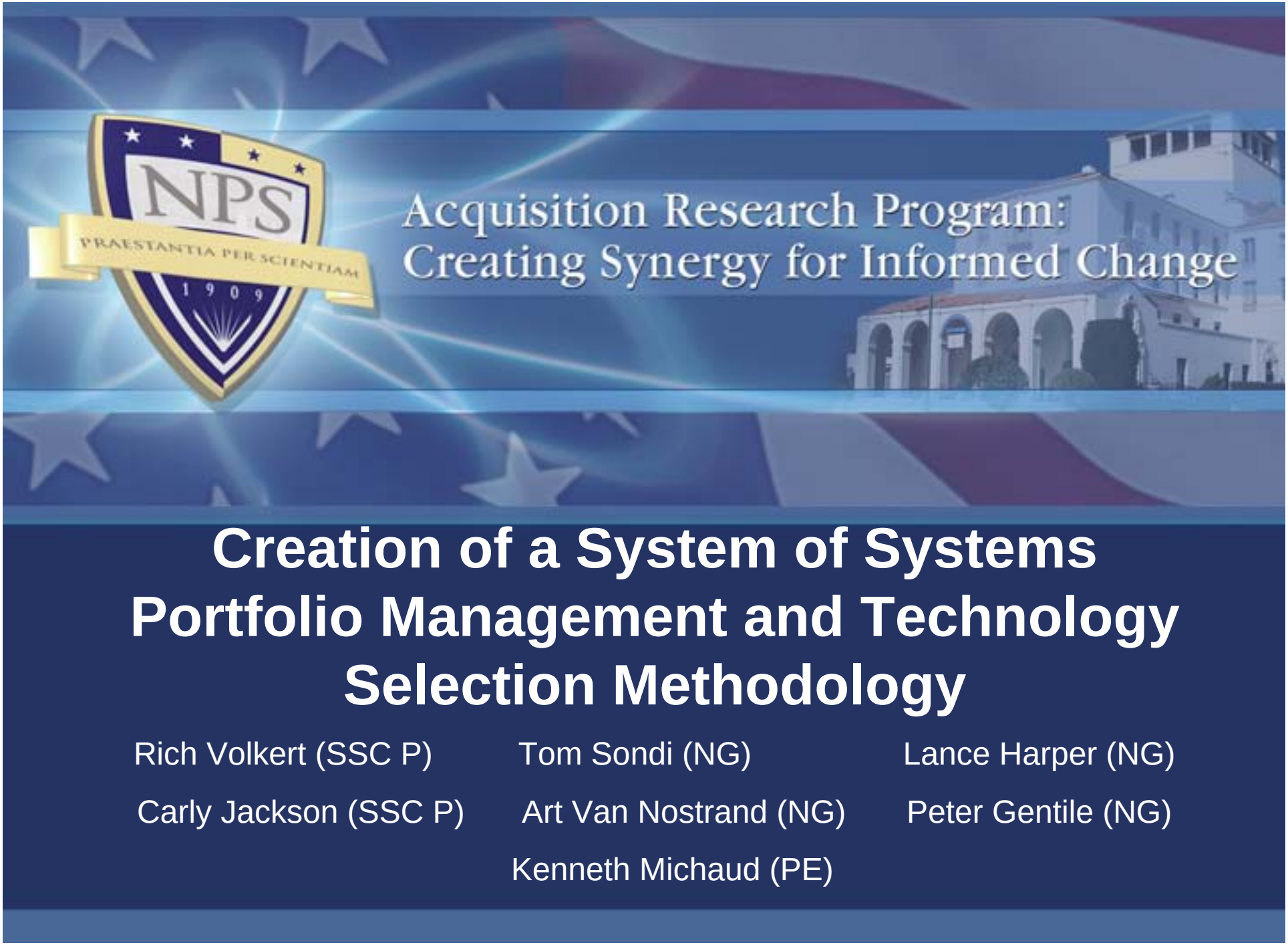

Creation of a System of Systems Portfolio Management and Technology Selection Methodology

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Lance Harper (NG)
Carly Jackson (SSC P)
Art Van Nostrand (NG)
Peter Gentile (NG)
Kenneth Michaud (PE)

Overview

- System of Systems Management
  - Acknowledged SoS Example Mission Modules Program
- Systems Engineering Management and Insight in SoS Programs
  - SRL Used to Determine SoS Maturity Analysis
  - Requirements Management & the Drive Towards Commonality in a SoS World
  - Cost Prediction and Monitoring of SoS
  - Understanding and Influencing SoS Reliability
- Expanding the tool set – Technology Trades & SoS Performance Predictions
  - Technology Insertion & SoS Analysis
  - Technology Analysis and Insertion Tool Development
  - Prediction of Performance Using a Performance Level Monitoring Methodology
- Conclusion

