Improving Affordability Using an Innovative Model-Driven Engineering Approach

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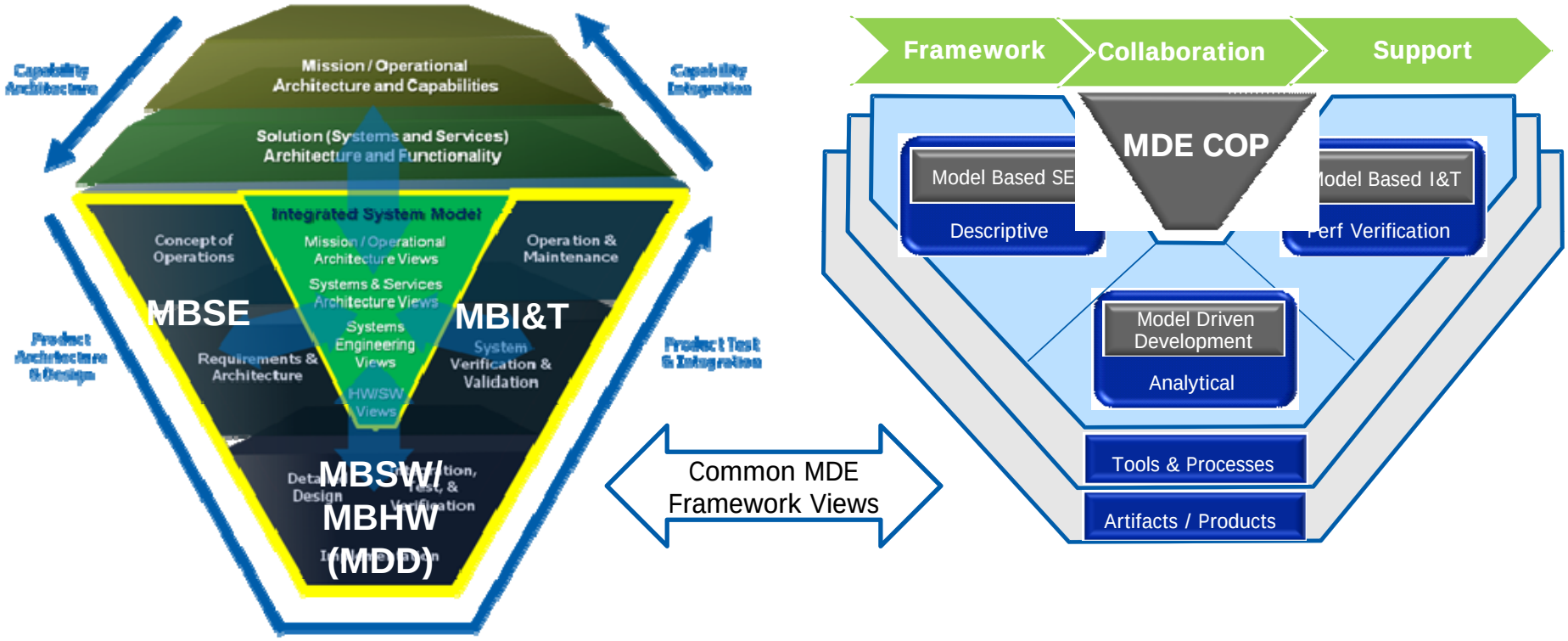
Tamara Valinoto
NGES Systems Architect/MDE CoP Chair
Tamara.valinoto@ngc.com

What is Model Driven Engineering?

MDE = MBSE + MDD + MBI&T



MDE includes Model-Based Systems Engineering, Model Driven Development, and Model Based Integration and Test

Why Model Driven Engineering?

"One Fact, One Place"

