

Modeling Standards

From SEBoK
Modeling Standards

Lead Author: Sanford Friedenthal, **Contributing Authors:** Dov Dori, Yaniv Mordecai

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).

Contents

- 1 Motivation for Modeling Standards
- 2 Types of Modeling Standards
 - 2.1 Modeling Languages for Systems
 - 2.2 Data Exchange Standards
 - 2.3 Model Transformations
 - 2.4 General Modeling Standards
 - 2.5 Other Domain-Specific Modeling Standards
- 3 References
 - 3.1 Works Cited
 - 3.2 Primary References
 - 3.3 Additional References

Motivation for Modeling Standards

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

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)

References

Works Cited

ANSI/IEEE. 2000. *Recommended Practice for Architectural Description for Software-Intensive Systems*. New York, NY, USA: American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE), ANSI/IEEE 1471-2000.

Grobshtein, Y. and D. Dori. 2011. "Generating SysML views from an OPM model: Design and evaluation," *Systems Engineering*, vol. 14, no. 3 Sept. 2011.

IEEE. 1998. *Distributed Interactive Simulation (DIS)*. Washington, DC, USA: Institute for Electrical and Electronic Engineers. IEEE 1278.1-1995. Available at: IEEE <http://standards.ieee.org/develop/project/1278.2.html>. Accessed December 4, 2014.

IEEE. 2008. *VHSIC Hardware Description Language (VHDL)*. Washington, DC, USA: Institute of Electrical and Electronics Engineers. IEEE Standard 1076-2008. Available at: IEEE <http://standards.ieee.org/findstds/standard/1076-2008.html>. Accessed December 4, 2014.

IEEE. 2010. *Standard for High Level Architecture*. Washington, DC, USA: Institute for Electrical and Electronic Engineers. IEEE Standard 1516. Available at: IEEE <http://standards.ieee.org/develop/intl/intlstds.html>. Accessed December 4, 2014.

ISO. 2005. *Application Protocol for Systems Engineering Data Exchange*. Geneva, Switzerland: International Organization for Standardization. ISO 10303-233. Available at: ISO http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?csnumber=55257. Accessed December 4, 2014.

ISO. 2015. *Automation Systems and Integration - Object Process Methodology*. Geneva, Switzerland: International Organization for Standardization. ISO/PAS 19450:2015. Available at: ISO <https://www.iso.org/obp/ui/#iso:std:iso:pas:19450:ed-1:v1:en>. Accessed March 15, 2020.

ISO/IEC/IEEE. 2011. *Systems and Software Engineering — Architecture Description*. Geneva, Switzerland: International Organization for Standardization/International Electrotechnical Commission/Institute of Electrical and Electronics Engineers. December 1, 2011. ISO/IEC/IEEE 42010:2011. Available at: ISO

http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=50508. Accessed December 4, 2014.

Modelica Association. 2010. *Modelica® - A Unified Object-Oriented Language for Physical Systems Modeling, Language Specification, Version 3.2*. Modelica Association. Available at: Modelica <https://www.modelica.org/documents/ModelicaSpec32.pdf>. Accessed December 4, 2014.

NIST. 1993. *Integration Definition for Functional Modeling (IDEF0)*. Gaithersburg, MD: National Institute for Standards and Technologies. Available at: IDEF <http://www.idef.com/IDEF0.htm>. Accessed December 4, 2014.

Oliver, D., T. Kelliher, and J. Keegan. 1997. *Engineering Complex Systems with Models and Objects*. New York, NY, USA: McGraw Hill.

OMG 2003a. *XML Metadata Interchange (XMI), Version 1.1*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/XML/>. Accessed December 4, 2014.

OMG. 2003b. *Model Driven Architecture (MDA®), Version 1.0.1*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/mda>. Accessed December 4, 2014.

OMG. 2009. *Modeling and Analysis for Real-Time and Embedded Systems (MARTE), Version 1.0*. Object Management Group. Available at: OMG <http://www.omg.org/spec/MARTE/1.0/>. Accessed December 4, 2014.

