System of Systems (SoS) Architecture Definition and Evaluation
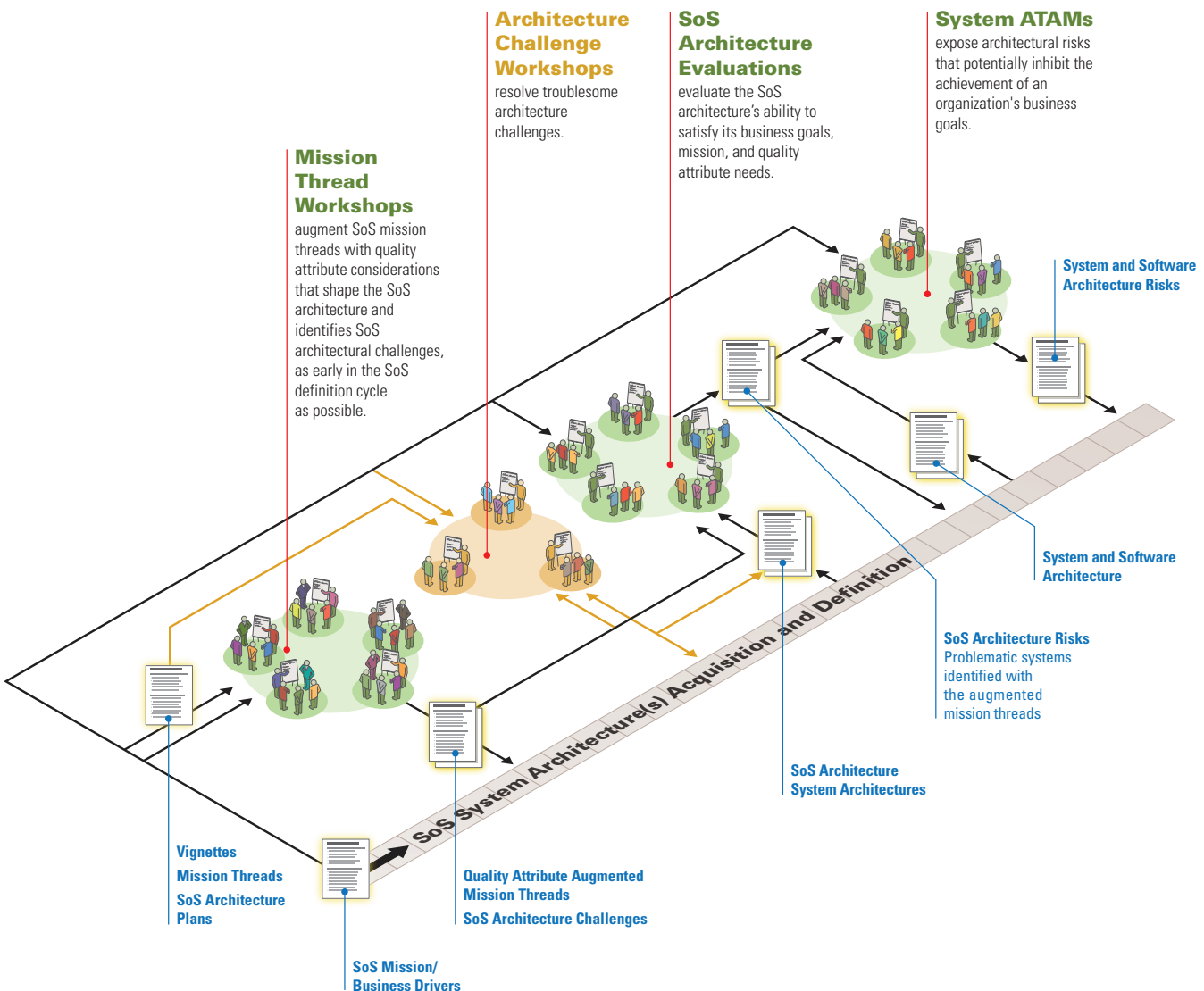
Have you ever encountered symptoms such as these?

- Communication bottlenecks under various load conditions that dramatically increase access time to critical capabilities
- Systems that hang up or crash causing warfighters to be without situational awareness during overly long recovery times
- Persistently unpredictable and unpleasant side-effects in portions of the SoS that distract warfighters from their primary focus
- Trouble sticking to an integration schedule during development
- Difficulty identifying the root causes of integration problems, resulting in the proliferation of patches and workarounds during integration and test

These common symptoms are indications of architectural deficiencies in systems of systems. If you have experienced these symptoms before, or if you want to identify the technical risks in your system of systems and avoid them in the future, the SEI can help.