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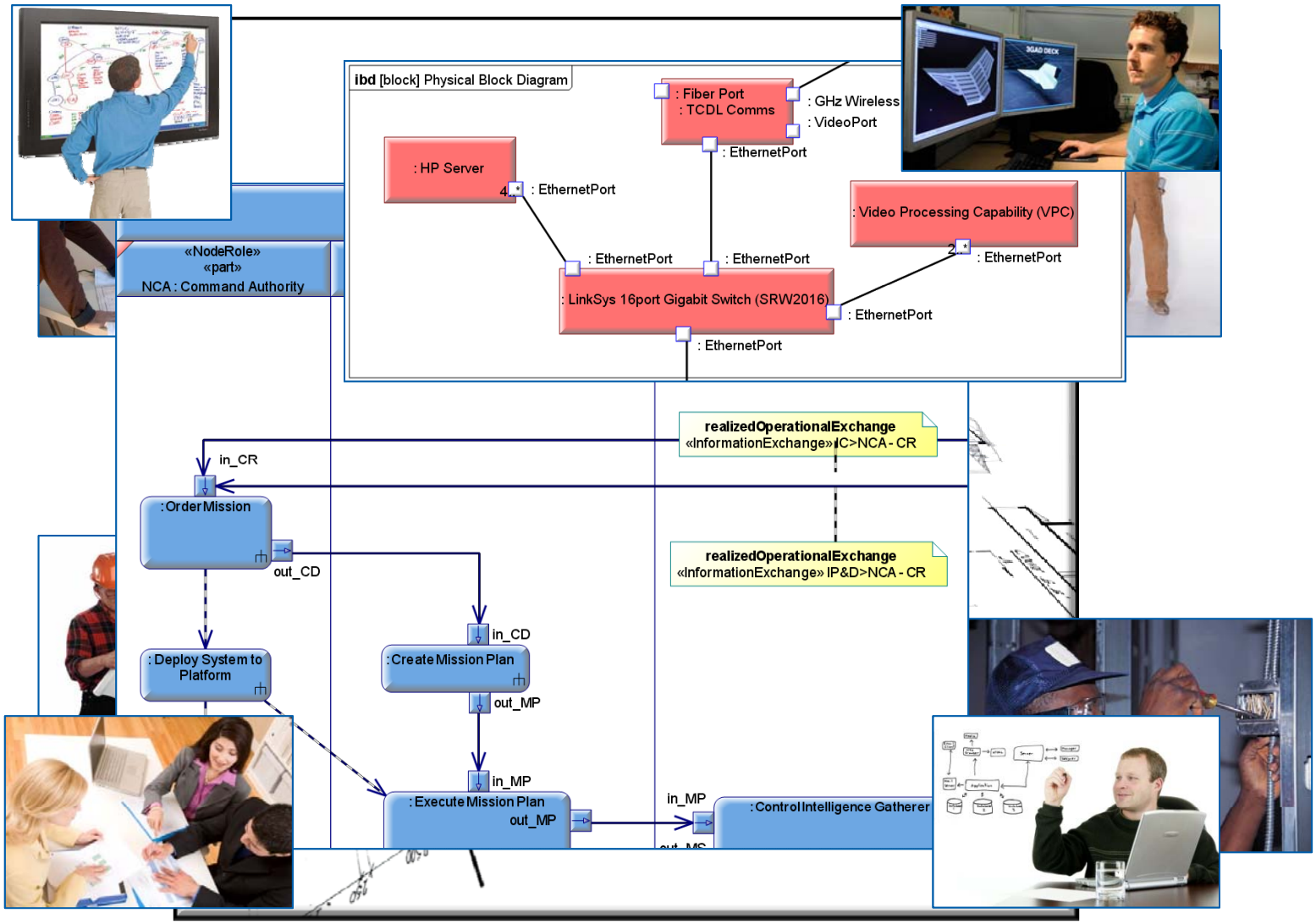

What's in a Name?

