models	
SVC 3.2	Execute Analysis	SysML v2 shall specify services to execute analysis models for each analysis scenario using the analysis infrastructure.	

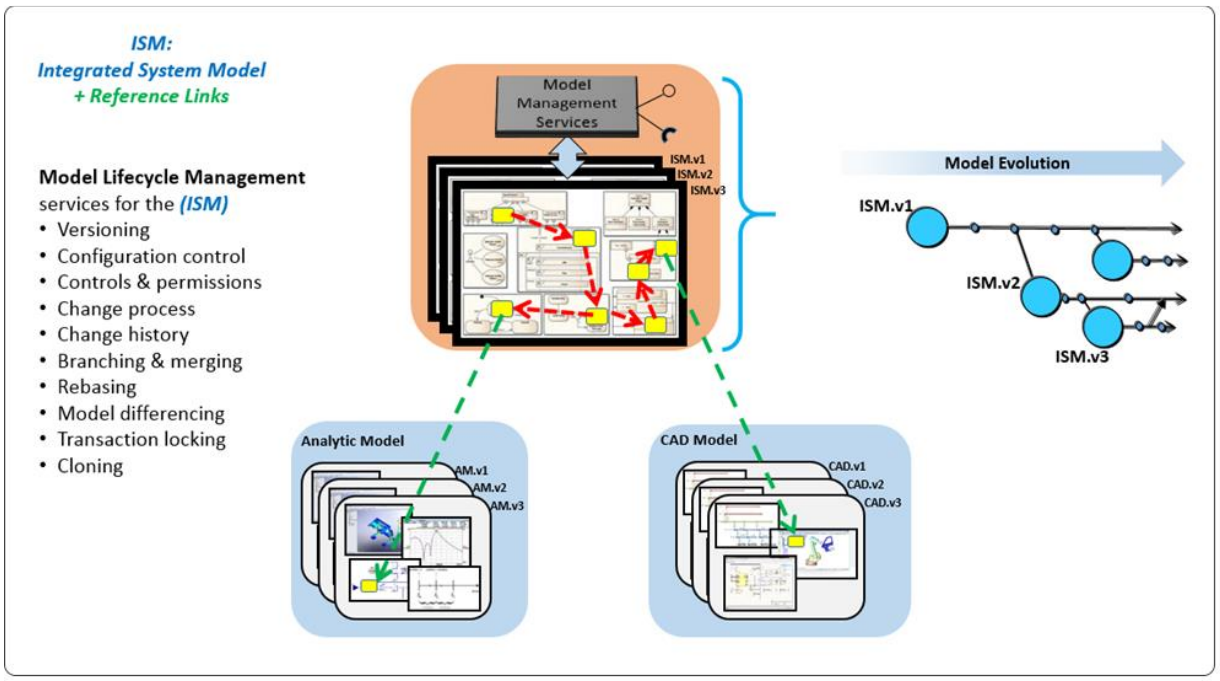
ID	Name	Requirement Text	SysML v1.x Construct
SVC 3.3	Validation Service	SysML v2 shall include the capability to define and execute validation rules to ensure the model is well formed.	
SVC 3.4	Store Analysis	SysML v2 shall specify services to version and store all the information related to an analysis, including analysis models and their execution results that may be stored in the SysML v2 model repository or in an external repository.	
SVC 3.5	Query Analyses and Results	SysML v2 shall specify services to query all the information related to an analysis, including querying and filtering analysis models and execution results that may be stored in the SysML v2 model repository or in an external repository.	

3.3.4 Model Management Services

3.3.4.1 Model Management Services Introduction

The background that led to the model management concept and requirements are described on the Model Management Wiki. The goals of the model management services are to manage the configuration of the system model, and manage the change process to update the system model. In addition to the system model, the scope of model management includes the links to other models and external data sources. This broader scope that includes the system model and the links is referred to as the integrated system model. Model management also encompasses management of other model constructs that are used to develop and maintain the system model such as those identified by the model construction services above. The model management concept is highlighted in the figure below.

Figure 3.42. Integrated System Model (ISM) Lifecycle Management Concepts (Source: SysML v2 RFP Model Management WG)



A key model management requirement is for each model element is to have a unique identifier, and for model elements to be capable of being versioned. The Universal Unique Identifier (UUID) was proposed as a potential standard for a globally unique id, along with the required metadata such as timestamp and its context (e.g., when created, changed, approved).

A model configuration item (MCI) refers to one or more model element ids, and is used to determine the level of the model that can be versioned. When any element referred to by an MCI is changed, the MCI is assigned a new version. An MCI can also refer to other MCI's. This general concept contrasts with many of the existing file-based versioning concepts that assign versions to entire models, and not to individual elements within a model. Providing more granular versioning capability will enable change histories to be defined at a more granular level, which provides more control over the configuration.

For SysML v2, there is a requirement for the metadata to be extensible. The intent is to identify what metadata is required to manage the system model, without over constraining where this metadata is stored, how it is stored, and whether the metadata is part of the SysML model. There is also a requirement to interchange the metadata in a standard way.

The primary model management services are to create versions, create baseline configurations, log changes, compare differences, merge capability that presents conflicting changes to the user to resolve, generate version histories, manage data protection controls such as data markings, and manage user authorizations to the data. Services are also required to extend the metadata.

3.3.4.2 Model Management Services Requirements

Table 3.21. Model Management Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 4	Model Management Services Requirement Group		
SVC 4.1	Model Management Services Group	The requirements in this group specify services to manage the model configuration and changes to model elements.	
SVC 4.1.01	Identify Scope	SysML v2 shall specify services to identify the model scope to be reviewed and/or updated by a task (i.e., a task change set).	
SVC 4.1.02	Provide Access	SysML v2 shall specify services to provide access permissions for identified users of a task to the model scope.	
SVC 4.1.03	Define MCI Definition Default Rules	SysML v2 shall specify services to define the rules to determine what level of model granularity will be versioned, which is referred to as a Model Configuration Item (MCI). **Supporting Information:** Examples include Container (i.e. Package), Block, Model Element	
SVC 4.1.04	Authorize Model Version Update	SysML v2 shall specify services to authorize MCI version updates.	
SVC 4.1.05	Create or Update MCI versions	SysML v2 shall specify services to create or update MCI versions.	
SVC 4.1.06	Log Change	SysML v2 shall specify services to log changes to model elements for a version.	
SVC 4.1.07	Compare and Identify Differences	SysML v2 shall specify services to identify differences between any two or more versions of the same MCI.	
SVC 4.1.08	Create Baseline Configuration	SysML v2 shall specify services to create a baseline configuration with MCIs.	
SVC 4.1.09	Create Branch Configuration	SysML v2 shall specify services to create a branch of a baseline configuration with MCIs.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 4.1.10	Update Branch with MCIs	SysML v2 shall specify services to update a branch of a baseline.	
SVC 4.1.11	Merge Branch	SysML v2 shall specify services to merge a branch to a trunk of a baseline or to another branch, and present conflicting changes to the user to resolve.	
SVC 4.1.12	Re-base Branch from Trunk	SysML v2 shall specify services to update a branch from a trunk baseline.	
SVC 4.1.13	Create Model Control	SysML v2 shall specify services to create the initial control of a model including the creation of a MCI and versioning.	
SVC 4.1.14	Add to Parent MCI	SysML v2 shall specify services to add additional model elements or MCIs to a parent MCI.	
SVC 4.1.15	Provide History	SysML v2 shall specify services to provide log change history that was created by the log change service.	
SVC 4.1.16	Model Integrity	SysML v2 in the model management services group shall NOT modify any system model content. **Supporting Information:** The model management metadata is separate from the user model.	
SVC 4.1.17	Timestamp generation	SysML v2 shall specify a service to provide a standard formatted timestamp with a context. **Supporting Information:** Example: timestamp= [time=2009-06-15T13:45:30; context=last-change] Refer to ISO 86010	
SVC 4.2	Manage Data Protection Control Services Group	The requirements in this group specify services to control markings of the model information (e.g., security classification, proprietary, ITAR, and others).	
SVC 4.2.1	Create Data Protection Controls	SysML v2 shall specify services to create data protection controls that include data classifications and data marking rules.	
SVC 4.2.2	Read Data Protection Controls	SysML v2 shall specify services to read data protection controls.	
SVC 4.2.3	Update Data Protection Controls	SysML v2 shall specify services to update data protection controls.	
SVC 4.2.4	Delete Data Protection Controls	SysML v2 shall specify services to delete data protection controls.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 4.3	Model Link Service	SysML v2 shall specify services to create, read, update, delete, and execute external links between SysML based system models and other structured data.	
SVC 4.4	Metadata Services Group	The intent of this set of services is to provide the capability to define new metadata terms that are needed by any of the SME service groups. Scope: Extending the required metadata elements that can be applied to model elements.	
SVC 4.4.1	Create Metadata Element	SysML v2 shall specify services to create new metadata elements to support capability extensions by any SME service group. **Supporting Information:** This would be similar to extending a metaclass with additional properties.	
SVC 4.4.2	Read Metadata Element	SysML v2 shall specify services to read metadata elements.	
SVC 4.4.3	Update Metadata Element	SysML v2 shall specify services to update metadata elements.	
SVC 4.4.4	Delete Metadata Element	SysML v2 shall specify services to delete metadata elements.	
SVC 4.4.5	Exchange Metadata Elements	SysML v2 shall specify services to exchange metadata elements. **Supporting Information**: Model exchange should include mechanism for preserving user defined metadata within the context of model exchange.	
SVC 4.4.6	MLM Metadata Persistence	SysML v2 shall specify services to provide persistent model management metadata either in the data model of authoring tool or in a separate repository owned by the service provider (applies to services that authoring tool utilizes).	