OMG. 2010a. *OMG Systems Modeling Language (SysML), Version 1.2*. Needham, MA, USA: Object Management Group. Available at: SysML forum <http://www.sysml.org/docs/specs/OMGSysML-v1.2-10-06-02.pdf>. Accessed December 4, 2014.

OMG. 2010b. *Unified Modeling Language™ (UML), Version 2*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/UML/>. Accessed December 4, 2014.

OMG. 2010c. *SysML-Modelica Transformation Specification, Beta Version*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/SyM/>. Accessed December 4, 2014.

OMG. 2011a. *Business Process Modeling Notation (BPMN), Version 2.0*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/BPMN/2.0/>. Accessed December 4, 2014.

OMG. 2011b. *Query View Transformations (QVT), Version 1.1*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/QVT/1.1/>. Accessed December 4, 2014.

OMG. 2011c. *Requirements Interchange Format (ReqIF), Version 1.0.1*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/ReqIF/>. Accessed December 4, 2014.

OMG. 2011d. *Semantics of a Foundational Subset for Executable UML Models (FUML), Version 1.0*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/FUML/1.0/>. Accessed December 4, 2014.

OMG. 2011e. *Unified Profile for DoDAF and MODAF (UPDM), Version 1.1*. Needham, MA, USA: Object Management Group. Available at: OMG <http://www.omg.org/spec/UPDM/>. Accessed December 4, 2014.

SAE. 2009. *Architecture Analysis & Design Language (AADL)*. Warrendale, PA, USA: SAE International. Available at: Society of Automotive Engineers <http://standards.sae.org/as5506a/>.

Accessed December 4, 2014.

W3C. 2004a. *Resource Description Framework (RDF)*, Version 1.0. World Wide Web Consortium. Available at: World Wide Web Consortium <http://www.w3.org/RDF/>. Accessed December 4, 2014.

W3C. 2004b. *Web Ontology Language. (OWL)*. World Wide Web Consortium. Available at: World Wide Web Consortium <http://www.w3.org/2004/OWL>. Accessed December 4, 2014.

Primary References

Dori, D. 2002. *Object-Process Methodology - A Holistic Systems Paradigm*. Berlin and Heidelberg, Germany; New York, NY, USA: Springer Verlag.

Friedenthal, S., A. Moore, R. Steiner, and M. Kaufman. 2012. *A Practical Guide to SysML: The Systems Modeling Language*, 2nd Edition. Needham, MA, USA: OMG Press.

Additional References

Fritzon, P. 2004. *Object-Oriented Modeling and Simulation with Modelica 2.1*. New York, NY, USA: Wiley Interscience and IEEE Press.

Bibliowicz, A. and D. Dori. 2012. "A graph grammar-based formal validation of object-process diagrams," *Software and Systems Modeling*, vol. 11, no. 2, pp. 287-302.

Blekhman, A. and D. Dori. 2011. "Model-Based Requirements Authoring." INCOSE 2011 - The 6th International Conference on System Engineering. March 2011.

Dori, D., R. Feldman, and A. Sturm. 2008. *From conceptual models to schemata: An object-process-based data warehouse construction method*," *Information Systems*, vol. 33, pp. 567-593.

Osorio, C.A., D. Dori, and J. Sussman. 2011. *COIM: An object-process based method for analyzing architectures of complex, interconnected, large-scale socio-technical systems*, *Systems Engineering*, vol. 14, no. 3.

Paredis, C.J.J. et al. 2010. "An overview of the SysML-Modelica transformation specification". Proceedings of the 20th Annual International Council on Systems Engineering (INCOSE) International Symposium, 12-15 July 2010, Chicago, IL.

Reinhartz-Berger, I. and D. Dori. 2005. "OPM vs. UML—Experimenting with comprehension and construction of web application models," *Empirical Software Engineering*, vol. 10, pp. 57-79, 2005.

Weilkiens, T. 2008. *Systems Engineering with SysML/UML*. Needham, MA, USA: OMG Press.

< Previous Article | Parent Article | Next Article (Part 3) >

SEBoK v. 2.3, released 30 October 2020

Retrieved from "https://sebokwiki.org/w/index.php?title=Modeling_Standards&oldid=59536"

-
- This page was last edited on 12 October 2020, at 13:36.