Different Kinds of Models for Different Purposes

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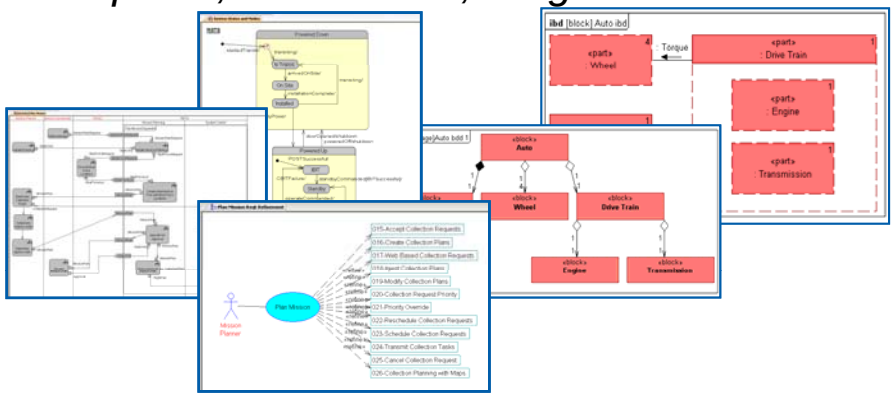
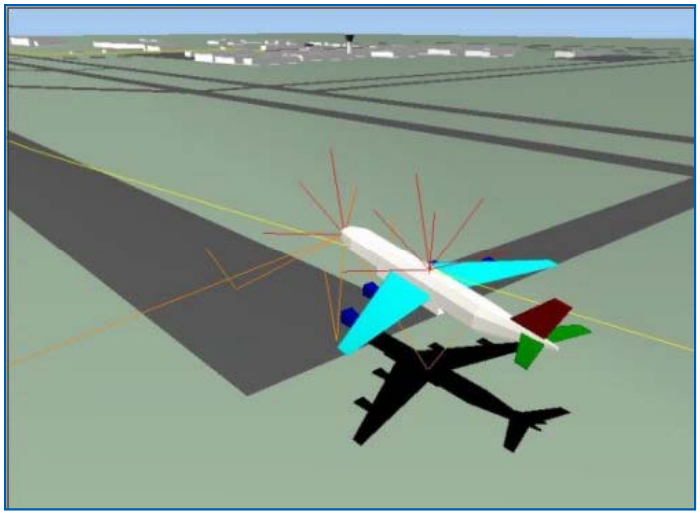
Descriptive"Model" (as in "Model Airplane")

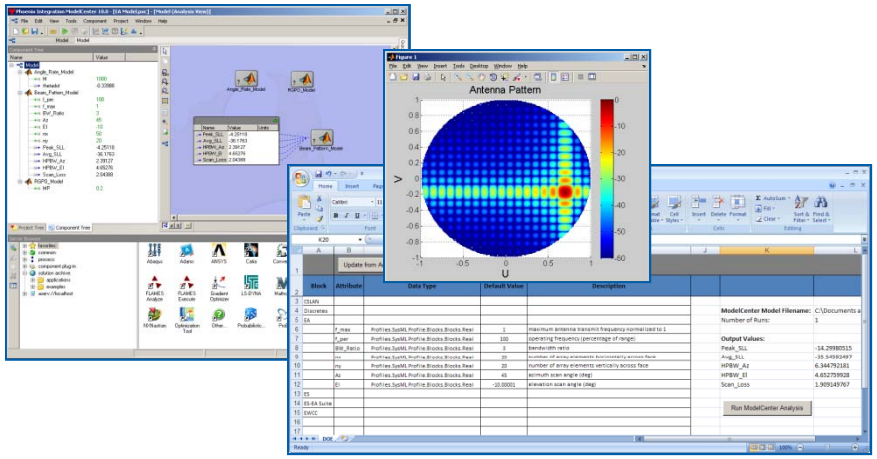
Blueprints, Schematics, Diagrams…



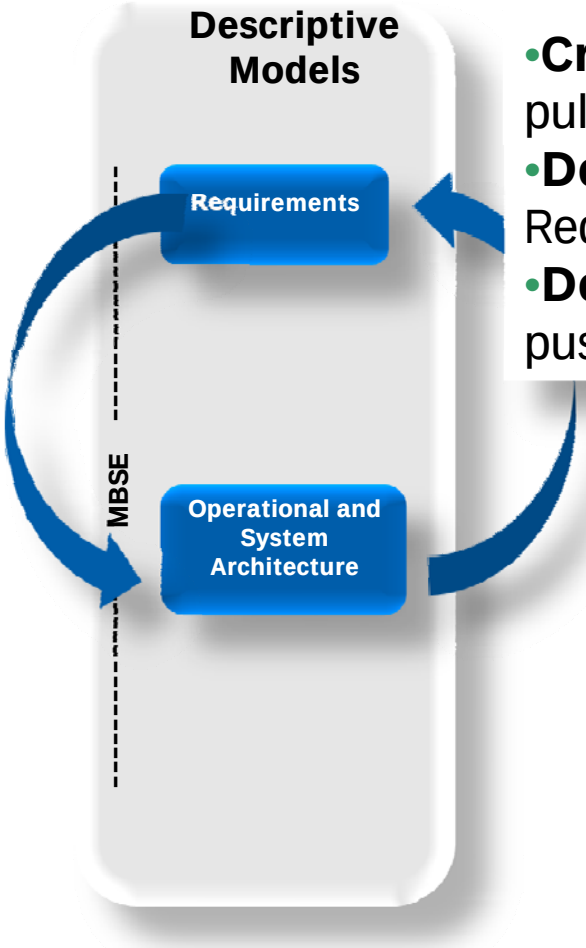


Analytical "Model" (as in "Flight Model")