SPAWAR
Systems Center
PACIFIC

NORTHROP GRUMMAN

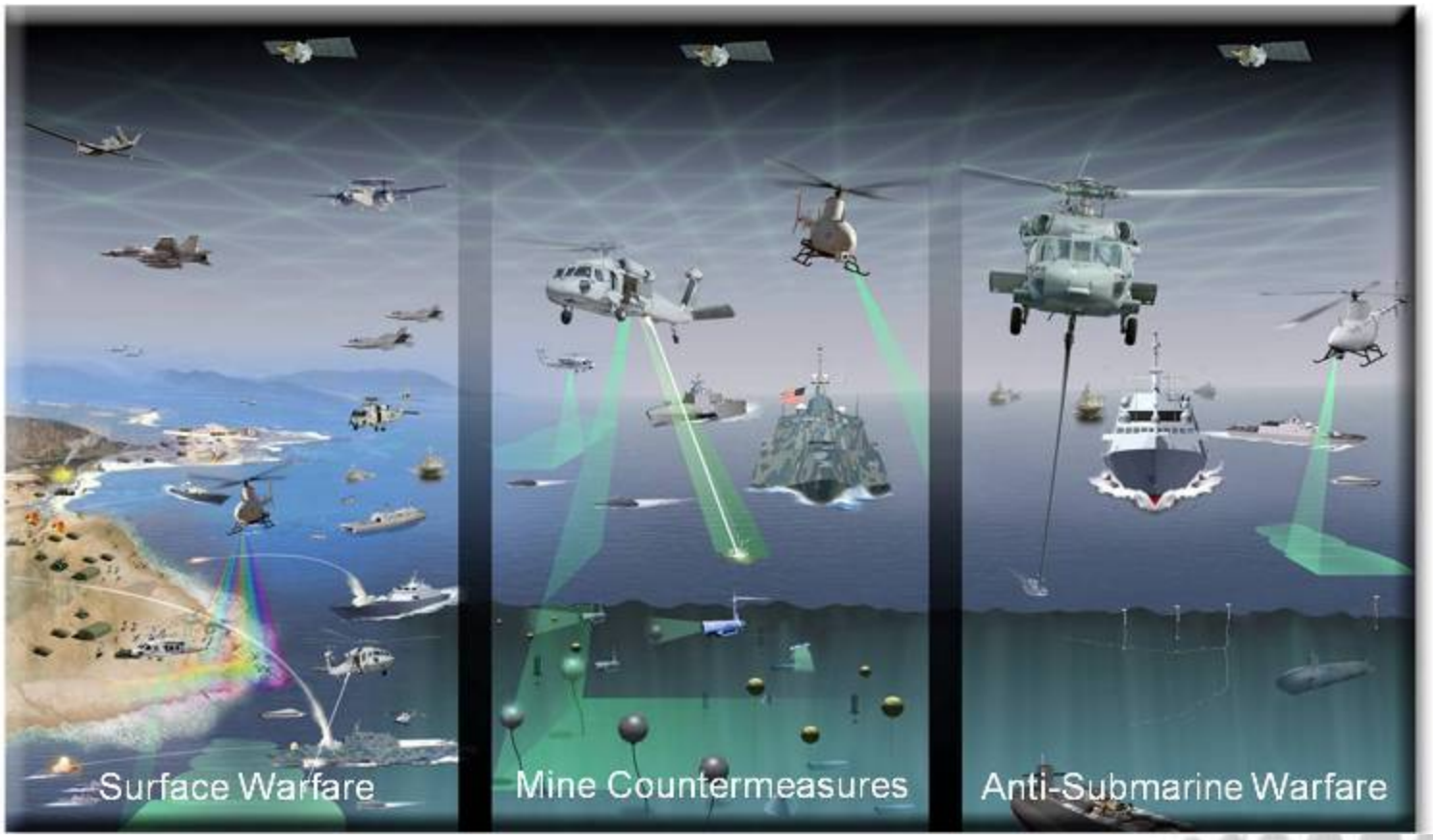
PIONEERING EVOLUTION

SoS Acquisition Challenges

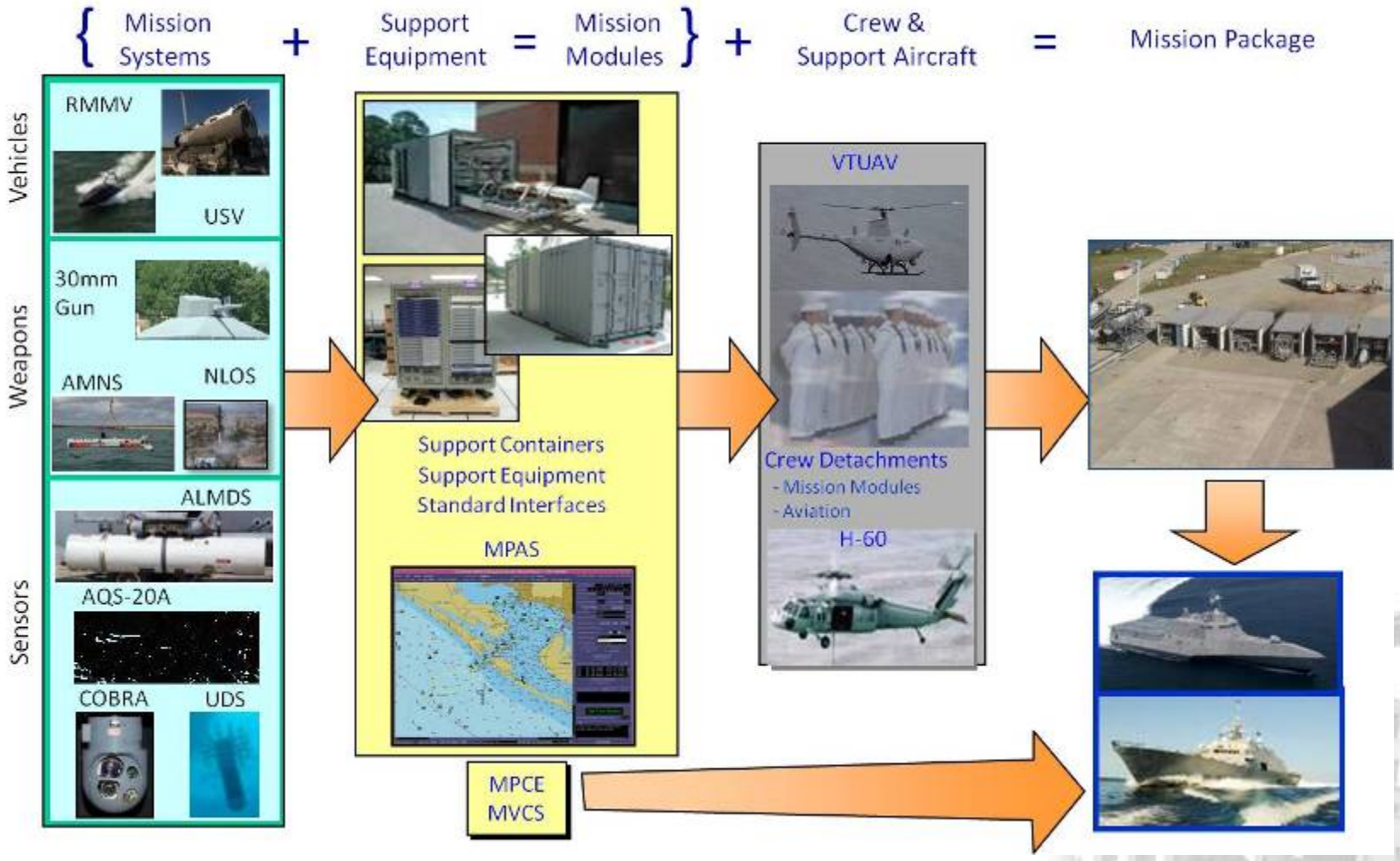
- SoS acquisition management - a significant increase in complexity over traditional system acquisition
- Development requires that significant numbers of technologies be integrated to one another
- Challenges traditional development monitoring tools and cost models
  - need to capture integration complexity
  - level of effort required to connect individual components
- Unintended Consequences - high degree of inter-linkage between components can cause unintended impacts to overall system performance
  - components are modified from original use
  - Technology change: replaced throughout the system life cycle

The result of this acquisition management paradigm shift has been significant schedule and cost overruns in SoS programs

