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Mission Engineering - Through Life Perspectives

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Abstract

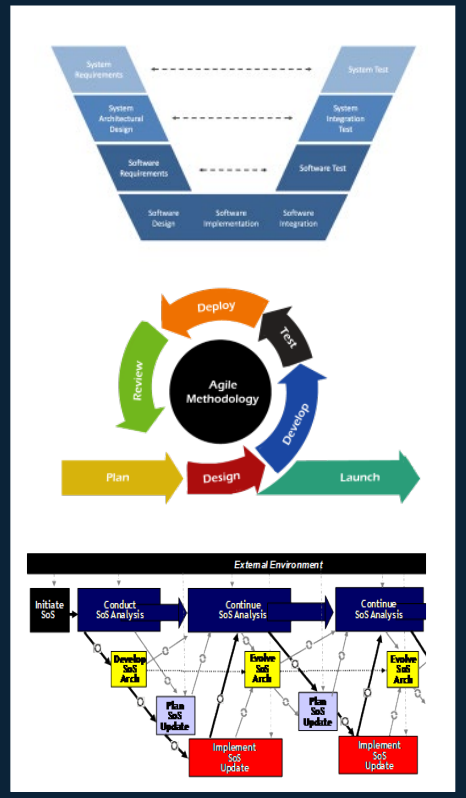
US Defense is increasing its focus on the application of systems engineering for mission. Motivated by Congressional direction to focus on capability portfolios, mission engineering has been viewed as the engineering support to addressing mission capability needs.

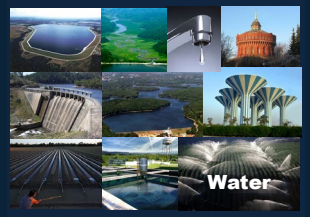
OUSD R&E Mission Integration, as the DoD lead for mission engineering (ME), published the Mission Engineering Guide (November 2023) and hosts an ME working group and forum to share ME experience and best practice. The Services are adopting ME to address their particular mission related objectives and there is now international interest in ME particularly in Australia and Japan. The R&E methodology focuses on the assessment of scenario driven mission priorities and the analysis of options for mitigating gaps to improve mission outcomes. The objective of ME is building the 'right' things (versus building things 'right').

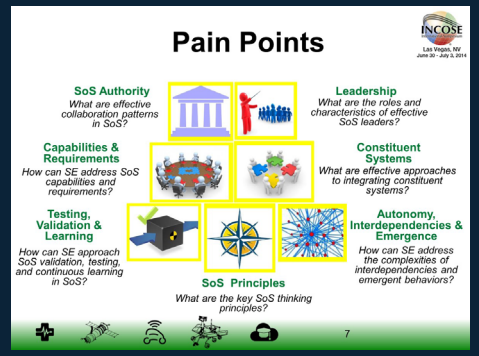
As ME is adopted, there is now attention to the role of ME in the latter and there are emerging approaches to the role of ME through the life of missions and systems, with a broader definition of ME from the SE Body of Knowledge (sebok.wiki.org) – "Application of systems engineering to Mission, where the system of interest is the mission."

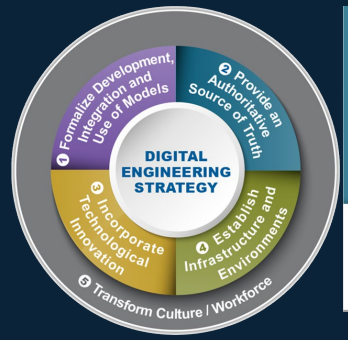
This presentation reviews these approaches to mission engineering and discusses the implications for future mission engineering evolution and application.

Directions in Systems, SoS and Mission Engineering

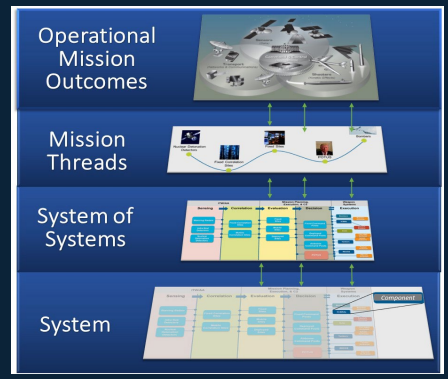








"Application of systems engineering to Mission, where the system of interest is the mission." (SEBOK)



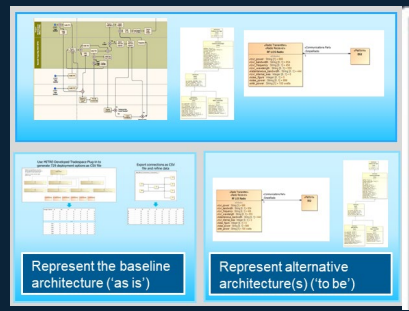
Purpose and Topics

- Purpose
  - Identify considerations for integrating ME analysis results ‘through life’ (design and Integration) to impact operational outcomes
- Topics
  - Outputs of ME (MEG 2.0)
  - Translation of engineering outputs into operational capability through
    - New systems
    - Systems of systems integration and evolution
  - Digital threads for ME/SoS and Systems

Challenge: Integrating mission engineering ‘through life’

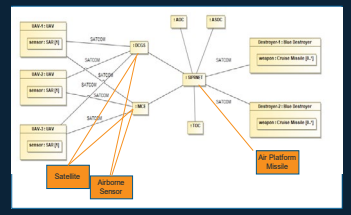
The Question

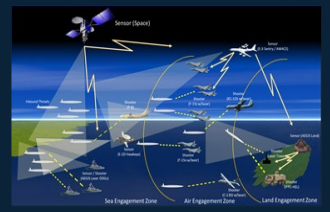
Mission Engineering



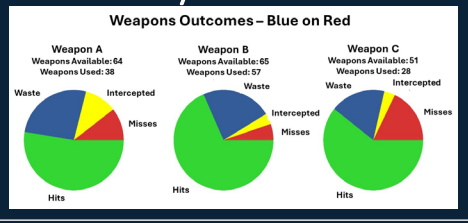
SySML Descriptive Mission Model

Dynamic Operational Simulation Model





Analysis Results



The goal of mission engineering is to *engineer missions* by *identifying the right things* (i.e., technologies, systems, SoS, or processes) to achieve the intended mission outcomes; and, to provide mission-based inputs into the systems engineering process to aid the Department in *building things right*.