3.3.5 Workflow & Collaboration Services

3.3.5.1 Workflow & Collaboration Services Introduction

The background that led to the workflow and collaboration concept and requirements are described on the MBSE Workflow and Collaboration Wiki. The Workflow and Collaboration

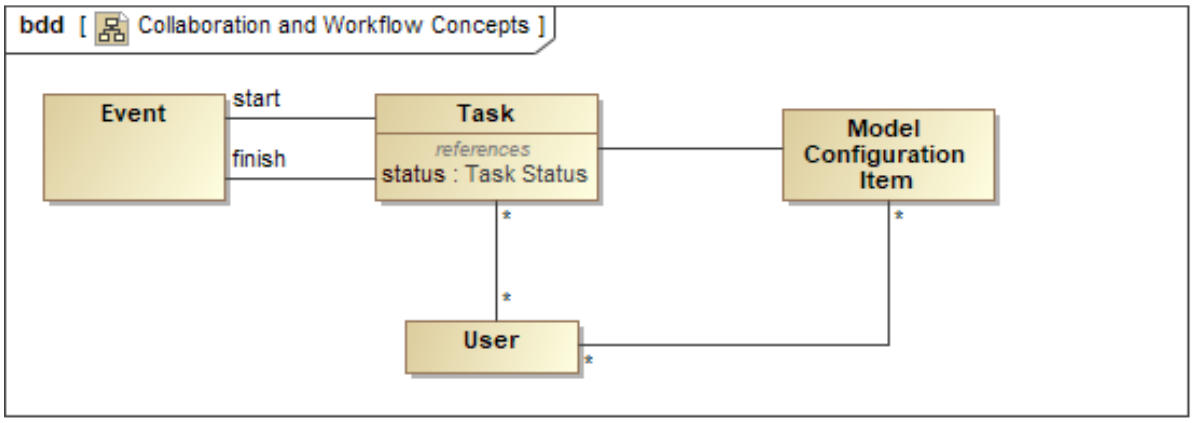
concept is defined in the context of an of an external workflow management capability that manages the overall engineering workflow.

The overall concept assumes that the MBSE practices are defined using a process modeling tool that can be a SysML tool or other specialized tool, and captured in a master practices repository. The practices are tailored to a particular project, and used as an input for project planning, execution, and monitoring. As part of the planning process, the tasks are assigned to roles, and roles are assigned to individuals to perform the modeling tasks.

The minimum requirements for SysML v2 are to provide services that support integration of the modeling tasks with external process definition and workflow management capabilities. In particular, SysML v2 should enable an external workflow environment to assign roles to specific users, accept notification to begin a task, and provide status/metrics on the performance and completion of the task.

The assignment of a user to a task should also include the scope of the model that the user must access to perform the task (i.e. the change set). This is indicated in the figure below by the relationship between the Task and User to the Model Configuration Item.

Figure 3.43. Workflow & Collaboration Concepts



3.3.5.2 Workflow & Collaboration Services Requirements

Table 3.22. Workflow & Collaboration Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 5	Workflow and Collaboration Services Group	The requirements in this group specify services to integrate with external workflow management capabilities and facilitate the execution of modeling tasks.	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 5.1	View Users	SysML v2 shall specify services to view available users.	
SVC 5.2	Start Task	SysML v2 shall specify services to create a specific task for a User.	
SVC 5.3	Task Status	SysML v2 shall specify services to provide user task state (e.g. completion) and metrics.	

3.3.6 Interoperability Services

3.3.6.1 Interoperability Services Introduction

The Interoperability Services support the interoperability requirements as defined in the interoperability section below.

3.3.6.2 Interoperability Services Requirements

Table 3.23. Interoperability Services Requirements

ID	Name	Requirement Text	SysML v1.x Construct
SVC 6	Interoperability Services Group	The requirements in this group specify services to support exchange of information using a SysML model.	
SVC 6.1	Model Transformation Service	SysML v2 shall specify services to create, read, update, delete, and execute model transformations specified as SysML models.	
SVC 6.2	SysML Version to Version Transformation	SysML v2 shall provide services to transform a model in a previous version of SysML to a model in the next version of SysML, beginning with the transformation from the current version of SysML v1 to SysML v2. **Supporting Information:** This includes the ability to transform the abstract syntax, concrete syntax and semantics. Some of the SysML v2 execution semantics are specified in other specifications including fUML, PSCS, and PSSM.	
SVC 6.3	Standard Read/Write Format	SysML v2 shall specify services to read and write a SysML model, its metadata, and its external links in the standard tool-independent interchange format as specified in the Language Architecture and Formalism requirement "Model Interchange".	

ID	Name	Requirement Text	SysML v1.x Construct
SVC 6.4	Structured Data Service	SysML v2 shall specify services to export and import structured data that includes, as a minimum, the comma delimited data format, requirements interchange format (include reference), HTML, open office, Office Open XML (ECMA 376).	

Appendix A References & Glossary Specific to this RFP

A.1 References Specific to this RFP

A.2.1 Bibliographic Citation List

The following documents are referenced in this document:

[1] Created for SECM - This citation indicates that this text was created specifically for the SECM and no other reference is known. Enter [1, created for SECM] at the end of the text field.

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[3] BKCASE Editorial Board. 2015. The Guide to the Systems Engineering Body of Knowledge (SEBoK), v. 1.5. R.D. Adcock (EIC). Hoboken, NJ: The Trustees of the Stevens Institute of Technology. Accessed DATE. www.sebokwiki.org. BKCASE is managed and maintained by the Stevens Institute of Technology Systems Engineering

Research Center, the International Council on Systems Engineering, and the Institute of Electrical and Electronics Engineers Computer Society.

[4] ISO/IEC 2008. Systems and Software Engineering -- System Life Cycle Processes. Geneva, Switzerland: International Organization for Standardization / International Electromechanical Commissions. ISO/IEC/IEEE 15288:2008 (E).

[5] ISO/IEC 2015. Systems and Software Engineering -- System Life Cycle Processes. Geneva, Switzerland: International Organization for Standardization / International Electromechanical Commissions. ISO/IEC/IEEE 15288:2015 (E).

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R.D. Hamelin, and, T. M. Shortell (Eds.). San Diego, CA: International Council on Systems Engineering. Published by John Wiley & Sons, Inc.

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[15] OMG Unified Modeling Language (OMG UML), Version 2.5, March 2015, OMG Document Number - formal/2015-03-01

[16] OMG Systems Modeling Language (OMG SysML), Version 1.4, September 2014, OMG Document Number: formal/2015-06-03

[17] ISO Online Browsing Platform (OBP), Terms and Definitions, https://www.iso.org/obp/ui/#home

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Expectations. In Handbook of Research on Multi-Agent Systems: Semantics and Dynamics of Organizational Models (p. 263-284) Hershey, PA: IGI Global.

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[26] OMG Systems Modeling Language (OMG SysML), Version 1.5, May 2017, OMG Document Number: formal/2017-05-0

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A.2.2 OMG Standards List

The following documents are referenced in this document:

[ALF] Action Language for Foundational UML™ (ALF ™)
http://www.omg.org/spec/ALF

[API2KB] Application Programming Interfaces (API) to Knowledge Bases (KB) RFP
http://www.omg.org/cgi-bin/doc.cgi?ad/2010-06-09

[BMM] Business Motivation Metamodel ™ (BMM™)
http://www.omg.org/spec/BMM

[BPMN] Business Process Model and Notation ™ (BPMN™)
http://www.omg.org/spec/BPMN

[DDS] Data Distribution Service ™ (DDS™)
http://www.omg.org/spec/DDS

[DMN] Decision Model and Notation ™ (DMN™)
http://www.omg.org/spec/DMN

[DD] Diagram Definition ™ (DD™)
http://www.omg.org/spec/DD

[FUML] Semantics of a Foundational Subset for Executable UML Models (FUML™)
http://www.omg.org/spec/FUML

[MOF] Meta Object Facility ™ (MOF™) Core
http://www.omg.org/spec/MOF/

[MOFVD] Versioning and Development Lifecycle ™ (MOFVD™)
http://www.omg.org/spec/MOFVD

[OCL] Object Constraint Language ™ (OCL™)
http://www.omg.org/spec/OCL

[PSCS] Precise Semantics of UML Composite Structures ™ (PSCS™)
http://www.omg.org/spec/PSCS

[PSSM] Precise Semantics of UML State Machines (PSSM)
http://www.omg.org/spec/PSSM

[QVT] Query View Transformation ™ (QVT™)
http://www.omg.org/spec/QVT

[ReqIF] Requirements Interchange Format (ReqIF ™)
http://www.omg.org/spec/ReqIF

[RAS] Reusable Asset Specification (RAS)
http://www.omg.org/spec/RAS

[S&R] Profile for Safety and Reliability
In process (POC Geoff Biggs)

[SBVR] Semantics of Business Vocabulary and Business Rules ™ (SBVR™)
http://www.omg.org/spec/SBVR

[SMOF] MOF Support for Semantic Structures ™ (SMOF™)
http://www.omg.org/spec/SMOF/

[SPEM] Software and Systems Process Engineering Metamodel ™ (SPEM™)
http://www.omg.org/spec/SPEM

[SysPISF] SysML Extension for Physical Interaction and Signal Flow Simulation (SysPISF)
http://www.omg.org/spec/SysPISF/1.0/Beta1/

[SysML] OMG Systems Modeling Language Version ™ (SysML®)
http://www.omg.org/spec/SysML/

[UAF] Unified Architecture Framework (UAF) previously UPDM
http://www.omg.org/spec/UAF

[UML] Unified Modeling Language ™ (UML®)
http://www.omg.org/spec/UML

[UTP] UML Testing Profile ™ (UTP™)
http://www.omg.org/spec/UTP

[XMI] XML Metadata Interchange ™ (XMI®)
http://www.omg.org/spec/XMI

A.2.3 Other Standards List

The following documents are referenced in this document:

[FMI] Functional Mock-Up Interface (FMI)
http://fmi-standard.org/

[STEP] ISO 10303-233:2012 (STEP)
https://www.iso.org/standard/55257.html

[ArchDes] ISO 42010 - Systems and software engineering - Architecture description
http://cabibbo.dia.uniroma3.it/asw/altrui/iso-iec-ieee-42010-2011.pdf

[SQuaRE] ISO/IEC 25062:2006(en) - Software engineering - Software product Quality Requirements and Evaluation (SQuaRE) - Common Industry Format (CIF) for usability test reports
https://www.iso.org/obp/ui/#iso:std:iso-iec:25062:ed-1:v2:en

[ISO 15288] ISO/IEC 15288:2015 - Systems and software engineering - System lifecycle processes
https://www.iso.org/obp/ui/#iso:std:iso-iec-ieee:15288:ed-1:v1:en

