

Model-Based Enterprise: Framework

AN AMERICAN NATIONAL STANDARD



The American Society of
Mechanical Engineers

Model-Based Enterprise: Framework

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**The American Society of
Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

In October 2016, the American Society of Mechanical Engineers (ASME) received a proposal to address new digital data needs within the design and manufacturing industry. The ASME Council on Standards and Certification approved the formation of a model-based enterprise (MBE) standards committee on February 28, 2018. The ASME MBE Standards Committee's task is to develop standards or related products that provide rules, guidance, and examples for the creation, use, and reuse of model-based data sets, data models, and related elements within an MBE.

ASME MBE-1 provides a framework that enables the development of MBE architectures and specifications for the elements of an MBE. This Standard is intended for MBE standard developers, MBE solution providers, and MBE system architects, as well as other professionals who want to understand structural elements for representing an MBE.

ASME MBE-1-2022 was approved by the American National Standards Institute as an American National Standard on April 5, 2022.

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Model-Based Enterprise

(The following is a roster of the Committee at the time of approval of this Standard.)

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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

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Interpretations. Upon request, the MBE Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the MBE Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at <http://go.asme.org/InterpretationRequest>. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the MBE Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

| | |
|-------------------------|---|
| Subject: | Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words. |
| Edition: | Cite the applicable edition of the Standard for which the interpretation is being requested. |
| Question: | Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable. |
| Proposed Reply(ies): | Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies. |
| Background Information: | Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information. |

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not “approve,” “certify,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

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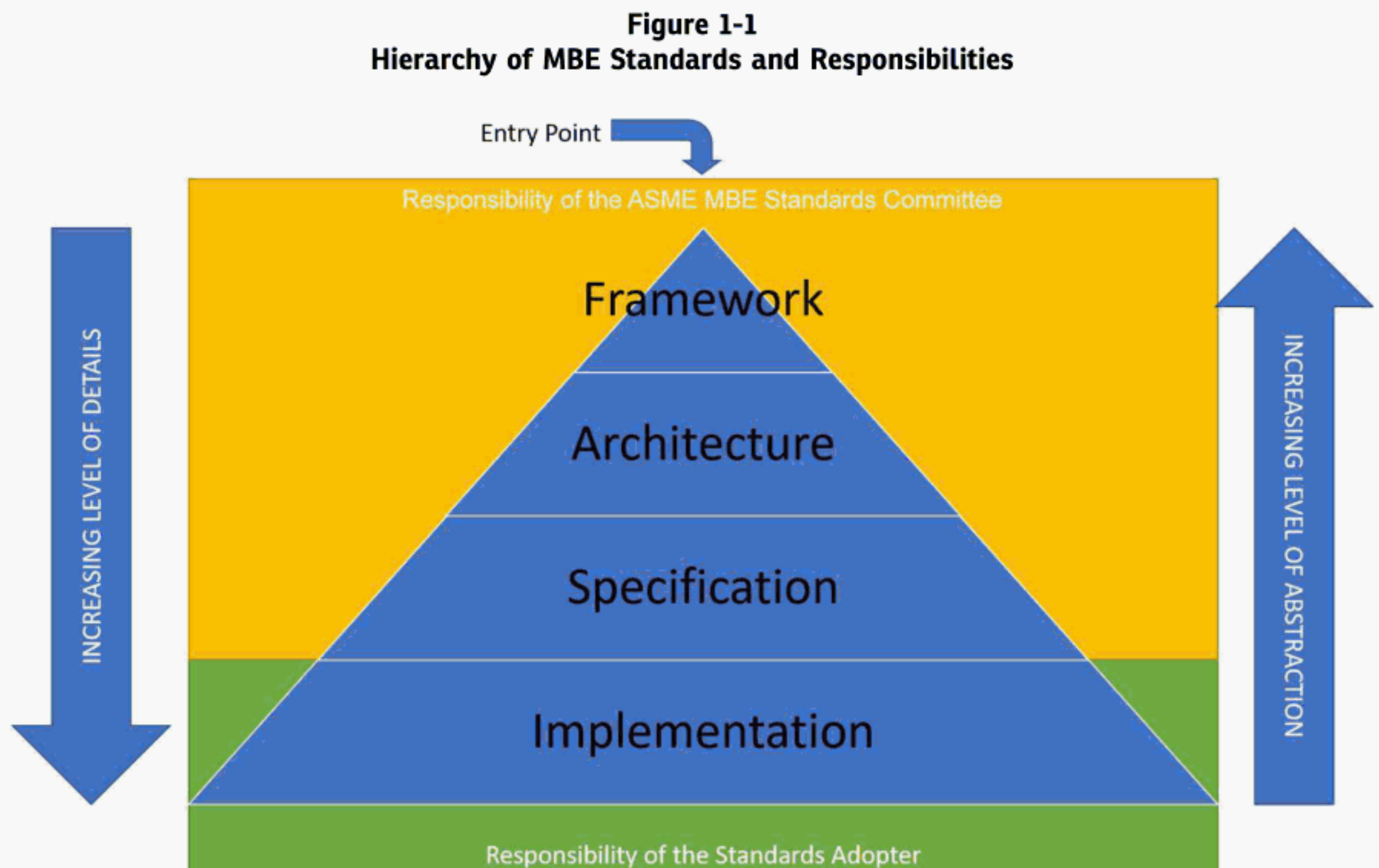
MODEL-BASED ENTERPRISE: FRAMEWORK

1 PURPOSE

The Model-Based Enterprise (MBE) Framework provides a high-level structural definition for the concept of an MBE and its elements. An MBE may be viewed as a system of systems in which the overall system and each constituent system have distinct components (e.g., elements and interfaces). The purpose of this Standard is to support consistent definitions of, organization of, and relationships between high-level elements of an MBE. This consistency will facilitate integration and communication between the elements of an MBE and will allow users of this Standard to apply the requirements of subsequent ASME MBE standards. The MBE Framework provides a prefabricated structure that users of this Standard can use to organize implementation of the MBE architecture into complementary views.

