



**Naval Postgraduate School
Systems Engineering Department
Monterey, CA**

Defining a Model-Based Systems Engineering Approach for Technical Reviews

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Dr. Warren Vaneman
CAPT, USN (Ret.)
Professor of Practice
Email: wvaneman@nps.edu

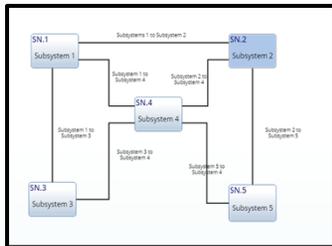
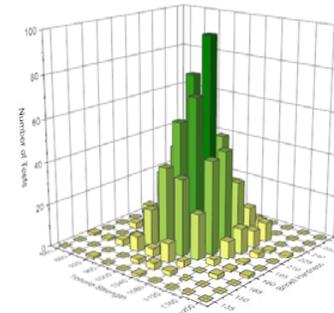
Prof. Ron Carlson
CAPT, USN (Ret.)
Professor of Practice
Email: rrcarlso@nps.edu

Background

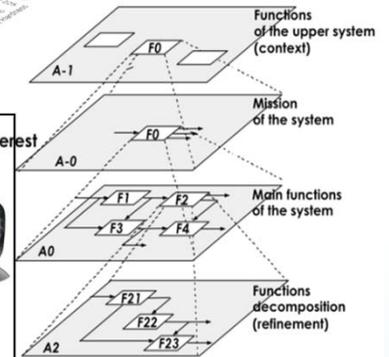
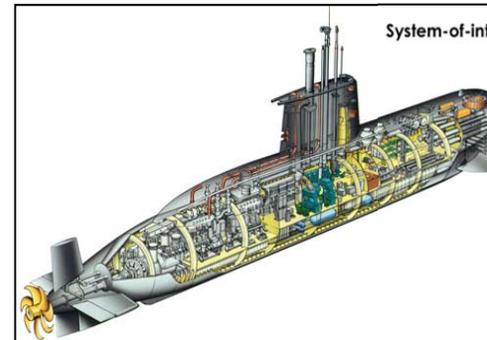
Traditional Systems Engineering Technical Reviews



Model-Based Systems Engineering Technical Reviews



Task Name	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Jan 08	###
1 DoDAF v2.0 Development												
2 Project Planning												
3 Conduct Kickoff Meeting												
4 Develop Statement of Objectives (SOO)												
5 Review DoDAF v2.0 Lessons Learned												
6 Develop Planned Milestones												
7 Develop Master Schedule												
8 Identify Requirements Workflows												
9 Develop Work Packages												
10 Develop Outreach Plan												
11 Coordinate DoDAF meetings												
12 Provide Support for OASDs and TWPs												
13 Publish Milestones												
14 Track Action Items												
15 Maintain and Publish Amendment Proposals												
16 Establish DoDAF Organizational												
17 Establish Development Team (DEV-T)												
18 Establish Core Management Group												
19 Establish Requirements Management												

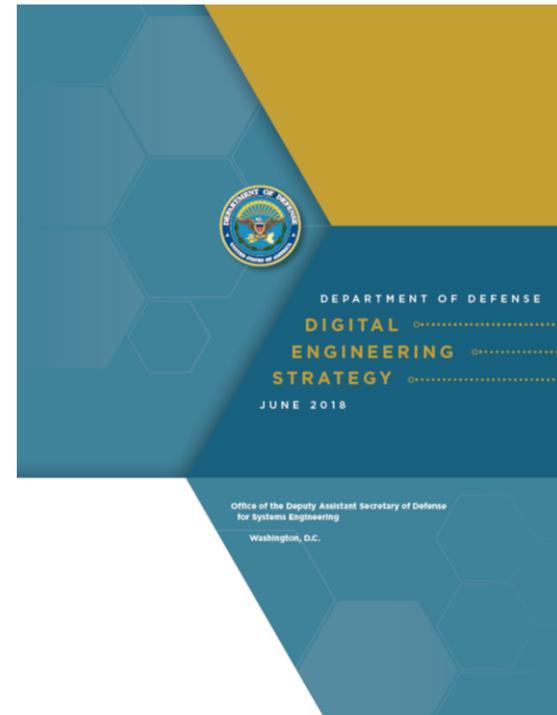


Model-Based Systems Engineering was envisioned to transform systems engineering from a document-based to model-based discipline.

