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# ACQUISITION SYSTEM INTEROPERABILITY CONSIDERATIONS

*National Defense Industrial Association (NDIA)*
*Systems Engineering Conference*

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# AGENDA

- Introduction
- Systems and Software Engineering – System Life Cycle Processes
- SE Life Cycle Processes  Interoperability Considerations
- Drivers to Increased Interoperability Emphasis
- NDIA 2107 AAA -  Modular Open System Approach
- MBSE and Acquisition
- Wrap Up

# INTRODUCTION

- Acquisition Reform efforts cancelled tens of thousands of military specifications and standards
  - There is a move to more non-governmental standards
  - There is a move to more profiles of acceptable standards, than mandated singular standards “There can be only one!”
  - Interoperability between some kinds of standards (e.g. data) is easier with current technology
  - There is increased appreciation that standards lag innovative technology
- An adoption of the ISO/IEC/IEEE8 15288, Systems and Software Engineering–System Life Cycle Processes was made by the DoD
- The NDAA 2107 Acquisition Agility Act (AAA) requires DoD acquisition to react more quickly and “agilely” to technology, Threat, and Mission changes using a Modular Open System Approach (MOSA)
- Open Architectures are being widely adopted in the DoD

***These are all enablers of increased Interoperability***

# SYSTEMS AND SOFTWARE ENGINEERING
## *SYSTEM LIFE CYCLE PROCESSES*

- **Acquisition reform efforts cancelled tens of thousands of military specifications and standards**
  - DoD Components expressed a need for SE-related standards to put on contract
  - Analysis was conducted to determine areas where new standards are needed
- **DoD adopted the voluntary consensus standard ISO/IEC/IEEE8 15288, *Systems and Software Engineering–System Life Cycle Processes,* for use in DoD acquisition.**
  - The standard establishes a common process framework for describing the life cycle of man-made systems and defines a set of SE processes and associated terminology typical for the full system life cycle - including conception, development, production, utilization, support, and retirement.
- **Two new DoD SE-focused Non-Government Standards (NGS) were developed and adopted by DoD as companion standards to ISO/IEC/IEEE8 15288**
  1) IEEE 15288.1, IEEE *Standard for Application of Systems Engineering on Defense Programs*; Issued May 15, 2015; adopted for use by DoD June 5, 2015
  2) IEEE 15288.2, IEEE *Standard for Technical Reviews and Audits on Defense Programs*; Issued May 15, 2015; adopted for use by DoD June 5, 2015

***They define DoD requirements for SE processes, technical reviews, and audits***

# THE 15288 AND COMPANION STANDARDS

- **Provide guidance for definition, control, and improvement of the organization or project's system life cycle processes**
- **Address man-made systems that may be configured with one or more of the following elements: hardware, software, data, humans, processes, procedures, facilities, materials, and naturally occurring entities… *(Pretty much everything!)***
- **IEEE 15288.1, IEEE *Standard for Application of Systems Engineering on Defense Programs*; expands on the SE life cycle processes with additional detail specific to DoD acquisition projects**
- **IEEE 15288.2, *Standard for Technical Reviews and Audits on Defense Programs,* provides detailed definition, requirements, and evaluation criteria for the technical reviews and audits associated with DoD acquisition projects**
- **NDIA, in collaboration with DoD representatives, drafted guidance for utilizing 15288.1 and 15288.2 on contracts.**
  - incorporated *in DoD Best Practices for Using SE Standards on Contracts for DoD Acquisition Programs* April 2017; http://www.acq.osd.mil/se/pg/guidance.html

# 15288 SE LIFE CYCLE PROCESSES

**Establishes a common framework for describing the life cycle of man-made systems and defines a set of processes and associated terminology from an engineering viewpoint**

| Agreement Processes | Technical Management Processes | Technical Processes |
|---|---|---|
| • Acquisition<br>• Supply | • Project Planning<br>• Project Assessment and Control<br>• Decision Management<br>• Risk Management<br>• Configuration Management<br>• Information Management<br>• Measurement<br>• Quality Assurance | • Business or Mission Analysis<br>• Stakeholder Needs and Requirements Definition<br>• System Requirements Definition<br>• Architecture Definition<br>• Design Definition<br>• System Analysis<br>• Implementation<br>• Integration<br>• Verification<br>• Transition<br>• Validation<br>• Operation<br>• Maintenance<br>• Disposal |
| **Organizational Project-Enabling Processes**<br>• Life Cycle Model Management<br>• Infrastructure Management<br>• Portfolio Management<br>• Human Resource Management<br>• Quality Management<br>• Knowledge Management | | |