Figure 1-1 presents the hierarchy of standards for which the ASME MBE Standards Committee is responsible. The layers of the pyramid represent the increasing level of detail within ASME MBE standards. The MBE Framework exists at the top of the pyramid with the highest level of abstraction. The MBE Framework enables the development of MBE architectures and specifications (e.g., requirements) for the elements of an MBE. Architecture and specification, the second and third layers of the pyramid, respectively, represent ASME MBE standards currently in development. The implementation layer at the bottom of the pyramid is outside the responsibility of the ASME MBE Standards Committee. Implementation is the responsibility of the individual making decisions about a specific MBE deployment.

ASME MBE-1 is not intended to be an implementation standard. The MBE Framework does not tell the user how to implement ASME MBE standards. Users of this Standard shall make the best available decisions for implementing the standards in ways that best fit the organization.



2 SCOPE

This Standard provides an architecture framework for the representation of an MBE. This Standard uses ISO/IEC/IEEE 42010:2011 architecture concepts to present an architectural view of an MBE and its constituent systems. The MBE Framework in this Standard defines the structure of an MBE and its elements. This Standard also provides guidance on using the MBE Framework. All conventions and common practices for describing the architecture of an MBE are within the scope of this Standard. In addition, this Standard provides a prefabricated representation of an MBE and its component systems. Decomposition of the MBE elements into architectural descriptions and specifications is out of scope for this Standard.

3 ORGANIZATION OF ASME MBE-1

This Standard is organized as follows:

- (a) [Section 1](#) states the purpose.
- (b) [Section 2](#) states the scope.
- (c) [Section 3](#) describes the organization.
- (d) [Section 4](#) provides the mandatory (normative) reference.
- (e) [Section 5](#) describes the intended audience.
- (f) [Section 6](#) defines terms.
- (g) [Section 7](#) defines the MBE Framework.
- (h) [Nonmandatory Appendix A](#) provides an informative recommended practice for using the MBE Framework.

4 MANDATORY REFERENCE

ISO/IEC/IEEE 42010:2011, Systems and software engineering — Architecture description

Publisher: International Organization for Standardization (ISO), Central Secretariat, Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland (www.iso.org)

5 AUDIENCE

This Standard is intended for use by MBE standard developers, MBE solution providers, and practicing MBE system architects. Users of this Standard should be familiar with general enterprise architecture concepts, architecture frameworks, and reference architectures. This Standard is also recommended for product and plant managers, information technology managers, business managers, and others who want to understand structural elements for representing an MBE, constituent systems of an MBE, and all the elemental relationships within the boundaries of an MBE.

6 DEFINITIONS

This Standard defines *may*, *shall*, and *should* as follows:

may: the verb used to indicate a course of action permissible within the limits of this Standard.

shall: the verb used to indicate mandatory requirements, which the user shall follow strictly to comply with this Standard.

should: the verb used to indicate that a possibility among a set of possibilities is recommended as particularly suitable (without mentioning or excluding other possibilities) or that a certain course of action is preferred but not necessarily required.

See Merriam-Webster's Unabridged Dictionary at <https://www.merriam-webster.com/> for definitions of words used in this Standard but not explicitly defined in this Standard.

7 MBE FRAMEWORK

The MBE and its elements shall represent an interacting system of systems. The MBE Framework shall be the basis for defining architecture descriptions that express the architecture exhibited by each system within an MBE. The boundaries of a system shall depend on stakeholder concerns and may include an entire MBE, a subset of MBE elements, or one or more products, processes, services, or other aggregations of interest. A system should be represented by models as defined within or in the context of the system environment and should trace back to an overall MBE. A system may be engineered, naturally occurring, or a combination thereof.

Figure 7-1 presents the context of architectural descriptions as defined in ISO/IEC/IEEE 42010:2011. The MBE Framework, combined with eventual architecture descriptions, shall be the basis for understanding an MBE's properties pertaining to its behavior, composition, deployment, utility, and maintainability, including the ability to be updated or disposed.

The definition of the MBE Framework is shown in Figure 7-2. An MBE shall consist of one or more stakeholders that have a contextual concern in one or more systems of interest. The contextual concern shall conform to a viewpoint, which is the one or more viewpoints of the one or more roles performed by the stakeholder. The contextual concern shall use one or more resources, which are the resource of the system of interest. The MBE Framework shall define the complete environment for an MBE. The MBE Framework shall determine the totality of influences upon an MBE, including the MBE's interactions with its environment. The environment of an MBE shall be bound by its stakeholder and the stakeholder's contextual concern.

7.1 Stakeholders

A stakeholder shall have an interest in a system of interest through a contextual concern. The stakeholder shall take responsibility and perform roles. A stakeholder may have more than one contextual concern, which shall be addressed by the stakeholder's interest in a system of interest.

A stakeholder may be an individual, group, or organization that holds contextual concern within a system of interest. A contextual concern shall be any interest in the system by one or more stakeholders and shall be contextualized by a viewpoint through the stakeholder's role (see para. 7.3). A contextual concern shall pertain to any influence of a system in its environment.