Recommendations/Decisions

How do ME recommendations / decisions translate into improved operational capability?

Range of Material and Non-Material Potential ME Results

- Mission engineering analysis results may identify effective options that include
  - Changes in CONOPs to more effectively use current capabilities
  - Increased capacity (e.g., added numbers of systems or increased access to system support)
  - New capabilities

Mission Engineering Guide focus on new capabilities is the focus for this presentation.

Mission engineering is used to identify and quantify gaps, issues, or opportunities across missions and seeks to address these by assessing the efficacy of potential capability solutions—materiel or non-materiel—that enhance mission outcomes.

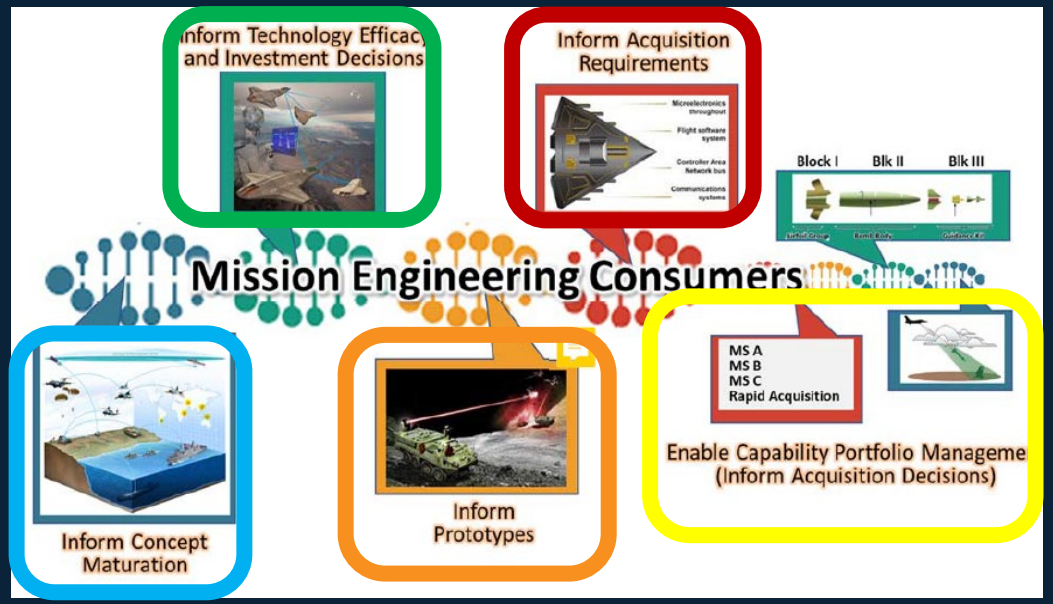
Mission engineering can assess a range of potential solutions— materiel and non-materiel—within a mission context to inform systems or SoS design and integration considerations, operational concepts, and trade-offs in Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P), based on impacts to the mission.

Mission Engineering Guide, 2.0

Several Cases – Engineering Focus

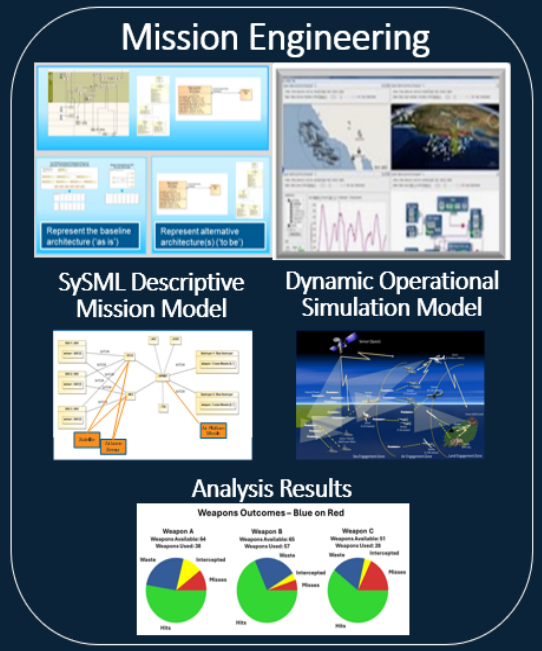
- ME results may recommend:
  - Requirements for a new system development or upgrade
  - Technology investment roadmap priorities
  - Prototype development
  - Concept maturation
  - Capability Portfolio Management/Acquisition Decisions

Mission engineering is an interdisciplinary process encompassing the entire technical effort to *analyze, design, and integrate* current and emerging operational needs and capabilities to achieve desired mission outcomes.



How do ME recommendations ('analyze') translate into follow-up actions ('*design and integrate'*) through the life of the Mission/SoS?