Quality Attributes: the key to mission success

In addition to providing needed capabilities, all systems, including systems of systems (SoS), must satisfy non-functional quality attributes that are essential to mission success and achievement of business goals. Examples of such quality attributes are performance, availability, reliability, security, usability, testability, safety, interoperability, maintainability, and spectrum management.

Mission Thread Workshops augment SoS mission threads with quality attribute considerations that shape the SoS architecture and identifies SoS architectural challenges, as early in the SoS definition cycle as possible.

Architecture Challenge Workshops resolve troublesome architecture challenges.

SoS Architecture Evaluations evaluate the SoS architecture's ability to satisfy its business goals, mission, and quality attribute needs.

System ATAMs expose architectural risks that potentially inhibit the achievement of an organization's business goals.

System and Software Architecture Risks

System and Software Architecture

SoS Architecture Risks Problematic systems identified with the augmented mission threads

SoS Architecture System Architectures

Quality Attribute Augmented Mission Threads

SoS Architecture Challenges

Vignettes
Mission Threads
SoS Architecture Plans

SoS Mission/ Business Drivers

SoS System Architecture(s) Acquisition and Definition

System of Systems (SoS) Architecture Definition and Evaluation

Severe integration, interoperability, and operational problems can arise from inconsistencies, ambiguities, and omissions in addressing the quality attributes of SoS architectures. In many cases, the root causes of interoperability and integration problems in systems of systems can be traced to a failure to address quality attributes in the architectures.

DoDAF and system use cases aren't enough

DoDAF and system use cases are common architecture/design practices that are used to identify and develop needed SoS capabilities. However, these practices do not adequately address cross-cutting quality attributes in an SoS. To be sure that systems will satisfy both their functional and non-functional requirements, developers need to consider quality attributes in the context of end-to-end mission threads.

SEI Engagement: SoS Architecture Definition and Evaluation

The SEI is currently piloting a multi-phased engagement process that can be applied throughout the stages of the architecture-definition life cycle. In its early phases, this engagement includes Mission Thread Workshops, Architecture Challenge Workshops, SoS Architecture Evaluations, and System ATAMs.

The purpose of a Mission Thread Workshop (MTW) is to augment end-to-end missions threads with quality attribute considerations and identify architecture, engineering, and capability challenges early in the definition of a system of systems architecture. An MTW brings together key stakeholders representing a variety of organizations, roles, and points of view. Together, these stakeholders augment end-to-end mission threads by considering and capturing quality attribute, mission, and capability needs. The information elicited in an MTW is then made available to the SoS architecture development,

integration, and test activities. The information is also reduced to a set of five to seven architectural challenges to inform system and software architecture development and acquisition.

The architectural challenges developed in the MTW will have undergone a review and been subdivided in terms of (at least) importance, difficulty, and timeliness. The Architecture Challenge Workshop (ACW) takes one or more of these challenges, either together or sequentially, and engages a small team of stakeholders in collectively organizing an approach to resolving the challenges. Challenges are turned into technical action items and assigned to working groups, with a schedule and a review process to ensure closure of the challenges and introduction of technology to overcome them.

The purpose of the SoS Architecture Evaluation is to evaluate the SoS architecture's ability to satisfy its business goals, mission, and quality attribute needs. It identifies architectural risks, using the augmented mission threads and architectural challenges developed in previous MTWs. The evaluation provides early identification of SoS architecture risks and identifies problematic systems and SoS components. The architects, along with the program office, can then identify, prioritize, and mitigate risks early in the life cycle, before integration. Working early with the program office to develop a sound architecture-centric acquisition strategy and associated artifacts motivates contractors to do the right thing architecturally. It also gives the program office visibility into the progress of SoS architecture definition.

In most cases, an SoS will include many legacy systems whose management is separate from the SoS management and that were developed with a different set of quality attribute requirements from the usage envisioned within the SoS. Some of

these legacy systems may be used as is, while others may require some changes (either to the legacy system or the SoS) in order to work coherently within the SoS. Architectural risks for legacy systems within an SoS can be identified early in the SoS life cycle by conducting System ATAMs on critical legacy systems. The System ATAMs use the quality-attribute-augmented SoS mission threads developed in the MTW as a basis for scenarios in the architecture evaluation.

In addition to these early-phase activities, the SEI's support for SoS development and evaluation includes attention to architecture and quality attributes throughout a program's life cycle. The SEI's approach is flexible and tailorable, and has been proven effective on a number of DoD SoSs (e.g., Navy CG(X), Army PM Battle Command, and Lockheed Martin).

Contact the SEI now

For more information about how you can engage with the SEI to reduce your technical risk and support development of your system of systems, contact

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