A stakeholder shall take one or more responsibilities and perform one or more roles. A stakeholder's responsibility shall be defined by requirements for which the stakeholder is accountable as the primary cause, motive, or agent of an activity. A stakeholder's role shall be defined by the functional requirements of the actors and activities of a domain, which have one or more viewpoints. All functional roles of an organization (e.g., engineer, manager, technologist, operator, analyst) should be encapsulated and accounted for by the stakeholder block of the MBE Framework.

7.2 Systems of Interest

A system of interest shall provide a boundary for a contextual concern. A system of interest shall define what is internal versus external of a domain. The stakeholder's interest in the system of interest shall conform to one or more viewpoints and account for the activities, lifecycle phases, roles, responsibilities, and resources for a specific domain in which a stakeholder has a contextual concern.

A system of interest shall be defined in one of the following domains (see Figure 7.2-1):

conceive: the activities of imagining, specifying, planning, and innovating an MBE's products and services.

design: the activities of describing, defining, developing, testing, analyzing, and validating an MBE's products and services.

realize: the activities of making, building, procuring, producing, selling, and delivering an MBE's products and services.

service: the activities of using, operating, maintaining, supporting, and sustaining an MBE's products and services.

disposal: the activities of phasing out, retiring, recycling, and disposing an MBE's products and services.

The system of interest shall be the starting point where an organization maps its structure to the framework and then defines stakeholder contextual concerns from appropriate viewpoints to identify the MBE requirements that apply to the interest of the stakeholder. Information should flow between the domains shown in Figure 7.2-1.

7.3 Viewpoints

A viewpoint shall provide the perspective to which a stakeholder's contextual concern shall conform. A viewpoint shall reconcile a stakeholder's role and contextual concern for the stakeholder's interest in a system of interest. A viewpoint shall be an architecture viewpoint as defined by ISO/IEC/IEEE 42010:2011: "[a] work product establishing the conventions for the construction, interpretation, and use of architecture views to frame specific system concerns." A viewpoint shall set the boundaries for the perspective that a stakeholder has when performing a role.

A viewpoint shall be defined in one of the following views, which are represented by the internal block diagram (IBD) in Figure 7.3-1:

business: the perspective and context for a stakeholder that is focused on external-facing concerns (e.g., marketing) related to the business functions of a system of interest.

customer: the perspective and context for a stakeholder that is focused on concerns related to the customer functions of a system of interest.

engineering: the perspective and context for a stakeholder that is focused on concerns related to the engineering functions of a system of interest.

legal: the perspective and context for a stakeholder that is focused on concerns related to the legal functions of a system of interest.

management: the perspective and context for a stakeholder that is focused on internal-facing concerns (e.g., human resources) related to the management functions of a system of interest.

operations: the perspective and context for a stakeholder that is focused on concerns related to the operations functions of a system of interest.

supplier: the perspective and context for a stakeholder that is focused on concerns related to the supplier functions of a system of interest.

7.4 Resources

Resources shall define the models, capabilities, and artifacts used by a stakeholder within the boundaries of a system of interest. A stakeholder with a contextual concern may use one or more of the following resources, which are represented by the IBD in [Figure 7.4-1](#).

(a) *Model*. A model shall be a representation that is physical (e.g., tangible), descriptive (e.g., logical), or analytical (e.g., mathematical). The model shall represent a real-world object, system, entity, phenomenon, or process. The model shall be purpose built and defined within the boundaries of the stakeholder's contextual concern.

(b) *Capability*. A capability shall be a conceptual feature or faculty that has the quality or state of having attributes required for accomplishing a task. A capability's Boolean property *Enabler* shall be set to *true* when the requirements for the capability are controlled by an entity other than the ASME MBE Standards Committee.

(c) *Enabler*. An enabler shall be a capability outside the scope of the ASME MBE Standards Committee that provides the means or opportunity to a stakeholder for accomplishing a task. Enabler capabilities may be leveraged, applied, and deployed to support an MBE.

(d) *Artifact*. An artifact shall be a physical object (e.g., gage, book) or a digital object (e.g., document, image). A model may represent an artifact. An artifact may describe a capability or a model.

Figure 7-1
Contextual Overview of Architectural Descriptions as Defined in ISO/IEC/IEEE 42010:2011

