

# Modeling Standards

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## Modeling Standards

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Different types of models are needed to support the analysis, specification, design, and verification of systems. The evolution of modeling standards enables the broad adoption of Model-Based Systems Engineering (MBSE).



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## Motivation for Modeling Standards

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Modeling standards play an important role in defining agreed-upon system modeling concepts that can be represented for a particular domain of interest and enable the integration of different types of models across

domains of interest. Modeling standards are extremely important to support MBSE, which aims to integrate various system aspects across various disciplines, products, and technologies.

Standards for system modeling languages can enable cross-discipline, cross-project, and cross-organization communication. This communication offers the potential to reduce the training requirements for practitioners who only need to learn about a particular system and enables the reuse of system artifacts. Standard modeling languages also provide a common foundation for advancing the practice of systems engineering, as do other systems engineering standards.

## **Types of Modeling Standards**

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Many different standards apply to systems modeling. Modeling standards include standards for modeling languages, data exchange between models, and the transformation of one model to another to achieve semantic interoperability. Each type of model can be used to represent different aspects of a system, such as representing the set of system components and their interconnections and interfaces, or to represent a system to support performance analysis or reliability analysis.

The following is a partial list of representative modeling standards, which also includes the common acronym, when applicable, and a reference as to where additional information can be found on the topic.

### **Modeling Languages for Systems**

**Descriptive Models** - These standards apply to general descriptive modeling of systems:

- Functional Flow Block Diagram (FFBD) (Oliver, Kelliher, and Keegan 1997)
- Integration Definition for Functional Modeling (IDEF0) (NIST 1993)
- Object-Process Methodology (OPM) [[1]] (Dori 2002; ISO/PAS 19450:2015)
- Systems Modeling Language (SysML)(OMG 2010a)
- Unified Profile for United States Department of Defense Architecture Framework (DoDAF) and United Kingdom Ministry of Defence Architecture Framework (MODAF) (OMG 2011e)

- Web ontology language (OWL) (W3C 2004b)

**Analytical Models and Simulations** - These standards apply to analytical models and simulations:

- Distributed Interactive Simulation (DIS) (IEEE 1998)
- High-Level Architecture (HLA) (IEEE 2010)
- Modelica (Modelica Association 2010)
- Semantics of a Foundational Subset for Executable Unified Modeling Language (UML) Models (FUML) (OMG 2011d)

## **Data Exchange Standards**

These standards enable the exchange of information between models:

- Application Protocol for Systems Engineering Data Exchange (ISO 10303-233) (AP-233) (ISO 2005)
- Requirements Interchange Format (ReqIF) (OMG 2011c)
- Extensible Mark-Up Language - (XML) Metadata Interchange (XMI) (OMG 2003a)
- Resource Description Framework (RDF) (W3C 2004a)

## **Model Transformations**

These standards apply to transforming one model to another to support semantic interoperability:

- Query View Transformations (QVT) (OMG 2011b)
- Systems Modeling Language (SysML)-Modelica Transformation (OMG 2010c)
- OPM-to-SysML Transformation (Grobshtein and Dori 2011)

## **General Modeling Standards**

These standards provide general frameworks for modeling:

- Model-driven architecture (MDA®) (OMG 2003b)
- IEEE 1471-2000 - Recommended Practice for Architectural Description of Software-Intensive Systems (ANSI/IEEE 2000) (ISO/IEC 2007)

## Other Domain-Specific Modeling Standards

### Software Design Models

These standards apply to modeling application software and/or embedded software design:

- Architecture Analysis and Design Language (AADL) (SAE 2009)
- Modeling and Analysis for Real-Time and Embedded Systems (MARTE) (OMG 2009)
- Unified Modeling Language (UML) (OMG 2010b)

### Hardware Design Models

These standards apply to modeling hardware design:

- Very-High-Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) (IEEE 2008)

### Business Process Models

These standards apply to modeling business processes:

- Business Process Modeling Notation (BPMN) (OMG 2011a)

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