Reference: **ISO/IEC/IEEE 15288, "Systems and Software Engineering System Life Cycle Processes"**

# 15288 SE LIFE CYCLE PROCESSES

- **Stress the importance of SE within the scope of the overall acquisition**
- **Define the acquirer's expectations, generally expressed in requirements, for a supplier's SE processes (outcomes, activities, and/or outputs) and technical reviews and audits**
- **Levy requirements on the supplier, via the contract, to perform effective SE**
- **Ensure the supplier's SE efforts are appropriately funded and resourced**
- **Ensure a means for the supplier to demonstrate compliance with those requirements**

***"The 15288 Standards provide one method to define the acquirer's expectations and requirements for the supplier's performance of SE processes and technical reviews and audits. Thoughtful and proper use of these standards can enhance communication and understanding between the acquirer and supplier throughout the solicitation process and contract execution."***

**Reference:** DoD Best Practices for Using SE Standards on Contracts for DoD Acquisition Programs April 2017; http://www.acq.osd.mil/se/pg/guidance.html

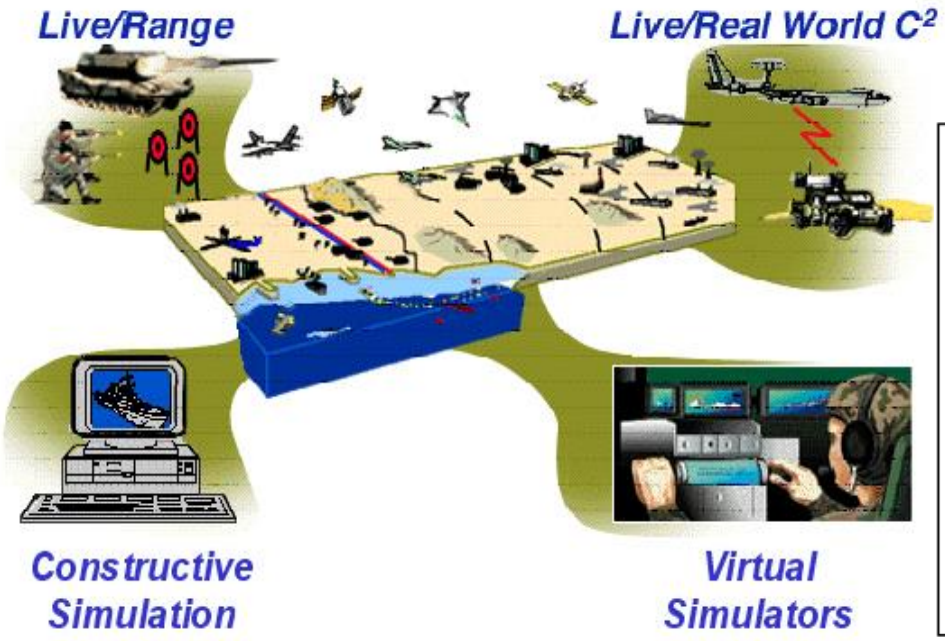
# SE LIFE CYCLE PROCESSES
## *INTEROPERABILITY CONSIDERATIONS*

- **Implementation of these SE System Life Cycle Processes involves interoperability consideration (both planned and unplanned) in engineering system capabilities where:**
  - Where the system function depends on data from external sources
  - Where the system functions cross system boundaries – distributed functionality
  - Where a the system needs an internal modular approach to accommodate technology basic system requirement (mission/threat) change within the Systems lifecycle.
  - Where system design and development, as well as performance in the system's functional role as a DoD capability, depend on that system's ability to interoperate with other systems to perform both planned, and unplanned missions.
- **An important consideration is anticipated or unanticipated interoperability**