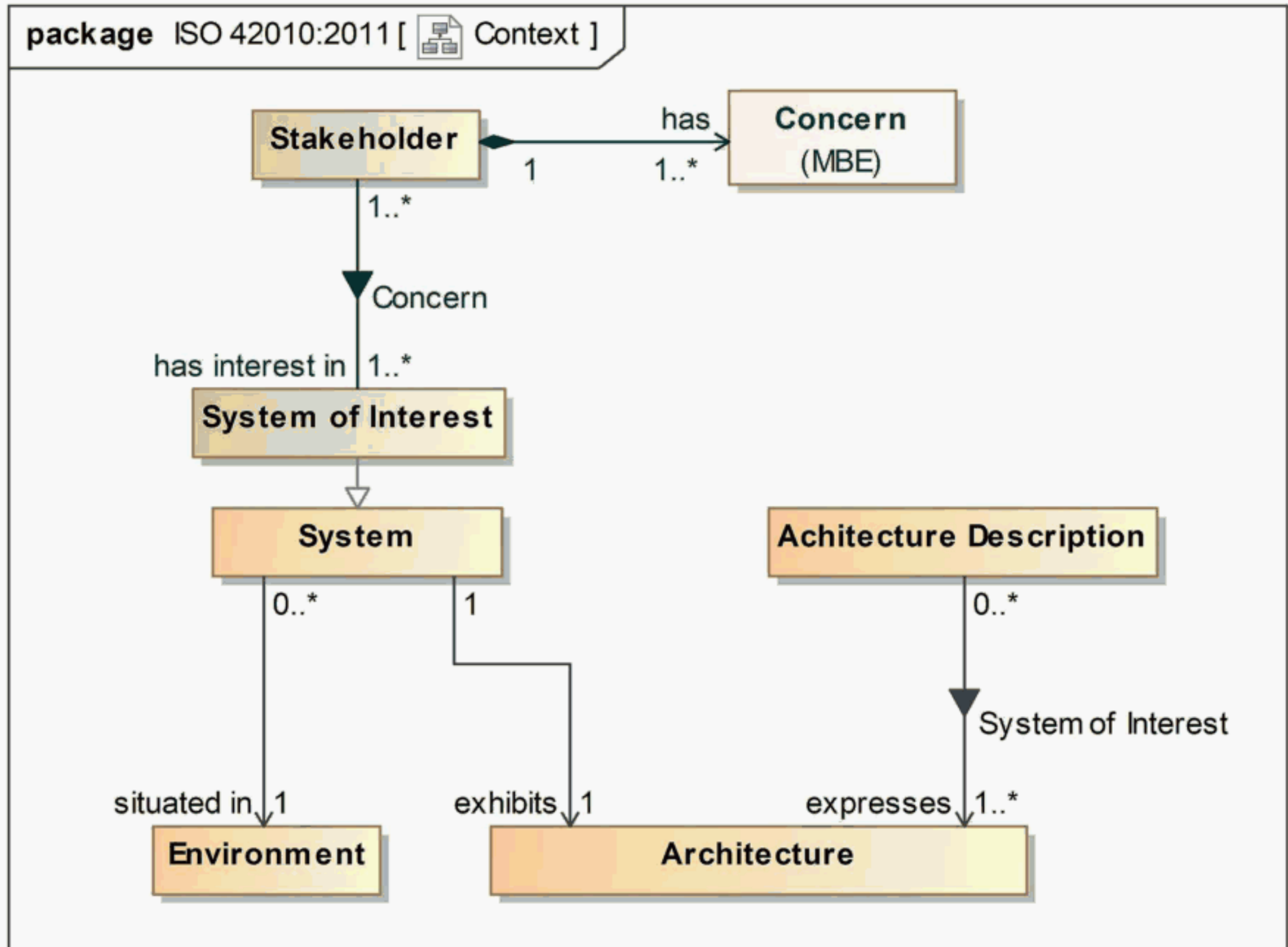


Figure 7-2
Block Definition Diagram: Definition of the MBE Framework

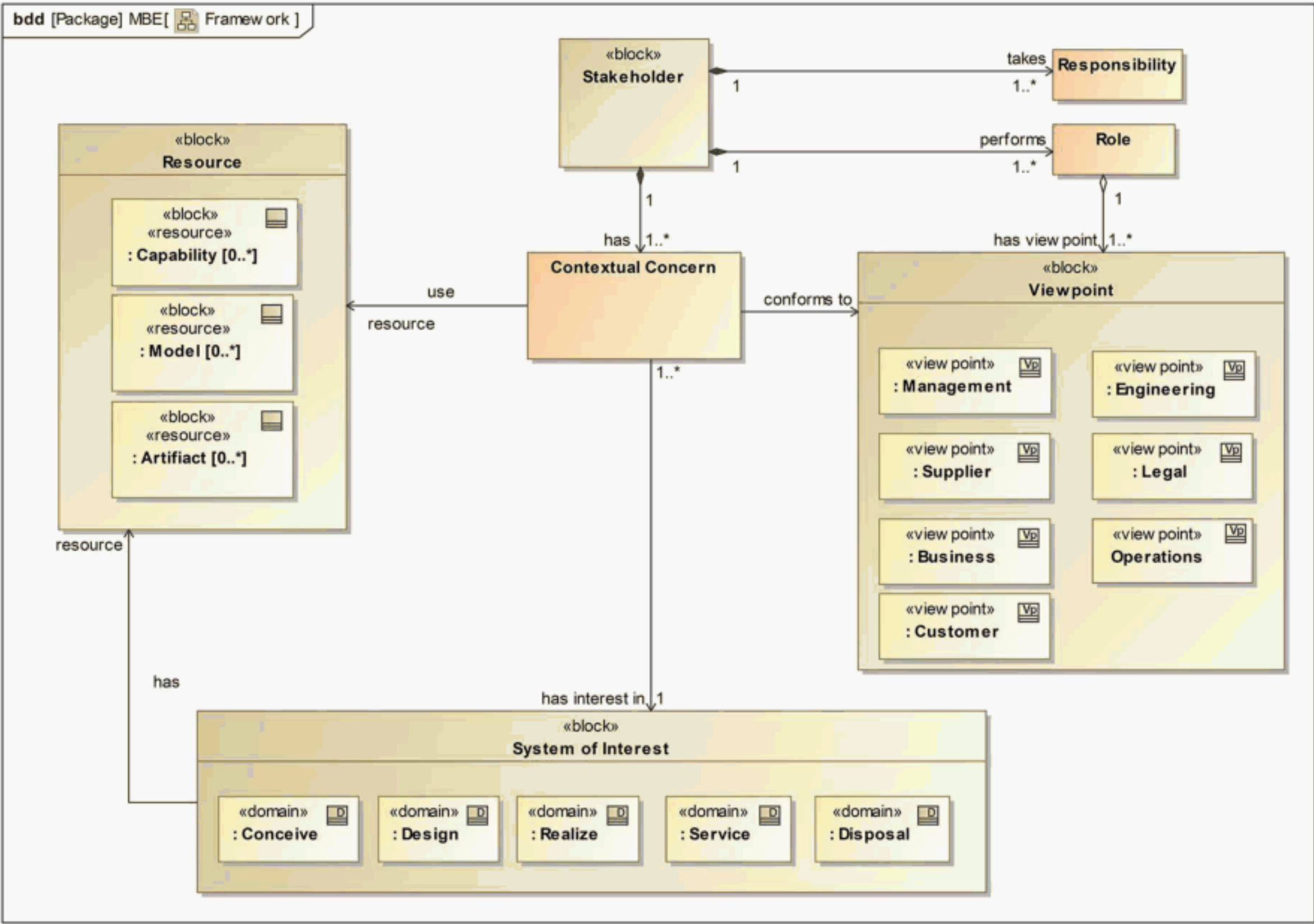


Figure 7.2-1
