Object Oriented Systems Engineering Method (OOSEM) Working Group

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Acknowledgment

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OOSEM WG Purpose

Evolve, extend, and advance the use of the Object-Oriented Systems Engineering Method (OOSEM) to drive greater quality, consistency, compatibility, and value to the practice of MBSE across the INCOSE community.

- Evolve OOSEM to incorporate lessons learned from 15+ years of using SysML v1.x

- Extend OOSEM to the paradigm shift in MBSE enabled by SysML v2

- Advance the use of OOSEM in the MBSE community through outreach and impactful products

- Maintain and evolve the Model Based Capability Matrix (MBCM)

OOSEM WG Goal

Advance the state of the practice of MBSE by accelerating convergence toward best practices, improving MBSE adoption and implementation outcomes, and elevating the discipline of MBSE practitioners

- Accelerate convergence of the community toward a consistent use of SysML v2
  - To improve model interoperability and understanding
- Aid the adoption of MBSE by organizations
  - By establishing a solid foundation of MBSE methods that can be readily tailored
- Improve organizations' ability to quickly extract value from MBSE
- Advance the state of the practice of MBSE
  - By improving modeling discipline both individually and collectively

OOSEM Background

- OOSEM is a top-down, scenario-driven process
  - Uses descriptive models to support analysis, specification, design, and verification of systems
  - Leverages OO concepts and other modeling techniques to help architect more flexible and extensible systems that can accommodate evolving technology and changing requirements
  - Eases integration with OO software development, hardware development, and test processes

- OOSEM was originally developed in 1998
  - Further evolved in a joint effort between Lockheed Martin Corporation and the Systems and Software Consortium (SSCI), previously known as the Software Productivity Consortium
  - Early pilots were conducted to assess the feasibility of the method
  - Initial implementation used the Unified Modeling Language (UML)

- OOSEM was further refined by the INCOSE OOSEM WG beginning in 2002
  - Led to the development of the Systems Modeling Language (SysML), which was formally released as a standard in 2007

OOSEM v1
A Recursive Specification and Design Process

- Purpose:
  - Process for analyzing needs and requirements, architecting the system, and specifying system elements

- Includes activities to:
  - Analyze requirements
  - Define the architecture
  - Analyze alternative designs
  - Manage traceability

- Can be applied recursively to multiple levels of design

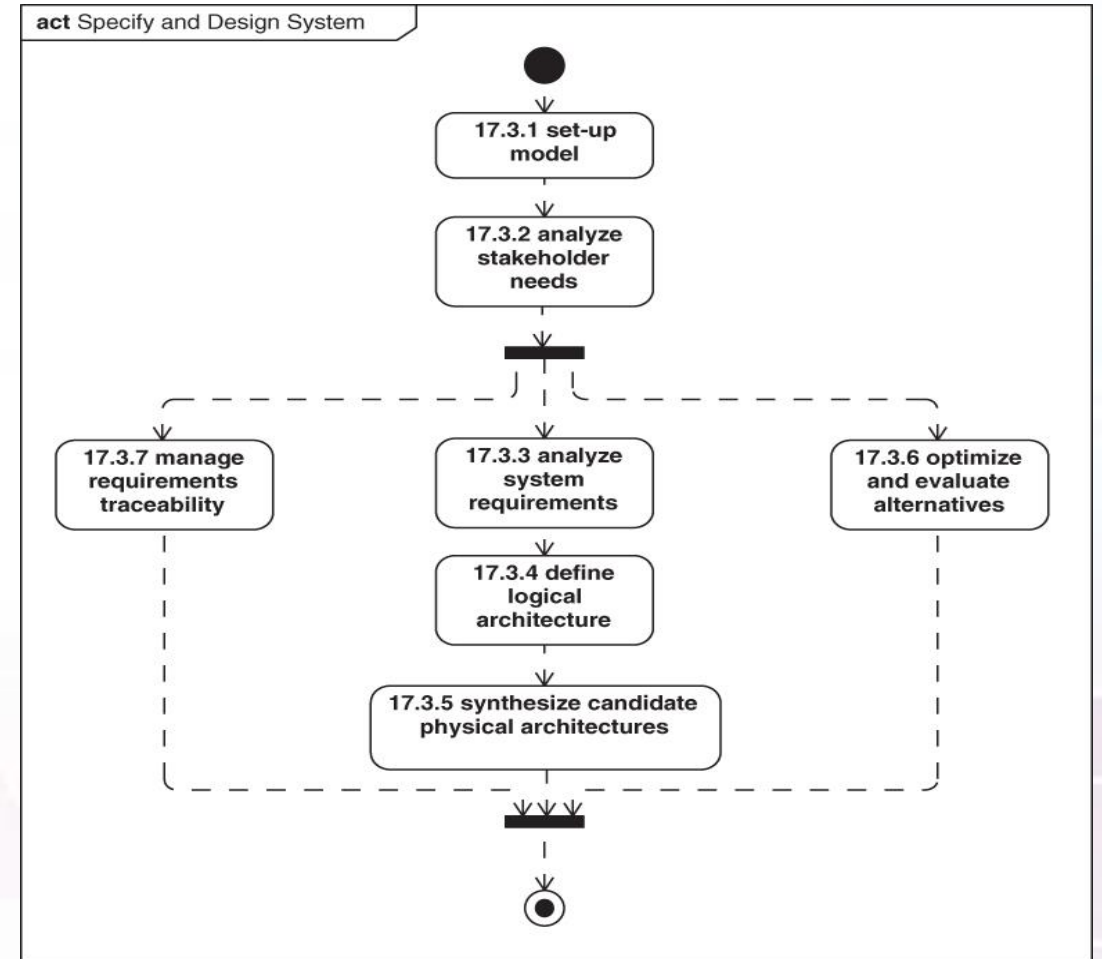**Source: A Practical Guide to SysML (3rd Edition)**