Computational Models, Simulations…



Utilized MBSE Methodology to Ensure Traceability between Functional Architecture and Requirements



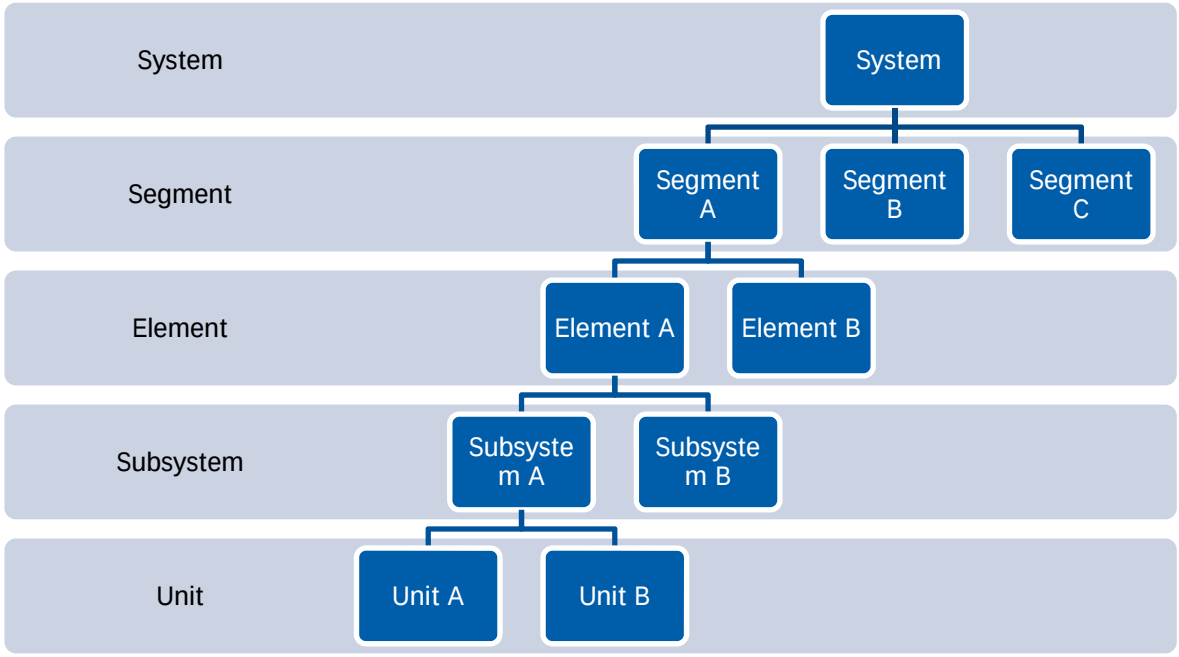
- **Created** bi-directional linkage to push OPSCON artifacts and pull requirements
- **Derived 91** System Functions from **236** System Requirements
- **Determined** EIS Methodology since high TRL systems to push Test and Demo verification method at element level

Category	Criticality	Extent of Verification
Essential	Establish capabilities necessary for safe mission operations	Normal rigor of verification and demonstration testing
Important	Functional & performance capabilities necessary to conduct and produce important mission products, or to meet TLCs	Limited verification since capabilities achieve can be validated and/or modified before transition to operations
Supporting	Capabilities that will be demonstrate at lower levels and are not *important* for mission operations	Verified by auditing capabilities at design complete only