Internal Block Diagram: Domains of the Systems of Interest in the MBE Framework

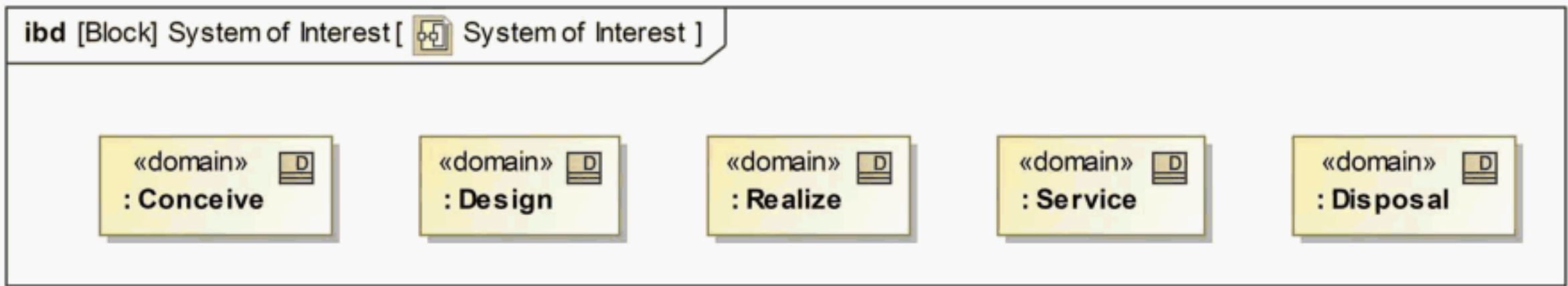


Figure 7.3-1
Internal Block Diagram: Viewpoints of the Systems of Interest in the MBE Framework