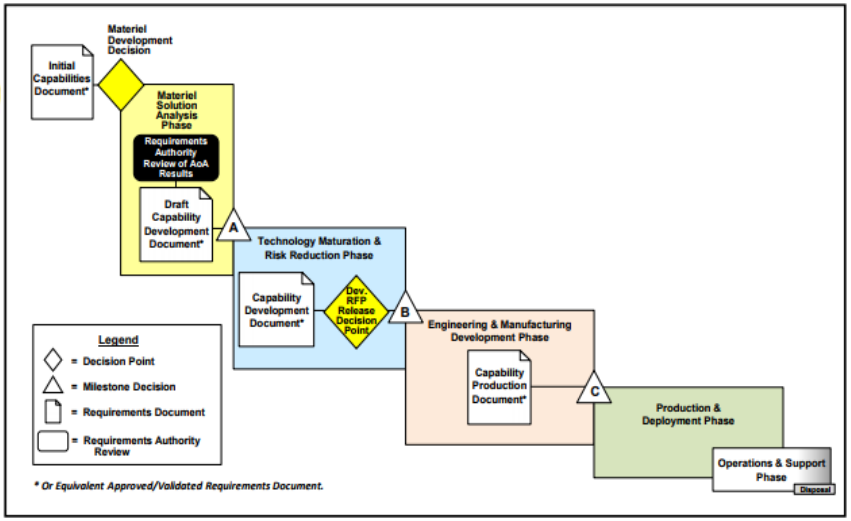
***Performing effective SE across the system life-cycle involves direct and indirect consideration of interoperability across technical, physical, stakeholder, acquisition, and mission (functional) domains.***

# ANTICIPATED INTEROPERABILITY

- Requirements to interoperate are well known and stable
- Need to interoperate is part of basic requirement set
- Technology and function/mission are on same time scales and predictable
- Acquisition life cycle is linear in traditional model

