System of Systems (SoS) Quality Attribute Specification and Architecture Evaluation

NDIA SE Tutorial
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Tutorial Objectives

Present an SoS Architecture Engagement comprising the Mission Thread Workshop, the Architecture Challenge Workshop, the SoS Architecture Evaluation and the System and Software Architecture Evaluation methods in the context of a DoD mission-critical SoS example

Gain an understanding of the benefits of applying these methods, including the points in the acquisition and development life cycles where each method provides the most leverage

Learn how to identify key stakeholders that are needed to make the methods successful

Understand how the results of these engagements can be applied within programs and organizations to reduce cost and risk and improve program success

Outline

Introduction

SoS Architecture Engagement Overview

Mission Thread Workshop

Methods/Activities Superimposed Over DoD SoS Life-Cycle

Architecture Challenges Workshop

Legacy System & Software Architecture Evaluation

SoS Architecture Evaluation

Next Steps

Introductions

Problem

Integration and operational problems arise due to inconsistencies, ambiguities, and omissions in addressing quality attributes between system and software architectures. This is further exacerbated in an SoS.

Example quality attributes: predictability in performance, availability/reliability, security, usability, testability, safety, interoperability, maintainability, force modularity, spectrum management

Functionality and capability are important, but the architecture must be driven by the quality attributes. Identifying and addressing quality attributes early and evaluating the architecture to identify risks is key to success.

Architecture plays an important role in every stage.

Common Symptoms

Failure to address quality attributes (non-functional requirements) in the architecture early will inevitably lead to symptoms such as these:

Operational

- Communication bottlenecks under various load conditions throughout SoS
- Systems that hang up or crash; portions that need rebooting too often
- Difficulty synching up after periods of disconnect and resume operations
- Judgment by users that system is unusable for variety of reasons
- Database access sluggish and unpredictable
- Lack of stability in overload conditions

Developmental

- Integration schedule blown, difficulty identifying root causes of problems
- Proliferation of patches and workarounds during integration and test
- Integration of new capabilities taking longer than expected, triggering breaking points for various resources
- Significant operational problems ensuing despite passage of integration and test
- Anticipated reuse benefits not being realized

These symptoms often point to architectural deficiencies.

The Need for Augmented Mission Threads in DoD SoS Architecture Definition

DoDAF is the SoS architecture framework for the DoD. It provides a good set of architectural views for an SoS architecture. However, it inadequately addresses cross-cutting quality attribute considerations.

System use cases focus on a functional slice of the system.

More than DoDAF and system use cases are needed to ensure that the SoS architecture satisfies its cross-cutting quality attribute needs.

SoS end-to-end mission threads augmented with quality attribute considerations are needed to help define the SoS Architecture precepts and guidelines, and then later evaluate the SoS architecture.

Definitions - 1

A **System of Systems** is "a set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities." [OSD Systems Engineering Guide for Systems of Systems, August 2008]

OSD SE Guide defines four types of SoSs:

- Directed
- Acknowledged
- Collaborative
- Virtual

The tutorial will be addressing Directed and Acknowledged SoSs

Definitions - 2

Directed. Directed SoS are those in which the integrated system-of-systems is built and managed to fulfill specific purposes. It is centrally managed during long-term operation to continue to fulfill those purposes as well as any new ones the system owners might wish to address. The component systems maintain an ability to operate independently, but their normal operational mode is subordinated to the central managed purpose.

Acknowledged. Acknowledged SoS have recognized objectives, a designated manager, and resources for the SoS; however, the constituent systems retain their independent ownership, objectives, funding, and development and sustainment approaches. Changes in the systems are based on collaboration between the SoS and the system.

Collaborative. In collaborative SoS the component systems interact more or less voluntarily to fulfill agreed upon central purposes. The Internet is a collaborative system. The Internet Engineering Task Force works out standards but has no power to enforce them. The central players collectively decide how to provide or deny service, thereby providing some means of enforcing and maintaining standards.

Virtual. Virtual SoS lack a central management authority and a centrally agreed upon purpose for the system-of-systems. Large-scale behavior emerges—and may be desirable—but this type of SoS must rely upon relatively invisible mechanisms to maintain it.

Definitions - 3

An **Architecture** is the structure of components, their relationships, and the principles and guidelines governing their design evolution over time [IEEE Std 610.12 and DoDAF].

*An **SoS Architecture** is the structure of constituent systems, their relationships, and the principles and guidelines governing their design evolution over time.*

Need to elaborate on this to clarify.

Elaboration

The structure(s) of the constituent systems include:

- Allocation of functionality to each constituent system
- End-to-end activity flows and communications, including operational, sustainment, development, and deployment activities.
- Externally visible properties and interfaces of the constituent systems, including behaviors, dependencies, use of shared resources, etc.
- Relationship among organizational entities and the constituent systems at each phase of the SoS lifecycle.
- Rationale and governance policies, for example, criteria for decisions about constituent system inclusion, continued participation and termination.

Depending on the type of SoS:

- the point at which the structures are determined and by whom can vary
- the level of specificity and abstractions can vary

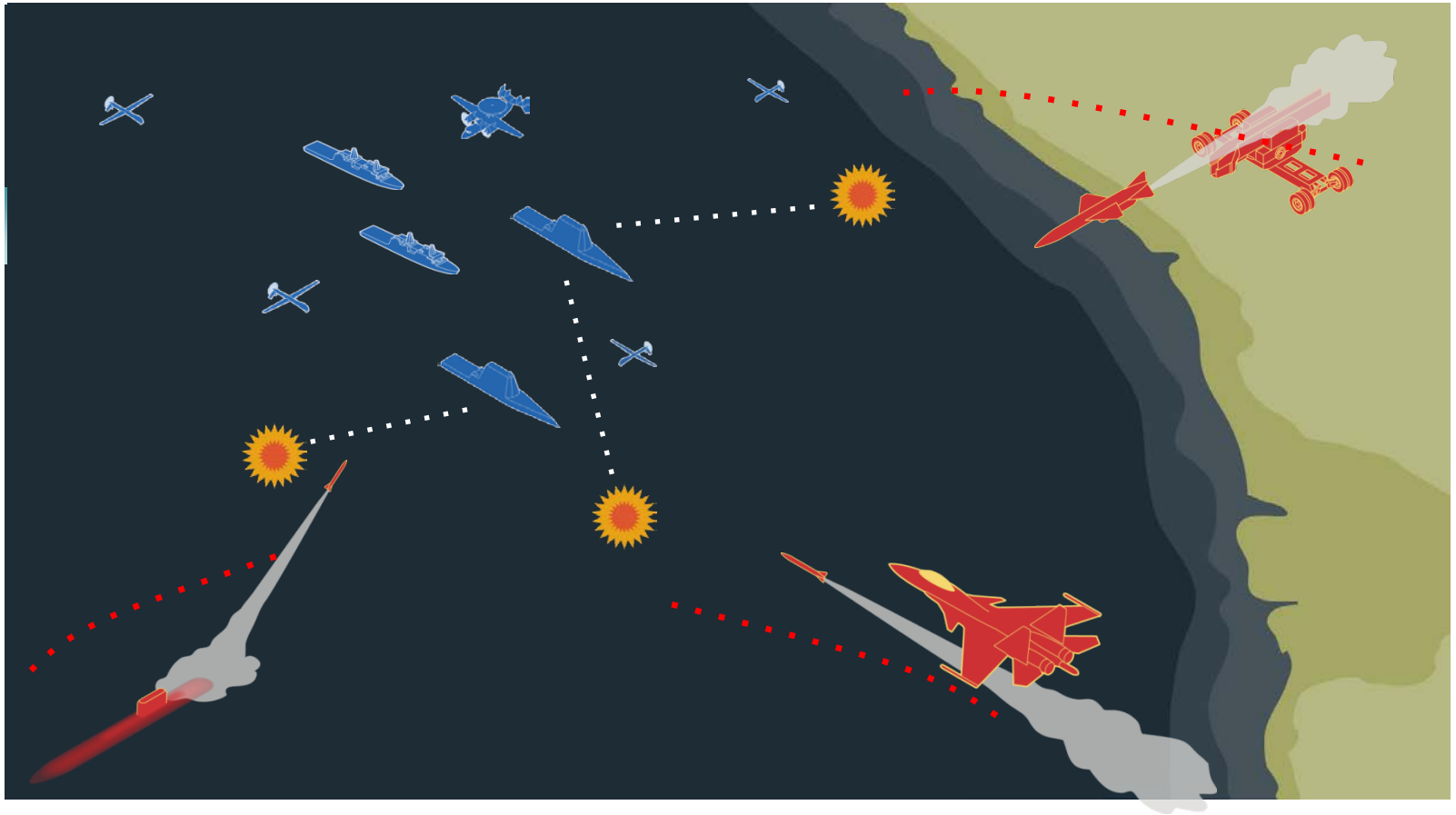
Definitions - 4

Warfare Vignette: A description of the geography, own force structure and mission, strategies and tactics, the enemy forces and their attack strategies and tactics, including timing. There may be associated Measures of Performance (MOP) and Measures of Effectiveness (MOE). A vignette provides context for one or more *mission threads*.

Mission Thread:
A sequence of end-to-end activities and events beginning with an opportunity to detect a threat or element that ought to be attacked and ending with a commander's assessment of damage after an attack. C4ISR for Future Naval Strike (Operational)

Sustainment: A sequence of activities and events which focus on development, deployment and maintenance.