Digital Engineering*

DoD defines digital engineering* as an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines that support lifecycle activities from concept through disposal.

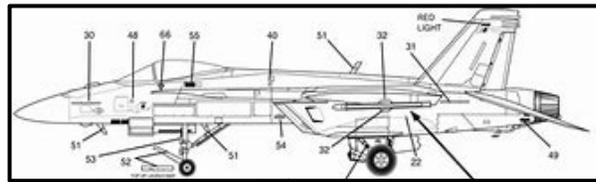
* The terms “Model-Based Systems Engineering (MBSE)” and “Digital Engineering” are considered synonymous for this presentation. MBSE is technically defined in the corresponding paper.



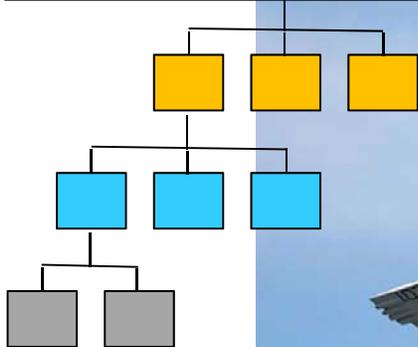
- **Goal 1: Formalize the Development, Integration, and Use of Models to Inform Enterprise and Program Decision Making**
 - 1.1 Formalize the planning for models to support engineering activities and decision making across the lifecycle.
 - 1.2 Formally develop, integrate, and curate models.
 - 1.3 Use models to support engineering activities and decision making across the lifecycle.

Source: DoD Digital Engineering Strategy (2018)

Dimensions of a System



Systems Perspective



Task Name	Duration	Start	Finish
1. Define Requirements	10/1/2010	10/1/2010	10/31/2010
2. Concept Definition	11/1/2010	11/1/2010	11/30/2010
3. System Architecture	12/1/2010	12/1/2010	12/31/2010
4. Preliminary Design	1/1/2011	1/1/2011	1/31/2011
5. Detailed Design	2/1/2011	2/1/2011	2/28/2011
6. Manufacturing	3/1/2011	3/1/2011	3/31/2011
7. Assembly	4/1/2011	4/1/2011	4/30/2011
8. Flight Test	5/1/2011	5/1/2011	5/31/2011
9. Operations	6/1/2011	6/1/2011	6/30/2011
10. Support	7/1/2011	7/1/2011	7/31/2011
11. Maintenance	8/1/2011	8/1/2011	8/31/2011
12. Training	9/1/2011	9/1/2011	9/30/2011
13. Logistics	10/1/2011	10/1/2011	10/31/2011
14. Procurement	11/1/2011	11/1/2011	11/30/2011
15. Contract Management	12/1/2011	12/1/2011	12/31/2011

Program Management Perspective

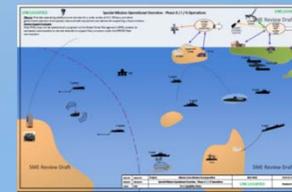


Work Breakdown Structure

Cost Breakdown Structure



Operational Perspective

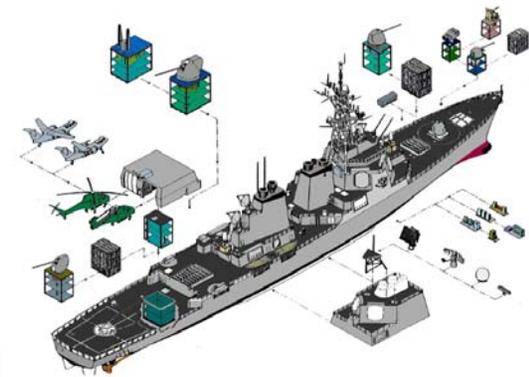


Concept of Operations

MBSE requires an increased emphasis on the model, specifically the objects and relationships it contains, rather than the “artifact” to encourage better model development, usage, and decision-making.