PMS 420 Tasking- Providing Focused Warfighting Capabilities



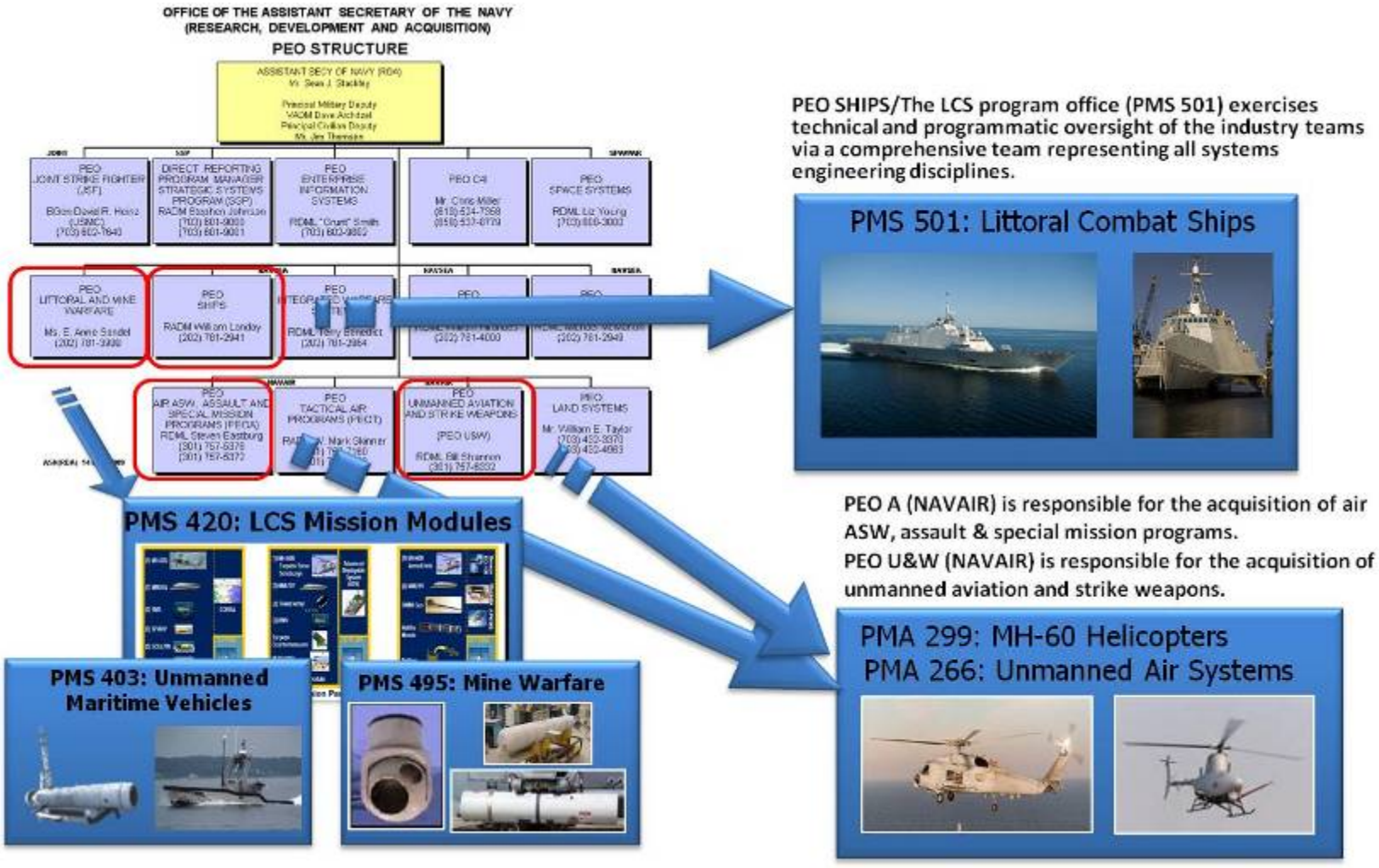
What is a Mission Package?



Program Office Role and Needs

- PEO LMW / PMS 420 is responsible for the development, acquisition, and sustainment of modular, swappable Mission Modules to be used on the Littoral Combat Ship (LCS)
- Mission Modules leverage considerable amounts of technology from existing programs of record, while also requiring development of new integration software and components
- Keys aspects of the project include not only monitoring the status of technology development, but also the maturity of the numerous integrations between those technologies and external interfaces
- This has resulted in a very complex and diverse System of Systems (SoS) engineering activity with a need to obtain quick and accurate snapshots of development maturity status, risks, and performance

SoS Organizational Challenges



Coordination of Multiple Independent Programs to meet PMS 420 Needs

SoS Developmental Challenges - Incremental Development

Increment 1 MP 1 in 2007 and MP 2 in 2009	Increment 2 MP 3 in 2012 and MP 4 in 2013	Increment 3 MP 5 in 2014 and MP 6 in 2015	Increment 4 BASELINE MP 7+ in 2016	TRL
RMMV (x2)	RMMV (x2)	RMMV (x2)	RMMV (x2)	8
AN/AQS-20A (x3)	AN/AQS-20A (x3)	AN/AQS-20A (x3)	AN/AQS-20A (x3)	8
AMNS (EDM x1)	AMNS (x1)	AMNS (x1)	AMNS (x1)	7
ALMDS (x1)	ALMDS (x1)	ALMDS (x1)	ALMDS (x1)	7
USV w US3 (x1)	USV with US3 not ready for procurement due to developmental and programmatic issues	USV w USS (x1)	USV w USS (x1)	6
Surf/ beach zone detection capability introduced with VTUAV/ COBRA	COBRA (x1)	COBRA (x1)	COBRA (x1)	8
Influence mine sweep capability is increased with the MH-60/ OASIS		OASIS (x1)	OASIS (x1)	6
Near-surface neutrali				