Vignettes Are the Starting Point – Example Context



Vignettes Are the Starting Point – Example Wording

Two ships (Alpha and Beta) are assigned to integrated air and missile defense (IAMD) to protect a fleet containing two high-value assets (HVA). A surveillance aircraft SA and 4 UAVs are assigned to the fleet and controlled by the ships. Two UAVs flying as a constellation can provide fire-control quality tracks directly to the two ships. A three-pronged attack on the fleet occurs:

- 20 land-based ballistic missiles from the east
- 5 minutes later from 5 aircraft-launched missiles from the south
- 3 minutes later from 7 submarine-launched missiles from the west.

The fleet is protected with no battle damage.

Mission Threads Flow from Vignettes – Example (Non-Augmented)

1. 20 land-based missiles launched - X minute window
2. Satellite detects missiles - cues CMDR
3. CMDR executes re-planning – reassigns Alpha and Beta
4. Satellite sends track/target data - before they cross horizon
5. Ships' radars are focused on horizon crossing points

…

N Engagement cycle is started on each ship

N+1. Aircraft are detected heading for fleet

N+2. SA detects missile launches – tells CMDR

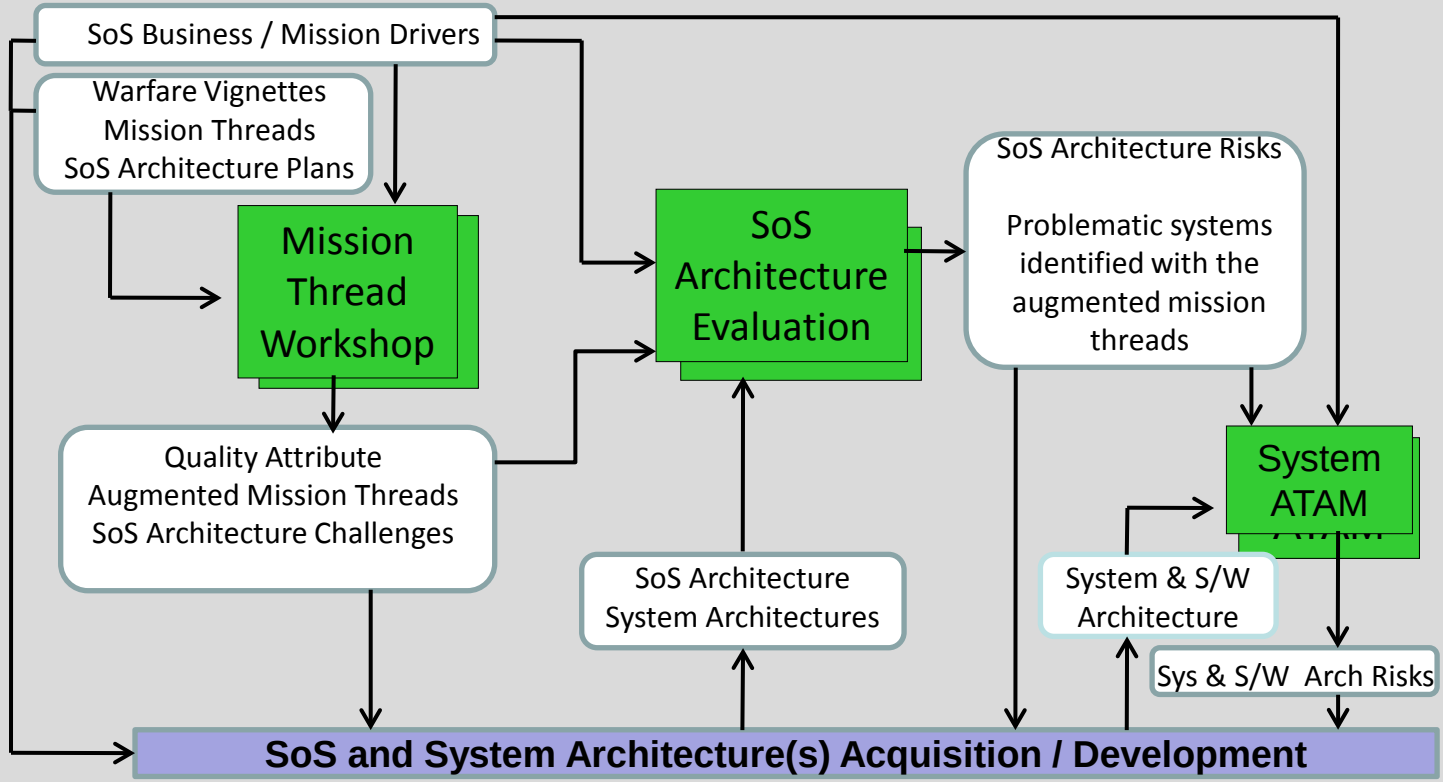
N+3. CMDR does re-planning - UAVs are re-directed

N+4. FCQ tracks are developed from UAV inputs

SoS Architecture Engagement - Overview

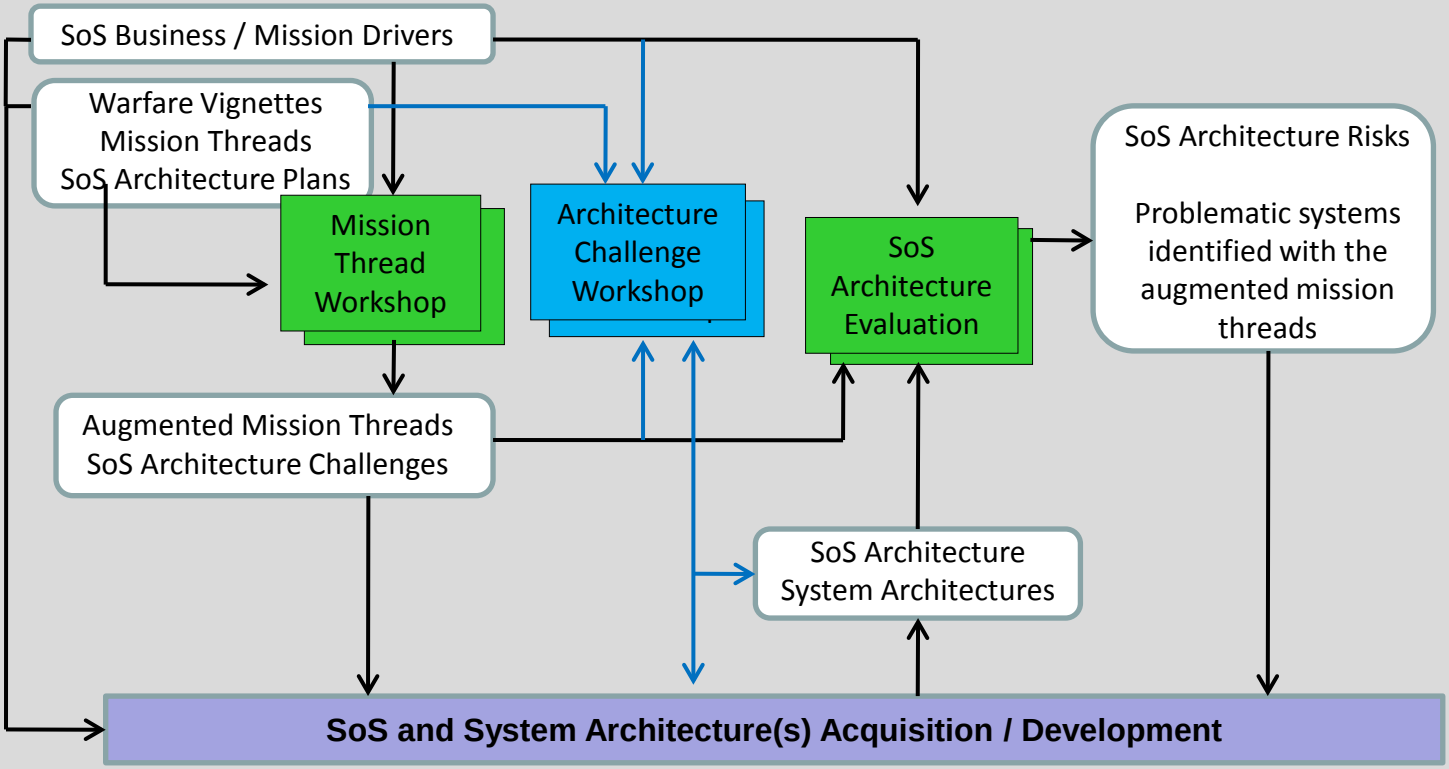
SoS Architecture Quality Attribute Specification and Evaluation Approach