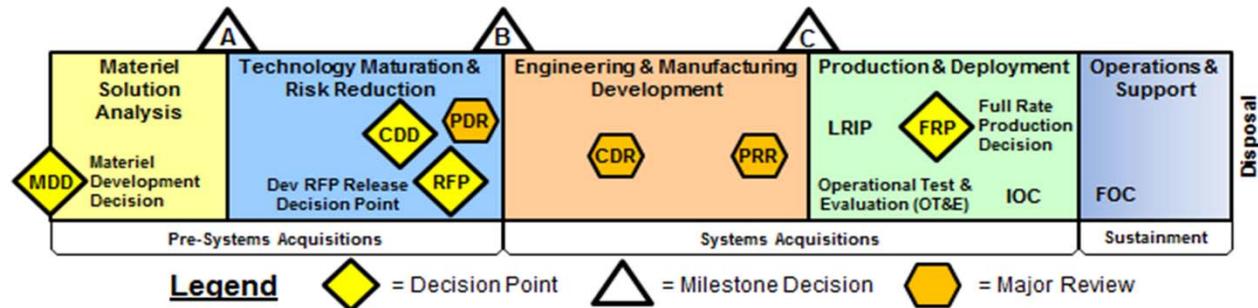
MBSE Approach

- A MBSE approach focuses on data at the entity level.
- Each entity has defined relationships, allowing it to represent the structural complexities within the system.
- Each entity has one or more corresponding visual representations that allow for comprehension and decision-making.
- The relationships between the principal entities define structure, address complexity, and ensure system traceability across the model.



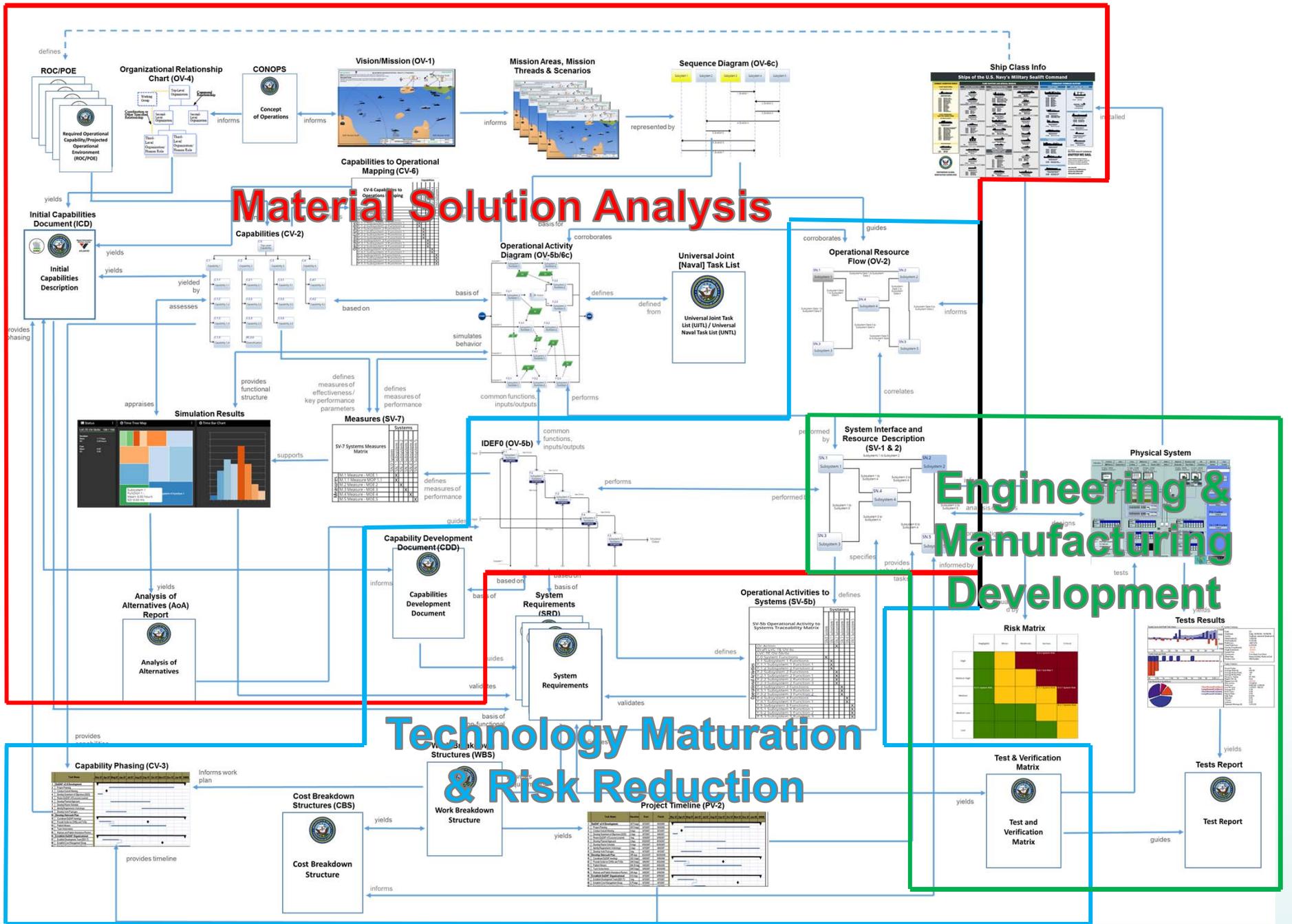
Systems consists of “building blocks” and the relationships between them that form a complete and functional entity.