COBRA

OASIS mounted on helo

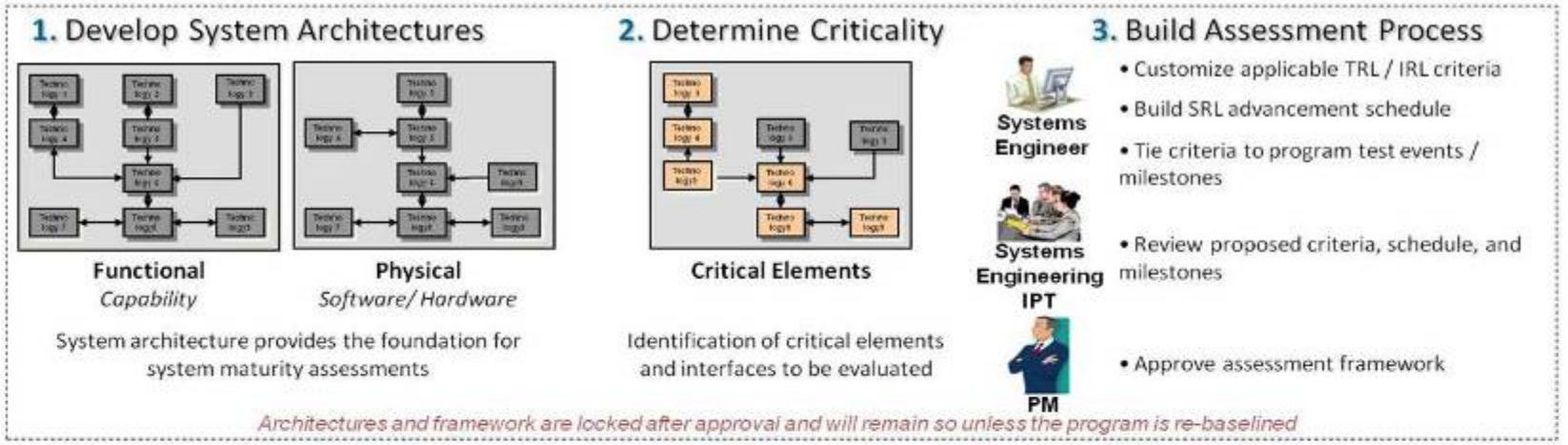
RAMICS mounted on helo

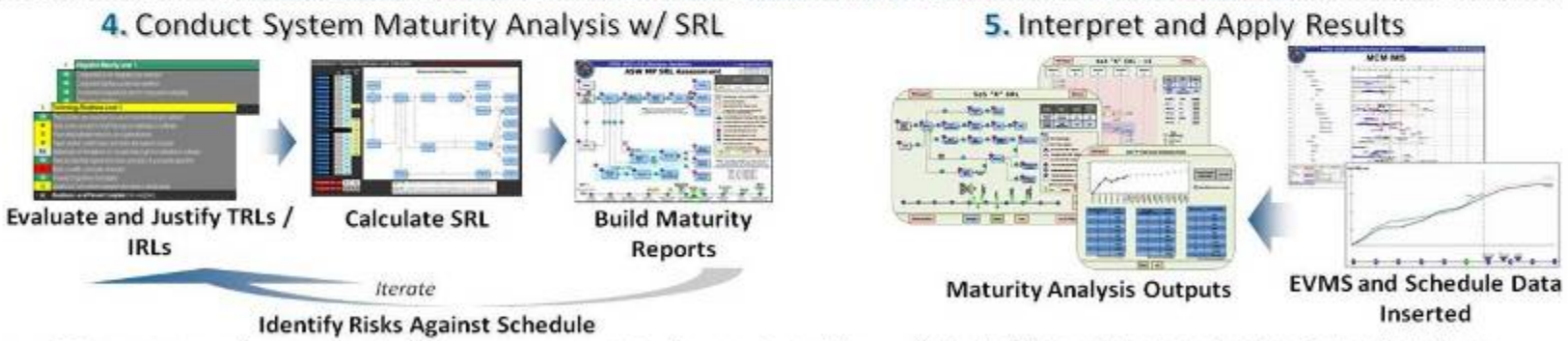
Future MCM MP Increments are subject to POR schedule slips that aren't under PMS 420 direct control

SoS Challenges – Modularity and Commonality throughout the SoS

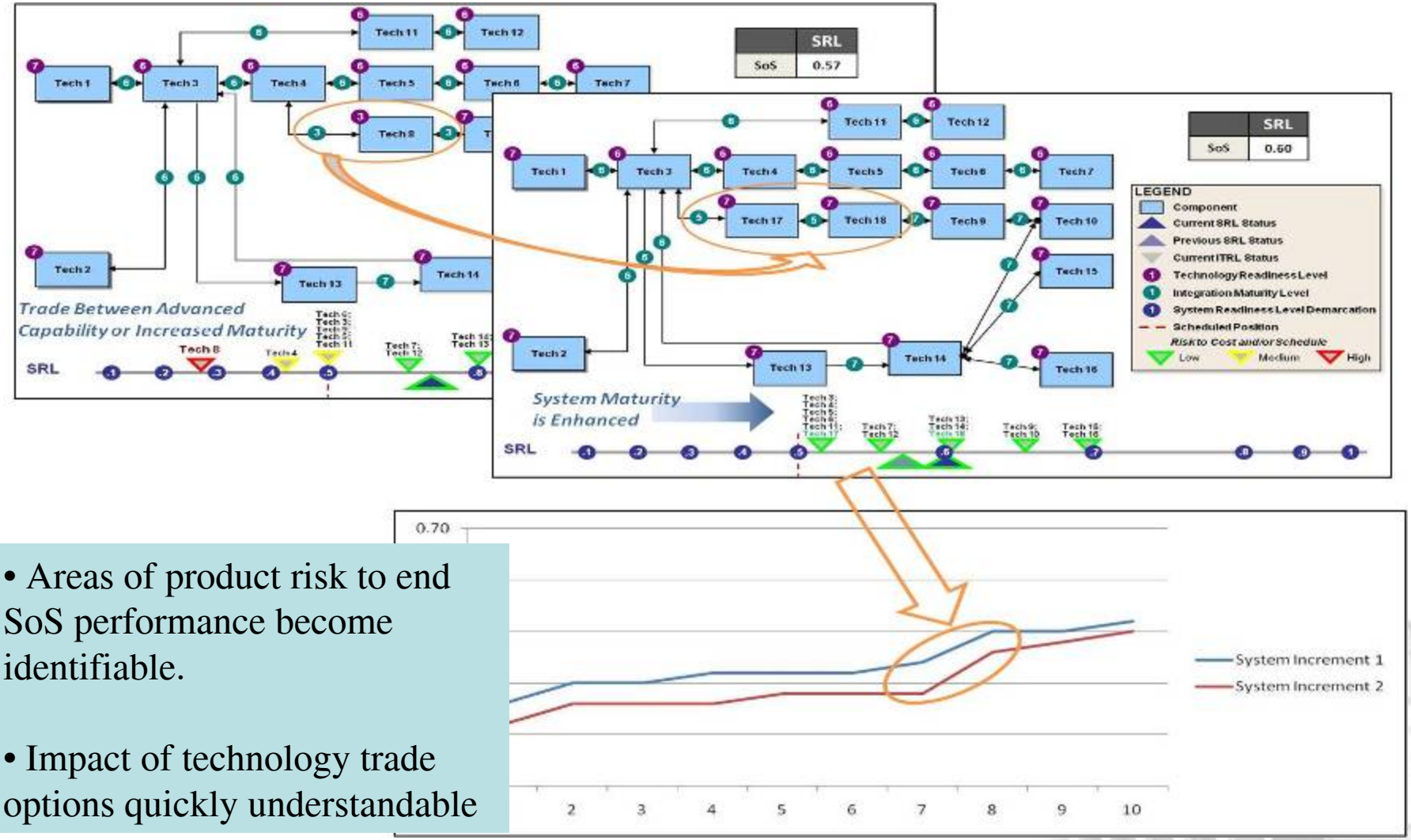
Improved Commonality viewed as key to LCC reductions and towards Improved multi-functional capability

