6.10 Adopt a Model-Based Systems Engineering (MBSE) Approach

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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)[1)] 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, autonomous driving cars, software solutions to include software-defined radios, and space applications (hardware and software).

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

1. Enhances precision, consistency, and traceability;
2. Includes behavioral analysis, system architecture, requirement traceability, performance analysis, simulation, test, etc.;
3. Formalizes the practice of systems development through the use of models;
4. Integrates information across discipline-specific engineering tools, including hardware and software design, analysis, simulation, and test; and
5. 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.

    For more information on MBSE, please see:

    - MBSE Specifications at OMG:
    - MBSE Overview in Appendix.

    The Object Management Group (OMG) also recommends that the Federal Reserve use the Unified Architecture Framework (UAF) for future CBDC efforts. See OMG Unified Architecture Framework (UAF):

    UAFP 1.0 supports the capability to:

- model architectures for a broad range of complex systems, which may include hardware, software, data, personnel, and facility elements;
- model consistent architectures for System-of-Systems (SoS) down to lower levels of design and implementation;
- support the analysis, specification, design, and verification of complex systems; and
- improve the ability to exchange architecture information among related tools that are SysML-based and tools that are based on other standards.

The intent of UAF is to provide a standard representation for describing enterprise architectures using a Model-Based Systems Engineering (MBSE) approach.

The Object Management Group also recommends that the Federal Reserve use the Unified Architecture Framework (UAF) for future CBDC efforts. See OMG Unified Architecture Framework (UAF), it is summarized here:

UAF Profile (UAFP) 1.0 supports the capability to:

- *Model architectures for a broad range of complex systems, which may include hardware, software, data, personnel, and facility elements;*
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- *Support the analysis, specification, design, and verification of complex systems; and*
- *Improve the ability to exchange architecture information among related tools that are SysML based and tools that are based on other standards.*

The intent of UAF is to provide a standard representation for describing enterprise architectures using a Model-Based Systems Engineering (MBSE) approach.

1)

"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 MBSE

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