[ISO 15704] Industrial automation systems - Requirements for enterprise-reference architectures and methodologies
https://www.iso.org/obp/ui/#iso:std:iso:15704:ed-1:v1:en

[ISO 26550] ISO/IEC 26550:2015 - Software and Systems Engineering - Reference model for product line engineering and management
https://www.iso.org/obp/ui/#iso:std:iso-iec:26550:ed-2:v1:en

[ISO 80000] Quantities and units -- Part 1: General: ISO 80000-1:2009
https://www.iso.org/standard/30669.html

[ISO-TC184] Interoperability, integration, and architectures for enterprise systems and automation applications
https://www.iso.org/committee/54192.html

[HCD] ISO/DIS 9241-220.2(en) Ergonomics of human-system interaction - Part 220: Processes for enabling, executing and assessing human-centered design within organizations
https://www.iso.org/obp/ui/#iso:std:iso:9241:-220:dis:ed-1:v2:en

[SE Handbook] INCOSE Systems Engineering Handbook
http://www.incose.org/ProductsPublications/sehandbook

[OSLC] Open Services for Lifecycle Collaboration (OSLC)
http://open-services.net/

[SEBoK] Systems Engineering Body of Knowledge (SEBoK)
www.sebokwiki.org

A.2 Glossary Specific to this RFP

Abstract Syntax **-** Those aspects of the rules used in the formal specification of data which are independent of the encoding technique to represent the data (ISO 10161-1:2014(en), 3.3.1) [17, ISO OBP Definitions]

Activity Setup **-** The activity that takes place before an analysis can be executed. This includes:

1. Model the types of analyses that need to be performed on the system representation
2. Model the analysis objectives mathematically
3. Define the key parameters (KPPs/MoEs) being computed or patterns/anti-patterns to be matched.
4. Define mapping/transformation from system model to analysis model
5. Execute the model transformation - Create or generate analysis model based on mapping/transformation (tool-neutral or tool-dependent)

[1, created for SECM]

Alias **-** An assumed or additional name. [11, Merriam Webster on-line dictionary]

An additional name could include, an acronym, an abbreviated name, a less formal name or a name used in a different domain. [1, created for SECM]

Allocation Relationship **-** Allocate relationship provides a mechanism for associating elements of different types, or in different hierarchies, at an abstract level. Allocate is used for assessing user model consistency and directing future design activity. It is expected that an allocate relationship between model elements is a precursor to a more concrete relationship between the elements, their properties, operations, attributes, or sub-classes. [16, derived from SysML spec]

Alternative **-** a: a proposition or situation offering a choice between two or more things only one of which may be chosen a government facing the alternative of high taxes or poor highways

b: an opportunity for deciding between two or more courses or propositions the alternative of going by train or by plane

[11, Merriam Webster on-line]

Analysis **-** The systematic investigation of a real or planned system to compare, evaluate, and select candidate system architectures, and/or determine causes & resolutions of failures and exceptions. [SEBoK, NASA SE Handbook 2007].

An analysis activity may include evaluation by means of modeling/simulation, inspection, demonstration, test, or a combination of these. [1, created for SECM]

A systematic investigation of a real or planned system to determine the information requirements and processes of the system and how these relate to each other and to any other system. (ISO/IEC/IEEE 2009) [3, SEBoK Glossary]

Analysis Case **-** A situation requiring analysis investigation or action. [1, created for SECM]

Analysis Evaluation **-** The activity that occurs for an analysis case to evaluate the outcome data against the success criteria and determines an outcome. [1, created for SECM]

Analysis Infrastructure **-** All items needed to conduct the analysis effort, including tools, people, measurement devices, procedures, documentation and information. [1, created for SECM]

Analysis Model **-** The computation model used to calculate the system properties (relevant to the analysis) to meet the analysis objectives. An Analysis model could be computer-based executable model (e.g. Mathematica/MATLAB code or FEA/CFD model), or a model representing physical measurement on a prototype or actual system. For every analysis model, the following characteristics are modeled:

1. Language in which the model is formulated
2. Software used to formulate the model
3. Type of model
4. Result data from executing the model
5. Relationship to the system representation, e.g. design model. This relationship embodies the model transformations required to generate or update the analysis model from the system representation

[1, created for SECM]

Analysis Objective **-** Represents the objective of the analysis. The objective can be specified in the form of textual description and/or as an expression. When the objective is modeled using a set of math expressions their formal evaluation can be automated. The objective of an analysis is met if the expressions can be successfully evaluated by the information generated during the analysis. [1, created for SECM]

Analysis Outcome **-** The output created from executing a scenario of an analysis case. [1, created for SECM]

Analysis Plan **-** Information item that presents a systematic course of action for achieving a declared purpose, including when, how, and by whom specific activities are to be performed. (ISO/IEC/IEEE 15289:2011) [3, SEBoK Glossary]

Analysis Result **-** This concept represents the result of the analysis in terms of the evaluations of all the expressions in the Analysis Objective. An analysis is successful if its objective has been met. [1, created for SECM]

Analysis Subject **-** Represents the subject of the analysis being performed. Since the scope of system analysis spans across the lifecycle, the subject of the analysis could be either of the following:

- Design representation of the system, such as a digital mock-up (computer model) of a spacecraft being developed
- Prototype of the system, such as a scaled or real prototype of the spacecraft
- Deployed system, such as the actual spacecraft deployed in orbit.

[1, created for SECM]

Analyst **-** 1. A member of the technical community (such as a systems engineer or business analyst, developing the system requirements) who is skilled and trained to define problems and to analyze, develop, and express algorithms. IEEE Std. 1233-1998 (R2002) IEEE Guide for Developing System Requirements Specifications.3.1 (ISO/IEC/IEEE 24765:2010(en), 3.104) [17, ISO OBP Definitions]

Annotation **-** A note added by way of comment or explanation. [11, Merriam Webster on-line dictionary]

An annotation contains a text statement and can also contain one or more navigational links.

API **-** In computer programming, an application programming interface (API) is a set of subroutine definitions, protocols, and tools for building application software. A good API makes it easier to develop a computer program by providing all the building blocks, which are then put together by the programmer. [8, Wiki]

As-Built Realization - A description of how a specific Component Realization was actually built. [1, created for SECM]

As-Designed Realization - A description of the design of a Component Realization. [1, created for SECM]

Assumption - 3 a: an assuming that something is true <a mistaken assumption>b : a fact or statement (such as a proposition, axiom (see axiom 2), postulate, or notion) taken for granted [11, Merriam Webster on-line]

Axiomatic Semantics - Meanings for program phrases defined indirectly via the axioms and rules of some logic of program properties. [23, Denotational Semantics Lecture]

Baseline - An immutable MCI Configuration. A Baseline uniquely defines an "unchanged over time" set of MCIs with its associated versions and variants. Model Baselines are often used to freeze MCIs at critical points in the model development lifecycle. [1, created for SECM]

Basic 2D/3D Library - A digital library containing a collection of predefined model elements representing a set of reusable basic two and three dimensional geometric shapes that can be copied or reference while constructing a model. [1, created for SECM]

Batch Mode - User initiated operations for creating model constructs using an external collection of model element properties, operations and/or relationships. [1, created for SECM]

Behavior - The interaction between individual structural elements and their change of state over time. [1, created for SECM]

Case - b (1): a situation requiring investigation or action (as by the police) (2): the object of investigation or consideration

[11, Merriam Webster on-line dictionary]

Cause-effect Relationship - Cause-effect relationship relates a cause to an effect. The cause and effect are the ends of the relationship. Those ends may be any model element including states. [1, Created for SECM]

Change Log - A chronological listing of changes to an MCI. Each change log is associated to a version. [1, created for the SECM]

Comment - a: an observation or remark expressing an opinion or attitude critical comments constructive comments

b: a judgment expressed indirectly sees the film as a comment on modern values

[11, Merriam Webster on-line dictionary]

A Comment is a textual annotation that can be attached to a set of (Model) Elements. [15, UML Spec]

A comment can also contain navigational links from this element or text within this element to other model elements or external elements. [1, created for SECM]

Component **-** (1) An entity with discrete structure, such as an assembly or software module, within a system considered at a particular level of analysis. (ISO/IEC 1998)

(2) One of the parts that make up a system. (IEEE 2008)

(3) A set of functional services in the software, which, when implemented, represents a well-defined set of functions and is distinguishable by a unique name. (ISO/IEC 2008)

[3, SEBoK Glossary]

In systems terms, we use component as the generic term for the level of decomposition at which system elements are no longer considered complex, and for which specialist design disciplines can be used. [3, SEBoK Glossary Discussion]

Component Definition **-** A component presents interface ends and connects to other components via interface agreements, or exchange agreements. Components can also contain sub-components that connect with each other. [1, created for SECM]

Component Library **-** A digital library containing a collection of predefined model elements representing a set of reusable components that can be copied or reference while constructing a model. [1, created for SECM]

Component Realization **-** A component that provides a solution that is intended to conform to the component specification. [1, created for SECM]

Component Specification **-** A specification is defined as:

a: a detailed precise presentation of something or of a plan or proposal for something, usually used in plural [11, Merriam-Webster on-line]

A Component Specification provides the physical, behavioral, and interface specification for a component to be designed and built. [1, created for SECM]

Concept **-** An abstraction; a general idea inferred or derived from specific instances. (Oxford Dictionaries Online 2012) [3, SEBoK Glossary]

Concrete Syntax **-** Those aspects of the rules used in the formal specification of data that embody a specific representation of those data

ISO/IEC 2382:2015(en), 2123126 [17, ISO OBP Definitions]

Configuration Element **-** Element of a Configuration Model

A Configuration Element may contain (or make use of) other Configuration Elements thereby constituting an explicit, fully expanded hierarchical composition structure. [1, created for SECM]

Configuration Management **-** The process to manage and control system elements and configurations over the lifecycle as well as managing consistency between a product and its associated configuration definition. [5, ISO/IEC/IEEE 15288]

Configuration Model **-** A model that represents a fully expanded hierarchical composition structure for a particular configuration of a system and its interfaces.

The Configuration Model can be used in two ways:

1. As an explicit representation that is generated from a Definition Model with a set of configuration parameters for any Variability Choice, e.g. chosen multiplicity or usage expression, as well as possible filtering or pruning.
2. Direct use of the Configuration Model as a simple 'loosely' typed hierarchical composition structure.