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks



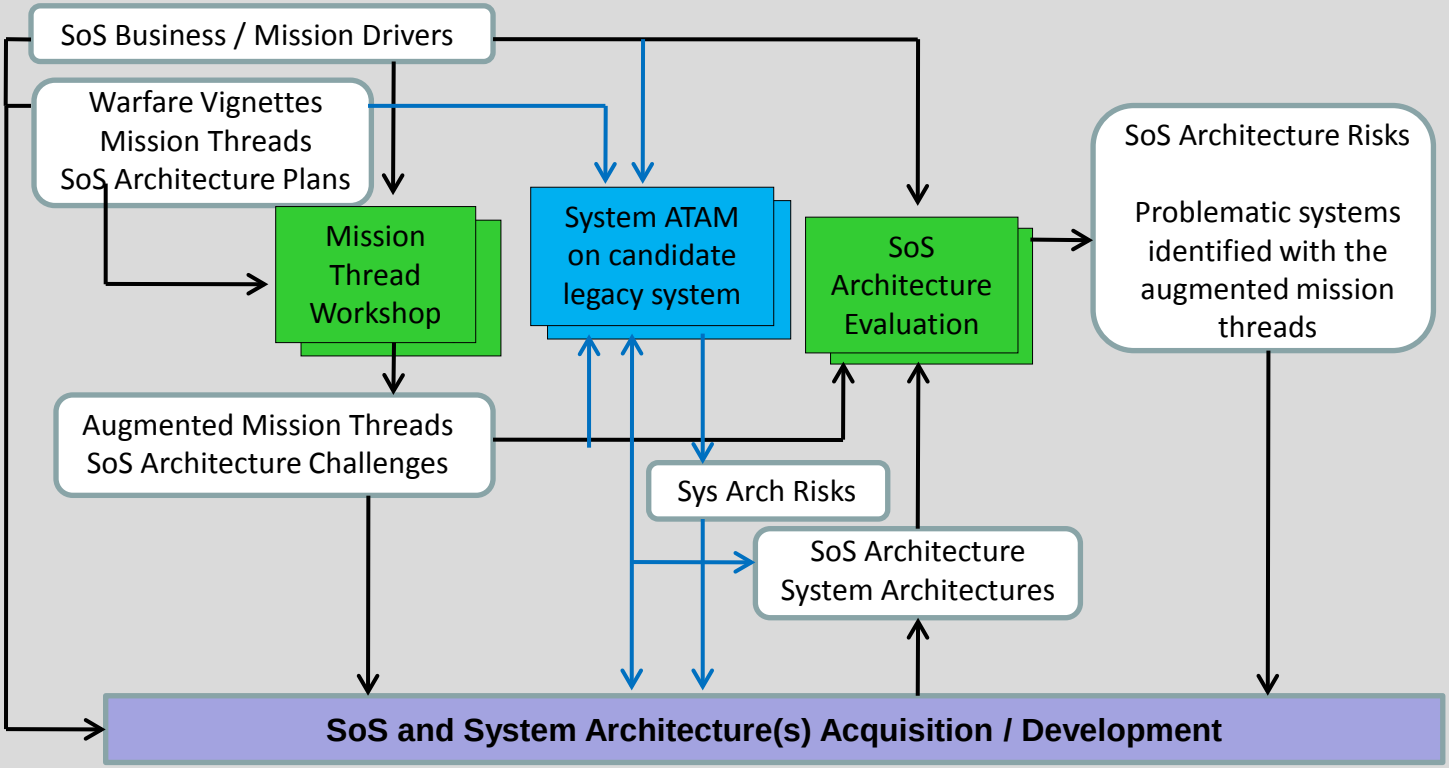
Identify and Address Architectural Challenges - Early

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks



Legacy System Architecture Evaluation - Early

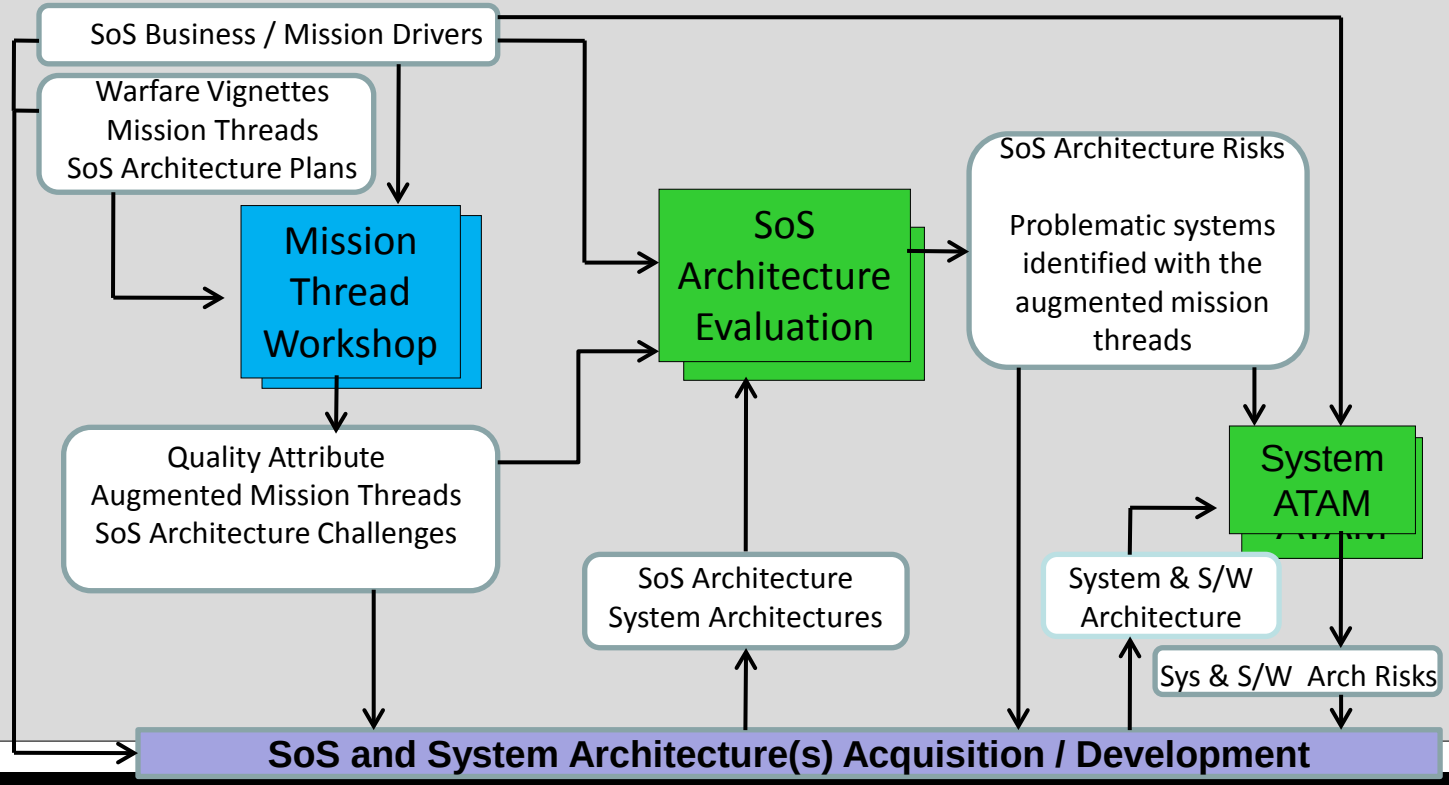
- Early elicitation of quality attribute considerations
- **Early identification and addressing of architecture challenges (e.g. candidate legacy system architecture evaluation)**
- Early identification and mitigation of architectural risks



Mission Thread Workshop

SoS Architecture Engagement

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks



Mission Thread Workshop (MTW) Purpose

The MTW ***augments SoS mission threads*** with quality attribute considerations that shape the SoS architecture and ***identifies SoS architectural challenges***, as early in the SoS development cycle as possible.

The mission thread augmentation is performed with inputs from key SoS stakeholders and is facilitated by the SEI.

The augmented mission threads and challenges are used to develop the SoS architecture and then later to evaluate the SoS architecture.

There will be a series of MTWs depending on scope, scale, and schedule considerations.

MTW sequence planning/scheduling and vignette and MT development/selection

Criteria for development/selection of vignettes and MTs

- Capability Coverage
- New requirements/capabilities
- Stressing the SoS
  - constituent systems, communications, etc
- New integrated existing capabilities

You can only do so many of these… make them count.

MTW Inputs - 1

SoS Business and Mission Drivers Presentation (15 mins)

- A representative from the SoS stakeholder community presents the SoS business and/or mission drivers including the business/programmatic context, high-level functional requirements, high-level constraints, high-level quality attributes, acquisition strategy, etc.

SoS Architecture Plans Presentation (30 mins)

- The SoS architect presents the architecture development plans including key business/programmatic requirements, key technical requirements and constraints that will drive architectural decisions, any relevant existing context diagrams, high-level SoS diagrams and descriptions, development spirals and integration schedule.

MTW Inputs - 2

Vignettes

- A description of the geography, own force structure and mission, strategies and tactics, the enemy forces and their attack strategies and tactics, including timing. There may be associated Measures of Performance (MOP) and Measures of Effectiveness (MOE).
  - An SoS will typically support multiple vignettes, i.e. multiple mission areas such as Air Defense, Ballistic Missile Defense, Replenishment, Mobility, etc.
  - Each vignette typically supports multiple mission threads

Mission Threads, types:

- Operational - A sequence of activities and events beginning with an opportunity to detect a threat or element that ought to be attacked and ending with a commander's assessment of damage after an attack.
- Sustainment: A sequence of activities and events which focus on development, deployment and maintenance.

Preparation

The SoS Program Manager develops a overview presentation on the SoS Mission / Business Drivers (see SoS Mission / Business driver presentation template).

The SoS Architect develops an overview presentation on the SoS Architecture Plans (see SoS Architecture Plans presentation template).

The SEI meets with the SoS Architect and PM to:

- Determine if the vignettes and MTs are sufficient to proceed.
- Provide feedback on the two presentations
- Reach agreement on scope and series of MTWs
- Identify Stakeholders
- Determine logistics

Stakeholders are Key!

When developing the initial set of vignettes and MTs, it is critical to associate them with the key stakeholder types that will be necessary to participate in the Workshops.

There may be groups of stakeholder types that are not necessary for specific vignettes.