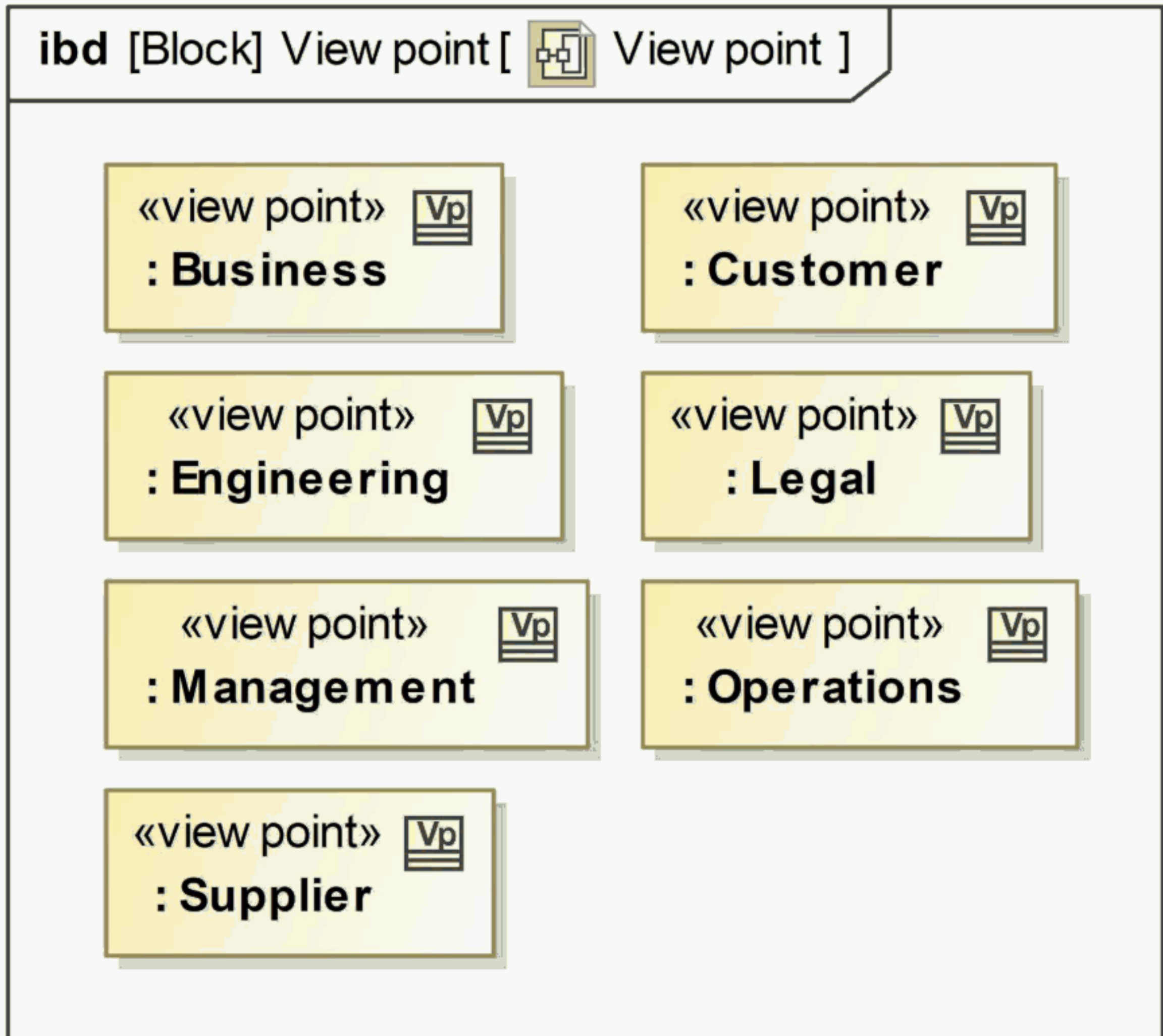
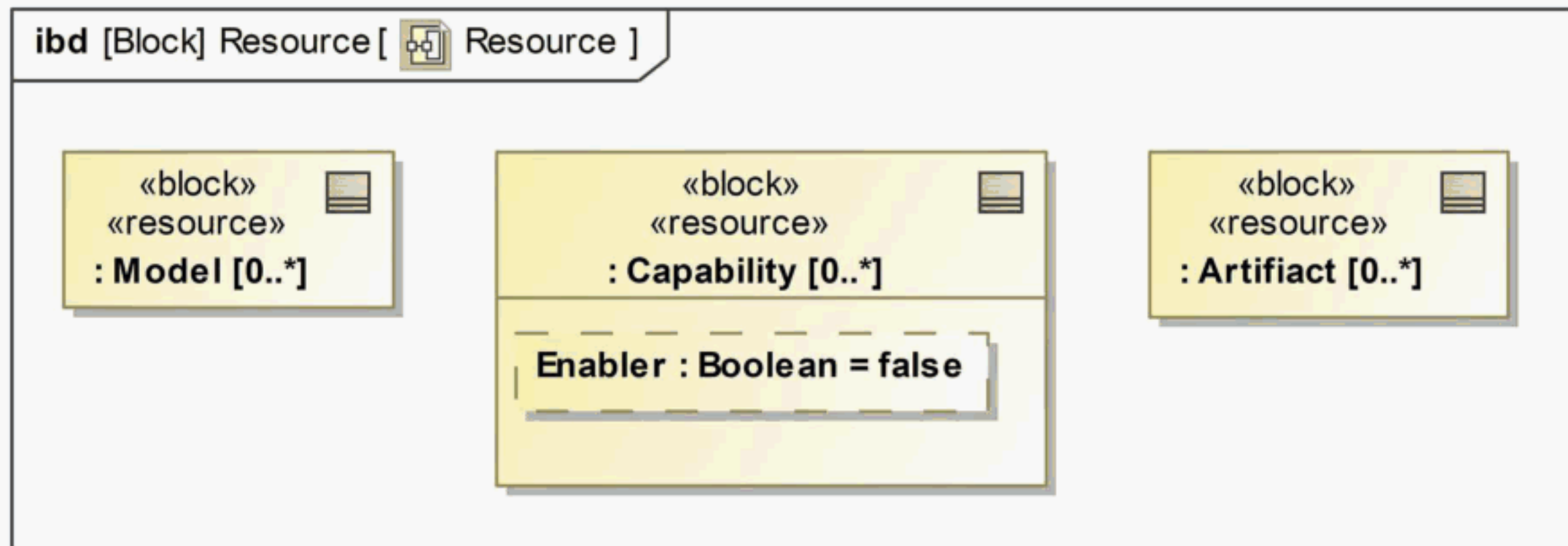


Figure 7.4-1
Internal Block Diagram: Resources Used by the Viewpoints in the MBE Framework



NONMANDATORY APPENDIX A

RECOMMENDED PRACTICE

A-1 INTRODUCTION

This Appendix provides a recommended practice for using the MBE Framework defined in this Standard. This recommended practice covers how to define scenario use cases and activities for contextual concerns of interest to stakeholders in an MBE.

A-2 SCENARIO USE CASES

This section provides a set of example scenario use cases for an MBE. The goal is to help users understand how to use scenario use cases and how to identify the required models, capabilities, and artifacts that must be available to achieve some outcome.

A-2.1 Example Use Cases

A use case represents a contextual concern of a specific activity for a stakeholder within an MBE. Use cases are sometimes considered high-level functional requirements.

The following table provides example scenario use cases related to a specific system of interest and viewpoint:

| Scenario | System of Interest | Viewpoint | Contextual Concern |
|--|--------------------|-------------|---|
| Design failure model effects analysis (FMEA) | Design | Engineering | Identifying risks in the performance and operation of a product based on design decisions |
| Process FMEA | Service | Operations | Identifying risks in servicing and sustaining a product based on known design decisions |
| First article inspection report generation | Realize | Management | Handing off from design to manufacturing to quality inspection |
| New product introduction | Conceive | Management | Using past performance of suppliers for making early product-requirements decisions and identifying potential supply-chain partners |

Stakeholders should document scenario use cases using the following outline:

Scenario: < name >

Context

* System of Interest: (Choose)

- Conceive
- Design
- Execute
- Service
- Disposal

* Viewpoints: (Choose)

- Customer
- Business
- Engineering
- Legal
- Management
- Supplier

As a: (Stakeholder)

> the person or role who will benefit from the feature;

I want:

> the feature; the problem they are trying to solve

So that:

> the benefit or value of the feature.

