### Enterprise Mission Assurance Concepts GSAW 2021

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## Purpose and Outline

Enterprise Mission Assurance (EMA) Concepts

• To provide new concepts for Mission Assurance at the Enterprise and Portfolio levels compared to traditional MA approaches at the system level

•OUTLINE:

- Background: Old and New Paradigms
- Definitions related to Traditional MA and EMA concepts
- Enterprise Architecture Activities and MA Approaches
- MA Approaches at ESE, Portfolio, and SoS Levels
- Conclusions and implications for ground system architectures
- References

# **Background: Old and New Paradigms**

#### **Traditional Mission Assurance Model for National Security Space**

MA Guide (Reference 1). See backup chart for Traditional MA from an SE perspective.



### New US Space Force Paradigms

Background for Enterprise Mission Assurance Concepts

- •US Space Force Priorities (Reference 8)
  - Empower a Lean and Agile Service
  - Develop Joint Warfighters
  - Deliver New Capabilities at Operationally Relevant Speeds
  - Expand Cooperation to Enhance
    Prosperity and Security
  - Create a Digital Service to Accelerate Innovation

#### **Operational Architecture (Reference 2)**



### New SMC 2.0 Paradigms

Space and Missile Systems Center is an acquisition arm of USSF

- Emphasis on prototyping and speed of development to stay ahead of the threat
- Integration of enterprise solutions (e.g. ground, space, launch, and network services)
- New SMC Portfolio Architect focus on optimizing the SMC portfolio of programs and integrating cross-mission solutions using SoS engineering in a digital environment

#### **SMC Portfolio Dimensions:**



PNT=Position, Navigation, & Timing SATCOM=Satellite Communications



New focus on architectures and integrated portfolio solutions drives new approaches to Mission Assurance

### Levels of Systems Architecture and Current MA Coverage

Aligned with levels of Mission Assurance

Level	Example	Comprised of:	Mission Assurance Approaches?
Enterprise	US Space Force Enterprise	SMC Portfolio, other government Portfolios, allied systems, etc. along with the people, processes, information, and technology that operate on or through them	No
Portfolio	SMC Portfolio	SBIRS + GPS + AEHF + Other programs	No
System of Systems	<u>ESA Galileo</u> <u>Architecture</u>	Satellites, Control Centres, Mission uplink stations, Galileo Sensor Stations, TT&C stations, other infrastructure	Some
Space System	Typical	GPS space segment (GPS IIR, GPS IIR-M, GPS IIF, and GPS IIIA constellations)	Yes
Satellite	GPS III SV01	Bus and payloads	Yes

# **Definitions Related to EMA Concepts**

## Mission Assurance (MA) Definitions

Comparison

- Traditional MA (Reference 1)
  - "The disciplined application of proven scientific, engineering, quality, and program management principles towards the goal of achieving **mission success**."
- Enterprise MA (working definition)
  - "A process (or set of practices) to ensure the delivery of effective and resilient capabilities to be used by (or support) warfighters through an evolving portfolio of programs and projects into an integrated multiorganizational and multinational space enterprise (space, launch, ground and user)."
  - Note: Resilience is defined in Reference 7 as:
    - "The ability of an architecture to support the functions necessary for mission success with higher probability; shorter periods of reduced capability; and across a wider range of scenarios, conditions, and threats, in spite of hostile action or adverse conditions."
    - "Resilience may leverage cross-domain or alternative government, commercial, or international capabilities."

## **Mission Success Definitions**

Comparison

- Traditional definition (MA Guide, Reference 1):
  - Achievement by an acquired system (or system of systems) to singularly or in combination meet:
    - Specified performance requirements
    - Expectations of the users and operators (safety, operability, suitability, and supportability)
  - Mission success is typically evaluated after operational turnover...
- Enterprise Mission Success Concept:
  - Success for an enterprise is:
    - Doing the best you can at delivering capabilities to achieve a desired future state
      - Within constrained resources while not jeopardizing current capabilities
  - It entails multidimensional tradeoffs over time:
    - Across many mission areas,
    - Constrained by fiscal limitations, and
    - Influenced by a dynamic and uncertain future threat environment.

#### Traditional measures of mission success are a poor barometer to guide Enterprise MA

# **Enterprise Architecture Activities and Enterprise Mission Assurance Approaches**

Initial Concepts for Enterprise MA, based on Enterprise Architecture Activities

### **Enterprise Architecture Activities and MA Approaches**

(Planning Enterprise Architecture Upgrades)

- EA process is focused on developing objective architectures and transition plans across a 10- to 20-year planning horizon annually/biennially
  - Inputs are mission needs (all mission areas) and strategic guidance (e.g. overall resilience)
  - Activities include teams that strategize roadmaps for each mission area and a process to merge and deconflict them
  - Outputs are the enterprise objective architecture and transition strategy over time
    - Each transition point along the roadmap must result in an **assured** operational capability.
- Enterprise Architecting Mission Assurance Approaches:
  - Independently study the outputs to ensure each transition step results in viable operational capabilities over all mission areas
  - Identify risks and opportunities that require further study in subsequent rounds of EA
  - Check that the EA process steps were properly followed

## Enterprise SE, Portfolio Definition, and SoS Engineering Activities and EMA Approaches

### What are Enterprise Systems Engineering (ESE) Process Activities?

From INCOSE SEBOK (Reference 3). See backup chart for purpose of each activity.