For the case (2) it is in principle possible to generate a (best effort) modular / typed Definition Model with some heuristic algorithm that detects elements of the same type.

Note: It is possible that a Configuration Model is over specified or out of sync w.r.t. to its associated Definition Model, and vice versa. Tool implementations will need to handle this situation with rules, refactoring and synchronization functionality.

[1, created for SECM]

Conform Relationship **-** The view conforms to the specified rules and conventions detailed in the viewpoint. When this is done, the view is said to conform to the viewpoint. [26, SysML 1.5]

Connector Definition **-** A connector defines the way in which two components interact. That interaction may take the form of an exchange agreement or an interface agreement, or a combination. [1, created for SECM]

Constrained Element **-** This element is bound to one or more elements in the realization that is constrained by the requirement. The constrained element is used by the Constraint Evaluation to determine is the system satisfied the requirement as stated in the constraining element.

In a traditional textual requirement statement, this element is equivalent to the subject of the verb "shall" (or will, should, etc.). [1, created for SECM]

Constraining Element **-** The element contained in a requirement that is used to specify a constraint. This element can apply to any model element including properties, behaviors, etc. [1, created for SECM]

Constraint **-** An expression that can be evaluated to true or false. [1, created for SECM]

Constraint Evaluation **-** The result of evaluating a constraint between the constraining element and the constrained element. [1, created for SECM]

Container **-** A kind of model element that contains other model elements and applies scoping rules such as namespace rules to the contained elements.

Containers can contain other containers providing a mechanism to organize the model. [1, created for SECM]

Context **-** 1. Background, environment, framework, setting, or situation surrounding an event or occurrence. [13, BusinessDictionary.com]

Data Model **-** A Data Model is an abstract model that organizes elements of data and standardizes how they relate to one another and to properties of the real world entities.

A data model explicitly determines the structure of data. Data models are specified in a data modeling notation, which is often graphical in form. [2] [8, Wiki]

Data Protection Controls **-** Data Protection Controls are those metadata items associated with managing who can create, read, update and delete model elements. This includes managing access permissions, roles, data rights, and security markings. [1, created for SECM]

Decision **-** b: a determination arrived at after consideration: conclusion made the decision to attend graduate school [11, Merriam Webster on-line]

A determination arrived at after consideration of a selected choice amongst alternatives. [1, created for SECM]

Decision Criteria **-** Factors that will be will considered in making the decision. [1, Created fro SECM]

Declarative Semantics **-** Association of meaning that specifies what rather than how. Communication with declarative semantics specifies what actions should be brought out in an interaction, rather than how they are brought out. [22, Modeling Interactions via Commitments and Expectations]

Definition - a: a statement expressing the essential nature of something

b: a statement of the meaning of a word or word group or a sign or symbol dictionary definitions

c: a product of defining

[11, Merriam Webster on-line dictionary]

Definition Element - An element of a Definition Model

The set of Definition Element contained by a Definition Model can be regarded as the fundamental and uniquely identifiable, named building blocks from which system representations, i.e. architectures, can be constructed. Apart from a unique identifier and a human readable name a Definition Element defines the essence of what it represents through a set of named and typed features. [1, created for SECM]

Definition Model - A model that captures a composite hierarchy of typed elements that represent the definition of a system and its interfaces

A Definition Model represents a strongly typed, modular, hierarchical composite structure. It allows for inclusion of variation points so that it can represent a set of possible system variants. It also provides a generic structure to represent interfaces consisting of two Interface Ends and an Interface Connector.

It is a generic pattern that can be specialized into concrete modular decomposition representations for e.g. a functional / behavior architecture and / or a physical architecture.

System variation points can be included, e.g. for multiplicity ranges, inclusion or exclusion of subtrees, alternative composition with or without constraints, etc.

The Definition Model contains a bag of building blocks represented by Definition Elements that may directly use (i.e. one level deep) zero or more Direct Usage Features of other Definition Elements.

In many cases there is a need to unambiguously identify and reference more deeply nested usages, e.g. to introduce local override of feature values for a particular usage two or more levels down from a Definition Element or to define an interface connector between nested interface ends. For this purpose the Deeply Nested Usage Feature is made available.

If no features need to be overridden, redefined nor added at a usage more than one level deep, then a Definition Model constitutes a complete implicit definition of the decomposition structure provided that a single top element is identified. With that, it is

possible to automatically generate a corresponding Configuration Model that represents the full and explicit (deeply nested) expansion of the decomposition structure.

It is important to note that Deeply Nested Usage Features need only be created (and persisted) if there is a need to override feature values, (re)define features or reference usages at a deeply nested level. Otherwise their representation can be automatically derived 'on the fly' as their existence is fully implied by Definition Elements and Direct Usage Features only.

In case there are Variation Points present in the Definition Model, choices must be made within the range of possible variabilities in order to transform the Definition Model into a Configuration Model that represents a single actual variant that complies with the implicit definition represented by the Definition Model.

Using some heuristics, and perhaps with some human assistance, it is in principle also possible to devise an algorithm that can automatically derive a Definition Model from a given Configuration Model. This is attractive since it would allow a beginning system modeler to start with the simpler, more easy to understand Configuration Model and transform it to the more powerful and generalized Definition Model. Such a capability would also support use cases for reverse engineering of existing system architectures.

[1, created for SECM]

Denotational Semantics - Concerned with giving mathematical models of programming languages. Meanings for program phrases defined abstractly as elements of some suitable mathematical structure. [23, Denotational Semantics Lecture]

Dependency Relationship - A Dependency is a Relationship that signifies that a single model Element or a set of model Elements requires other model Elements for their specification or implementation. This means that the complete semantics of the client Element(s) are either semantically or structurally dependent on the definition of the supplier Element(s). [15, UML Spec]

Derived Relationship - A relationship that is derived from other relationships.

An example is a derived relationship from a transitive relationship where B relates to A and C relates to B, then C relates to A.

Another example is a connector between two composite parts that is derived from a connector between their nested parts. [1, created for SECM]

Design Constraint - One of the potential category requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be imposed during the design process. [1, created for SECM]

Domain Specific View **-** A domain view is one or more views that are defined using presentations, shapes and icons that are specific for that domain, such as electrical views, software views, and mechanical views. [1, created for SECM]

Element **-** A entity with a unique identifier including Model Elements, Links, Scripts, Constructs, Files, Data, [1, created for SECM]

Element Group **-** A mechanism for grouping various and possibly heterogeneous model elements. For example, it can group elements that are associated with a particular release of the model, have a certain risk level, or are associated with a legacy design. The semantics of Element Group is modeler-defined. [16, SysML Spec]

Element Group Relationship **-** Element Group Relationship relates an element group to a member of the group. Logical expressions can be applied to membership of the group, such as AND, OR, XOR, NOT, and conditional expressions like IF-THEN-ELSE and IF-AND-ONLY-IF. [1, created for SECM]

Environment **-** (1) Anything affecting a subject system or affected by a subject system through interactions with it, or anything sharing an interpretation of interactions with a subject system. (IEEE 1175.1-2002 (R2007), 3.6)

(2) The surroundings (natural or man-made) in which the system-of-interest is utilized and supported; or in which the system is being developed, produced or retired. (INCOSE 2010) [3, SEBoK Glossary]

Event **-** 1. Occurrence of a particular set of circumstances. ISO/IEC 16085:2006 (IEEE Std. 16085-2006), Systems and software engineering - Lifecycle processes - Risk management.3.2.

2. An external or internal stimulus used for synchronization purposes

[17, ISO OBP Definitions]

Explanation Relationship **-** This relationship is used between two elements to establish traceability between the element being rationalized, i.e. the conclusion, and the element justifying the conclusion, i.e. the rationale.

A conclusion element can be any type of element including elements such as blocks, requirements or relationships.

Typical rationale relationship elements include a derived or satisfy relationship.

Rationale elements can include a comment containing a text statement or an analysis.

[1, created for SECM]

Expression **-** In mathematics, an expression or mathematical expression is a finite combination of symbols that is well-formed according to rules that depend on the context. Mathematical symbols can designate numbers (constants), variables, operations, functions, brackets, punctuation, and grouping to help determine order of operations, and other aspects of logical syntax. [8, Wiki]

External (Resource) Collection **-** A file based or database or link based mechanism to persist descriptions of model elements. [1, created for SECM]

External Element **-** An entity external to the containing model or the SME. This external entity can include items such as a file, web page, or a model element in another model [1, created for SECM]

Formal Requirement Statement **-** A formal requirement captures all aspects of a requirement in a machine readable form, vs. text in a Textual requirement. This allows requirements to be used to automate tasks associated with validation of requirement information, verification of requirements and the use of the requirement parameters during system analysis.

Transformation of a textual requirement to a new formal requirement is one means of deriving a formal requirement. A textual view of a set of selected requirements is very useful to a user performing analysis or for a review. [1, created for SECM]

Formalism **-** A description of something in formal mathematical or logical terms. [24, Oxford Living Dictionaries, "formal, n."

Function **-** (1) A system outcomes which contribute to goals or objectives. To have a function, a system must be able to provide the outcome through two or more different combinations of elemental behavior. (Ackoff 1971)

(2) An action, a task, or an activity performed to achieve a desired outcome. (Hitchins 2007)

(3) A broad work area encompassing multiple related disciplines (e.g., Engineering, Finance, Human Resources, etc.). (Created for SEBoK)

(4) A function is defined by the transformation of input flows to output flows, with defined performance. (Created for SEBoK)

[3, SEBoK Glossary]

Functional Requirement **-** One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a functional requirement. [1, created for SECM]

Generalization Relationship **-** A Generalization is a taxonomic relationship between a more general Classifier and a more specific Classifier. Each instance of the specific Classifier is also an instance of the general Classifier. The specific Classifier inherits the features of the more general Classifier. A Generalization is owned by the specific Classifier. [15, UML 2.5 Spec]

Geometric View **-** The geometric view is intended to specify geometric envelopes and requires concepts of shape and coordinate system. Refer to STEP standards. [1, created for SECM]

Hardware **-** 1. Physical equipment used to process, store, or transmit computer programs or data. 2. All or part of the physical components of an information system. ISO/IEC 2382-1:1993, Information technology - Vocabulary - Part 1: Fundamental terms.01.010.07 cf. software [17, ISO OBP Definitions]

Hyperlink **-** A hyperlink is a reference to data that the reader can directly follow either by clicking, tapping, or hovering. A hyperlink points to a whole document or to a specific element within a document. Hypertext is text with hyperlinks. [8, Wiki]

In a model links can also exist between model elements or information within in a model element such as values within an element, e.g. text within a definition. [1, created for SECM]

Individual Element **-** An element of an Individual Model

An Individual Element typically has an identifier that uniquely identifies that element, e.g. a serial number, a batch number, or an effectivity.