Story:

> provide some description on the motivation / background for writing this user scenario

Existing Standards

> List existing standards that apply to this scenario

Model: (After Modeling Step)

> < Cameo Use Case Model From Modelers >

For example, a use case for a design FMEA scenario is shown below.

Scenario: Design Failure Model Effects Analysis (FMEA)

Context

* System of Interest: Design

* Viewpoints: Engineering

As a:

* Design Engineer (Stakeholder)

I want:

* Identify risks in the maintainability of a product based on design decisions

So that:

* The risks for maintainability of the product are minimized and the effectivity and efficiencies of the maintenance stakeholders' responsibilities and roles are maximized.

Story:

> provide some description on the motivation / background for writing this user scenario

Existing Standards

* SAE J1739_202101, Potential Failure Mode and Effects Analysis (FMEA) Including Design FMEA, Supplemental FMEA-MSR, and Process FMEA.

Model:

See Figure A-2.3-1.

A-2.2 Use-Case Diagrams

Scenario use cases shall be captured using a systems modeling language (SysML) use-case diagram. [Figure A-2.2-1](#) shows an example use-case diagram that captures the contextual concern for a series of stakeholders related to a design FMEA scenario. Stakeholders shall identify use cases within the boundaries of a contextual concern block. The contextual concern block shall have an association to a system of interest block. Each use case included within the contextual concern block shall have an association to one or more stakeholders. Each stakeholder shall have an association to one or more viewpoints. Requirements may be included in the diagram to link them to the scenario's use cases.

The recommended workflow for defining a use-case diagram is as follows:

Step 1. Define a block with the <<Contextual Concern>> stereotype in a SysML use-case diagram to define the boundary of the stakeholders' interests. Associate the contextual concern block to the system of interest block for the domain related to the contextual concern.

Step 2. Define the appropriate stakeholders with a contextual concern related to the scenario, and associate each stakeholder to one or more appropriate viewpoints.

Step 3. Model each scenario use case as a SysML use case inside the contextual concern block to identify stakeholders' interests in cognizant MBE activities.

Step 4. Associate the use cases to the appropriate stakeholders.

Step 5 (Optional). Define requirements that are critical for the MBE to present them at the same high level as the scenario use case.

Step 6. Generate a SysML activity diagram for each use case.

A-2.3 Use-Case Activities

Each scenario use case shall be decomposed in a SysML activity diagram. [Figure A-2.3-1](#) provides an example of the activity for developing a control-plan use case within the contextual concern of a design FMEA scenario. The activity workflow with associated stakeholders and resources shall be defined within the activity diagram. The stakeholder requirements satisfied by activities should be included in the activity diagram. The usage of the MBE Framework stops at the activity level. The next step is to define lower-level requirements and enterprise architectures for the MBE, which will be addressed in future standards.