Example stakeholders: (leads in the following)

- Modeling and Simulations
- Integration and Test Facility (SIL)
- CONOPS, DRM, Operational Analysts,
- SoS, System and Software Architects
- Legacy System Architects

Typical MTW Agenda

08:00-08:15	Welcome/Introductions/Opening Remarks (joint)
08:15-08:45	MTW Overview (SEI)
08:45-09:00	Business Drivers and Quality Attributes (Architect)
09:00-09:40	OV-1 & Vignettes Overview (Architect)
09:40-09:55	Break
09:55-12:00	Augmentation of 1st mission thread (SEI facilitated)
12:00-13:00	Lunch
13:00-13:20	Review OV-1 and vignette associated with 2nd mission thread (Architect)
13:20-15:00	Augmentation of 2nd mission thread (SEI facilitated)
15:00-15:15	Break
15:15-15:45	Review OV-1 and vignette associated with 3rd mission thread (Architect)
15:45-17:00	Augmentation of 3rd mission thread (SEI facilitated)

Augmentation Process – Per Mission Thread

1) For each event in the mission thread:
   - Elicit quality attribute considerations. Capturing any engineering issues, assumptions, challenges, additional use case and mission threads (with QA context etc.)
   - Capture any capability and/or mission issues that arise.

2) Elicit any over-arching quality attribute considerations
   - Capturing any over-arching assumptions, engineering issues, challenges, additional use cases and mission threads (with QA context) etc.

3) Capture any capability and/or mission issues that arise.

4) Capture any MT extensions for a later pass.

Parking Lot – for organization, programmatic, non-technical issues that arise (will not be further pursued in the MTW).

SEI facilitates and scribes using a pre-defined MTW template.

Stakeholder Inputs are Key.

Rules

SEI will provide the facilitation and scribing.

This is a big crowd: side conversations, cell calls, etc. will not be allowed to disrupt the meeting.

Once an issue is identified and discussed, we will not allow it to be re-discussed. It will be noted at the appropriate place.

Will keep the discussions within scope.

Will not get into the details of potential solutions to issues.

Programmatic, organizational, and other non-technical issues will be noted, but not discussed in detail.

Example MTW Walk-Through

At this point in the tutorial we will switch to the MTW template which is partially filled in. We will walk through the MTW augmentation process using the DoD SoS example.

Starting with the example business driver and architecture plans presentations, then proceeding to the example mission thread augmentation.

MTW Presentation Topics

Scope and Stakeholders

Business Drivers

- Design Precepts
- Engineering Strategy

Quality Attributes

- Architecture Quality Attributes
- Technical Model

Scope

Interested in “Whole Ship” level interactions with other assets, invited stakeholders

- Engagement management, Communications
- Missiles, Radar, UAV, Helo
- Analysts, Planner, Survivability
- Modeling and simulation, Test
- Programmatic

Identify missing use cases

Identify additional engineering analysis tasks

Design Precepts 1

Life-cycle costs

- Ease of component removal and replacement for maintenance and modernization
- Open Architecture COTS solutions
- Effective Resource management (power, cooling, inter-connectivity, interface controls, weight, and volume)

Design Precepts 2

Government led Design using Integrated Product and Process Development with Industry and Government teams

- Key IPTs and Working Groups Co-Chaired by Program and Technical leads
- Technical Authority applied in periodic reviews and issue resolution
- All Design Characteristics will be traceable to requirements references through Total Ship Systems Engineering Process

Engineering Strategy

Decouple product development from platform development

Re-use (and potentially re-engineer) existing POR products

Strive for commonality across ship classes

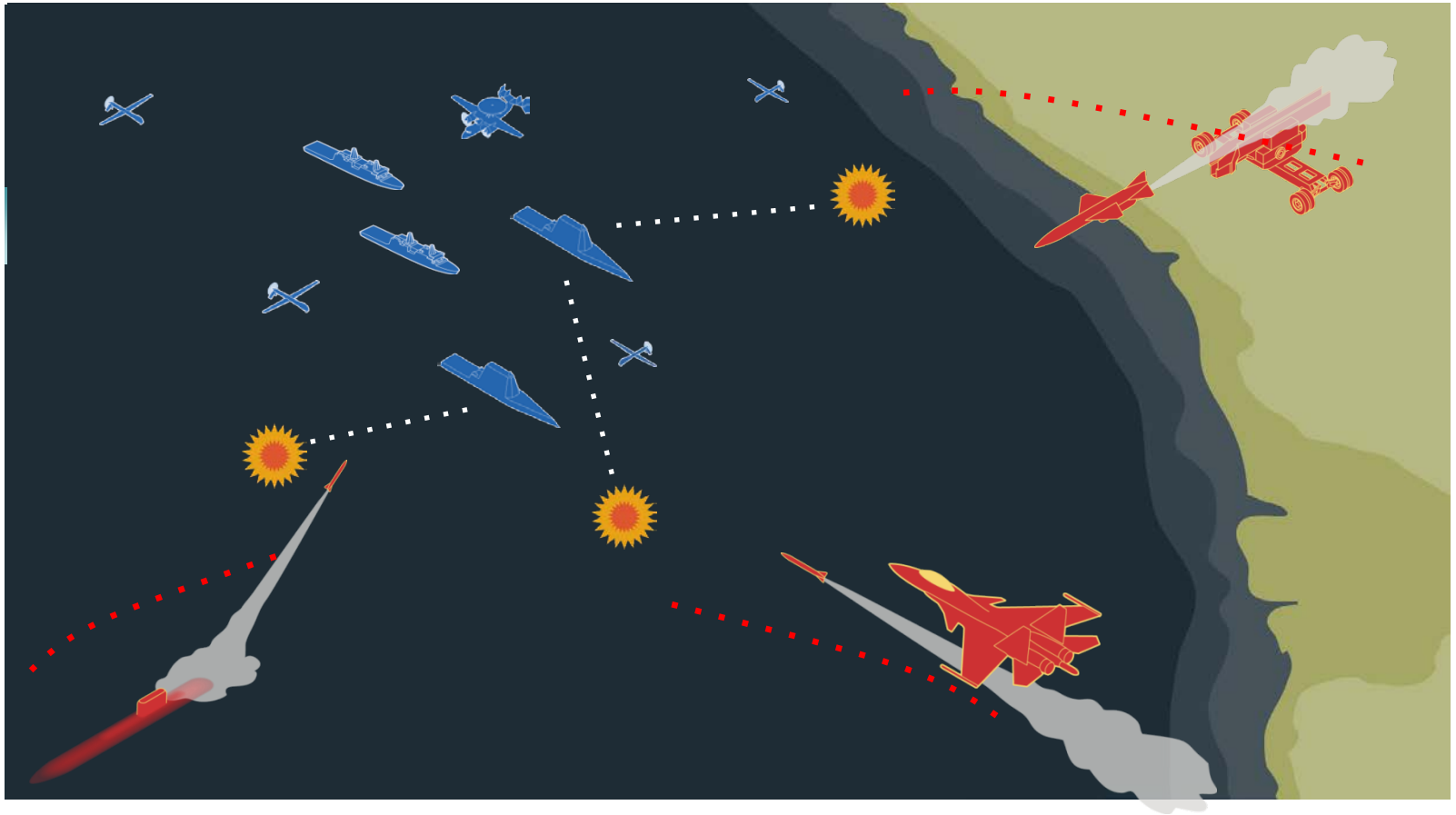
Government owned architecture

Quality Attributes

End User Impact	Interoperation Impact	Acquisition Impact

Performance
Availability
  Reliability
  Maintainability
  Fault Tolerance
Survivability
Safety
Usability
Mission Flexibility
Accuracy
Supportability
	Interoperability
	Backward Compatibility
	Network-Centricity
	  Information Exchange
	  Information Assurance
	  Security
	  Privacy
		Openness
		Reusability
		Affordability
		Testability
		Extensibility
		  Scalability
		  Adaptability
		  Expandability

Example Operational View



MTW Outputs

Individual MTWs

- Augmented Mission Threads (.doc, using MTW template)
  - Over-arching quality attribute augmentations for the mission thread
  - Capability and mission augmentations to the mission thread
  - Quality attribute augmentations for each event in the mission thread
  - Identified mission/additional use cases (with context) and mission threads

- Challenges (.ppt slides, vetted with sponsor)
  - Architectural, capability and mission challenges derived from the mission thread augmentations.
  - The MTW team will roll up challenges from the data and provide an out-brief of the challenges.
    - Mapped to contributing augmented mission thread steps
    - These are vetted and updated with the principals
  - Identify any candidate legacy system architecture that may require architecture evaluation.
  - Refer to the example MTW template here.

SoS Architectural Challenges (.ppt slides, vetted with sponsor)

- Report upon completion of series of MTWs:
  - SoS architectural challenges derived and rolled up from the mission thread augmentations; upon completion of the series of mission thread workshops for the SoS.
  - Meet with the principals to “rack and stack” challenges.

Examples of Rolled-up Challenges

Address resource management issues dealing with supporting the number of missiles and radar coverage

Performance timelines and deadlines need defined and decomposed

Engineering studies/analyses insufficient in area of manning/automation

Develop a better understanding of external interfaces due to the impacts they will have on the system.

Sensor coordination between the two ships and the UAVs needs further refinement.

MTW Experiences – 1

Conducted a total of 15 MTWs, each 1 -2 day meetings

Plan 4 MTs per MTW, but expect to augment 3.

Expect 25-30 stakeholders to want to participate per MTW. Benefits from strong facilitation and independent 3rd party leadership.

Clients developed very good first pass vignettes and MTs after initial introduction

Criteria for MT selection include: New capability, High perceived risk, proposal differentiators, etc.