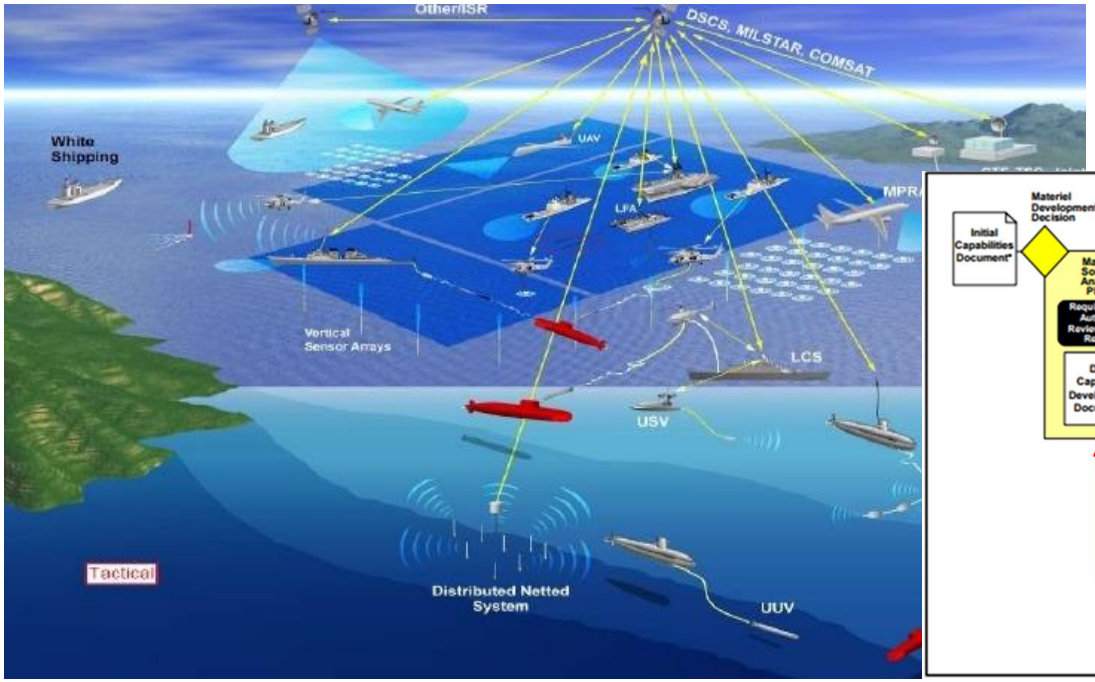



*e.g. LVCAR Distributed training*

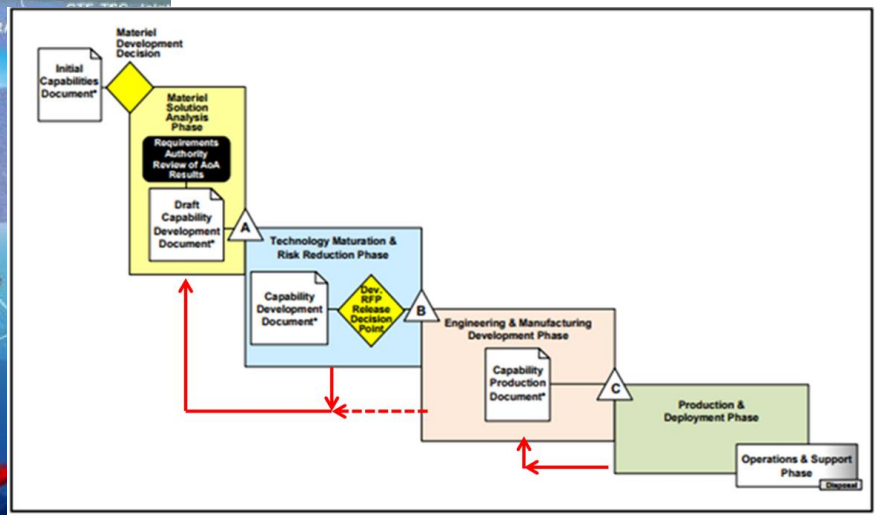


# UNANTICIPATED INTEROPERABILITY

- **Interoperability needs develop during acquisition**
- **Very hard /impossible to define *up-front* in traditional acquisition model**
- **Other systems/missions desire to leverage system capability**
- **Technology and function/mission change, often on differing time scales and unpredictably**
- **Acquisition life cycle requires feedback loops to accommodate evolving requirements and disparate time scales of technology and mission**




***e.g. C4ISR network***



# DRIVERS TO INCREASED INTEROPERABILITY EMPHASIS

- **15288 Systems Engineering Life Cycle Processes -** *requiring increased rigor in and contracting accountability for robust SE across entire lifecycle*
- **NDAA 2017 DoD Acquisition Agility Act (AAA) -** *Sec. 805. Modular Open System Approach In Development Of Major Weapon Systems*
- **Joint Staff changes to JCIDS -** *ongoing revisions (e.g. "IT Box"; Incremental CDD's…)*
- **Rapid Technology change -** *accelerated timelines, especially in certain areas: (e.g. battery technology)*
- **Unanticipated Threat/Mission change -** (e.g Asia-Pacific rebalance)
- **Ubiquitous data availability -** *new uses in current capabilities (e.g. geospatial implementation)*
- **Focus beyond data interoperability -** *to functional interoperability*