Figure A-2.2-1
Use-Case Diagram: Contextual Concern of a Design FMEA

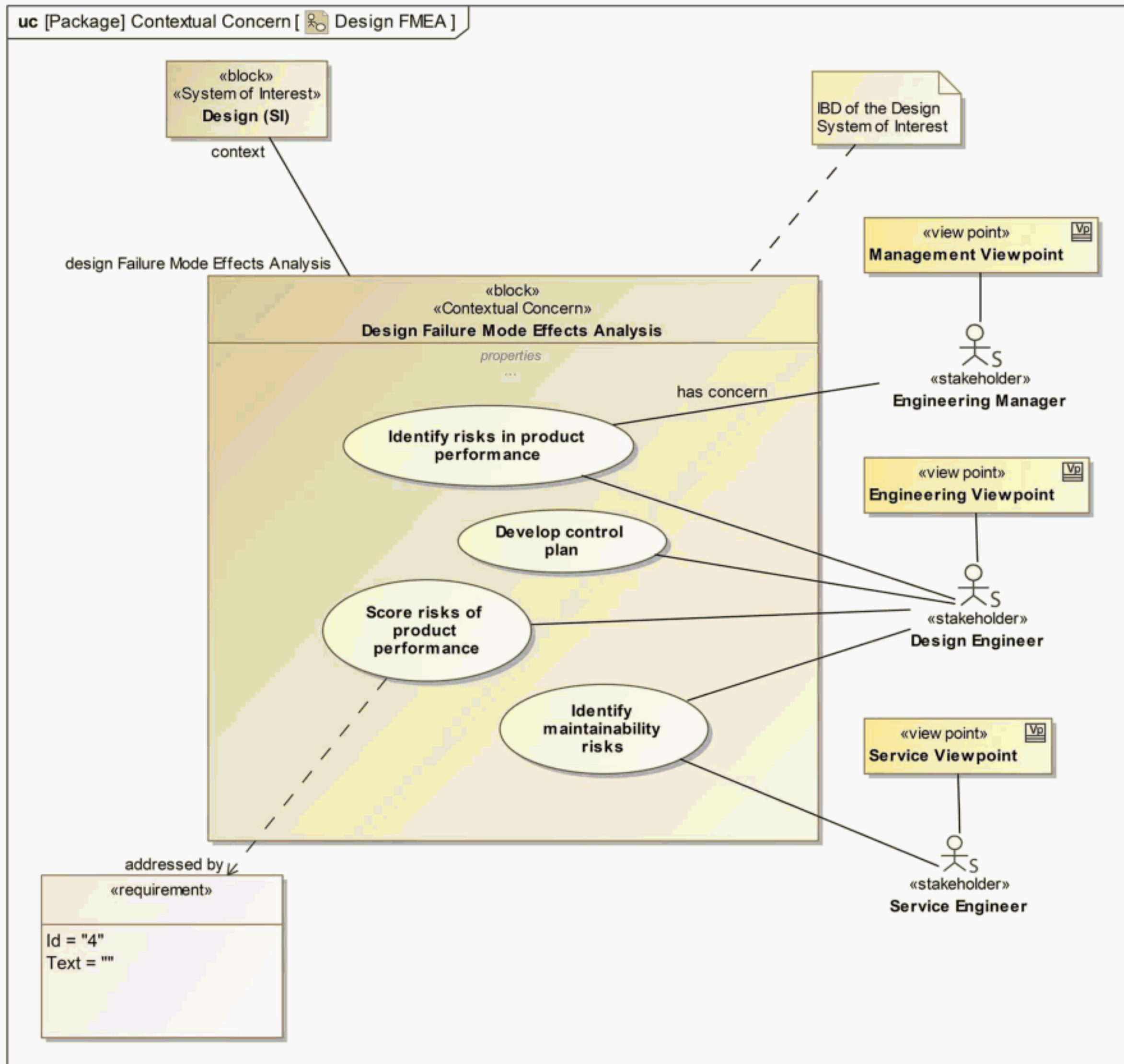
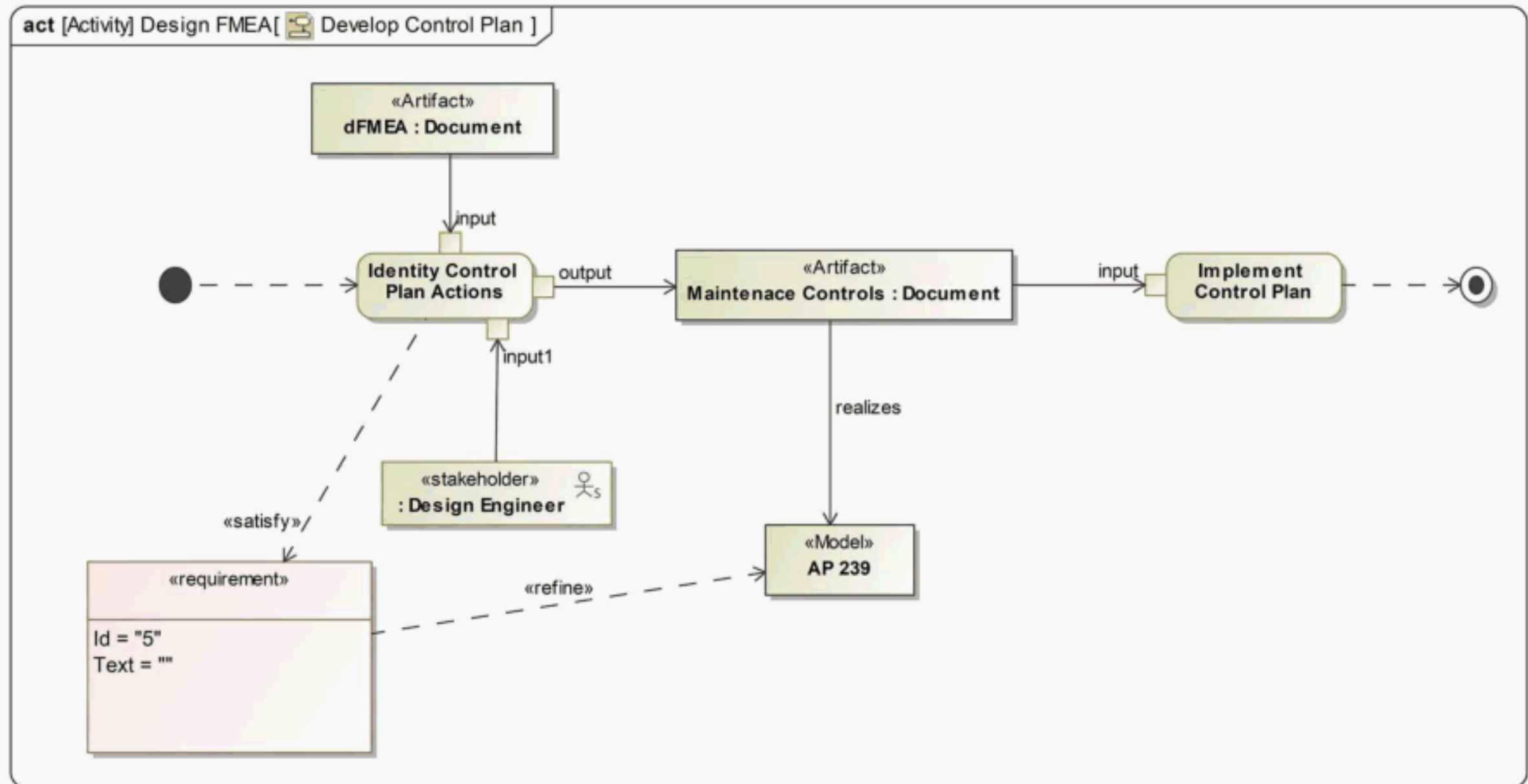


Figure A-2.3-1
Activity Diagram: Developing a Control-Plan Use Case Within the Contextual Concern of a Design FMEA



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