System Maturity Model (SMM) Methodology



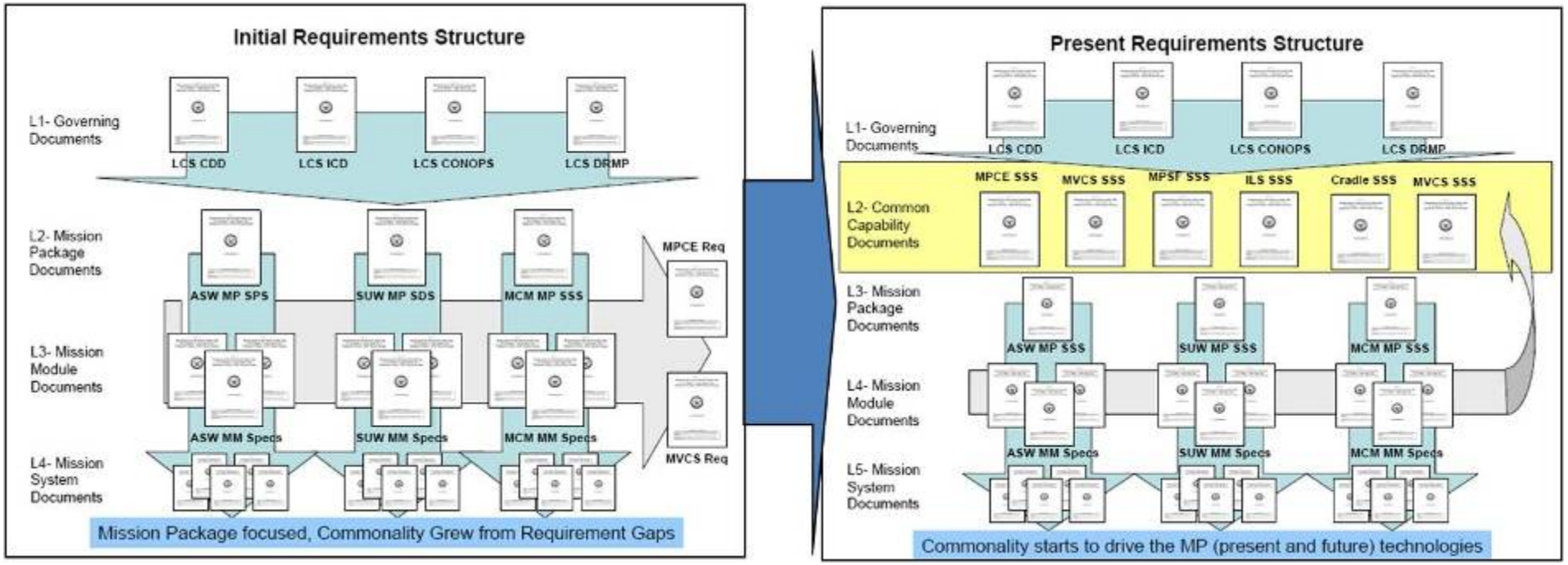


Taking Action to Enhance Performance



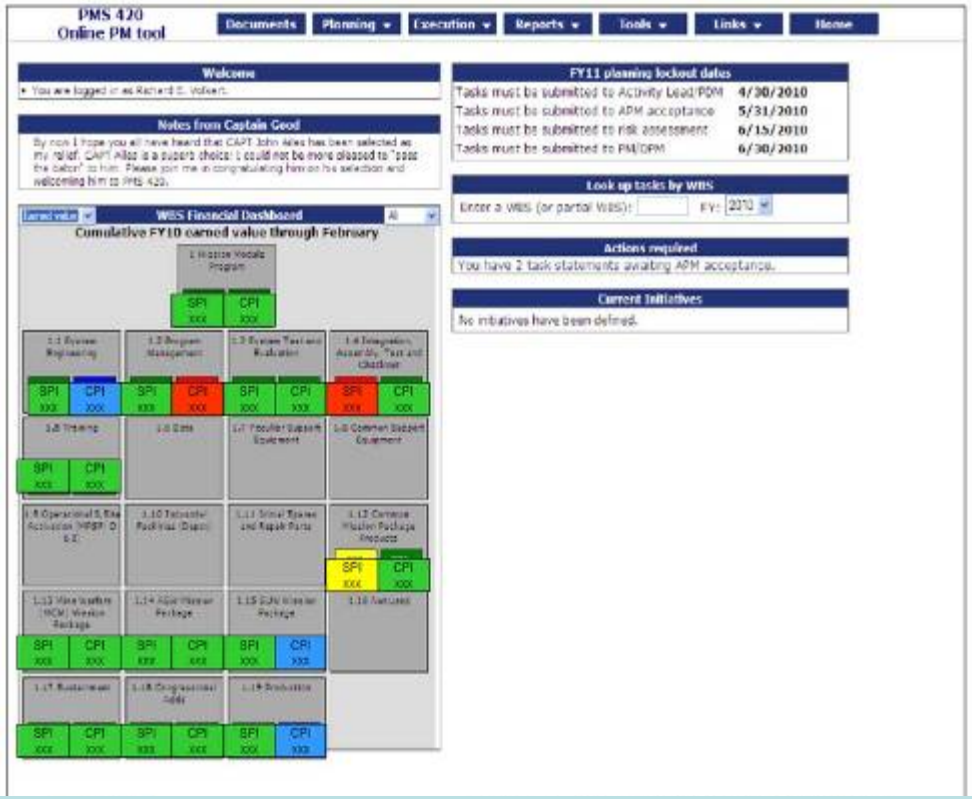
- Areas of product risk to end SoS performance become identifiable.
- Impact of technology trade options quickly understandable