Path Through Life for Each Case From Recommendation to Operations



Operational Need

Tech Investment

Tech Development

System Requirements

Concept Development

Experimentation

Prototype Development

CPM Decisions

Acquisition Priorities

System Acquisition

JCIDS Acquisition PPBE

New System

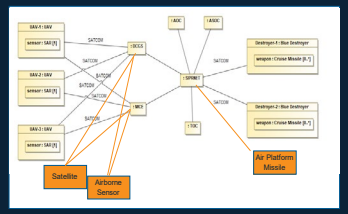
Operations

To effect mission outcomes, engineering recommendations lead to new system capabilities

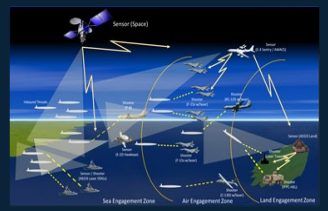
The Question

Mission Engineering

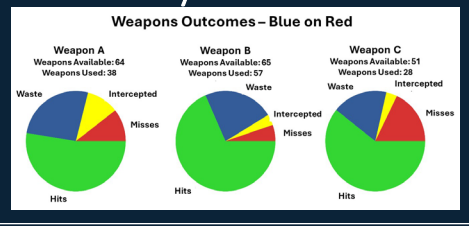
SySML Descriptive Mission Model



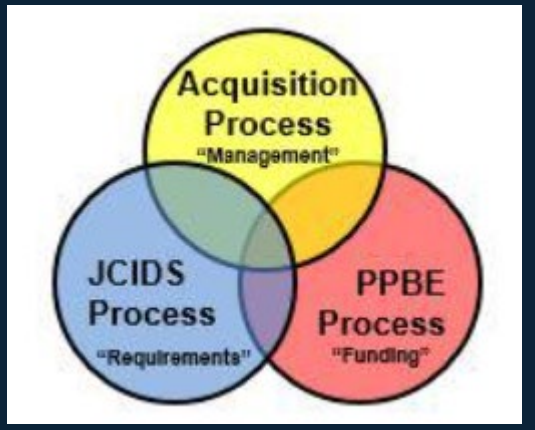
Dynamic Operational Simulation Model



Analysis Results



New System Acquisition



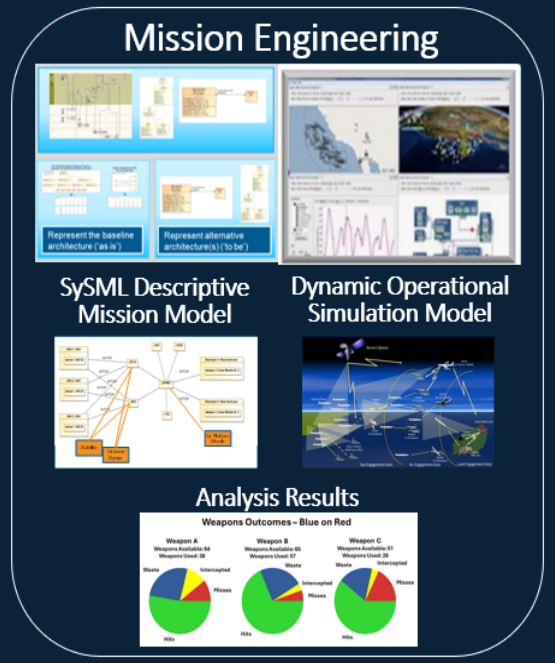
Recommendations/Decisions

How do ME recommendations / decisions translate into improved operational capability?

ME Drives JCIDs/Acquisition – Traditional Approach

Relationship of ME to the Capabilities Based Assessment (CBA) and the Analysis of Alternatives (AoA) ?

CBA **AoA**



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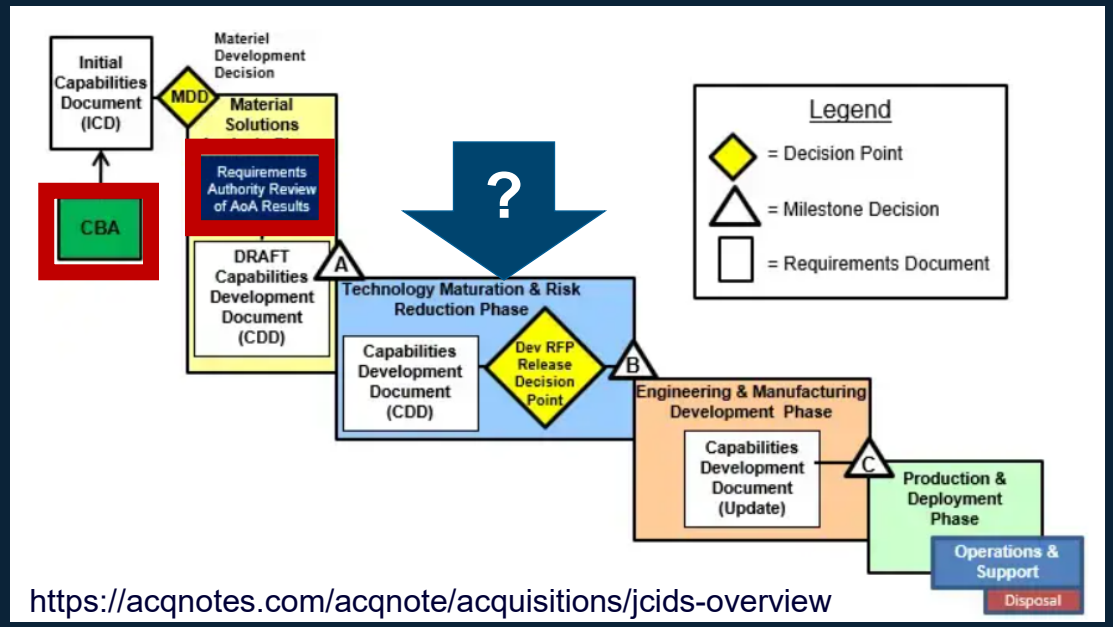