An Individual Element may be associated with a "slot" in the Configuration Model as represented by a Configuration Element or it may represent a spare part that is not (yet) integrated into a larger whole. [1, created for SECM]

Individual Model **-** A model that is a digital representation of an individual system or product that actually or potentially exists in the real world.

An Individual Model can be regarded as a "digital record" of the state of an individual system or product that was built according to a particular Configuration Model for e.g. development testing, verification, shipping, deployment or operation. Sometimes such a model is also known as a "digital twin". [1, created for SECM]

Integrated System Model **-** Contains the information about the system at any given stage during its lifecycle. It includes the system model and model-based connections between the system model and the various domain-specific models, such as CAD and CAE models that describe various aspects of the system and its sub-systems [27, SLIM Part 1] [28, SLIM Part 2]. The connections between the System Model (or model elements) and domain-specific models (or model elements) may have different

behaviors [4, Intro to SLIM], such as (1) reference connections for basic traceability, (2) data map connections for exchange for parameter values, (3) function wrap connections for wrapping executable code in system model elements, and (4) model transform connections for generating and synchronizing model structures bi-directionally. [1, created for SECM]

Interactive Mode - User initiated operations using the graphical interface of the SysML user interface to interact with the modeling tool, for example to create, update, modify and delete model constructs and to maintain the model. [1, created for SECM]

Interactive Viewpoint - An interactive viewpoint provides visualization services that allows the user to adjust the view to meet the specific user's needs at the time. This interactive behavior can include services such as support for auto-layout, dynamic interactive visualization and manual diagram layout capability. The user will need to adjust the select scope of model being viewed, filters information content of the view, zoom in and out of specific areas of the view and the ability to specify which diagram layers are included. A diagram layers that consist of a group of diagram elements. Each layer can be included or removed, be assigned colors or offsets, etc.). [1, created for SECM]

Interface - 1. A relationship that enables the physical and functional interaction between structural elements that includes two (2) interface ends, the connection between them, and any constraints on the interaction. [1, created for SECM]

2. A shared boundary between two functional units, defined by various characteristics pertaining to the functions, physical signal exchanges, and other characteristics. (ISO/IEC 1993)

3. A hardware or software component that connects two or more other components for the purpose of passing information from one to the other. (ISO/IEC 1993)

4. To connect two or more components for the purpose of passing information from one to the other. (ISO/IEC/IEEE 200)

[3, SEBoK Glossary]

Interface Agreement Definition - Specifies the rules that govern the exchange of items flowing between two components.

A type of exchange agreement is a communication protocol.

In telecommunications, a communications protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity. These are the rules or standard that defines the syntax, semantics and synchronization of communication and possible error recovery methods. Protocols may be implemented by hardware, software, or a combination of both.

[8, Wiki, Communications Protocol]

Interface End Definition - An interface agreement specifies the rules that govern the parametric relationships between two components. A type of interface agreement is a set of simultaneous equations. [1, created for SECM]

Interface Medium Definition - An interface medium represents the transmission medium between components. Like components, it presents interface ends and connects to other components via interface agreements, or exchange agreements. [1, created for SECM]

Interface Requirement - One of the potential category requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be associated with an interface. [1, created for SECM]

ISM - Acronym for Integrated System Model. See Integrated System Model for the definition. [1, created for SECM]

Item Definition - Describes an item, physical or information, which is exchanged between components. [1, created for SECM]

Keyword - Assigns a key word to any model element as a lightweight extension mechanism.

It is an inheritable feature such that any sub-class will inherit this keyword. It is similar to a very lightweight usage of a stereotype at the user model level and not at the metamodel level. [1, created for SECM]

Language Binding - In computing, a binding from a programming language to a library or operating system service is an application programming interface (API) providing glue code to use that library or service in a particular programming language. [8, Wiki]

Layered Interface - A layered interface is a set of connectors that are related to each other, and that connect the same components. Each layer has its own interface or exchange agreements, and all agreements must be true in isolation and combination for the layered interface as a whole to work properly. Each layer typically addresses a distinct set of concerns. Data or physical material undergoes a transformation when it moves from one layer to an adjacent one. Data transfer within a given layer is called an exchange, and between layers is called a transformation. [1, created for SECM]

Layout Definition - A layout definition defines how the view will be organized and presented. It applies to graphical symbols, tables, serialized data, etc. It can include non-model info such as a backgrounds. [1, created for SECM]

Machine-readable Data - Machine-readable data is data (or metadata) which is in a format that can be understood by a computer. [8, Wiki]

Mapping **-** Specification of a mechanism for transforming the elements of a model conforming to a particular metamodel into elements of another model that conforms to another (possibly the same) metamodel. [33, OMG RFP Template]

Mapping Rules **-** A set of rules that define how the elements of a model conforming to a particular metamodel are transformed into elements of another model that conforms to another (possibly the same) metamodel. [1, created for SECM]

Mathematical Logic **-** An extension of the formal method of mathematics to the field of logic. [19, Mathematical Logic, Hilbert & Ackerman]

MCI **-** MCI is an acronym for Model Configuration Item. See Model Configuration Item for the definition. [1, created for SECM]

MCI Configuration **-** A set of MCIs with their associated Versions and Variants. Within a specific Configuration, every MCI has a single and unique Version/Variant. A configuration is itself a MCI. [1, created for SECM]

Meta Object Facility **-** This International Standard provides the basis for metamodel definition in OMG's family of MDA languages and is based on a simplification of UML2's class modeling capabilities. In addition to providing the means for metamodel definition it adds core capabilities for model management in general, including Identifiers, a simple generic Tag capability and Reflective operations that are defined generically and can be applied regardless of metamodel. [31, MOF Spec]

An OMG standard, closely related to UML, that enables metadata management and language definition. [33, OMG RFP Template]

Metadata **-** Metadata is "data that provides information about other data". Two types of metadata exist: structural metadata and descriptive metadata. Structural metadata is data about the containers of data. Descriptive metadata uses individual instances of application data or the data content.

Metadata is defined as the data providing information about one or more aspects of the data; it is used to summarize basic information about data which can make tracking and working with specific data easier. Some examples include:

- Means of creation of the data
- Purpose of the data
- Time and date of creation
- Creator or author of the data
- Location on a computer network where the data was created
- Standards used
- File size

[8, Wiki, Metadata]

Metamodel - A metamodel or surrogate model is a model of a model, and metamodeling is the process of generating such metamodels. [8, Wiki]

MLM - Acronym for Model Lifecycle Management. See Model Lifecycle Management for the definition. [1, created for SECM]

Model - A representation of one or more concepts that may be realized in a physical world. [20, A Practical guide to SysML]

Model Collection - A collection of model elements and/or modeling constructs used to construct the system model. [1, created for SECM]

Model Configuration Item - A specific portion of the system model (content and granularity) that is maintained in a controlled fashion, i.e. has a unique ID and version history. MCI can be defined in different granularities, from an individual fine grained Model Element, a set of Model Elements, a set of Elements, to the entire Model. Any MCI can contain another MCI. [1, created for SECM]

Model Constructor - A model element or other entity used to construct a system model that includes model patterns, queries, rules and expressions, transformations, and links to external data elements. [1, created for SECM]

An element used to construct a system model. The model constructor can include elements such as model patterns, queries, rules and expressions, transformations, and links to external data elements or any combination of them. [1, created for SECM]

Model Element - A constituent of a model. [15, UML Spec]

Model elements include things such as entities, relationships, properties, behaviors, multiplicities, comments, model organizational elements, etc. In the UML modeling language this is referred to as an "Element". [1, created for SECM]

Because of the extensive use of the word "Element" in Systems Engineering the word "Model" was added to this term so as to express more specifically its intended use. [1, created for SECM]

Model Library - A library is a collection of sources of information and similar resources, made accessible to a defined community for reference or borrowing. [8, Wiki]

A model library is a digital library containing a collection of predefined model elements representing a set of reusable components that can be copied or reference while constructing a model. [1, created for SECM]

Model Lifecycle Management **-** Manages the Engineering Change Process to provide Proposed Changes in response to Engineering Change Requests from the Formal Release Change Process. [1, created for SECM]

Model Pattern **-** (1) An expression of an observed regularity. (Alexander 1979)

(2) A representation of similarities in a set or class of problems, solutions, or systems. (Alexander 1979)

(3) Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice. (Alexander 1979)

[3, SEBoK Glossary]

A Model Pattern is a specification of a set of model elements including their relationships that can be used (i.e., applied) to create a conforming model fragment (e.g., an interface pattern). [1, created for SECM]

Model Repository **-** The model repository is located within the SME context and contains the data such as that associated with system models, analyses data, metadata, reuse libraries and persistent view data. [1, created for SECM]

Model Transformation **-** A mapping between two modeling languages that enables a model expressed in one modeling language to be expressed in whole or in part in the other modeling language. (Created for SEBoK) [3, SEBoK Glossary]

Model Validation **-** The process of ensuring the model correctly represents the domain or system-of-interest. (Friedenthal 2009) [3, SEBoK Glossary]

Model-Theoretic Semantics **-** An account of meaning in which sentences are interpreted in terms of a model of, or abstract formal structure representing, an actual or possible state of the world: compare possible world. Usually, at least, an account of truth conditions; i.e. sentences are interpreted as true or false in such a model. [32, Oxford Dictionary of Linguistics]

MOF **-** Acronym for Meta Object Facility. See Meta Object Facility for the definition. [1, created for SECM]

Navigation Relationship **-** d: an identifier attached to an element (as an index term) in a system in order to indicate or permit connection with other similarly identified elements; especially: one (as a hyper link) in a computer file [11, Merriam-Webster]