Modeling with the System Acquisition Lifecycle



- The System Acquisition Lifecycle Model identifies five primary phases which take the system from concept develop and materiel solution analysis through operations and support.
 - The first three phases (prior to Milestone C) are where the most significant engineering occurs.
 - Each phase contains one or more technical reviews.
- MBSE focuses on model development of the “virtual system” throughout the lifecycle, and away from artifacts produced exclusively for technical reviews.

Use models to support engineering activities and decision making across the lifecycle. - DoD Digital Engineering Strategy, Goal 1.3



Requirements Document			
1. Is the initial CONOPS updated to reflect current user position about capability gap(s), supported missions, interfacing/enabling systems in the operational architecture?	N/A	N/A	None to display
2. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
3. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
4. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
5. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
6. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
7. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display
8. Do the requirements include and supporting references (ODD and ODDs) support the mission and supporting references (ODD and ODDs)?	N/A	N/A	None to display

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Alternative System Review (ASR) Criteria

Requirements Document

Documents

Technical Review Criteria

CONOPS

Concept of Operations Document			
0. Version History	N/A	N/A	None to display
1. Executive Summary	N/A	N/A	None to display
2. Introduction	N/A	N/A	None to display
2.1 Capability Need	N/A	N/A	None to display
2.1.1 MNS Required Mission(s) and Need(s)	N/A	N/A	None to display
2.1.2 MNS Capability Gap	N/A	N/A	None to display

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System CONOPS

Concept of Operations Document

Specific Criteria

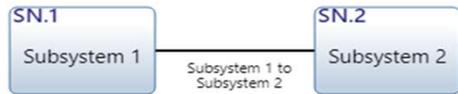
Statements

Relevant Supporting Evidence

Alternative System Review (ASR) Criteria	
1.	Is the initial CONOPS updated to reflect current user position about capability gap(s), supported missions, interfacing/enabling systems in the operational architecture?

System CONOPS	
2.1 Capability Need	<p>2.1.1 MNS Required Mission(s) and Need(s)</p> <ul style="list-style-type: none"> Identify the required mission(s) in functional terms. If appropriate, discuss the threats, threat assessment and threat environment that drives the mission (e.g., terrorist attack, natural disaster). Describe capabilities required by DHS or its' stakeholders/partners to accomplish the mission. Describe the capabilities independently of whether or not DHS currently possesses them. <p>2.1.2 MNS Capability Gap</p> <ul style="list-style-type: none"> Using the DOTMLPF/S/R/G factor structure (as appropriate) describe the capability gaps. These are capabilities that DHS and/or its stakeholders/partners require to perform the mission but do not currently possess and are not planned to be provided by existing programs. Very briefly describe at a high level the capabilities and gaps in the context of how DHS and its' stakeholders (e.g., States) currently perform the missions. Discuss what other existing and planned systems (IT or non-IT) are conducting the same or similar missions or performing the same or similar functions.

Systems



Risks

	Analysis	Notes	Medium	High	Critical
High	Green	Yellow	Red	Dark Red	Black
Medium-High	Green	Yellow	Red	Dark Red	Black
Medium	Green	Yellow	Red	Dark Red	Black
Medium-Low	Green	Yellow	Red	Dark Red	Black
Low	Green	Yellow	Red	Dark Red	Black