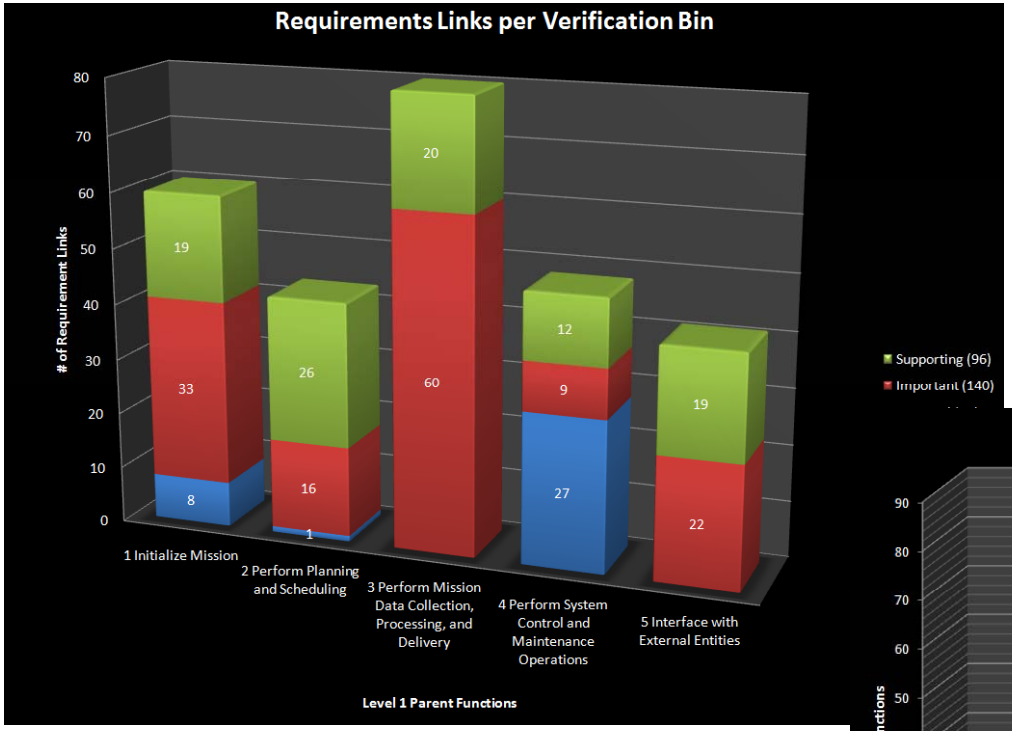
Applying EIS will add Verification Method of "Design Audit" to Reduce Redundant Requirements and Rework

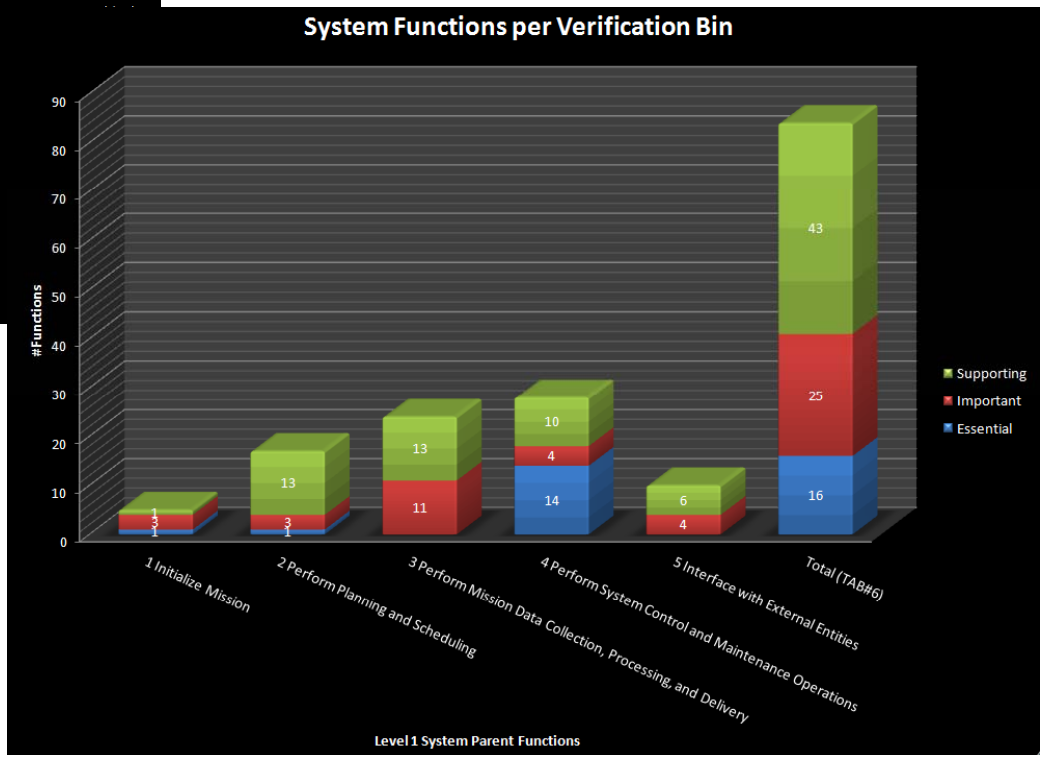
Method	Definition
(DA) Design Audit	An audit of the design performed at the design complete state to determine conformance to requirements. This audit can be an analysis or inspection performed at this state of the design and development phase. Since these requirements are verified at the design complete state, the responsible system engineer will identify as-built parameters to be monitored to validate that the design has not changed at the point of final acceptance review of the elements. The point of final acceptance review (e.g., this may be a pre-ship readiness review for an item provided by a subcontractor or an element provider not located at the SV assembly, integration, and test factory) will be established for each item.