A Navigational Link is one that establishes a navigable connection from a model element or text within a model element to an entity internal or external to the containing

model. This could be a connection to an entity within the SME or external to the SME. [1, created for SECM]

The connections may have different behaviors, such as (1) reference connections for basic traceability, (2) data map connections for exchange for parameter values, (3) function wrap connections for wrapping executable code in system model elements, and (4) model transform connections for generating and synchronizing model structures bi-directionally. [29, Into to SLIM]

Operational Semantics **-** Meanings for program phrases defined in terms of the steps of computation they can take during program execution. [23, Denotational Semantics Lecture]

Originator/Author Attribute **-** The originator/author is the person responsible for entering the requirement. [14, Guide Writing Requirements, 5.3.3]

Owner Attribute **-** Identifies the person or element of the organization that maintains the requirement, who has the right to say something about this requirement, approves changes to the requirement, and reports the status of the requirement. [14, Guide Writing Requirements, 5.3.5]

Performance Requirement **-** One of the potential category requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a performance requirement. [1, created for SECM]

Physical Requirement **-** One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a physical related requirement. [1, created for SECM]

PIM **-** Acronym for Platform Independent Model. See Platform Independent Model for the definition. [1, created for SECM]

Plan Verification Activity **-** An activity that creates a verification plan for the verification case. [1, created for SECM]

Platform Independent Model **-** A model of a subsystem that contains no information specific to the platform, or the technology that is used to realize it. [33, OMG RFP Template]

A platform independent model (PIM) is a model of system or business system that is independent of the specific technological platform used to implement it. [8, Wiki]

Platform Specific Model **-** A model of a subsystem that includes information about the specific technology that is used in the realization of it on a specific platform, and hence possibly contains elements that are specific to the platform. [33, OMG RFP Template]

Precondition Expression **-** Something that must exist or happen before something else can exist or happen [11, Merriam-Webster on-line definition]

Types of preconditions can include:

- Property values
- Events
- Textual Statements
- Provided in external referenced documents

[1, created for SECM]

Priority Attribute **-** This is how important the requirement is to the stakeholders. It may not be a critical requirement (that is, one the system must possess or it won't work at all), but simply something that the stakeholder(s) hold very dear. Priority may be characterized in terms of a level (1, 2, 3 or high, medium, low). Priority may be inherited from a parent requirement. High priority requirements must always be met for the project to be successful; lower priority requirements may be traded off when conflicts occur or when there are budget or schedule issues. [14, Guide Writing Requirements, 5.3.20]

Problem **-** A Problem is a deficiency, limitation, or failure to satisfy a requirement or need or cause some other undesired outcome or effect from the perspective of a stakeholder. It may be used to capture problems identified during analysis, design, verification, or manufacture and associate the problem with the relevant model elements. [16, derived from SysML spec]

Process Requirement **-** One of the potential category requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be imposed on a process that is to be used during a development, manufacturing, support or maintenance process. [1, created for SECM]

Property **-** Any named, measurable or observable attribute, quality or characteristic of a system or system element. (OMG 2003) [3 SEBoK Glossary]

Note: SEBoK defined term was for System Property. It was changed to Property so it could be used at multiple levels, i.e. element, System Element and System.

PSM **-** Acronym for Platform Specific Model. See Platform Specific Model for the definition. [1, created for SECM]

Query **-** A precise request for information retrieval with database and information systems. [8, Wiki]

Query Language **-** Query languages are computer languages used to make queries in databases and information systems. [8, Wiki]

Query Method - A query method provides the functionality to query the models and associated metadata. [1, created for SECM]

Rationale - Argument that provides the justification for the selection of an engineering element. (Faisandier 2012) [3, SEBoK Glossary]

Realization Relationship - Realization is a specialized Abstraction relationship between two sets of model Elements, one representing a specification (the supplier) and the other represents an implementation of the latter (the client). Realization can be used to model stepwise refinement, optimizations, transformations, templates, model synthesis, framework composition, etc. [15, UML Spec]

Realized Element - An element within the realization component that is constrained by the constraining element. [1, created for SECM]

Reference Information - b: something (such as a sign or indication) that refers a reader or consulter to another source of information (such as a book or passage). [11, Merriam Webster on-line dictionary]

This text can contain navigational links from this element or text within this element to the actual referenced material. [1, created for SECM]

Reference Model - A reference model in systems, enterprise, and software engineering is an abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts produced by an expert or body of experts in order to encourage clear communication. A reference model can represent the component parts of any consistent idea, from business functions to system components, as long as it represents a complete set. This frame of reference can then be used to communicate ideas clearly among members of the same community. [8, Wiki]

Refine Relationship - From UML 2.5, Refine Relationship Definition

Specifies a refinement relationship between model elements at different semantic levels, such as analysis and design. The mapping specifies the relationship between the two elements or sets of elements. The mapping may or may not be computable, and it may be unidirectional or bidirectional. Refinement can be used to model transformations from analysis to design and other such changes. [15, UML]

Relationship - The way in which two or more things are connected. [11, Merriam-Webster on-line] When the Relationship property "iisDirected" is true the relationship is a directed relationship. A directed relationship is a relationship between a source model Element and a target model Element. [1, created for SECM]

Reliability Requirement - One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a reliability related requirement. [1, created for SECM]

Rendering Method - A rendering provides the functionality to generate a view this includes rendering in any combination of a tabular, serialized, graphical and document form. [1, created for SECM]

Required/Desired - This is a property of the formal requirement statement that defines if the requirement is a mandatory (required) requirement or a desired requirement from a customer perspective. In textual requirement statements the verb "shall" or "will" are typically used, respectively, to do this. When a textual form of the formal requirement statement is automatically generated then this verb will be used in the textual statement. [1, created for SECM]

Requirement - This concept represents a usage of a Requirement Definition and is therefore typed by a Requirement Definition. [1, created for SECM]

Requirement Attribute Library - A digital library containing a collection of predefined model elements representing a set of reusable requirement attributes that can be copied or reference while constructing a model.

This collection should include all attributes and types defined in the INCOSE Requirements Writing Guide (see reference14).

The intent is to make this library available to each organization and/or project to allow that organization or project to select which best fit their workflow needs.

[1, created for SECM]

Requirement Attribute - An attribute is additional information included with a requirement statement, which is used to aid in the management of that requirement. [14, Guide Writing Requirements, Definitions)

Requirement Context Element - An element that is referenced in the formal requirement statement that is contained within the context of the constraining element. [1, created for SECM]

Requirement Decompose Relationship - A decompose relationship is established from a requirement group to a requirement. The intent is to add constraints. There can be 1 or more decompose relationships from a requirement group. They are used to identify the set of requirements within a requirement group. [1, created for SECM]

Requirement Definition - Statement that identifies a product* or process operational, functional, or design characteristic or constraint, which is unambiguous, testable or measurable, and necessary for product or process acceptability. (ISO/IEC 2007)

*includes product, service, or enterprise. [3, SEBoK Glossary]

Requirement Derive Relationship - A derived relationship imposes constraints to meet a higher level constraint. A derived relationship indicates a requirement has been added. It can be used in two ways;

1. A relationship between a higher architectural level requirement and one or more requirements derived in lower architectural components.
2. A relationship between 2 requirements on the same architectural level where one constraining element constrains another.

[1, created for SECM]

Requirement Group - A grouping or organization of requirements. This can be an entity of a specification that contains a set of related requirements or it can any grouped set of requirements to facilitate any analysis task.

In a black box specification a requirement context could be a functional items, external interfaces, or topic areas such as security, safety, design constraints, etc. In a white box requirement a context could also be a sub-components.

The context can contain other related supporting information to help understand the requirements such as examples from other systems.

[1, created for SECM]

Requirement Identifier - This is an identifier that uniquely identifies a requirement from other requirements, which can be either a number or mixture of characters and numbers used to refer to the specific requirement. This identifier is not a paragraph number.

It can be a separate identifier or automatically assigned by whatever Requirement Management Tool (RMT) the organization is using. This identifier is used once and never reused.

An identifier that is unique is also needed to link requirements in support of the flow down of requirements (allocation), traceability, and to establish peer-to-peer relationships. Some organizations include in the identifier codes that relate to the SOI to which the requirement applies: e.g., [SOI] 1234.

[14, Guide Writing Requirements, 5.3.1]

This is not the same as the Universally Unique Identifier (UUID) that every model element contains. This identifier should be unique across all requirements and can be tailored to meet a specific organization's needs. This identify typically includes some intelligence built into the number to help humans relate to its context (for example CR_100 for a customer requirement, where CR_ is a user-defined prefix unique to a requirement specification, and 100 is tool generated). [1, created for SECM]

Requirement Status Attribute **-** This requirement attribute is intended to maintain the current status of the requirement. Typical values can include "draft", "ready for review", "accepted", "rejected", "implemented" and "verified".

A requirement can continue to change after being accepted, implemented and/or verified. This change control management is typically managed via the same change control process as other model elements. [1, created for SECM]

Requirement Type/Category **-** Each organization will define types or categories to which a requirement fits, based on how they may wish to organize their requirements. The Type/Category field is most useful because it allows the requirements database to be viewed by a large number of designers and stakeholders for a wide range of uses. [14, Guide Writing Requirements, 5.3.25]

Restricted Requirement Statement **-** A specific type of Textual Requirement Statement, specified by using a restricted/controlled natural language that puts restrictions on grammar (which can be realized by templates and patterns) and vocabulary (by using e.g., pre-defined keywords). Restricted Requirement Statements (RRS) strikes a balance between practicality and level of automation, bridges the gap from informal requirements specifications in natural language to formal, precise, and analyzable specifications. [1, created for SECM]

Result Expression **-** This is the expression that determines the boundary used by the Constraint Evaluation. This boundary expression can be as simple as a text statement or define a volume in three-dimensional space. It can be presented in many forms including a table, equation, multidimensional graph or text. [1, created for SECM]

Revision **-** A state associated with the lifetime of a MCI at a given point in time, as designated by the formal release change process. [1, created for SECM]

Risk Attribute **-** A risk value assigned to each requirement based on risk factors. Requirements that are at risk include requirements that fail to have the set of characteristics that all well-formed requirements must have: necessary, singular, conforming, appropriate, correct, unambiguous, complete, feasible, and verifiable. Risk can also address feasibility/attainability in terms of technology, schedule, and cost. If the technology needed to meet the requirement is new with a low maturity, the risk is higher than if using a mature technology used in other similar projects. The requirement can be high risk if the cost and time to develop a technology is outside what has been planned for the project. Risk may be inherited from a parent requirement. [14, Guide Writing Requirements, 5.3.22]

Safety Requirement **-** One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a safety related requirement. [1, created for SECM]

Satisfy Relationship - A relationship between a requirement and the constrained element (realized element) or its context (the container for the realized element), which asserts the constraint evaluation is true between the constraining element and the constrained element.