Figure 17.3

OOSEM Emerging Context

- Since the original development of OOSEM, several key developments in the state of the art and practice of MBSE have occurred
  - 15+ years of learning with SysML v1
  - Emergence of SysML v2 as a paradigm-shifting successor to SysML v1
  - Recognition of criticality of disciplined MBSE implementation & transition planning
    - To improve the odds of achieving the intended outcomes of adopting MBSE
  - Integration of MBSE within a broader Digital Engineering paradigm
    - Digitally connects information and work across a wide range of disciplines and organizations
  - INCOSE's 2035 Vision and Future of Systems Engineering initiative
    - Which seek to push the state of the art and practice of SE to the next level
  - The recent explosion of growth of deep learning
    - Game-changing technology that can revolutionize the practice of SE

OOSEM WG Work Scope

- Develop, evolve, and advance MBSE methodology in both the large and the small
  - *In the large*: A full life cycle approach to adopting, implementing, and evolving MBSE
  - *In the small*: Define best-practice approach to modeling to capture evolving SE knowledge to enable MBSE
- Collaboration and information exchange within and outside of INCOSE
  - Within INCOSE – particularly the Working Groups
    - Align with INCOSE-promulgated best practices and lexicon
    - Identify focal points to coordinate with those Working Groups
    - Establish best practices for developing SysML v2 models within INCOSE
  - With the OMG Systems Modeling Community (SMC)
    - Develop SysML v2 modeling patterns
    - Improve consistency of MBSE practice and interoperability of SysML v2 models
  - Other professional societies and coalitions

OOSEM WG Work Scope

- Sharing of experiences among members of the WG
  - Solicit input for case studies
  - Identify lessons learned from use of OOSEM and MBCM and other methods
  - Converge to consensus on best practices

- Review of related work
  - e.g., case studies, major research efforts by graduate students

- Review and evaluation of tool support for OOSEM

- Outreach, education, training, and development of materials
  - To facilitate dissemination and adoption of OOSEM

OOSEM

- OOSEM was matured in the OOSEM WG but was not formally published as a product
  - The best source for understanding OOSEM and its application in practice is in the book *A Practical Guide to SysML*, by Sandy Friedenthal, Alan Moore, and Rick Steiner
    - Chapter 17 illustrates the application of OOSEM with SysML
  - Other existing materials include a few conference papers and two tutorial slide decks
    - A tutorial slide deck was created jointly by INCOSE and JHU APL but appears to require JHU APL approval to disseminate
  - A SysML process model was created to illustrate the OOSEM process flow