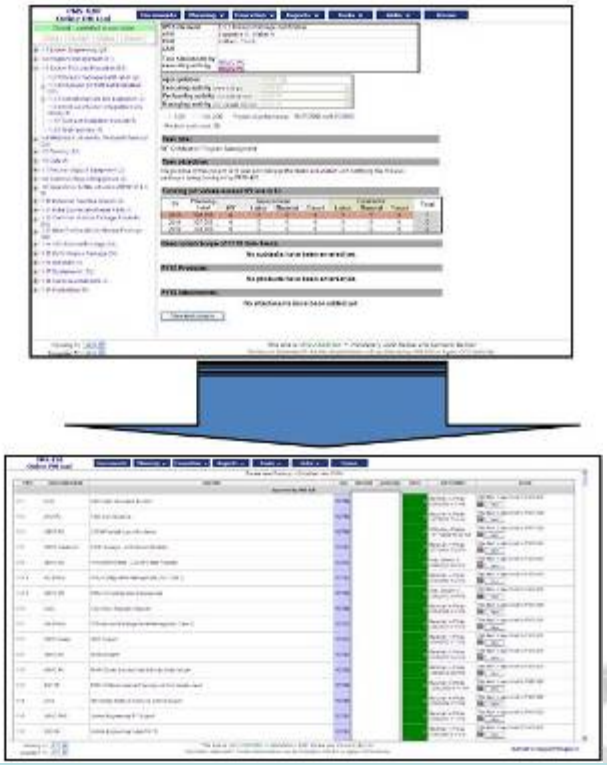
Implementing Effective Requirements Management & the Drive Towards Commonality



- Establishment of a Cross Organization Requirements Database
- Enforced CM process involving all SE stakeholders
- Implementation of a Cultural Change towards Common Solutions

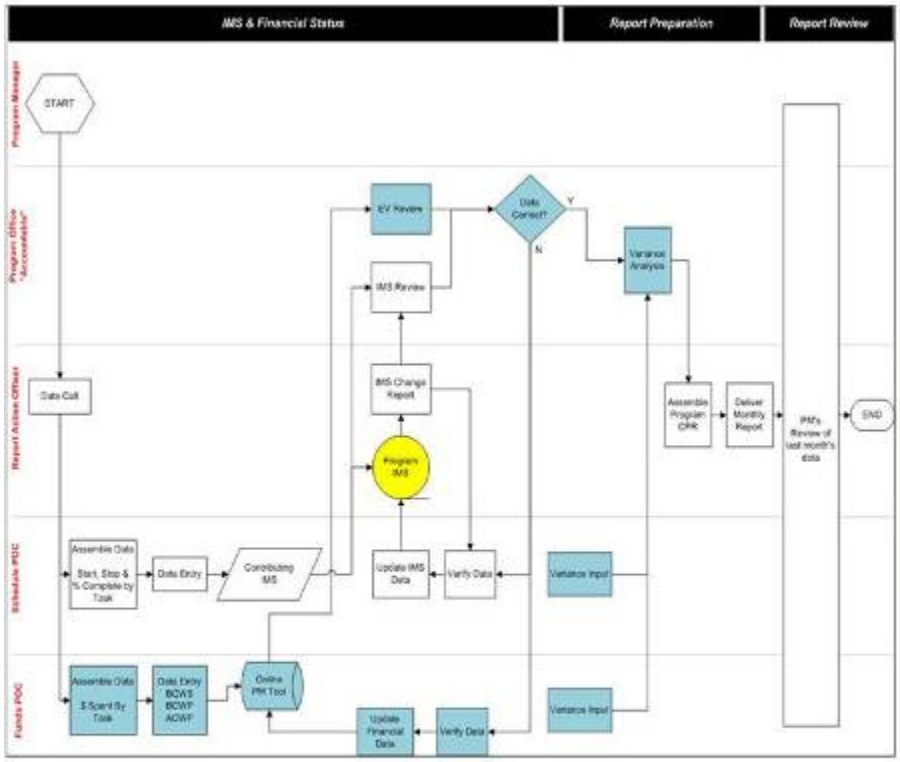
Going Beyond EVMS-Electronic Task: Management & Tracking

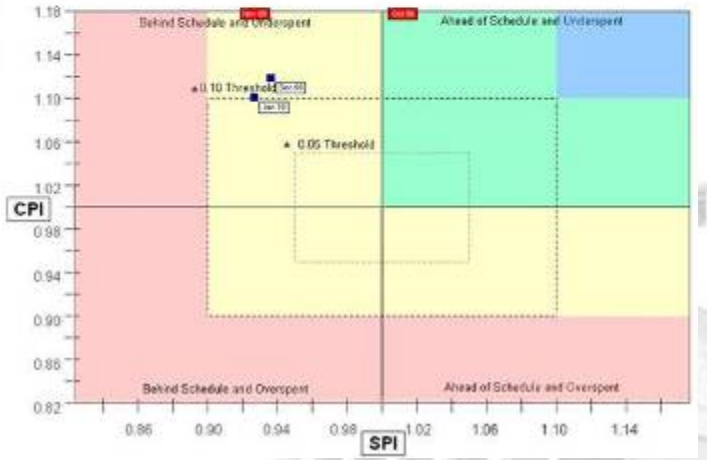




Program Management tool providing the entire program management team visibility into and the ability to track funding and tasking allocations by year, color, type, and organization from start of task definition through funding approval

Going Beyond EVMS-Electronic Task: Management & Tracking





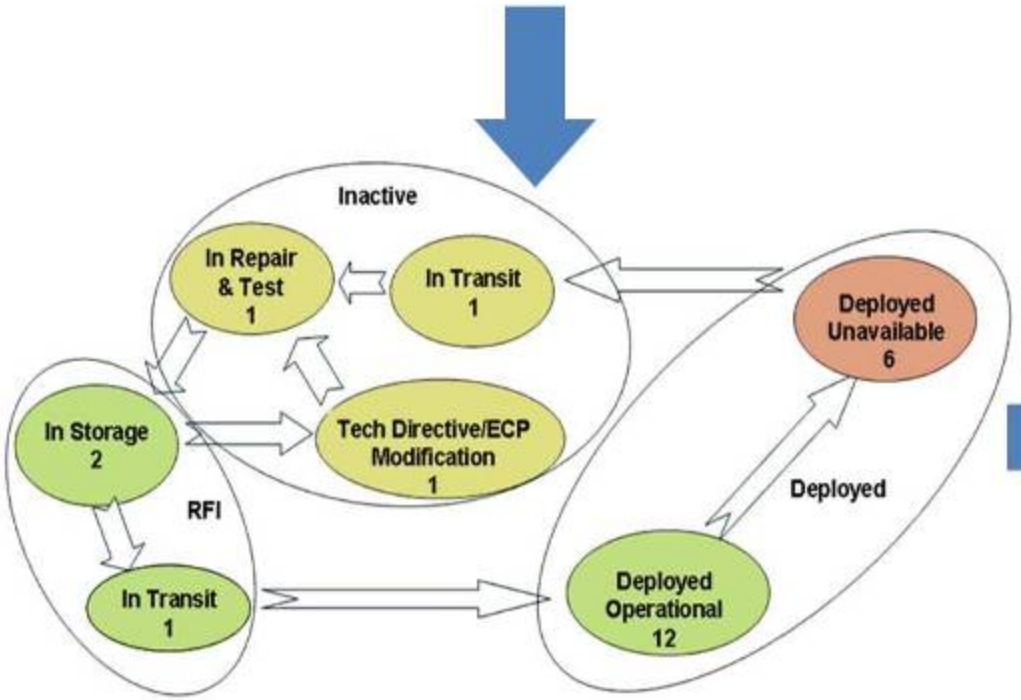
Translating complex management data into displayable and actionable information