DoDAF OV-1's were sufficient level of documentation going into the MTWs

MTW Experiences - 2

Most of the time taken by step elaboration, for example

- Command authority, network communications, step constraints
- Manned vs Automated, timelines, planning considerations
- Availability and Survivability considerations
- Readiness, environmental conditions, start up/shut down
- Current capabilities/extensions
- CONOPS missing
- Assumptions

Extensions

- Clients built some initially
- Added them as we go (to sideline discussions)

MTW Experiences - 3

Quality Attributes

- Timeline often built into thread (weeks to seconds)
- Availability/ Degraded Operation / Resource Management under-developed
- Focus on operational MTs, separate MTW for development and support
- Over-arching MT pass collects much of the QA considerations
- Identified additional use cases and MTs (e.g. survivability)

Challenges

- Currently doing on a MT basis
- Some challenges need to be kicked up to the SoS Architecture level to address. Implies a SoS Architecture and Guidelines Document.

MTW – Initial Results - 1

The MTW and SoS Arch Evaluation methods adopted by the organization and required in their architecture development process

Many of the identified challenges drove some early risk mitigation activities (e.g. prototyping, EDM, white papers).

Many new use cases and additional mission threads identified. The QA considerations will be included in the use cases.

Excellent vehicle to promote communication between architects and stakeholders.

Capability and Mission Challenges were identified as well as Architectural Challenges.

MTW – Initial Results - 2

SoS Architecture and Guidelines document is needed. Developed a template for use on an Army program.

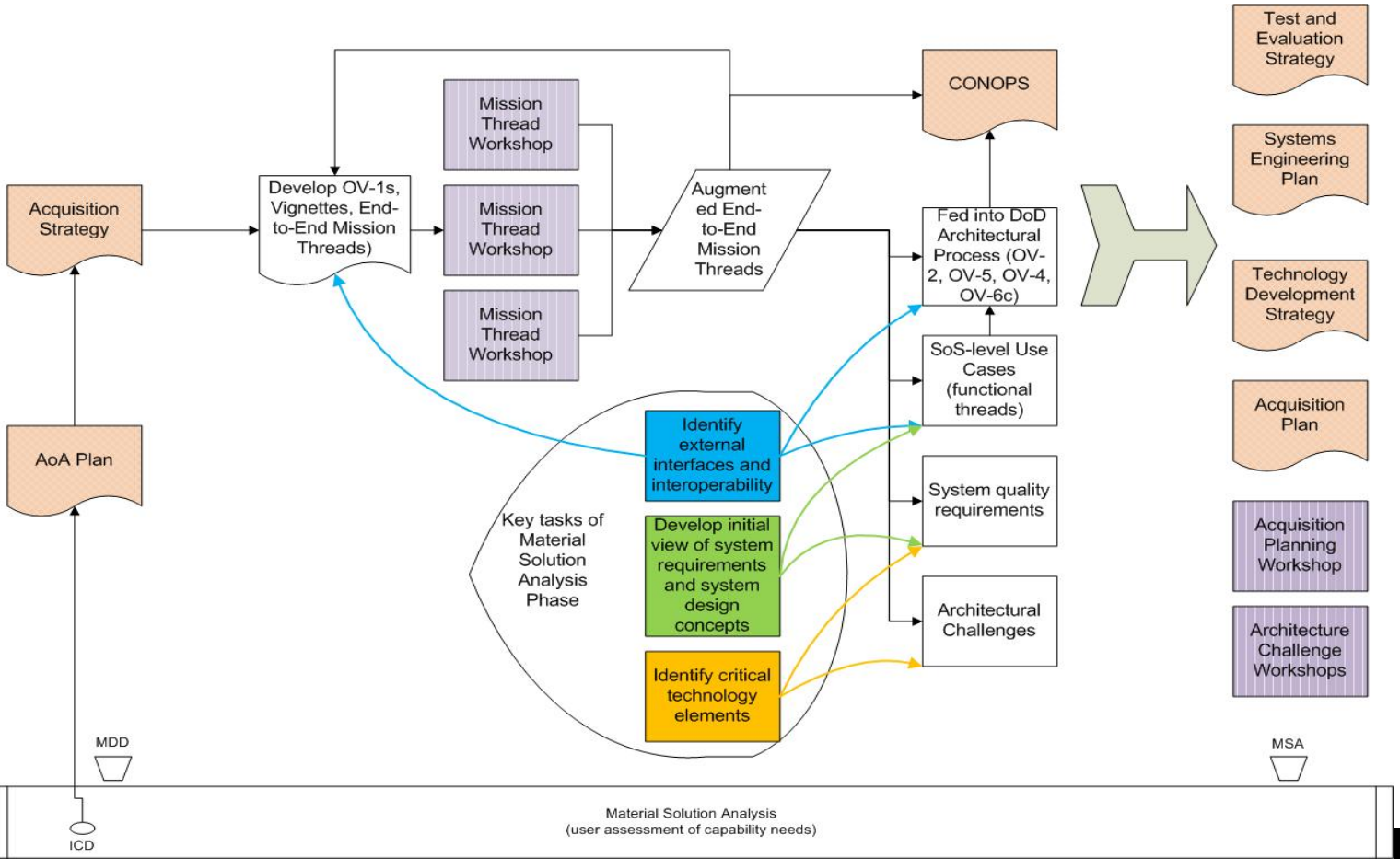
Supports programs' DoDAF architecture development efforts

3rd Party facilitation by the MTW facilitators enabled the leads to think about and participate in the discussions rather than trying to lead/control the meetings

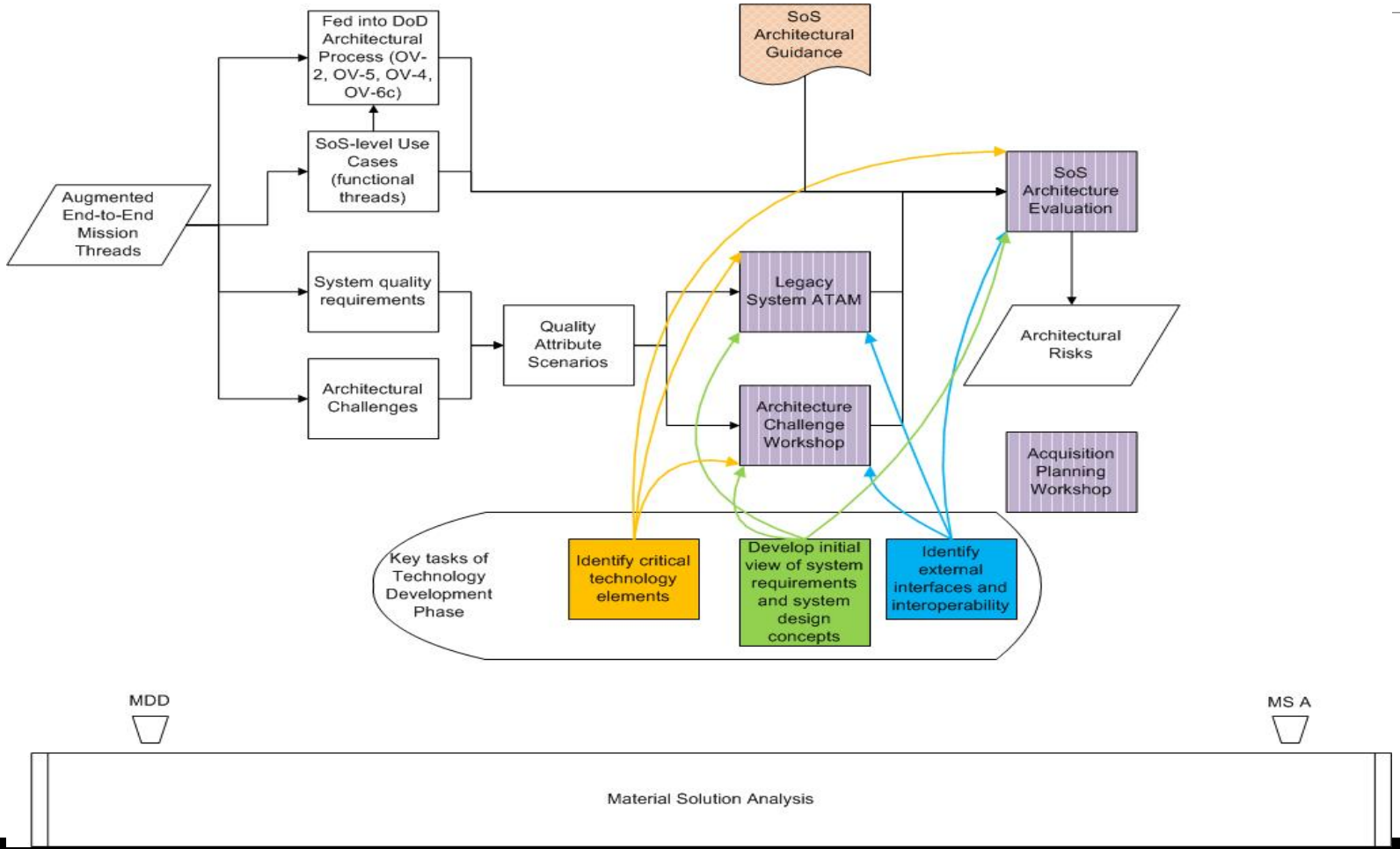
Method worked for non-software elements, as well as software-intensive elements