Schedule

Task Name	Start	End	Progress
1. Initial ASR Development	Jan 10	Jan 17	100%
2. ASR Review	Jan 17	Jan 24	100%
3. ASR Approval	Jan 24	Jan 31	100%
4. ASR Implementation	Jan 31	Feb 7	100%
5. ASR Reporting	Feb 7	Feb 14	100%
6. ASR Review	Feb 14	Feb 21	100%
7. ASR Approval	Feb 21	Feb 28	100%
8. ASR Implementation	Feb 28	Mar 6	100%
9. ASR Reporting	Mar 6	Mar 13	100%
10. ASR Review	Mar 13	Mar 20	100%
11. ASR Approval	Mar 20	Mar 27	100%
12. ASR Implementation	Mar 27	Apr 3	100%
13. ASR Reporting	Apr 3	Apr 10	100%
14. ASR Review	Apr 10	Apr 17	100%
15. ASR Approval	Apr 17	Apr 24	100%
16. ASR Implementation	Apr 24	May 1	100%
17. ASR Reporting	May 1	May 8	100%
18. ASR Review	May 8	May 15	100%
19. ASR Approval	May 15	May 22	100%
20. ASR Implementation	May 22	May 29	100%
21. ASR Reporting	May 29	Jun 5	100%
22. ASR Review	Jun 5	Jun 12	100%
23. ASR Approval	Jun 12	Jun 19	100%
24. ASR Implementation	Jun 19	Jun 26	100%
25. ASR Reporting	Jun 26	Jul 3	100%
26. ASR Review	Jul 3	Jul 10	100%
27. ASR Approval	Jul 10	Jul 17	100%
28. ASR Implementation	Jul 17	Jul 24	100%
29. ASR Reporting	Jul 24	Jul 31	100%
30. ASR Review	Jul 31	Aug 7	100%
31. ASR Approval	Aug 7	Aug 14	100%
32. ASR Implementation	Aug 14	Aug 21	100%
33. ASR Reporting	Aug 21	Aug 28	100%
34. ASR Review	Aug 28	Sep 4	100%
35. ASR Approval	Sep 4	Sep 11	100%
36. ASR Implementation	Sep 11	Sep 18	100%
37. ASR Reporting	Sep 18	Sep 25	100%
38. ASR Review	Sep 25	Oct 2	100%
39. ASR Approval	Oct 2	Oct 9	100%
40. ASR Implementation	Oct 9	Oct 16	100%
41. ASR Reporting	Oct 16	Oct 23	100%
42. ASR Review	Oct 23	Oct 30	100%
43. ASR Approval	Oct 30	Nov 6	100%
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210. ASR Review	Jan		

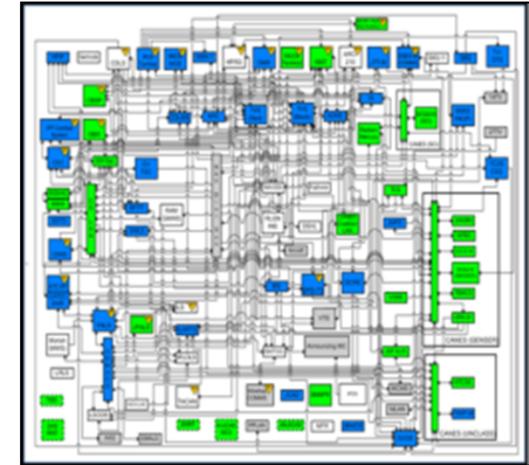
MBSE Technical Review Outcomes



Ensure focus on the system vision with an iteratively developed model



Ensure that review questions are clearly understood, prioritized and addressed



Manage complexity



Support engineering decisions (cost, schedule and technical)



Manage design changes throughout the development lifecycle



Identify critical details that need special consideration/mitigation

MBSE Technical Reviews Issues

- Many current questions are not suited for MBSE technical reviews.
 - Ambiguous questions with “yes” or “no” answers that provide limited value into the maturity of the system.
 - e.g. Has a computer and software security plan, including safety, been developed?
 - Topics that do not have corresponding models.
 - e.g. Logistics and Supply Chain Management, System Safety, Producibility and Manufacturing.
- Addition of questions overtime have created an unwarranted scope increase that often deviates from spirit of the review criteria.
 - A fresh look at the review criteria and questions is needed to make the MBSE Technical Review effective.
- New models must be developed for a more comprehensive view of the system to better understand and manage complexity.

Getting Off the Stage Thoughts...



- Formalized planning for modeling and decision-making across the lifecycle must include a new approach to technical reviews.
- Next Steps:
 - Revise technical review entrance criteria to capitalize on the new MBSE approach.
 - Perform a “generic” review to highlight the changes in information available.
- There is a strong need to ensure that decision-makers understand the different model types and what information can be gleaned from them.

MBSE requires a mindset change, a change in systems engineering processes, and a change in expectations of the artifacts required during the systems engineering process.



NAVAL POSTGRADUATE SCHOOL

SYSTEMS ENGINEERING

EST. 2002