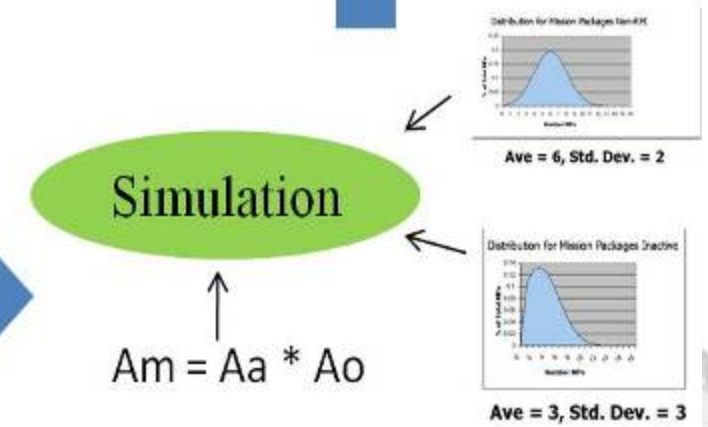
Understanding and Influencing SoS Reliability

-From Flight 0+ CDD June 2009, Focused Mission Package Annexes: Required A_m:

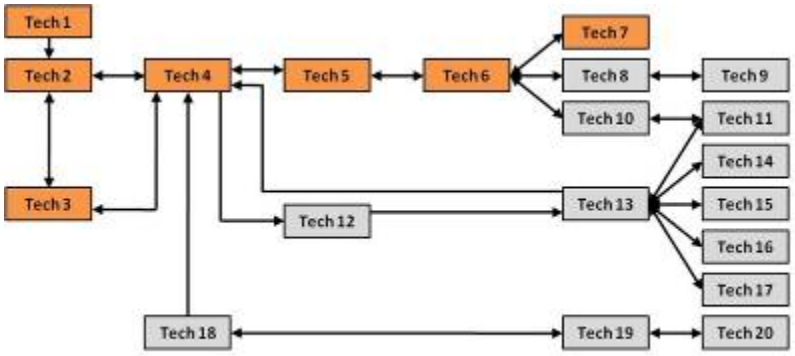
(U) CCJO Key Characteristics	(U) Key Performance Parameter	(U) Development Threshold	(U) Development Objective
(U) Resilient/ Persistent	6.4.3 (U) ASW Mission Package Materiel Availability	(U) 0.64	(U) 0.712

CDD Requirement	Target A_a	Target A_o	Target A_{fo}
Threshold .64	0.887	0.738	0.655
Objective .712	0.887	0.809	0.718

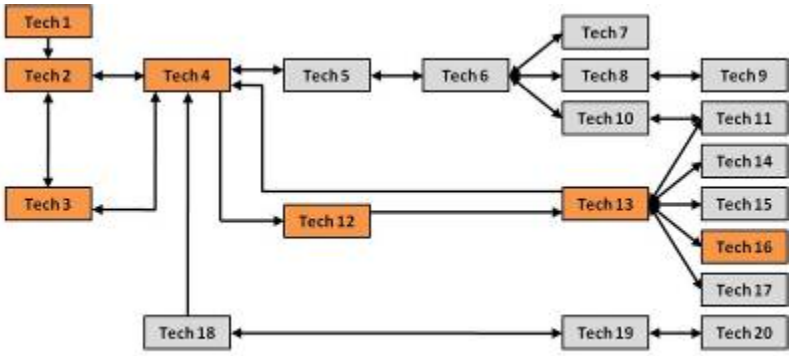




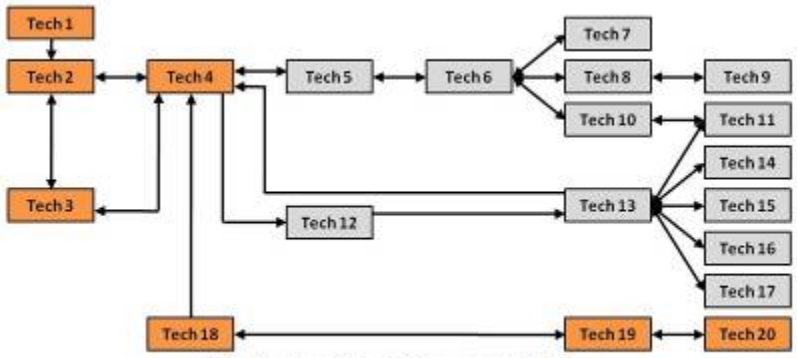
Understanding and Influencing SoS Reliability



Mission Function 1 Component String



Mission Function 2 Component String

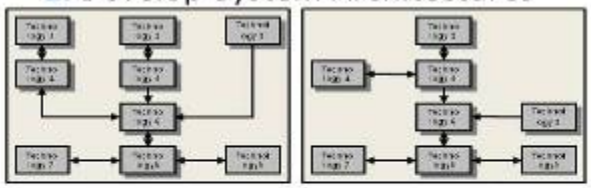


Mission Function 3 Component String

- Operational strings are analyzed to identify the components required to execute independent mission functions of the system
- An assessment of the string to achieve a Mission A_o contribution is performed
- Common components (nodes) which form a critical function in more than one mission function are identified, operational time is calculated for each mission it touches over the deployment cycle
- Allocation of the Mission A_o decomposes to an A_o requirement at the component and Lowest Replaceable Unit (LRU) level

Future Steps: Evaluating Technology Analysis and Insertion

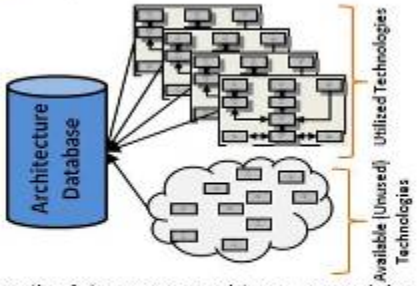
1. Develop System Architectures



Functional *Capability* | **Physical** *Software/Hardware*

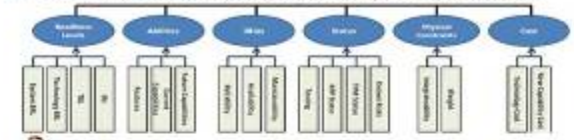
System architecture provides the foundation for system maturity assessments (SRL, CRL, etc.)

