MOSA Considerations Throughout the Systems Engineering Lifecycle - Implementation Guidance

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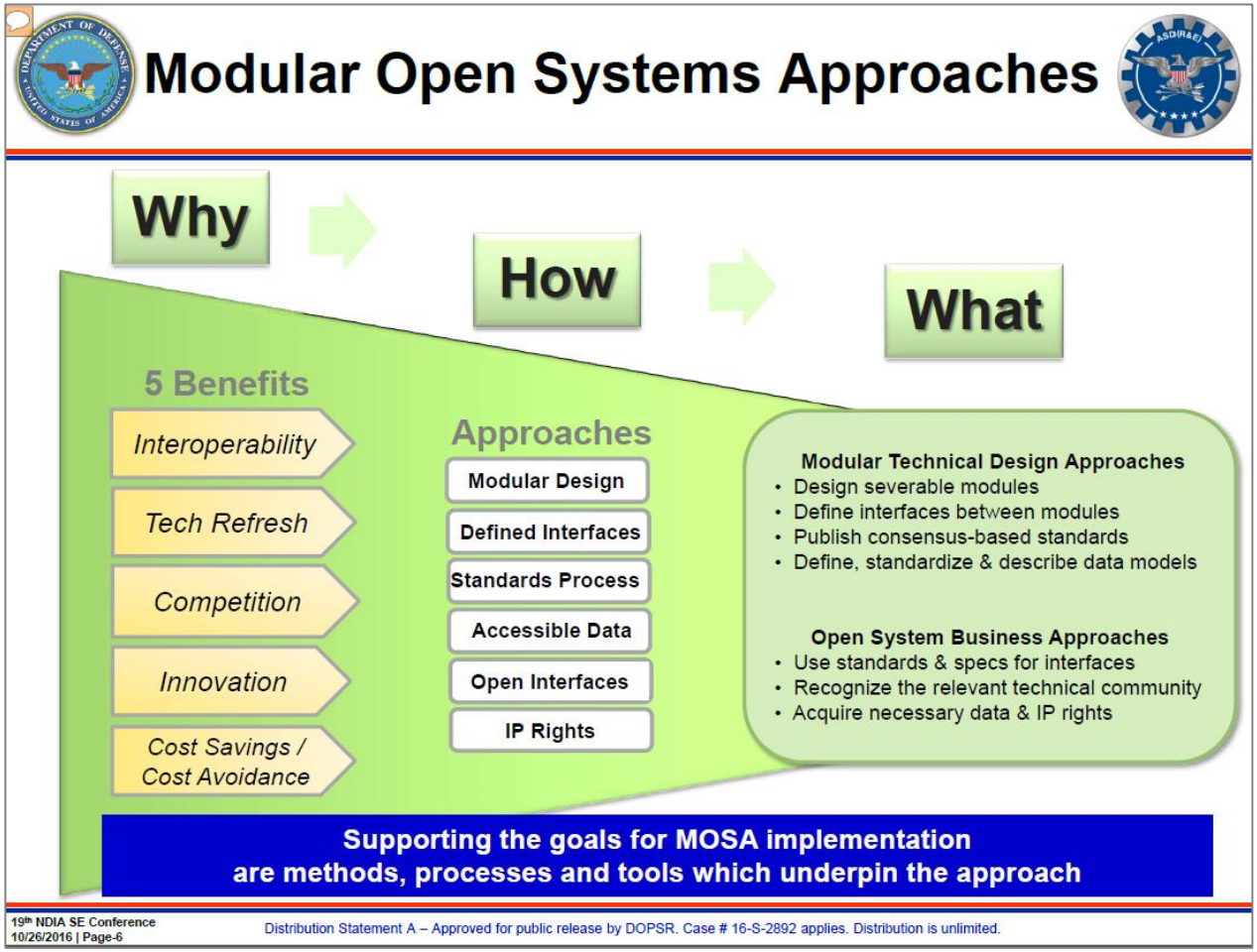
MOSA Benefits and Approaches



Challenge:

How do we translate this into practical MOSA considerations incorporated into systems engineering activities at each acquisition stage?