ME results *may* satisfy the requirements for a CBA or provide the starting point for an AoA [MEG 2.0]

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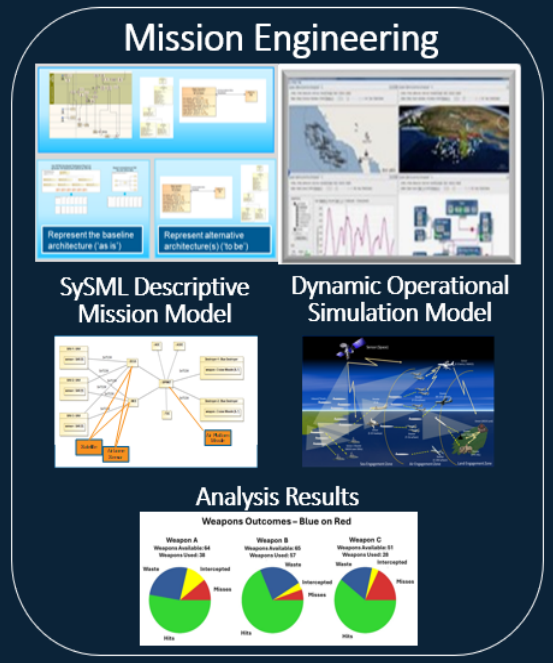
ME Drives JCIDs/Acquisition – Traditional Approach

Do the ME results affect the selection of the acquisition path?



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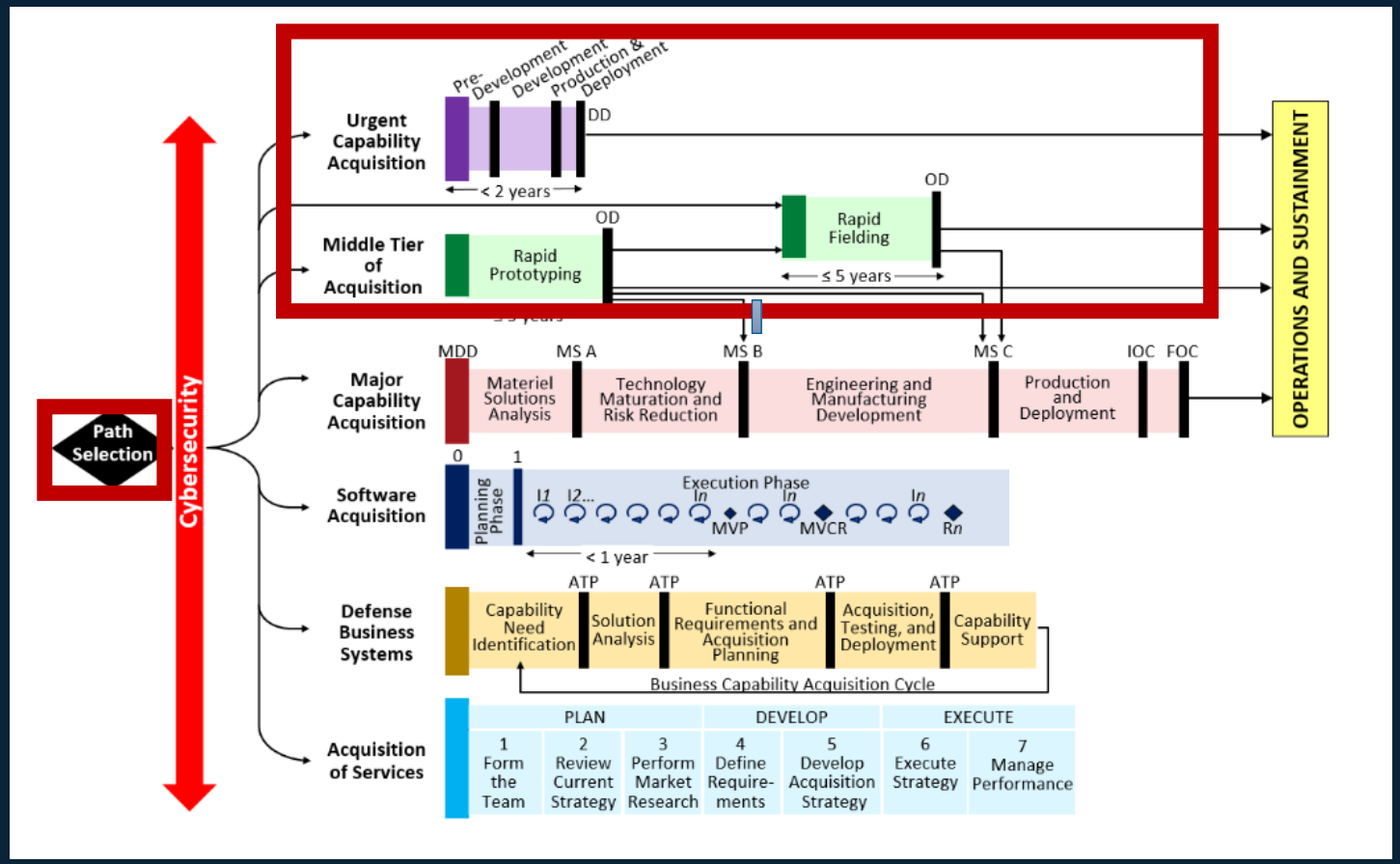