#### Proposed Portfolio Definition Process Activities (based on Reference 4)

Makes use of Enterprise Systems Engineering Activities (blue boxes)



Portfolio Definition defines the programs needed to achieve the roadmap

## Space System of Systems (SoS) Engineering & Integration

SoS Engineering allocates requirements to materiel solutions

### • Inputs:

- Desired Architecture Attributes
- Desired Performance
- Mission Threads and Scenarios
- Activities:
  - Requirements and Performance Analysis and Allocation
  - Functional Analysis and Allocation
- Outputs:
  - Desired materiel solutions and their capabilities over time
  - System and interface requirements over time
  - Concepts of Operation over time
  - Verification/Evaluation approaches for each transition



## Possible Enterprise MA Approaches at ESE, Portfolio, and SoS Levels

(Planning Portfolio Upgrades and SoS Engineering)

- Enterprise MA Approaches at the ESE level:
  - Evaluate the risks and effectiveness of the alternative enterprise strategies and roadmaps (vertical and horizontal) against a range of conceivable alternate future threats, and bring those potential risks or opportunities to the decisionmaker
    - Preferred Future, Unpreferred Future, Wild Card Future
- Enterprise MA Approaches at the Portfolio level:
  - Assess the risks of future portfolio alternatives to inform portfolio planning decisions
    - Is each portfolio alternative feasible?
    - Does each alternative provide sufficient value (effectiveness and resilience) for its cost?
    - Are there other opportunities that should be evaluated?
- Enterprise MA Approaches at the SoS level (similar to traditional MA):
  - Plan desired mission assurance tasks for each SoS capability and materiel solution on the roadmap, then execute those tasks
    - May include monitoring use of digital engineering best practices

# **Conclusions and Implications for Ground Systems Architectures**

### **Conclusions and Implications**

Enterprise Mission Assurance (EMA) concepts

## • In 2020, established a conceptual foundation for EMA

- Defined EMA, distinguishing it from TMA
- identified the ESE, portfolio definition, and SOS Engineering levels where EMA has the potential to benefit Aerospace customers the most (before budget is allocated)
- Identified possible EMA approaches applicable to each level
- Implications for Ground System Architectures
  - Consider alternative future ground architectures that can add value across your enterprise
    - Consolidation and standardization can reduce overall enterprise cost
    - Use optimized strategies for transitioning updates to operations (see Reference 9)
  - Provide MA-relevant insight early in enterprise, portfolio, and SoS design
    - Don't design for yesterday's (e.g., cyber) threats, consider a range of future threats
    - An independent EMA body could identify risks in architecture changes and their transitions early

#### In 2021, additional work will include leveraging digital engineering and system-theoretic methods

#### References

- 1. Guarro, S., G. Johnson-Roth and W. Tosney, "Mission Assurance Guide, TOR-2007(8546)-6018," Aerospace Corporation, 2012.
- Erwin, Sandra, U.S. military space architecture to bring in commercial systems, small satellites, August 5, 2020, <u>https://spacenews.com/u-s-military-space-architecture-to-bring-in-commercial-systems-small-satellites/</u>
- 3. Martin, J., B. Lawson and A. Faisandier, "Enterprise Systems Engineering Process Activities (SEBOK Wiki)," 7 May 2020. [Accessed 22 October 2020]. https://www.sebokwiki.org/wiki/Enterprise\_Systems\_Engineering\_Process\_Activities
- 4. Miller, J., "A Proven Project Portfolio Management Process," in Project Management Institute Annual Seminars and Symposium, San Antonio, TX, 2002.
- 5. "Mission Assurance Strategy," Department of Defense (DoD), 2012.
- 6. "Final Report on Organizational and Management Structure for the National Security Space Components of the Department of Defense," DOD, 2018.
- Joint Chiefs of Staff Publication 3-14, Space Operations, 10 April 2018 (Incorporating Change 1 26 October 2020)
- 8. 1<sup>st</sup> Chief of Space Operations, Chief of Space Operations' Planning Guidance, Nov 9, 2020. https://media.defense.gov/2020/Nov/09/2002531998/-1/-1/0/CSO%20PLANNING%20GUIDANCE.PDF
- Crombie, R., and E. Chang, Important Considerations for Transitioning Ground Systems to Operations, GSAW 2018 Proceedings (Session 10), February 28, 2018

# Backup

## Traditional Mission Assurance from a Systems Engineering Perspective

MA Guide (Reference 1)



### Enterprise Systems Engineering (ESE) Process Activity Purposes

ESE Process Activity	Purpose	
Strategic Technical	Establishes the overall technical strategy for the enterprise in terms of	
Planning	new technologies or standards that align with capability needs	
Capability-Based	Translates enterprise goals into a set of current and future capabilities	
Planning Analysis		
Technology and	Technology planning characterizes technology trends in the commercial	
Standards Planning	marketplace and the research community; Standards planning	
	identifies needs for new or updated technical standards	
Enterprise Architecture	EA provides a model to understand how the parts of the enterprise fit	
(EA) & Conceptual	together; Conceptual design produces new EA concepts to meet	
Design	enterprise requirements in the future	
Enterprise	Translates needed capabilities into a set of enterprise requirements	
Requirements		
Definition & Mgt		
Enterprise Evaluation	Measures progress towards realizing the enterprise vision to determine	
& Assessment	if the enterprise is heading in the right direction	
Opportunity & Risk	Manages activities dealing with opportunities to achieve enterprise	
Assessment & Mgt	goals or risks to pursuing those opportunities	

ESE establishes the enterprise architecture and capability roadmap