- There is interest in more comprehensive and authoritative documentation of OOSEM
  - This would improve its ability to be adopted by individuals and organizations

OOSEM v2

- The SysML v2 specification is in finalization in the Object Management Group (OMG)
  - Adoption by OMG expected in 2025

- SysML v2 represents a significant paradigm shift in descriptive system modeling, offering many advantages over the previous v1.x versions of SysML
  - A new textual representation to complement the graphical notation
  - Usage-focused decomposition, which improves model usability and reusability
  - Standardized approaches for addressing analysis cases, verification cases, property-based requirements, variant modeling, modeling of timeslices and snapshots, etc.
  - Standardized API and Services specification regularizes programmatic access to models

- OOSEM v2 will be designed to take advantage of the new features and paradigm of SysML v2 to provide a more effective MBSE experience
  - Sandy Friedenthal, one of the lead authors of OOSEM v1 and one of the leading developers of SysML v2, has signed on to lead the development of OOSEM v2
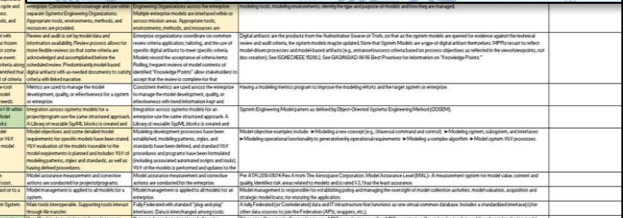
OOSEM v2 Products

- Primary Product: Object Oriented Systems Engineering Method v2.0
  - Updates OOSEM to incorporate best practices from the past 15+ years of using SysML v1.x
  - Updates OOSEM to address the new modeling paradigm afforded by SysML v2
  - Serves as an authoritative definition of OOSEM v2
  - Provide an example SysML v2 model to illustrate application of OOSEM v2
  - OOSEM process model (SysML v2 and/or v1)

- Related Products - pending availability of contributors
  - Updated OOSEM Training Course materials
  - OOSEM Case Studies
  - Tailoring of OOSEM for application to more lightweight applications
  - Tailoring OOSEM for enterprise or mission engineering modeling using UAF v2
  - Examples of OOSEM application in other system modeling languages

Model Based Capability Matrix (MBCM)

- The INCOSE Model Based Capability Matrix (MBCM) was originally developed in a partnership between Aerospace Corporation and NASA Marshall Space Flight Center

- The MBCM is an instrument to aid the assessment of an organization's maturity in 42 essential synergistic capabilities that are needed to achieve the benefits of MBSE

- MBCM was published as an INCOSE product in January 2020

- Since its publication, it has been used by many organizations in their MBSE maturity assessments and planning and implementation efforts

Model Based Capability Matrix (MBCM) v2

- Since its publication, some organizations have used MBCM extensively and have identified some areas for potential improvement
  - Facilitate use in more highly constrained SE applications
    - e.g., Small programs, early-stage R&D, non-traditional applications
  - Address Transition between MBSE approaches
    - e.g., SysML v1 to SysML v2
  - Enable recategorization of MBSE capabilities to improve organizational alignment
  - Facilitate broader scope of assessment to include adjacent disciplines
    - e.g., analysis and design activities that rely on the descriptive models
  - Facilitate model-based acquisition activities

MBCM v2 Products

- Primary Product: MBCM v2 User Guide and Matrix
  - Updates the MBCM (and the associated MBCM User Guide)
    - To address best practices and lessons learned over the past 4+ years of using the MBCM
  - Updates the MBCM (and the associated MBCM User Guide) to address the new modeling paradigms, capabilities, opportunities, and challenges of SysML v2
    - Including organizational or project transition from SysML v1 to v2
  - Guidance for tailoring of the MBCM

- Related Products
  - SysML (v1 and/or v2) model of the updated MBCM to support enterprise planning of MBSE adoption or evolution activities
  - Lightweight version of MBCM to streamline the assessment process
  - Expanded scope of MBCM to address the broader scope of Digital Engineering (DE)

OOSEM WG Summary

- Rebooting the OOSEM WG to focus on developing impactful products to advance the state of the practice of MBSE
  - OOSEM v2
  - MBCM v2
  - etc…

- Working to achieve the vision of INCOSE Vision 2035 and the Future of Systems Engineering Initiative

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