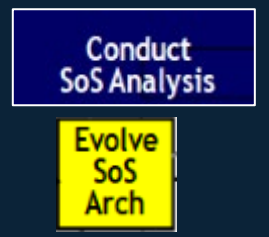
https://aaf.dau.edu/

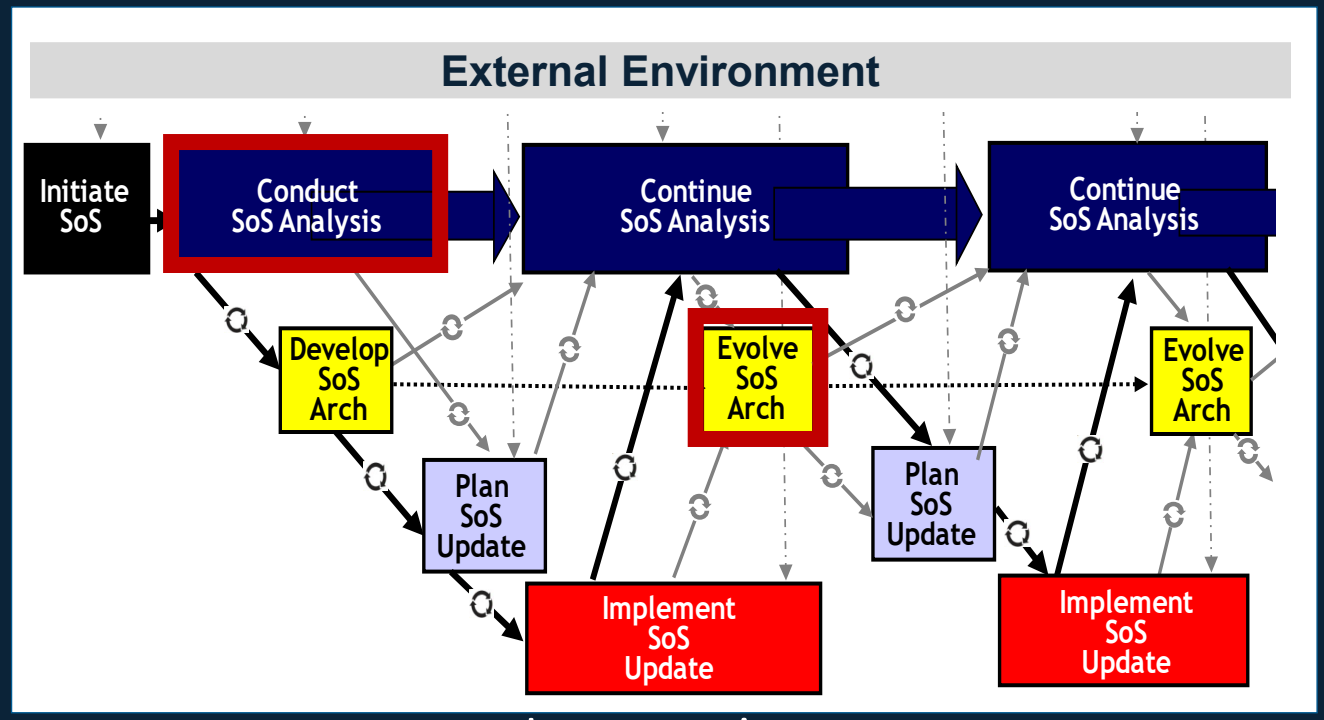
So how does the new system(s) get ‘integrated’ into the Mission/SoS?

- One view of SoS engineering is the evolution of SoS capabilities over time as shown in the ‘SoS Wave Model’
- ME may reflect ‘SoS analysis’ driving ‘evolution of the SoS architecture’
- ME may identify multiple changes needed to effect mission outcomes
- These may be implemented incrementally over time leading to changes intended to improve mission effectiveness of the SoS

Is ME one way to conduct SoS Analysis?

Do ME results reflect recommended changes to the SoS architecture?