There are other terms that are sometimes used for the term satisfy such as conforms, realize and specify. For this effort we have defined these terms as follows:

- The terms realize and conforms are synonymous. Both of these terms are essentially defined as an abstraction of the set of satisfy relationships between the constrained elements and the requirements in a component spec. See the definition for conforms relationship for more information. We chose to use conforms vs. realize.
- The term specify is the opposite of conforms and realize, i.e. converses of each other. Therefore if specify relationship did exist it would go from a Component Specification to the Component Realization. We chose to use one term not both and chose conforms vs specify.

[1, created for SECM]

Scenario Definition - The definition of the procedural steps required to perform the analysis scenario. [1, created for SECM]

Security Requirement - One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a security related requirement. [1, created for SECM]

Semantics - The rules by which syntactic expressions and model elements are assigned meaning. (ISO 13537:2010, 3.2.3.14) [17, ISO OBP Definitions]

Service - A service is a discrete unit of functionality that can be accessed remotely and acted upon and updated independently, such as retrieving a credit card statement on-line.

A service has four properties according to one of many definitions of SOA:

1. It logically represents a business activity with a specified outcome.
2. It is self-contained.
3. It is a black box for its consumers.
4. It may consist of other underlying services.

[8, Wiki, Service-oriented architecture]

SME - Acronym for System Modeling Environment. See System Modeling Environment for the definition.

SMOF **-** MOF Support for Semantic Structures. This extension to MOF modifies MOF 2 to support dynamically mutable multiple classifications of elements and to declare the circumstances under which such multiple classifications are allowed, required, and prohibited. [30, OMG SMOF]

Software **-** All or part of the programs, procedures, rules, and associated documentation of an information processing system. (ISO/IEC 2382-1:1993) [3, SEBoK Glossary]

Specify Relationship **-** The Specify Relationship assumes that the realization has (or will) provided a satisfaction relationship from its constrained elements to each of the applicable requirements in the Component Specification. It can be thought of as a group of satisfied relationships.

The "conforms to" connection will be able to specify what part, or subset of requirements, of the specification are applicable. This can be done by identifying each requirement ID or by identifying one or more requirement groups IDs.

See the definition for the satisfy relationship to see the distinction in the terms satisfy, conforms, realize and specify, as defined for this effort.

[1, created for SECM]

Stakeholder **-** (1) Individual or organization having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations (ISO/IEC/IEEE 2015)

(2) Individual or organization having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations; N.B. Stakeholders include, but are not limited to end users, end user organizations, supporters, developers, producers, trainers, maintainers, disposers, acquires, customers, operators, supplier organizations and regulatory bodies. (ISO/IEC June 2010)

(3) An individual, team, or organization (or classes thereof) with interests in, or concerns relative to, a system. (ISO/IEC 2007)

(4) A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives. (Freeman 1984)[3, SEBoK Glossary]

Standard View **-** A standard view is a SysML defined diagram type. They may or may not be the same set that were defined for SysML 1.x. [1, created for SECM]

Structured Data **-** Structured data refers to information that has a high level of organization such as in a pre-defined data model, images, lists, spreadsheets, relational databases, etc. Structured data is data that has been organized into a formatted repository so that its elements can be made addressable for more effective processing

and analysis. [Derived from WhatIs.com, 29 Nov 2016, http://whatis.techtarget.com/definition/structured-data].

Supportability Requirement **-** One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a supportability related requirement. [1, created for SECM]

Supporting Information **-** Supporting Information provides additional information to help better understand the intent of a model element and specifically for a requirement or requirement group. This information can include items such as an introduction to a set of requirements, one or more goals, a reference to further readings, justification, rationales, examples, diagrams, pictures, graphs, tables, etc. In addition it can include navigational links from this element or text within this element. [1, created for SECM]

Syntax **-** Structure of expressions in a language, and the rules governing the structure of a language; the relationships among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (ISO/PAS 16917:2002(en), 3.2.68) [17, ISO OBP Definitions]

SysML **-** The OMG Systems Modeling Language (OMG SysMLTM) is a general-purpose language for systems engineering applications.

SysML supports the specification, analysis, design, verification, and validation of a broad range of complex systems.

These systems may include hardware, software, information, processes, personnel, and facilities. [16, derived from SysML spec]

SysML v2 Metamodel **-** A model of a SysML model. [1, created for SECM]

System **-** (1) A set of elements in interaction. (von Bertalanffy 1968)

(2) Combination of interacting elements organized to achieve one or more stated purposes (ISO/IEC/IEEE 15288:2015)

[3, SEBoK Glossary]

System Context **-** (1) Describes the system relationships and environment, resolved around a selected system-of-interest. (Flood and Carson 1993)

(2) Diagram defining the highest level view of a system in its environment. (Flood and Carson 1993)

[3, SEBoK Glossary]

System Element - A member of a set of elements that constitutes a system. A system element is a discrete part of a system that can be implemented to fulfill specified requirements. A system element can be hardware, software, data, humans, processes (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials, and naturally occurring entities (e.g., water, organisms, minerals), or any combination. (ISO/IEC 15288:2015) [3, SEBoK Glossary]

System Model - (3) A simplified representation of a system at some particular point in time or space intended to promote understanding of the real system. (Bellinger 2004)

(4) An abstraction of a system, aimed at understanding, communicating, explaining, or designing aspects of interest of that system (Dori 2002)

(5) A selective representation of some system whose form and content are chosen based on a specific set of concerns. The model is related to the system by an explicit or implicit mapping. (Object Management Group 2010)

[3, SEBoK Glossary]

System Model Management - Model Management Services for the Integrated System Model (ISM). It does not replace the linked model's native configuration management tool. [1, created for SECM]

System Modeling Environment - The System Modeling Environment (SME) is the part of the overall Model-Based Engineering (MBE) environment that systems engineers use to perform model-based systems engineering (MBSE) and interact with other members of the development team. The SME must implement the SME services to provide the functionality needed to enable systems engineers and others to evolve the system model throughout the lifecycle. [21, Insight Article Part 2]

Task - A piece of work to be undertaken. [1, Created for SECM]

Task Status - The current situation (state) for a specific task (e.g. not started, stage of completeness, completed successfully, etc.) [1, Created for SECM]

Textual Requirement Statement - The traditional "shall" textual statement used to state a requirement. [1, created for SECM]

Timestamp - A sequence of characters or encoded information identifying when a certain event occurred, including the date and time of day. The timestamp refers to digital date and time information attached to digital data. For example, computer files contain timestamps that tell when the file was last modified. [8, Wiki]

A timestamp should be represented using a common, time zone independent format that includes resolution and context such as UTC. Format example: time=2009-06-15T13:45:30; context=last change [1, created for SECM]

UML - Acronym for Unified Modeling Language. See Unified Modeling Language for the definition. [1, created for SECM]

UML Profile - A standardized set of extensions and constraints that tailors UML to particular use. [33, OMG RFP Template]

Uncategorized Requirement - One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies that categorizing requirements is part of the organization's process but the task has not been completed. [1, created for SECM]

Unified Modeling Language - The objective of the Unified Modeling Language (UML) is to provide system architects, software engineers, and software developers with tools for analysis, design, and implementation of software-based systems as well as for modeling business and similar processes. [15, UML Spec] An OMG standard language for specifying the structure and behavior of systems. The standard defines an abstract syntax and a graphical concrete syntax. [33, OMG RFP Template]

Unique Identifier - This unique identifier is assigned to every element. This identifier must be unique universally, that is within the containing model, within the SME and external to the SME. [1, created for SECM]

Unit Under Verification - A system or part of a system that is the subject of a verification procedure. [1, created for SECM]

Units Library - A digital library containing a collection of predefined model elements representing a set of reusable units and quantity kinds that can be copied or reference while constructing a model. [1, created for SECM]

URI - In information technology, a Uniform Resource Identifier (URI) is a string of characters used to identify a resource. Such identification enables interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols. [8, Wiki]

Usability - The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. [25, ISO 9241-210:2010]

Usability Requirement - One of the potential category of requirement selections available in the Requirement Type attribute. This selection identifies the requirement to be a user usability related requirement. [1, created for SECM]

Usage Feature - A named usage by a Definition Element of another Definition Element

In other words through a Usage Feature a Definition Element establishes that containing or making use of another Definition Element is one of its essential characteristics.