# NDAA 2107 AAA MODULAR OPEN SYSTEM APPROACH (MOSA)

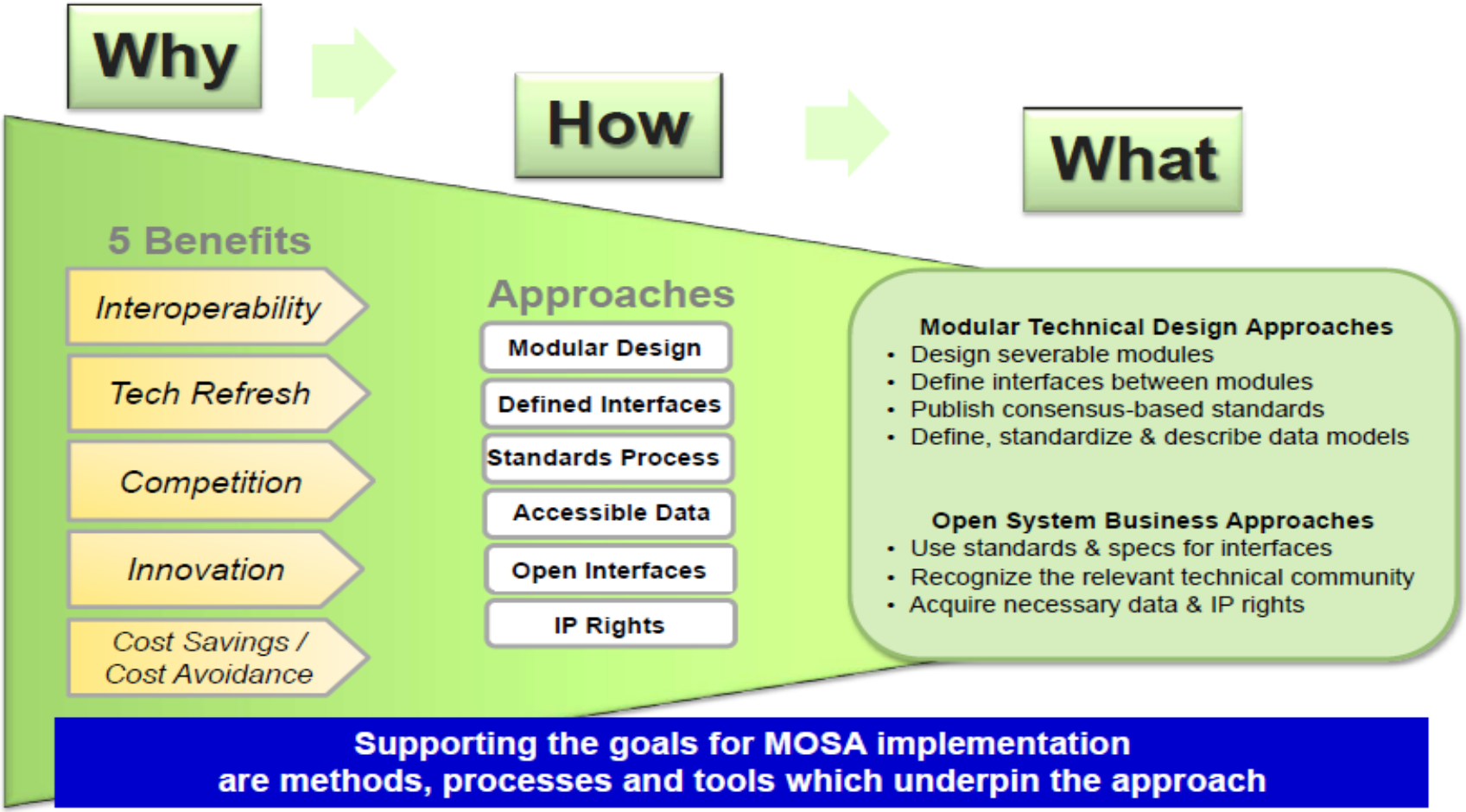
- **SEC. 805. MODULAR OPEN SYSTEM APPROACH IN DEVELOPMENT OF MAJOR WEAPON SYSTEMS.**
  - § 2446a. **Requirement for modular open system approach in major defense acquisition programs** *A major defense acquisition program that receives Milestone A or Milestone B approval after January 1, 2019, shall be designed and developed, to the maximum extent practicable, with a modular open system approach to enable incremental development and enhance competition, innovation, and interoperability.*
  - § 2446b. **Requirement to address modular open system approach in program capabilities development and acquisition weapon system design** *In Program Capability Documents; Analysis Of Alternatives; Acquisition Strategy; Request For Proposals*
  - '§ 2446c. **Requirements relating to availability of major system interfaces and support for modular open system approach***: "for each major defense acquisition program that receives Milestone B approval after January 1, 2019, a brief summary description of the key elements of the modular open system approach as defined in section 2446a of this title or, if a modular open system approach was not used, the rationale for not using such an approach"*

# NDAA 2107 AAA
## *BENEFITS OF MOSA*

"2446a.(b).(1).(C) uses a system architecture that allows severable major system components at the appropriate level to be incrementally added, removed, or replaced throughout the life cycle of a major system platform to afford opportunities for enhanced competition and innovation while yielding—

"(i) significant cost savings or avoidance;
"(ii) schedule reduction;
"(iii) opportunities for technical upgrades;
"(iv) increased interoperability, including system of systems interoperability and mission integration; or
"(v) other benefits during the sustainment phase of a major weapon system; and…"