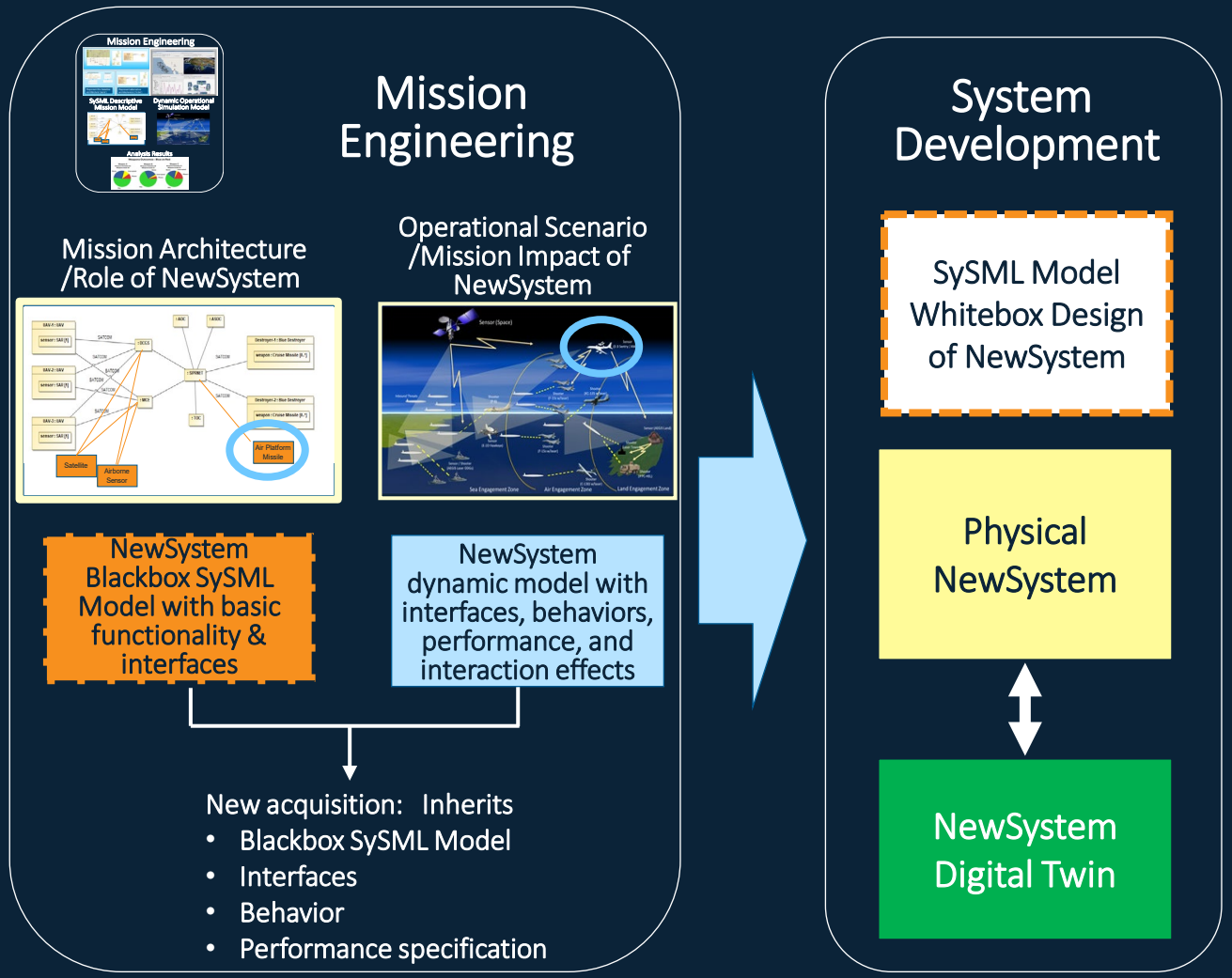
SoS Implementers’ View

Other through life options?

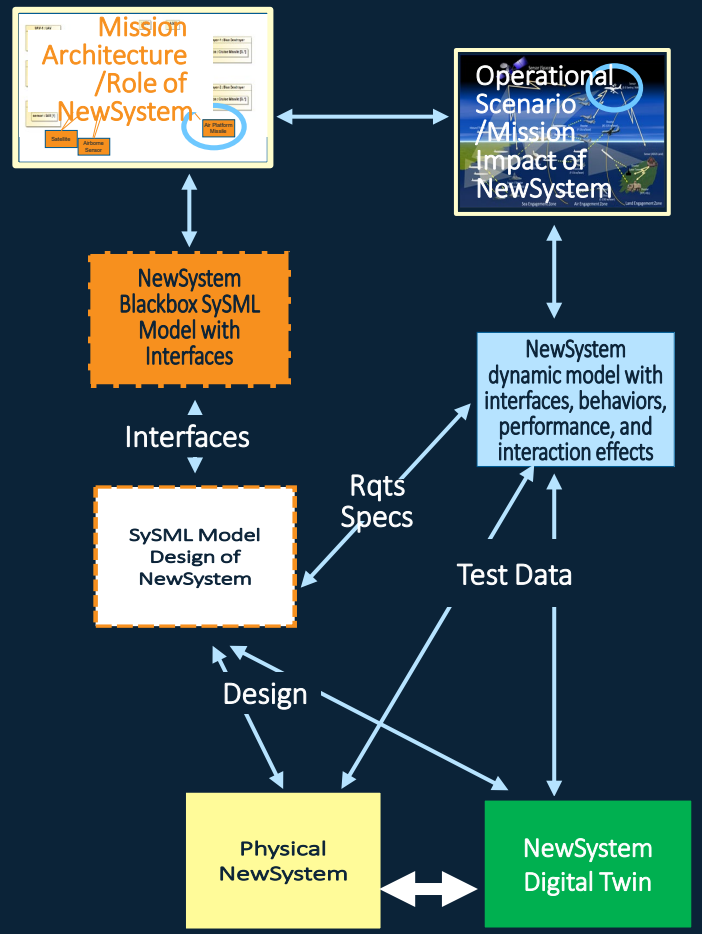
- Checkpoints at each milestone to assess changes in mission and in system specifications, to ensure on track for mission impact
- Logistics and maintenance changes could impact systems reliability and available as well as support costs
- Tying development and operation test and evaluation to mission outcomes

ME/System/SoS Digital Thread – Acquisition

A data-driven framework that connects models and other data to streamline the procurement process and system lifecycle