Enabling security has been identified as an added MOSA benefit

Assumptions

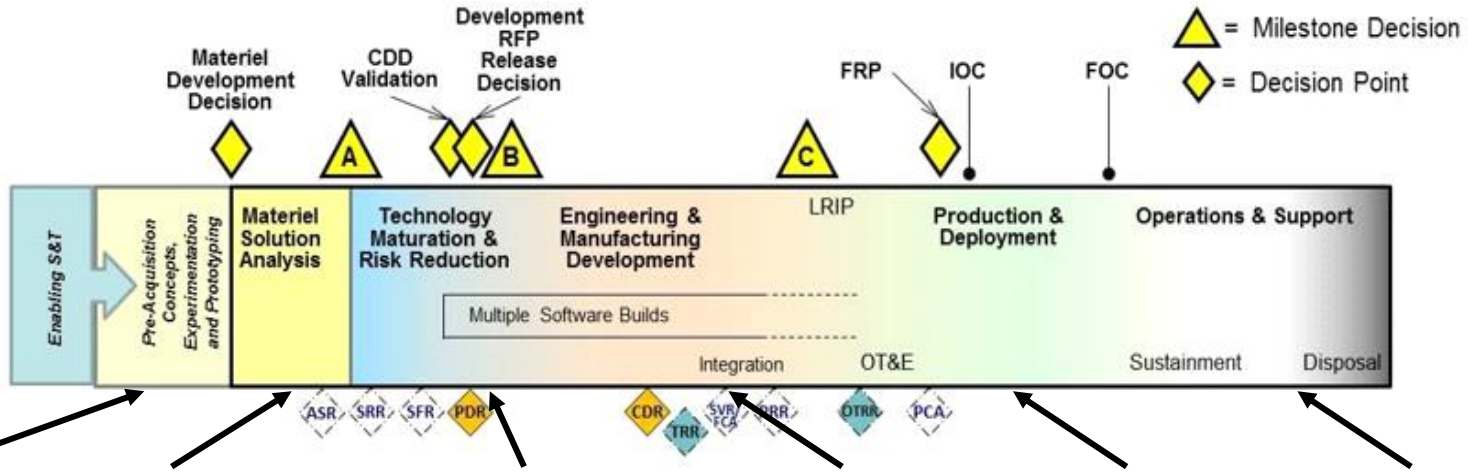
- **Implementation of modularity and open systems in a system development or upgrade can provide particular benefits to each system**
- **To achieve these benefits for a system it is important to**
  - Understand the objectives and drivers for a new system or system upgrade early and assess how modularity and open systems can be used to achieve these objectives
  - Address MOSA considerations at each stage in development as they apply to the desired benefits for the particular system
- **This needs to be done as an integral part of the systems engineering for the system with relevant MOSA considerations in trades at each stage of development**
  - AoA, preferred solution, requirements, design, development and test
- **…. and relevant MOSA considerations need to be reflected in acquisition, systems engineering and test planning**

The Basic Concept

- **To effectively implement modularity and open systems through SE to achieve system objectives ….**
  - Identify where MOSA can benefit the system as envisioned and factor this into **actions throughout the entire lifecycle**
  - Begin with assessing the o**bjectives and drivers of the future deployed system** with a MOSA perspective at the earliest point
- **Key points**
  - **Tailor** use of MOSA to the situation of the **particular system**
  - Identify **opportunities for MOSA** benefits at the **inception** of the system development
  - Implement **engineering follow-though** at each stage to ensure these MOSA benefits are explicitly addressed in the engineering decisions **as part of the systems engineering process**

Develop a set of MOSA considerations and related questions to be addressed at each stage of development

MOSA Considerations At Each Stage



Pre-MDD: What are the drivers for this system and how can MOSA support these? Are these addressed in AoA guidance?

MSA: Does the preferred solution provide opportunity to employ MOSA to achieve system objectives?

TMRR: Are the factors to achieve desired MOSA benefits included in acquisition strategy, SE Plan, and T&E strategy, lifecycle support strategy, RFP and preliminary design?