# MOSA APPROACHES




**Reference: "Using the 5 Benefits of a Modular Open Systems Approach (MOSA) to Choose Enablers"; Philomena Zimmerman; NDIA SE Conference, October 26, 2016**

# MODULAR OPEN SYSTEM APPROACH
## *AN ENABLER OF INTEROPERABILITY?*

Among other benefits, a **modular approach can enable interoperability** in areas where implemented:

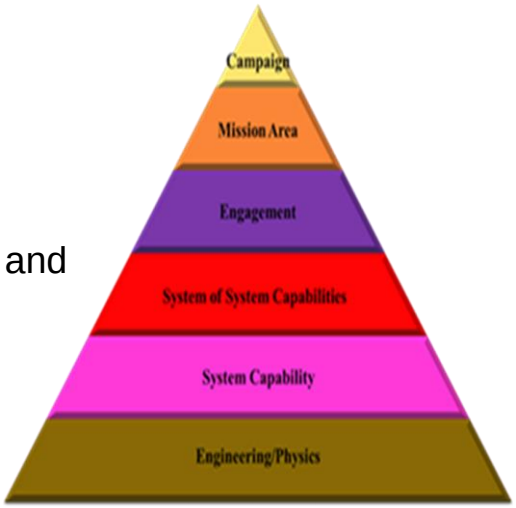
- **Implies architecture and interfaces are published and well known -** *Open Architecture Approach?*
- **Allows for Anticipated/Unanticipated interoperability**
- **Component modularization enables tech refresh/evolution, as well as interoperability with other components –** *internal and external*
- **Physical systems modularity and interoperability a key new acquisition emphasis** *e.g Virginia class SSN/LCS ships*
- **Enables more rapid response in system acquisition to new threats -** *e.g. EW systems*
- **Extent of modularity is driven by many other factors -** *cost, performance, complexity etc…*

- ***How much is enough?***
- ***How is modularization for another capability's interoperability needs paid for?***
- ***How do missions put a "marker" on systems for interoperability in their mission area?***

# OPPORTUNITY

**To implement MOSA and other changes to the Acquisition System to accommodate Complexity/ Technology/Threat/Interoperability what new Systems Engineering processes can we utilize?**

- System Engineering in general, and as practiced by DoD is changing and new tools, techniques, and types of analysis are sought for the more complex systems, and systems of systems of today
- Engineers are very familiar with the use of software modeling frameworks and tools to solve complex engineering problems, these are used in every facet of design and production by manufacturers - Why not government Aquisition and oversight?
- Many modeling and architecture tools exist for data parsing and interoperability between stages of acquisition:
  - Data set interoperability is easier **"up the modeling pyramid"** from development level activities to oversight (higher to lower fidelity)
  - This enables looking at "**Top-Level" capability mission performance** for refining/updating requirements, and accommodating system changes and trade-off's due to threat/technology/mission evolution and change




***Model-Based System Engineering (MBSE) is a methodology and tools (often part of architecture tools) to help us manage complexity, modularization, and enhance interoperability***

# MODEL BASED SYSTEMS ENGINEERING (MBSE)

## *HELP WITH INTERNAL SYSTEM ACQUISITION INTEROPERABILITY ?*

- **MBSE provides a method to organize data to function / purpose over a program's lifecycle – it *could be a robust Systems Engineering Process in supporting 15288 implementation***
  - It can be used in an acquisition program to organize cost, schedule, and performance data in a structured way amenable to software tools for analysis/display/decision making
  - An MBSE approach is inherently robust and contains the data required to model the process:
    - Requires a structure that organizes a process with often disparate data into an organized entity
    - Has the prerequisite digital structure to support modeling capability performance
- **MBSE can be used to help objectively model an acquisition programs capability in performance terms and *address trade-offs on modularity***
- **MBSE can model an acquisition programs capability and *interoperability between it and mission partner capabilities* to optimize them**
- **MBSE can enable End-to-End modeling and simulation and provide clarity on requirements and insight on trades between both functional and performance requirements; and provide insight on interoperability gaps and needs**

***If we view an acquisition lifecycle as a process, with many sub processes also "model-able".. then the use of a scalable conceptual framework (MBSE) to organize data and model it is attractive***

# Questions/Discussion

# ACQUISITION "MID-COURSE GUIDANCE"