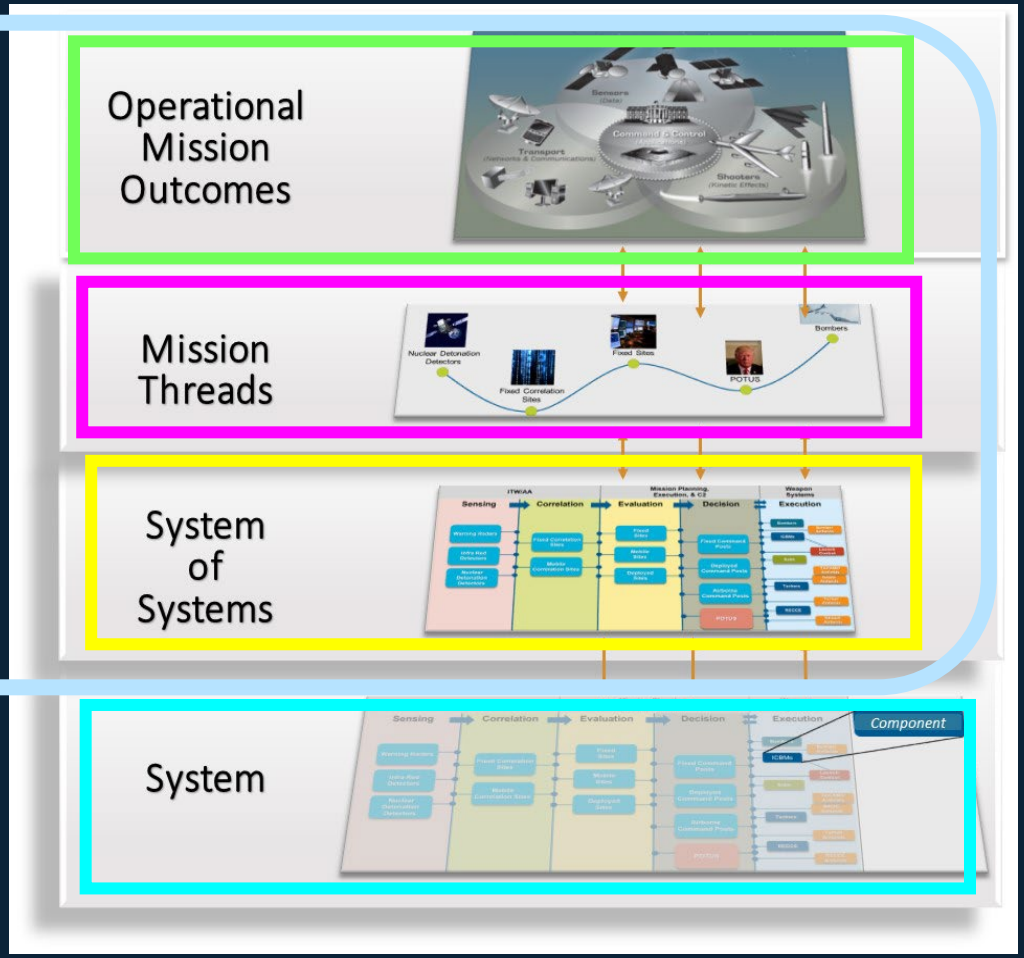


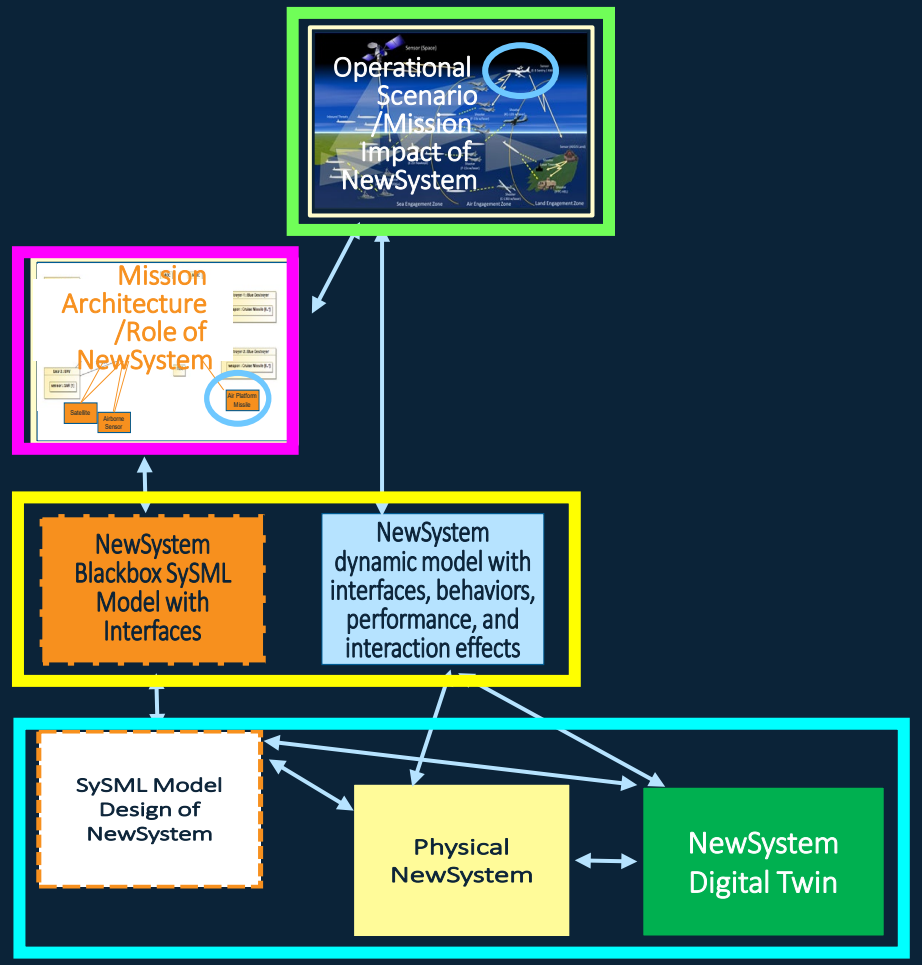
Model Alignment



Linking Models
Mission, Systems of Systems, and Systems in a Mission Context

Mission Engineering





