

# Introduction

For more than forty years, the practice of systems engineering followed a linear path: requirements are documented first, followed by analysis then conceptual design—through the development life cycle. However, regardless of the engineering process employed—waterfall, incremental, iterative, spiral, and even sprint-based—the lack of integration from one phase to another in the cycle results in longer delivery times and increases costs to correct errors introduced at transition points.

Model-Based Systems Engineering (MBSE) is an initiative in the systems engineering community that uses model-based descriptions and transformations so that work occurs concurrently. Requirements collection, analysis, and specifications are performed at the same time as conceptual design. MBSE is practiced across many industries around the globe. For example, it was used to develop the world's largest telescopes, propulsion engines for fighter jets, and autonomous driving cars.

# **Value Proposition**

MBSE is often contrasted with a more traditional document-based approach to systems engineering where system information is spread across many document-based artifacts (hand-written text documents, spreadsheets, and drawings). MBSE brings information together into a cohesive integrated model of the system that:

- Enhances precision, consistency, and traceability;
- Includes behavioral analysis, system architecture, requirement traceability, performance analysis, simulation, test, etc.;
- Formalizes the practice of systems development through the use of models;
- Integrates information across discipline-specific engineering tools, including hardware and software design, analysis, simulation, and test; and
- Facilitates shared understanding of the system among the development team resulting in:
  - quality/productivity improvements and lower risk;
  - rigor and precision;
  - ongoing communications among development team and customer; and
  - management of complexity.

"Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02), Sept 2007

## **Model-Based Engineering at OMG**

The Object Management Group<sup>®</sup> (OMG<sup>®</sup>) in conjunction with the International Council on Systems Engineering (INCOSE) has led standardization efforts for MBSE. In particular, the OMG Systems Modeling Language<sup>™</sup> (OMG SysML<sup>™</sup>) and Unified Profile for DoDAF and MODAF<sup>™</sup> (UPDM<sup>™</sup>) were developed under the auspices of the OMG, working in conjunction with INCOSE. These standards have become broadly recognized for systems and enterprise modeling. The combination of OMG standards like UPDM, SysML<sup>®</sup>, and Unified Modeling Language<sup>™</sup> (UML<sup>®</sup>) enables modeling from the enterprise to system to software design. Other OMG standards, such as Requirements Interchange Format<sup>™</sup> (ReqIF<sup>™</sup>) which provides a standard format for exchanging requirements information between different requirements tools, further enables this capability. These MBSE foundations are listed below.

## Unified Profile for DoDAF and MODAF (UPDM)

The OMG Unified Profile for DoDAF and MODAF is a further extension of SysML to support enterprise architecture modeling. UPDM adds capabilities to model projects and organizations and their associated visions, capabilities, and resources. UPDM provides a robust means for representing multiple aspects of the enterprise that can include service oriented architectures and standards compliance. Although UPDM was originally focused on supporting specific architecture frameworks used for defense enterprises such as the DoD, MOD, and NATO, the UPDM has recently been renamed the Unified Architecture Framework<sup>®</sup> (UAF<sup>®</sup>) to recognize its more general application to any commercial, government, infrastructure or defense enterprise. The addition of Security and Human Factors views adds capabilities not found in the original frameworks, further emphasizing its extensibility.

## Systems Modeling Language (SysML)

The OMG SysML<sup>™</sup> is a general-purpose graphical language for specifying, analyzing, designing and verifying complex systems that include: hardware, software, personnel, procedures, and facilities. In particular, the language provides graphical representations with a semantic foundation for modeling system requirements, behaviors, and structures. SysML is an extended subset of UML that meets the requirements established by OMG and INCOSE in their initial Request for Proposal for UML for Systems Engineering. OMG SysML started in 2006 and is currently finishing up SysML v1.5. For more information on the standard, visit <u>www.omgsysml.org.</u>

The OMG has begun work on the next generation of SysML (v2) that will provide enhanced capabilities for system modeling including improved precision, visualization, usability, and interoperability. This update is intended to integrate with a broad range of other models and tools used in a model-based engineering environment.

## Unified Modeling Language (UML)

The modeling standard for 30 years, UML serves as the basis for other modeling languages like SysML or UPDM.

## **Requirements Interchange Format (ReqIF)**

The OMG Requirements Interchange Format (ReqIF) is a standard for exchange of requirements information among requirements management tools and modeling tools. It was first introduced for the automotive industry in Europe but has gained broad traction as an important part of the MBSE standards landscape. ReqIF supports the broader MBSE goal of integrating information across many different tools and models.

## Want to learn more?

We are happy to discuss how OMG membership will benefit your organization! Please feel free to explore our website at **www.omg.org** and when you are ready, please contact bd-team@omg.org or call + 1-781-444-0404 to get started.

## **About OMG**

OMG Task Forces develop enterprise integration standards for a wide range of technologies and an even wider range of industries. OMG's modeling standards enable powerful visual design, execution and maintenance of software and other processes. Visit **www.omg.org** for more information.



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