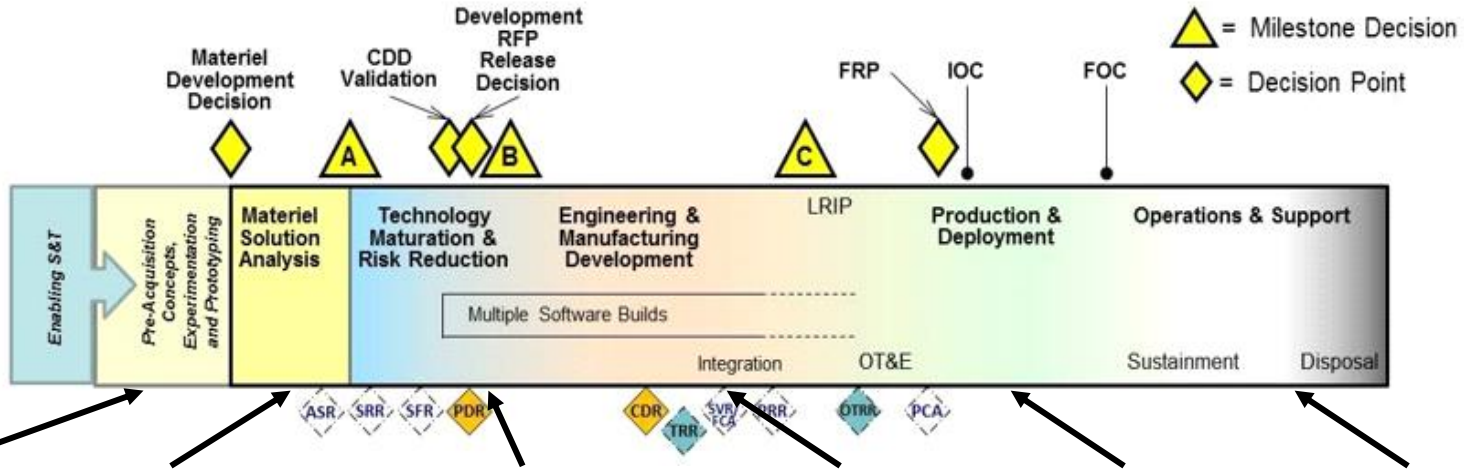
EMDD: Does the detailed design and developmental test incorporate MOSA considerations, to assure design and development will achieve expected benefits?

P&D: Does the plan include continued review, testing and evaluation to ensure the product baseline modularity and openness?

O&S: How is support of the system structured to take advantage of the MOSA characteristics expected to benefit the systems?

Planning for P&D and O&S needs to be done early

Questions to Be Addressed Though Life Cycle Stages



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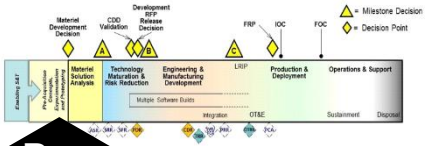
MOSA Considerations: Pre-Materiel Development Decision



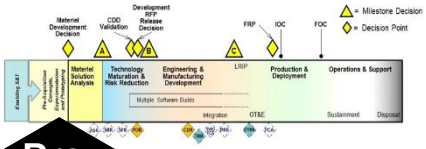
- **Questions to assess how each of the 5 benefits might apply to the system being considered**
- **Identify the *specific system components* for modularity and open systems.**

Interoperability | **Tech Refresh** | **Innovation** | **Cost Savings/Cost Avoidance**

Enhanced Competition			
Rationale	**Pre-MDD**	**Questions**	**Actions**
Modularity and open systems enable **enhanced competition** by allowing for acquisition of components of the system at the outset and over time **to be offered and obtained from all providers**, allowing for more competition selection of best match, **regardless of previous provider, on a component level**.	To make this feasible, those components of a prospective system which may be **amenable to independent procurement**, need to be identified and there needs to be **analysis to determine that there are multiple prospective suppliers**. Once identified, it is important identify system solutions which allow for making these components as separable modules in the system design with clear definition of functionality and interfaces. While these specifications will not be defined until later phases of the development, at this stage, it is important to ensure that the **alternatives being considered do not preclude such a design**, and that the **considerations in the Analysis of Alternatives (AoA)** address the ability to modularize the design to enable enhanced competition for these particular components of this prospective system.	• Given the alternatives being considered, **are there components or types of components which could benefit from enhanced competition? What are these components?** • Is there a large **performer base** for ..... types of systems considered in the alternatives**? Commercial availability and variety**? Commercial maturity? Market availability? • Do the **alternatives being considered allow for modularity and open systems** approaches which would support enhanced competition .....? • Does the **AoA guidance** call for consideration of potential of modularity and open systems to .....? • Does the AoA guidance include **business considerations, relative to data rights** for components and performers, that will enhance competition? Specific products to consider include reference architecture, technical standards ..... •	The need to apply MOSA to enable enhanced competition for specific components (or component types) should be included **in an initial version of the modularity and open system plans** for this acquisition and in **early system requirements and design considerations**. In particular, the plan should identify the **specific type of components which benefit from MOSA** for enhanced completion and the **supporting business case**, including evidence of available suppliers of the particular components. At this stage, the most useful .... **focus on functional architectures and logical grouping of functions that would enable MOSA implementation later**. *[Example: Sensor on a weapons platform]*

Snapshot example – comparable tables for other benefits

MOSA Considerations: Pre-Materiel Development Decision



- **Questions to assess how each of the 5 benefits might apply to the system being considered**
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Example questions

- Given the alternatives being considered, are there components or **types of components which could benefit from enhanced competition**? What are these components?
- Is there a **large performer base** for some or all of the elements in the types of systems considered in the alternatives? Commercial availability and variety? Commercial maturity? **Market availability**?
- Do the alternatives being considered allow for modularity and open systems approaches which would support enhanced competition for these components?