Methods/Activities Superimposed Over DoD SoS Life-Cycle

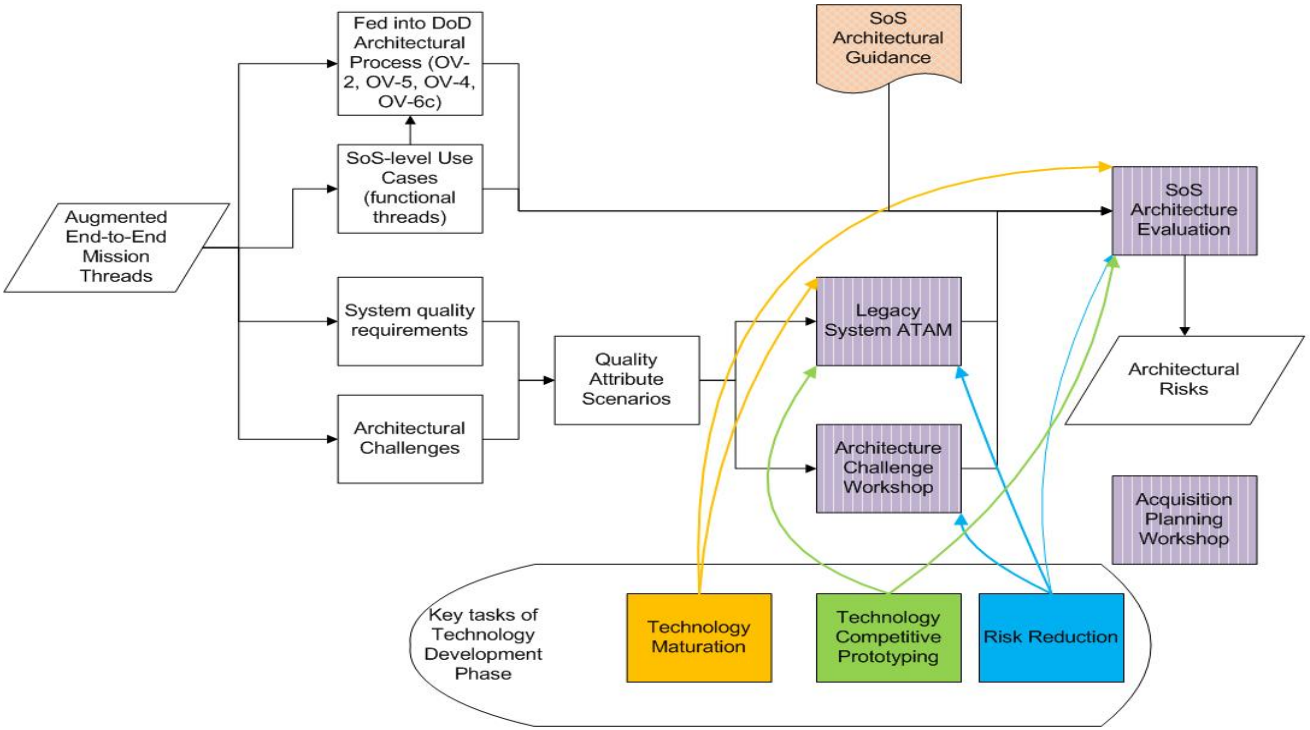
Material Solution Analysis Phase



Material Solution Analysis Phase



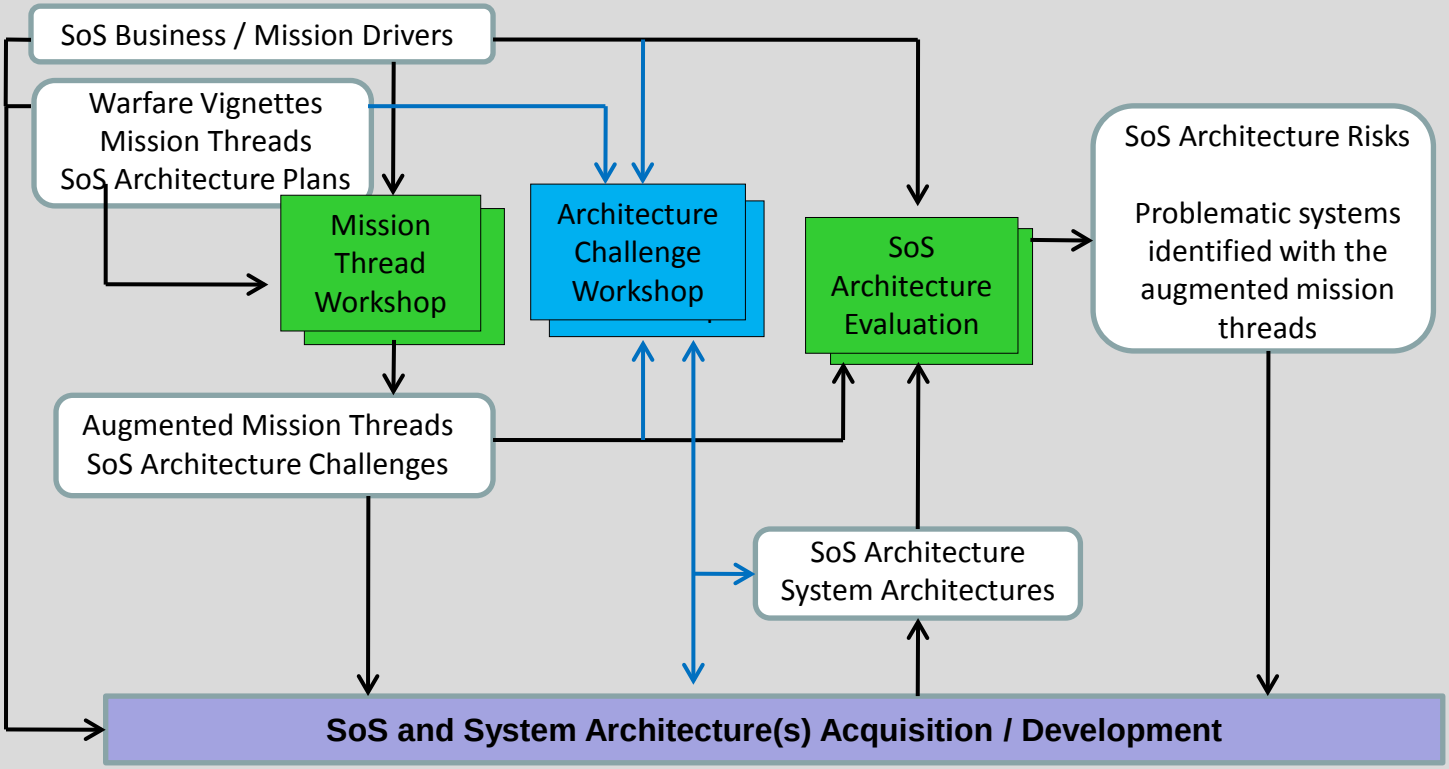
Technology Development Phase



Architecture Challenges Workshop

Identify and Address Architectural Challenges - Early

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks



Outline of ACW

Purpose: To resolve a challenge from the MTW

Inputs: Vignettes / thread steps that contribute to the ACW

Preparation: Preliminary technical analysis

Processing: Review the challenges impact and develop aspects of the challenge

Outputs: Plan to handle challenge aspects

Resource Management- Purpose

To describe the resource management issues that arose during the MTW, and organize them such that the design can resolve these issues.

Resource Management- Inputs

Missiles : Steps 1 , 8, 9, 10, 14, 15, 16, 20, Ex2

Radar Coverage: 2, 6, 7, 11, Ex1 (all)

Communications: Av2, AV3, AV4, Av6, Av7

Degraded Operations: Av5

Resource Management - Preparatory

The air defense (AD) daily planning must include

- The radar coverage of: SA, 4 UAVs, own radar
- Missiles available for AD and their status (both ships)

The AD planning to handle imminent threats

- Assignment of incoming missiles to Alpha and Beta for engagement

There are a number of fault conditions that impact operations

- Lack of radar coverage
- Communication failures

Degraded modes must be defined clearly

Resource Management- Rack and Stack

Type	Imp	Diffic	Unfamil	Priority
AD Daily Planning	Low	High	Low	4
AD Threat Planning	High	High	High	1
Fault Conditions	High	High	Low	2
Degraded Modes	Med.	Low	Low	3

Resource Management- Processing

Agenda

Review and edit the input material

Review and edit the preparatory material

Determine the segments impacted

Define the interactions between these segments and the interactions with external actors

Plan the design steps

- White papers, prototyping, experiments, design, etc.