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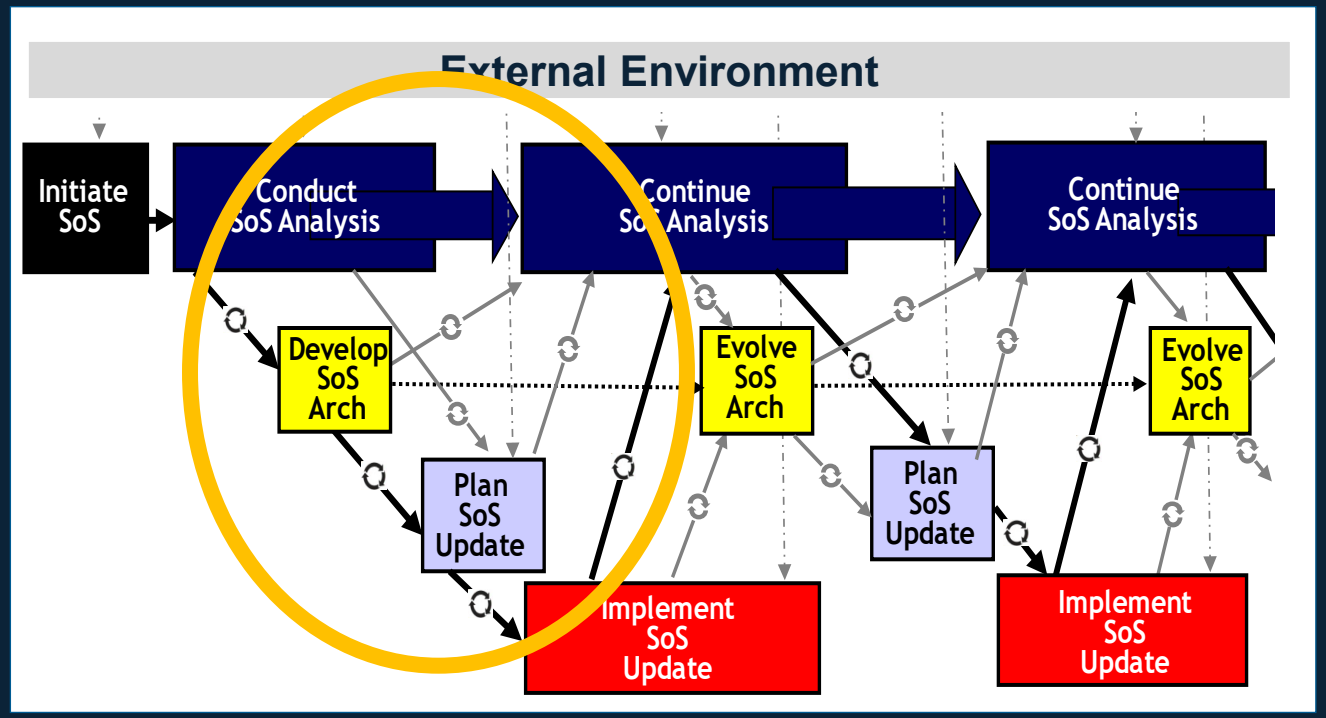

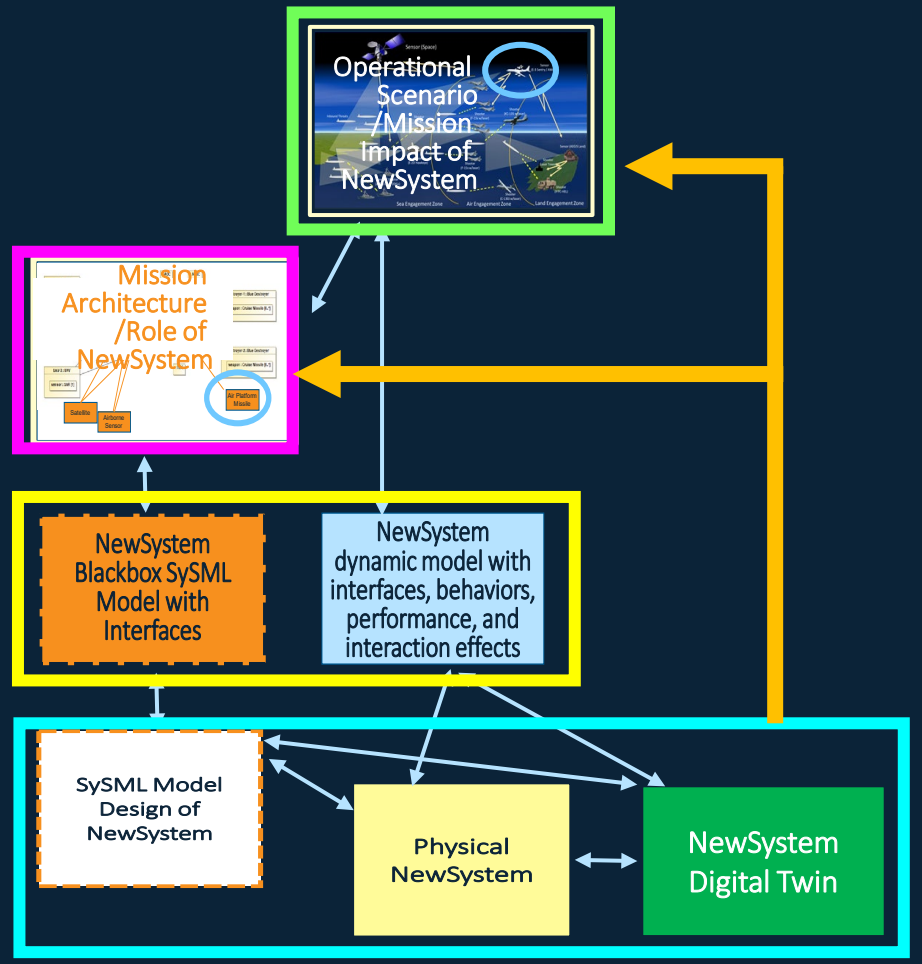

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Discussion

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