- Utilize as much of the existing Element and lower level requirements
- Derive requirement at appropriate system level and show traceability to parent without repeating at each level in the chain
- Eliminates the roll-up of verification at each "level up the chain" or analysis on top of analysis to trace verification back up to the system level



Visualizing EIS “binning” for Requirements and Functions Enable Team to Focus on Critical Design Aspects





Example of System *Essential* Function Mapped to OPSCON and Segment Behavior Diagrams to Ensure System Design Validation

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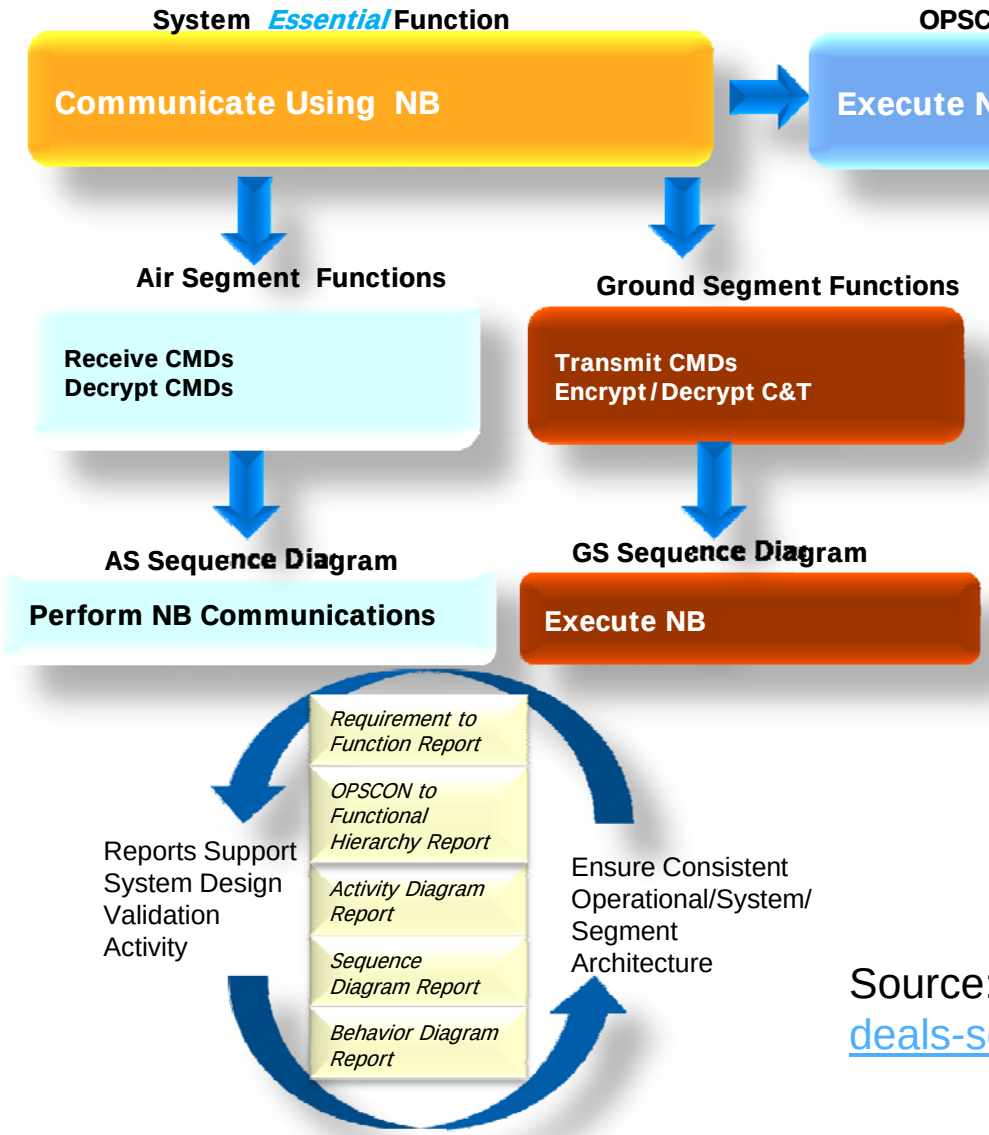