2. Populate Architectures



Details of the system architectures and the technologies are stored in the Architecture Database

3. Define Trade-Off Analysis Criteria



Systems Engineer

•Customize Applicable Trade-Off Criteria

Systems Engineer IPT

•Review Proposed Trade-Off Criteria

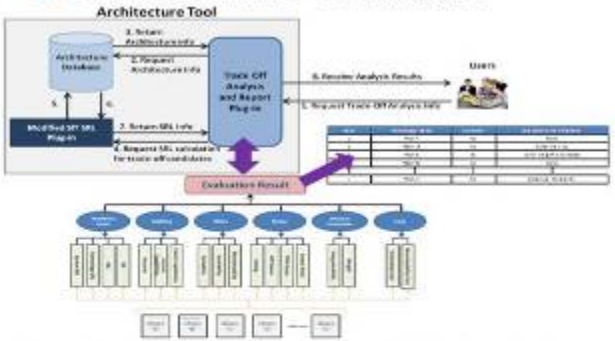
PM

•Approve Analysis Criteria

4. Define Analysis Criteria Weightings

Weighting values are selected based on the programs current focus and direction

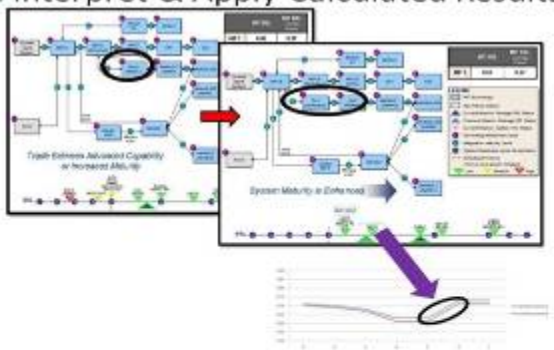
5. Calculate Trade-Off Analysis



Data of the currently utilized and available technologies are compared in the analysis

Results are displayed in ranked order, with known issues for each technologies displayed

6. Interpret & Apply Calculated Results

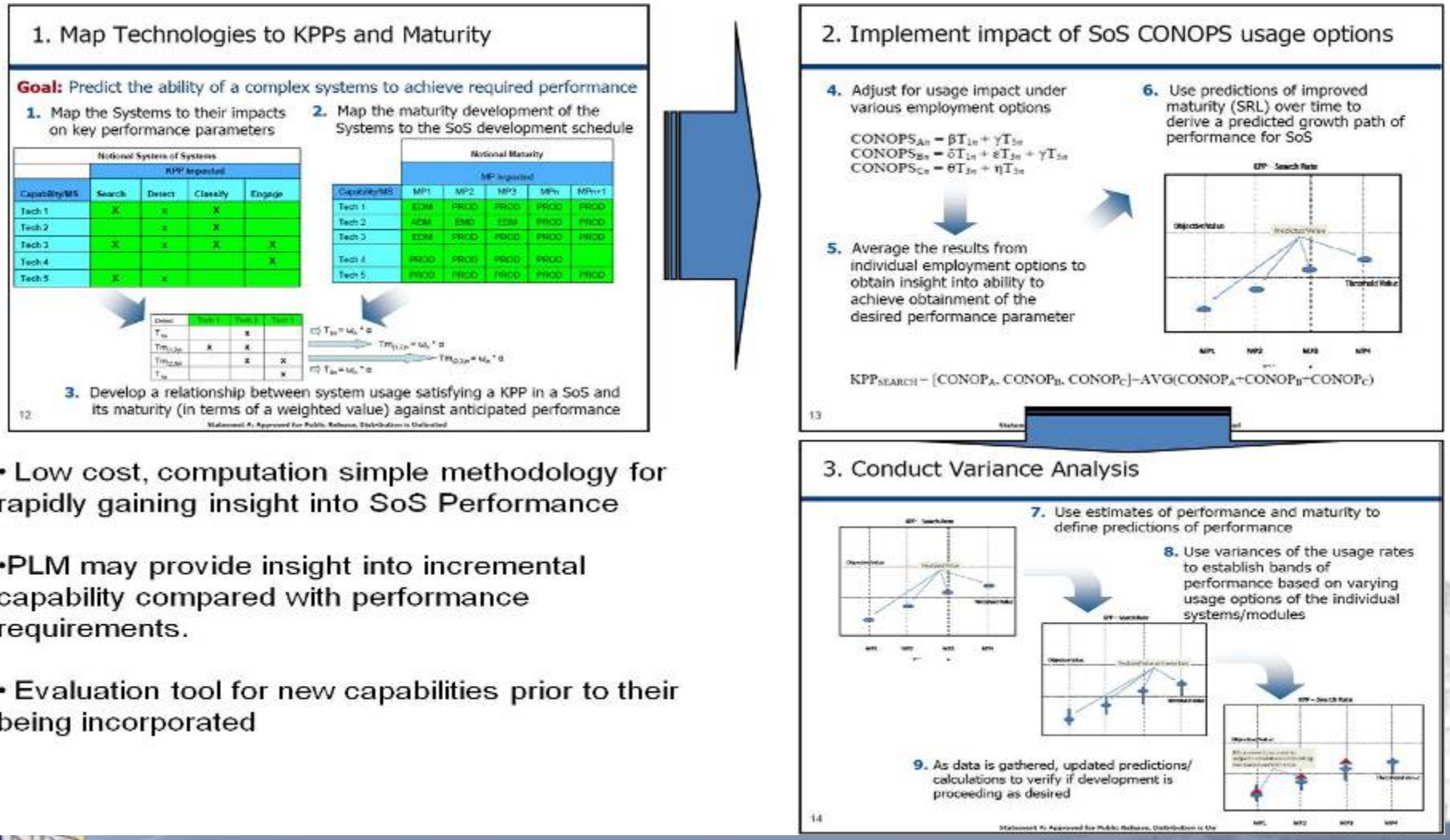


Outputs of the analysis are used to make decisions that will impact the future iterations (and technology refreshes) of the Mission Packages

Iterate

Iterate

Future Steps: Performance Level Assessment



- Low cost, computation simple methodology for rapidly gaining insight into SoS Performance

- PLM may provide insight into incremental capability compared with performance requirements.

- Evaluation tool for new capabilities prior to their being incorporated

Concluding Thoughts

- System of Systems (SoS) implementation is an exceptional integration challenge.
  - Managing multiple interfaces well and constantly is key.
- Effective employment of modular MPs is feasible with:
  - Modularity, open business model, and open systems architecture supported by financial and programmatic tools that address complexity.
- PMS 420 is at the forefront of SoS acquisition.
  - New methodologies are being developed to provide technical and program management insight

QUESTIONS?