The Usage Feature permits to recursively construct modular, deeply nested hierarchical compositions. The usage relationships shall form an acyclic graph. [1, created for SECM]

User - A specific, defined end user of the System Modeling Environment (SME). [1, Created for SECM]

User Defined Requirement Attribute - This is a requirement attribute that is not available in the Requirement Attribute Library but can be can be created and defined by a specific organization or project to meet the needs of their workflow. See INCOSE Requirements Writing Guide [14] for additional attribute suggestions. [1, created for SECM]

User Defined View - This type of view is one or more views that are defined specifically for a meet a user's or organization's needs. The presentations, shapes and icons may be unique for this specific use. [1, created for SECM]

UUID - Universally Unique identifier (UUID) - A unique identifier assigned to every model element. This identifier must be unique both within the SME and external to the SME. This UUID conforms to IETF RFC 4122 http://datatracker.ietf.org/doc/rfc4122/. See also http://en.wikipedia.org/wiki/Universally_unique_identifier for a practical introduction on a UUID. [1, created for SECM]

Validation Rule - A Validation rule is a criterion or constraint used in the process of data validation, carried out after the data has been encoded onto an input medium and involves a data vet or validation program. [8, Wiki]

Value Expression - An expression that can be evaluated to yield a value typed by a Value Type. The expression is stated in an expression language that support all usual mathematical and logical operators. [1, created for SECM]

Value Property - A Model Element that has a value that is typed by a Value Type. [1, created for SECM]

Value Type - Named definition of the essential semantics and structure of the set of possible values of a value-based characteristic, without the value itself. [1, created for SECM]

Variability Choice - Sometimes referred to as Variation Point. A definition of choice from more than one possible value for some characteristic (feature) of a Definition Element. The addition of one or more Variability Choices in a Definition Element allows for a compact and inherently consistent representation of options or alternatives at any level in the hierarchical composition established by a Definition Model. Variability Choices permit coherent modeling of e.g. design or configuration options as well as requirements specifications and architectures for product lines. See also

Configuration Model for resolving all Variability Choices into a single Variant. [1, created for SECM]

Variability Context **-** A model that captures the desired variabilities and constraints for a set of system configurations. [1, Created for SECM]

Variability Expression **-** A variability constraint constrains the combination of variants. [1, Created for SECM]

Variant **-** A variant (or option) represents a choice that realizes a particular variation point (or feature). A variant can include additional variation points. [1, Created for SECM]

Variant Binding **-** A variant binding binds a base model element to a variant [1, Created for SECM]

Variation Point **-** Refer to Variability Choice [1, created for SECM]

Verification **-** (1a) Confirmation, through the provision of objective evidence, that specified (system) requirements have been fulfilled. (ISO/IEC 2008, section 4.38)

(1b) Verification is a set of activities that compares a system or system element against the required characteristics. This includes, but is not limited to, specified requirements, design description and the system itself. The system was built right. (ISO/IEC/IEEE 2015, 1, Section 6.4.6)

(2) The evaluation of whether or not a product, service, or system complies with a regulation, requirement, specification, or imposed condition. It is often an internal process. Contrast with validation. (PMI 2013)

[3, SEBoK definition]

Verification Outcome **-** Describes the data and any other results from performing the Verification Activity. [1, created for SECM]

Verification Activity **-** An activity that accomplishes (i.e., realizes) one or more steps of the verification case. [1, created for SECM]

Verification Case **-** A structured scenario that describes a verification objective and individual steps representing the verification activities required. [1, created for SECM]

Verification Context **-** An environment context that supports the ability to ensure that requirements have been met. [1, created for SECM]

Verification Evaluation Activity **-** An activity that compares the verification outcome data produced by the verification activity with the verification success criteria. [1, created for SECM]

Verification Method **-** The verification method for each requirement simply states the planned method of verification (inspection, demonstration, test, analysis, and simulation). [10, INCOSE Handbook]

The Description property provides a textual description of the steps that will be taken in Verification Activity and Verification Evaluation Activity. [1, created for SECM]

The type of method may also include sampling and analogy. [2, SEBoK Verification]

Verification Objective **-** An objective is the result to be achieved (ISO/IEC 27000:2016(en), 2.56) [17, ISO OBP Definitions]

A verification object is the expected result to be achieved when executing a verification case. [1, created for SECM]

Verification Plan **-** This plan identifies and includes a verification strategy, selected verification actions, verification procedures, verification tools, the verified element or system, verification reports, issue/trouble reports, and change requests on design. [3, SEBoK, System Verification]

Verification Requirement **-** A requirement applied to the means of establishing compliance of an end item with its specification requirements. [1, created for SECM]

Verification Result **-** The result of the Verification Evaluation. [1, created for SECM]

Verification Success Criteria **-** The success criteria is a subset of the requirement being verified (e.g. selected points in a flight test envelope). [1, created for SECM]

Verification System **-** An aggregation of enabling elements needed to perform verification activities. This includes the equipment, users and facilities used to perform the activity. [1, created for SECM]

Verification System Element **-** A system element used to stimulate and interact with the unit under verification during the execution of the verification case. [1, created for SECM]

Verify Relationship **-** A relationship between a requirement and a verification case that can be elaborated to specify how verification of the requirement is accomplished and to produce a result from the constraint evaluation. [1, created for SECM]

Version **-** A state associated with the lifetime of a MCI at a given point in time, as designated by the engineering change process. [1, created for SECM]

View Definition **-** A representation of a system from the perspective of a viewpoint. (OMG 2010) [3, SEBoK Glossary]

View Element **-** A constituent of a view Metamodel that defines how a model element is presented. [1, created for SECM]

View Instance **-** A view instance is view at a specific instance of time. [1, created for SECM]

View Metamodel **-** A model of a View model that references a set of domain specific View Elements. [1, created for SECM]

Viewpoint **-** A viewpoint is a specification of the conventions and rules for constructing and using a view for the purpose of addressing a set of stakeholder concerns (OMG 2010) [3, SEBoK Glossary]

Viewpoint Library **-** A digital library containing a collection of predefined model elements representing a set of reusable viewpoints that can be copied or reference while constructing a model. [1, created for SECM]

Appendix B General Reference and Glossary

B.1 General References

The following documents are referenced in this document:

[BCQ] OMG Board of Directors Business Committee Questionnaire
http://doc.omg.org/bcq

[CCM] CORBA Core Components Specification
http://www.omg.org/spec/CCM/

[CORBA] Common Object Request Broker Architecture (CORBA)
http://www.omg.org/spec/CORBA/

[CORP] UML Profile for CORBA
http://www.omg.org/spec/CORP

[CWM] Common Warehouse Metamodel Specification
http://www.omg.org/spec/CWM

[EDOC] UML Profile for EDOC Specification
http://www.omg.org/spec/EDOC/

[Guide] The OMG Hitchhiker's
http://doc.omg.org/hh

[IDL] Interface Definition Language Specification
http://www.omg.org/spec/IDL35

[INVENT] Inventory of Files for a Submission/Revision/Finalization
http://doc.omg.org/inventory

[IPR] IPR Policy
http://doc.omg.org/ipr

[ISO2] ISO/IEC Directives, Part 2 - Rules for the structure and drafting of International Standards
http://isotc.iso.org/livelink/livelink?func=ll&objId=4230456

[LOI] OMG RFP Letter of Intent template
http://doc.omg.org/loi

[MDAa] OMG Architecture Board, "Model Driven Architecture - A Technical Perspective"
http://www.omg.org/mda/papers.htm

[MDAb] Developing in OMG's Model Driven Architecture (MDA)
http://www.omg.org/mda/papers.htm

[MDAc] MDA Guide
http://www.omg.org/docs/omg/03-06-01.pdf

[MDAd] MDA "The Architecture of Choice for a Changing World
http://www.omg.org/mda

[MOF] Meta Object Facility Specification
http://www.omg.org/spec/MOF/

[NS] Naming Service
http://www.omg.org/spec/NAM

[OMA] Object Management Architecture
http://www.omg.org/oma/

[OTS] Transaction Service
http://www.omg.org/spec/OTS

[P&P] Policies and Procedures of the OMG Technical Process
http://doc.omg.org/pp

[RAD] Resource Access Decision Facility
http://www.omg.org/spec/RAD

[ISO2] ISO/IEC Directives, Part 2 - Rules for the structure and drafting of International Standards
http://isotc.iso.org/livelink/livelink?func=ll&objId=4230456

[RM-ODP]
ISO/IEC 10746

[SEC] CORBA Security Service
http://www.omg.org/spec/SEC

[TEMPL] Specification Template
http://doc.omg.org/submission-template

[TOS] Trading Object Service
http://www.omg.org/spec/TRADE

[UML] Unified Modeling Language Specification
http://www.omg.org/spec/UML

[XMI] XML Metadata Interchange Specification
http://www.omg.org/spec/XMI

B.2 General Glossary

Architecture Board (AB) **-** The OMG plenary that is responsible for ensuring the technical merit and MDA compliance of RFPs and their submissions. [33, OMG RFP Template]

Board of Directors (BoD) **-** The OMG body that is responsible for adopting technology. [33, OMG RFP Template]

Common Object Request Broker Architecture (CORBA) **-** An OMG distributed computing platform specification that is independent of implementation languages. [33, OMG RFP Template]

Common Warehouse Metamodel (CWM) **-** An OMG specification for data repository integration. [33, OMG RFP Template]

CORBA Component Model (CCM) **-** An OMG specification for an implementation language independent distributed component model. [33, OMG RFP Template]

Interface Definition Language (IDL) **-** An OMG and ISO standard language for specifying interfaces and associated data structures. [33, OMG RFP Template]

Letter of Intent (LOI) **-** A letter submitted to the OMG BoDs Business Committee signed by an officer of an organization signifying its intent to respond to the RFP and

confirming the organizations willingness to comply with OMGs terms and conditions, and commercial availability requirements. [33, OMG RFP Template]

Model Driven Architecture (MDA) - An approach to IT system specification that separates the specification of functionality from the specification of the implementation of that functionality on a specific technology platform. [33, OMG RFP Template]

Normative Provisions - To which an implementation shall conform to in order to claim compliance with the standard (as opposed to non-normative or informative material, included only to assist in understanding the standard). [33, OMG RFP Template]

Normative Reference References - To documents that contain provisions to which an implementation shall conform to in order to claim compliance with the standard. [33, OMG RFP Template]

Platform - A set of subsystems/technologies that provide a coherent set of functionality through interfaces and specified usage patterns that any subsystem that depends on the platform can use without concern for the details of how the functionality provided by the platform is implemented. [33, OMG RFP Template]

Platform Independent Model (PIM) - A model of a subsystem that contains no information specific to the platform, or the technology that is used to realize it. [33, OMG RFP Template]

Request for Information (RFI) - A general request to industry, academia, and any other interested parties to submit information about a particular technology area to one of the OMG's Technology Committee subgroups. [33, OMG RFP Template]

Request for Proposal (RFP) - A document requesting OMG members to submit proposals to an OMG Technology Committee. [33, OMG RFP Template]

Task Force (TF) - The OMG Technology Committee subgroup responsible for issuing a RFP and evaluating submission(s). [33, OMG RFP Template]

Technology Committee (TC) - The body responsible for recommending technologies for adoption to the BoD. There are two TCs in OMG the Platform TC (PTC) focuses on IT and modeling infrastructure related standards; while the Domain TC (DTC) focuses on domain specific standards. [33, OMG RFP Template]

XML Metadata Interchange (XMI) - An OMG standard that facilitates interchange of models via XML documents. [33, OMG RFP Template]