Figure 2. Baseline UAS Operational View - 1 (OV-1)

Source: http://www.occupy.com/article/north-carolina-deals-setback-drone-surveillance-%E2%80%94-now

Example of System *Important* Function Mapped to OPSCON and Segment Behavior Diagrams to Ensure System Design Validation

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System *Important* Function

Produce data

OPSCON Activity Diagram

Collect / Store data Data
Process Mission Data

Air Segment Functions

Perform data Operations
Provide Mission Data Storage

G round Segment Functions

Produce data Products
Produce Geolocation Support Data
Manage Mission Data Products

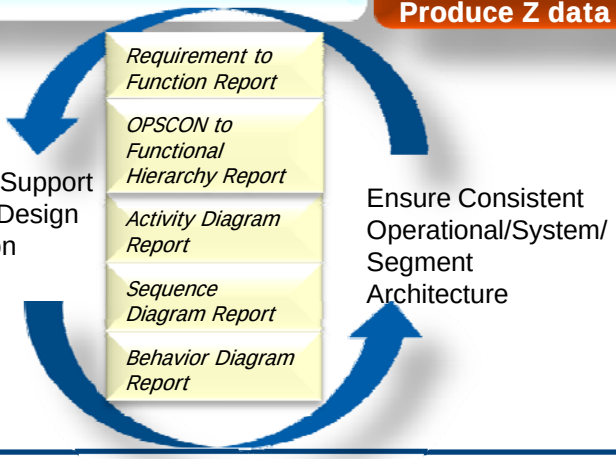
AS Activity & Sequence Diagram

Collect Mission Image
Write Mission Data

GS Sequence Diagram

Produce X data Products
Produce Y data Products
Produce Z data Products

Figure 2. Baseline UAS Operational View - 1 (OV-1)



Reports Support System Design Validation Activity

Ensure Consistent Operational/System/ Segment Architecture

Source: http://www.occupy.com/article/north-carolina-deals-setback-drone-surveillance-%E2%80%94-now

Example of System *Supporting* Function Mapped to OPSCON and Segment Behavior Diagrams to Ensure System Design Validation

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System *Supporting* Function

Transition from Ancillary to Primary

OPSCON Activity Diagram

Return to Ops

GS Functions

Transition to/from Ancillary

GS Sequence Diagram

Transition H&S Operations

- *Requirement to Function Report*
- *OPSCON to Functional Hierarchy Report*
- *Activity Diagram Report*
- *Sequence Diagram Report*
- *Behavior Diagram Report*

Reports Support System Design Validation Activity

Ensure Consistent Operational/System/ Segment Architecture

Figure 2. Baseline UAS Operational View - 1 (OV-1)