Resource Management - Outputs

Perform simulation studies to determine how best to allocate resource coverage from different resources

Write a white paper on AD engagement assignment

- Current approach and shortcomings
- Study alternative approaches
- Suggest what should be done

Write a white paper on failure conditions that can arise and the recovery procedures that could be invoked

A first pass definition of degraded operational modes was made in briefing form

Schedule of above activities

Typical Architectural Challenge Workshop Agenda

08:00-08:15 Welcome/Introductions/Opening Remarks (joint)

08:15-08:45 ACW Overview (SEI)

08:45-09:40 OV-1/Vignettes/Augmented MT Steps Associated with Arch Challenge (Architect)

09:40-09:55 Break

09:55-12:00 Review and develop aspects of the challenge (SEI facilitated)

12:00-13:00 Lunch

13:00-15:00 Review and discuss the architects' architectural approaches (SEI Facilitated)

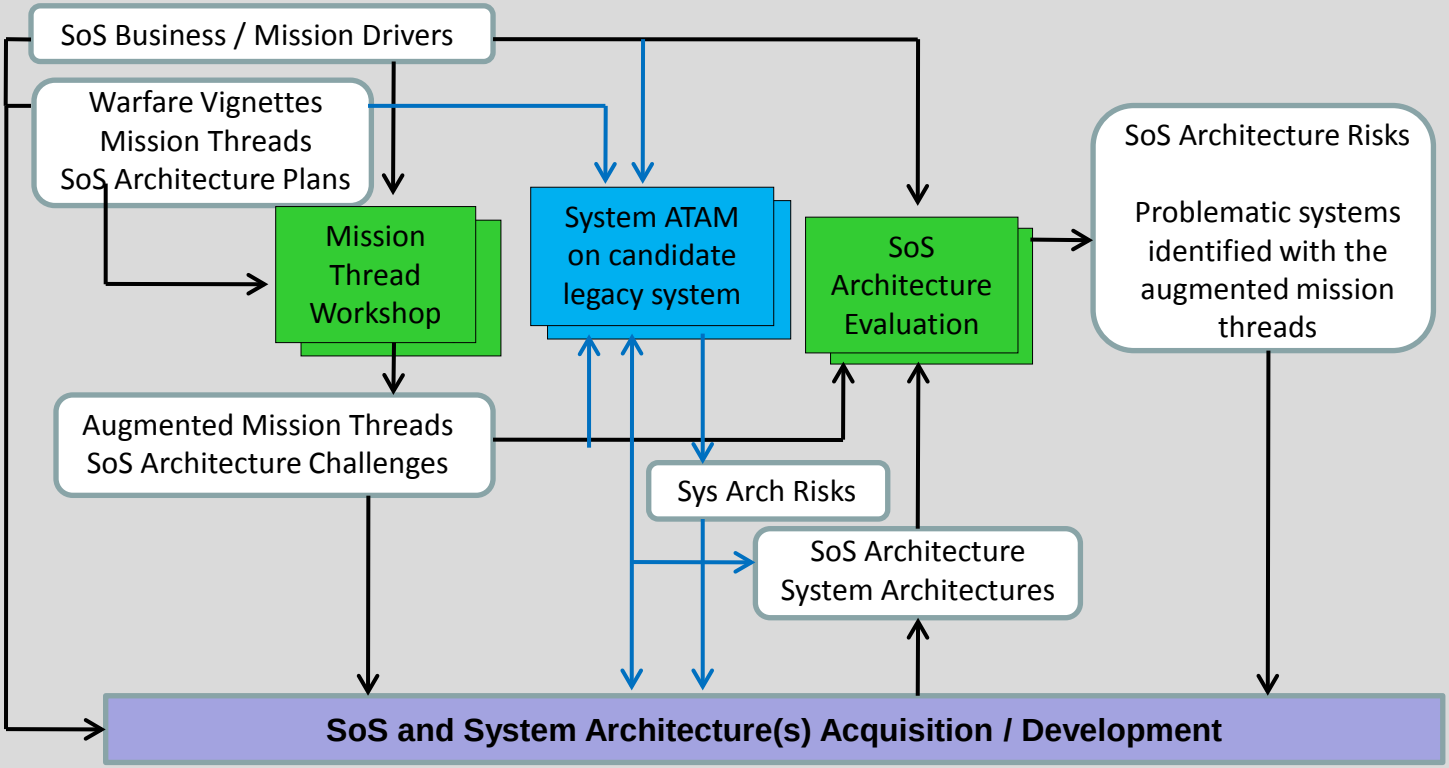
15:00-15:15 Break

15:15-17:00 Plan the design steps (SEI facilitated)

Legacy System Architecture Evaluation Using ATAM

Legacy System Architecture Evaluation - Early

- Early elicitation of quality attribute considerations
- **Early identification and addressing of architecture challenges (e.g. candidate legacy system architecture evaluation)**
- Early identification and mitigation of architectural risks



Is a System ATAM Variant Appropriate For Defensive Engagement System?

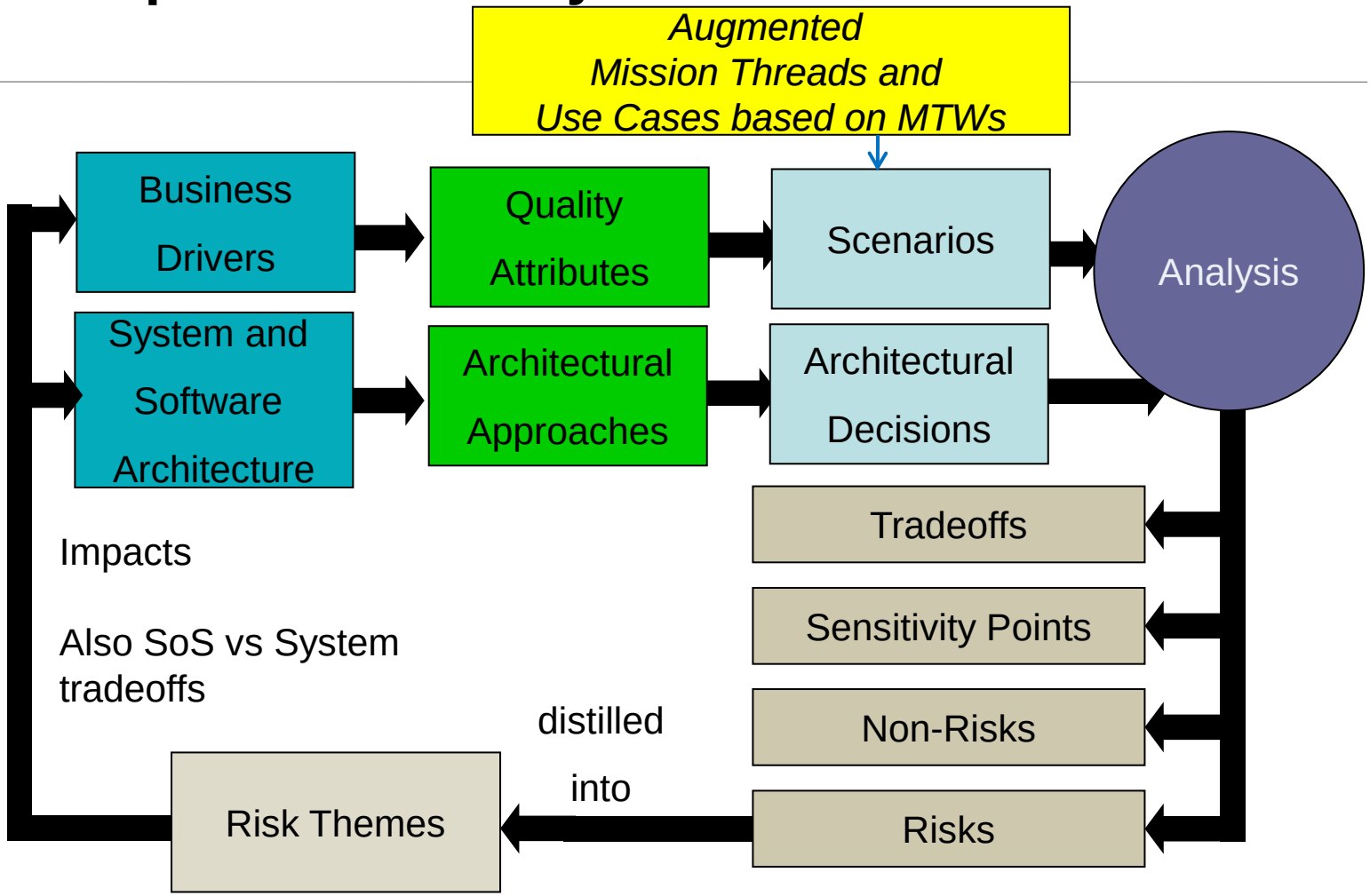
Comments from augmented mission thread:

- The Defensive Engagement System may not be able to support the deconfliction timeline for 5 incoming missiles.
- The Defensive Engagement System may not have the capability to acknowledge Beta's acceptance of its assignment of 2 missiles.
- Is the Defensive Engagement System capable of sending track updates to the interceptor missiles that Beta had launched within the intercept timeline?

In Phase 0, the System ATAM lead meets with SoS and appropriate system architects to discuss what is in and out of scope concerning the system under analysis and if appropriate documentation exists

Agree on scenarios based upon the augmented mission thread, with the understanding that additional scenarios can be added during Phase 2 of the System ATAM

Conceptual Flow of System ATAM Variant



Examples of Scenarios

Scenarios address both system and software aspects

Use case scenario

> *The Defensive Engagement System (DES) is able to support de-confliction of 7 incoming missiles using own-ship and external information within XX seconds.*

Growth scenario

> *An upgraded DES is able to reduce the confliction time by 40% of 7 incoming missiles with no loss of existing functionality.*

Exploratory scenario

> *The DES is able to operate at up to 80% of its time budget for de-confliction of 7 incoming missiles with 8 coalition UAVs and 3 coalition helicopters operating in its vicinity.*

ATAM Phase 2 Specifics

Stakeholders will consist of:

- System Architects of relevant, associated systems to system under evaluation
- SoS Architects who know the total system and how the system under evaluation is envisioned to fit in
- Relevant stakeholders of the system under evaluation in the areas of requirements, development, T&E, sustainment, M&S

ATAM evaluators will look to identify/expose potential system and software architecture risks, with the help of the stakeholders. Subject matter experts may be used on the evaluation team, if necessary.

Walk-through of a scenario derived from augmented MT

The Defensive Engagement System (DES) is able to support de-confliction of 7 incoming missiles using own-ship and external information within XX seconds.