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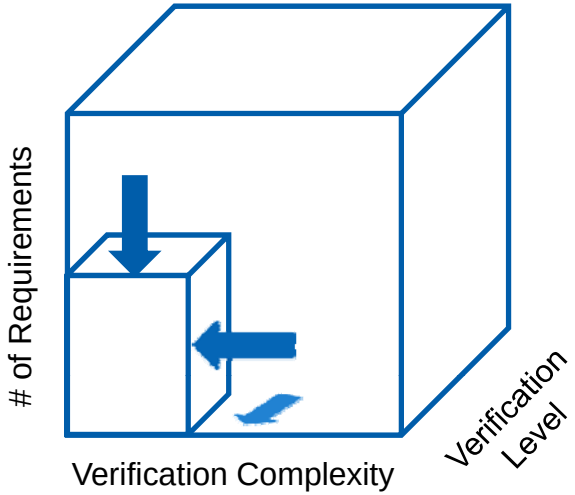
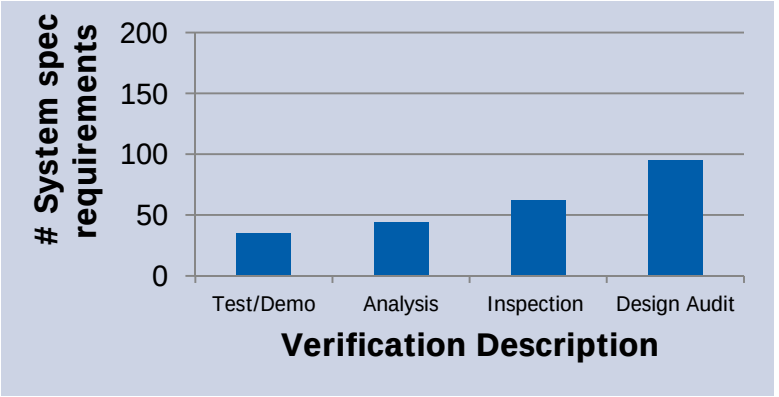
Complete Verification Activities as Early as Possible on Low Risk Requirements

Reduce Redundant Requirements



Push System Verification Down to Lowest Level



Category	% in System Spec	Criticality	Extent of Verification
Essential	15%	Establish capabilities necessary for safe mission ops	Normal rigor of verification and demonstration testing
Important	45%	Functional and performance capabilities necessary to conduct mission and produce system outputs to meet program TLCs	Limited verification since capabilities achieved can be validated and/or modified between IOC and FOC
Supporting	40%	Capabilities that will be demonstrated at lower levels and are not important for mission ops	Verified by auditing capabilities at CDR only – “design audit”

Complete Verification Activities as Early as Possible on Low Risk Requirements

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- Analysis or Inspection is performed with the same diligence as if performed as part of the “normal” verification effort
- Verification results are recorded and considered complete
- Verification is only revisited if “As-built” system does not pass its lower level requirements, meaning design was not realized

Design Audit – Verification Method defined to identify Analysis or Inspection performed on Design rather than As-Built System

Conclusion

- Affordability objectives
  - How can we learn for our past and take advantage of our experience?
  - What processes can we tailor to provide the best-value to the program?
- Verification is one such area for the right program
  - Capability-Based
  - High reuse of components with high TRLs
  - Experience testing similar systems
- Certain level of risk tolerance on the part of both the internal and external PMO
- “Buy in” is essential with the Chief SE and Segment Architects during functional analysis stage
- Develop a whitepaper and metrics discussing concept to PMO

THE VALUE OF PERFORMANCE.

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Bio

- Tamara Valinoto is a Principal Systems Architect for Northrop Grumman Electronic Systems (NGES), Baltimore, MD where she has worked for the last eight years. During her time at NGES, she has provided design expertise in the disciplines of Human Systems Engineering, Maintainability, and Reliability for a variety of airborne, ground-based, and postal systems. She graduated from the Architect Apprentice Program (AAP) in Nov 2010 after integrating and demonstrating a system that was deployed OCONUS. She led a cross sector Model Driven Engineering (MDE) program to ensure traceability top-down from a capabilities based to implemented architecture with a diverse and dispersed architecture team. She currently is the SEIT Lead and MDE lead on an EW program while supporting and leading the MDE Community of Practice (CoP) for the corporation.

Abstract

- The architecture team plays a key role in minimizing cost and streamlining Verification and Validation (V&V) starting with the thought of, " What are the system building blocks?". During the system architecture definition phase, a functional analysis is necessary to visualize the types of system functional capabilities required to perform the desired operational needs. Identification of these functions can be derived from the system requirements or from determining the system's information, material, and energy required for operations. An architecture team applies an Essential, Important, and Supporting (EIS) approach to "bin" the System functions and associated requirements using standard tools (i.e. Artisan and DOORS). The EIS approach opened up a new verification method, "design-audit", which was applied to system requirements to push normal rigor of verification to lower levels of architecture. In order for other programs to apply "design-audit", a least resource intensive verification method, upfront in the architecture definition phase, this presentation will cover "how" to identify system functions, "what" the EIS categories are, and "how" to get your customer and internal stakeholders on board.