System architect identifies that currently DES can support 3 incoming missiles with 25% spare capacity given the existing hardware. The architect also states that the system has a monolithic software architecture which is tightly coupled to the hardware.

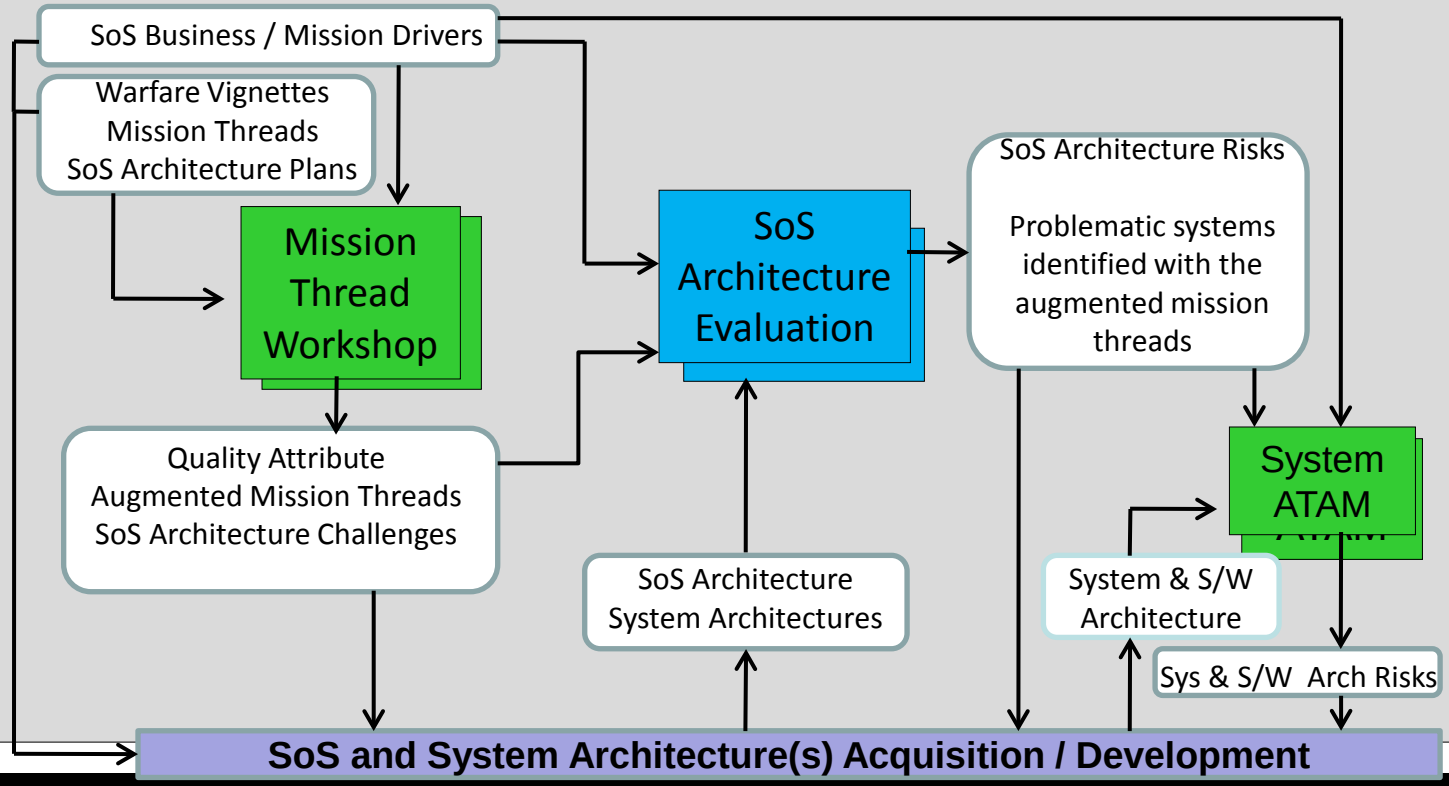
The architect identifies that upgraded hardware is available for the system which will improve performance, but the software will need to be re-designed to support it.

DES software architecture risk identified early and mitigations planned

SoS Architecture Evaluation

SoS Architecture Engagement

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks



SoS Architecture Evaluation Purpose

The SoS Architecture Evaluations ***identifies SoS architectural risks*** by probing the SoS architecture, using the augmented SoS mission threads and challenges, to evaluate the SoS architecture. It also ***identifies any problematic systems that require further evaluation***.

There will be a series of SoS Architecture Evaluations depending on scope, scale, and schedule considerations.

Evaluation Approach - 1

Similar to ATAM in some ways

- Appropriate architecture documentation required
- Stakeholders required throughout
- Architect(s) walk the augmented mission thread through the SoS architecture with evaluation team probing for risks, non-risks, etc.
- 2 day max per evaluation
  - not a precise, exhaustive evaluation
- Risks rolled up into risk themes
- Evaluation team required throughout
- Scoping is critical

Evaluation Approach - 2

Differs from ATAM in some ways

- Use existing augmented mission threads from the MTW
  - Requires execution of a MTW prior to evaluation
  - Mission threads augmentation nor occurring during the evaluation
- Identify problematic areas for more focused architecture evaluation
- Initial preparation requires proper scoping and development of a scheduled series of SoS Arch Evals:
  - Ensure proper stakeholder representation; balance between not wasting anyone's time versus benefits of participation and communication. Depends on:
    - Mission thread "type" – operational, sustainment
    - Clustering of constituent systems per mission thread
  - Constrained by time it takes to go through a mission thread (1 per day)

Evaluation Approach - 3

Three stages

- Preparation
- Execution
- Roll-up and Follow-up

Stage 1: Preparation - 1

Review results of MTW, noting the architectural challenges and expected resolutions; and highlight augmentations that require further explanation

Identify the mission threads for the SoS Arch Eval with the SoS architect

- Assume that only 1-2 mission threads can be evaluated per day max.

Develop and review the SoS business/mission drivers and the SoS and System/SW architecture presentations

Review SoS and system architecture documentation for sufficiency

Identify stakeholders (some to assist with the evaluation)

Stage 1: Preparation - 2

Develop a schedule of the evaluations

Set up logistics and send out read-ahead with invitations

Walk-through one mission thread for practice

Identify evaluation team

- Lead, Scribe, 3 Evaluators
  - ATAM evaluator qualified
- Domain SMEs (e.g. Communications, sensors, weapons, platforms, warfare experts)

Evaluation team reviews the inputs and becomes familiar with the SoS Architecture in advance of the evaluation

Stage 2: Execution - 1

Note: 2 day max for each SoS Arch Eval

- Probably will only get through 2 mission threads

Presentations:

- SoS Business/Mission Driver Presentation
- SoS Architecture Presentation
- Augmented Mission Threads for this evaluation
- Architectural Challenges from the MTW

Stage 2: Execution - 2

Analysis for each architecture challenge

- The architect describes how the architecture satisfies each architecture challenge indentified in the MTWs

Analysis for each augmented mission thread

- Start with SoS Architect
- Walkthrough the architecture describing how the architecture satisfies the MT
  - Step by step probing all highlighted QAs, looking for risks
  - Some hybrid of completing a step for all QAs and completing all steps for a QA.

For each analysis above:

- SoS architect can hand over to system and s/w architects as needed
- The evaluation team probes for risks
- Scribe risks, non-risks and issues, etc using the evaluation template

Stage 2: Execution - 3

Strong facilitation to stay on track; Do not go too deep in system architectures, whatever is architecturally significant for the MT at the SoS level.

Create “Parking Lot” for non-technical issues

Summarize findings in an out-brief

Stage 3: Roll-up and Follow-up

At the end of each SoS Arch Eval:

- Output Briefing
  - SoS Architectural Risk Themes, Non risks, Trade-offs
  - Any non-architectural issues discovered
  - One example of an mission thread analysis with discovered SoS architectural risks, trade-off points and non-risks
  - Any problematic systems identified for future
  - Identify “parking lot” issues
- Summary Report of individual SoS Arch Eval
  - Detailed write-ups on the risk themes, non-risks, etc found during the evaluation
  - Summary of the SoS architecture, approaches, guidelines, etc
  - Summary of the SoS business and mission drivers, quality attributes, summarizing implications of any mismatches between SoS and systems

SoS Arch Evals Roll-up

At the end of the series of SoS Arch Evals

- Evaluation team meets to roll-up the findings from the series of SoS Arch Evals
- Annotated Summary Briefing
  - SoS Architectural Risk Themes and Non-risks (rolled up)
  - Any non-architectural issues discovered (rolled up)
  - Identify problematic areas and schedule “focused” architecture evaluations (e.g. System & Software ATAM)
  - Recommendations
- SoS Arch Eval Summary Report
  - Detailed write-ups on the risk themes, non-risks, etc found during the evaluation
  - Summary of the SoS architecture, approaches, guidelines, etc
  - Summary of the SoS business and mission drivers, quality attributes, summarizing implications of any mismatches between SoS and systems
  - Recommended Next Steps

Summary and Next Steps

Next Steps

Extensions

- Programmatic, Acquisition, Planning and Business Thread Workshops
  - E.g. Business Thread Workshop - “Vignette” replaced by “Business Context”, “Mission Thread” replaced by “End-to-end Business Thread”

SoS Acquisition to be more architecture-centric

- RFPs, SOWs, acquisition strategies, etc

SoS Architecture Guidelines template

- Turn this into a CDRL
- Transition from architectural challenges to actionable items and guideline development.

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