What are the drivers for this system and how can MOSA support them?

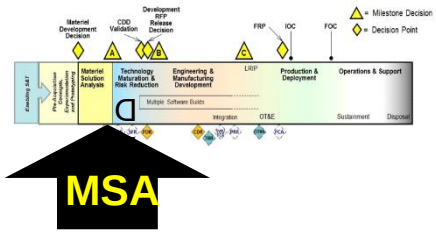
Sets the basis for considerations through life cycle stages

Describe Where System Can Benefit From Modularity or Open Systems

- **Based on the review of the Pre-MDD MOSA considerations for the system**
  - **Describe which components of the system can benefit, *identifying* the benefit, describing the *rationale* and pointing to a program *documentation* reference**
- **This information is carried through to subsequent stages as the basis for assuring follow-through in engineering trades and decisions**
- **May be revised based on new information or engineering decision**
  - **Key point is to assure that identified MOSA benefits are explicitly considered**

Component/Interface	MOSA Benefit	Rationale	Reported in …..
Name of component or interface identified as benefiting from modularity or open systems/ standards	Which of the MOSA benefits apply to this component/interface: Enhanced competition • Technology refresh • Incorporate innovation • Cost savings/cost avoidance • Interoperability	What is the rationale for applying MOSA to this component or interface?	How has this been documented? (e.g. reflected in the AoA Guidance, included in the AoA plan, other….)
Repeat for each component	Repeat for each component	Repeat for each component	Repeat for each component
Repeat for each component	Repeat for each component	Repeat for each component	Repeat for each component

MOSA Considerations: Materiel Solution Analysis



- **Questions on how the *system concept* supports achievement of the specific benefits anticipated for each specific system component identified for modularity and open systems**

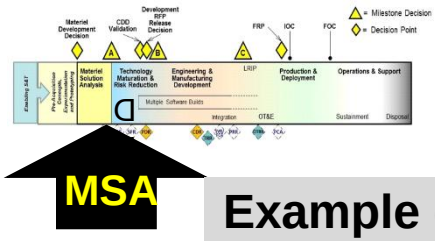
Key activities during MSA

Enhanced Competition	
MSA Activity	**Questions**
Conduct AoA. Includes all activities and analyses conducted by the AoA Study team under the direction of the Senior Advisory Group/Executive Steering Committee (SAG/ESC) and CAPE, or Service equivalent. Concludes with a final SAG/ESC and AoA Report. Systems Engineers should support this activity.	• Where appropriate, does the AoA incorporate assessment criteria for promoting enhanced competition? o In particular, does the AoA analysis and results consider the **impact of alternatives on the ability of the system to independently procure** the <identified component>? (e.g. Does the solution provide the ability for the government to **replace/divest** the specific component?)
Perform Analysis to Support Selection of a Preferred Materiel Solution. Includes all engineering activities and technical analysis performed to support Service selection of the preferred materiel solution by balancing cost, performance, schedule and risk.	• Does the preferred solution allow for modularity and open standards which would be needed to independently procure the <identified component>? o That is, does the preferred solution allow for the <identified component> to **be a separable module with clear definition of functionality and interfaces amenable to independent procurement**? • **If not, have the consequences** of not being able to benefit from enhanced competition for the identified component **been explicitly factored** into the selection of the preferred solution?

Questions to help ensure MOSA considerations are addressed

Snapshot example: comparable tables for other benefits

MOSA Considerations: Materiel Solution Analysis



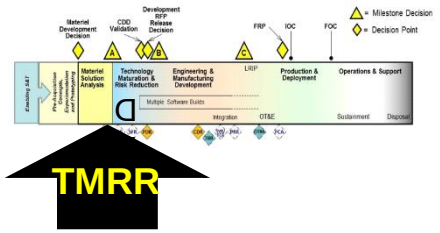
- **Questions on how the *system concept* supports achievement of the specific benefits anticipated for each specific system component identified for**

Example questions

- Where appropriate, does the AoA incorporate assessment criteria for promoting enhanced competition?
- Does the preferred solution allow for modularity and open standards which would be needed to independently procure the <*identified component*>?
- If not have the consequences of not being able to benefit from enhanced competition for the identified component been explicitly factored into the selection of the preferred solution?
- Does the market research address and do the results reinforce the expectation that there are multiple potential sources of the <*identified component*>?

Ensure that decisions about the preferred solution explicitly consider the potential benefits of MOSA identified for the system

MOSA Considerations: Tech Maturation and Risk Reduction



- **Questions about the preliminary design to assess the extent to which it supports *key design considerations* for the specific components identified for modularity and openness**

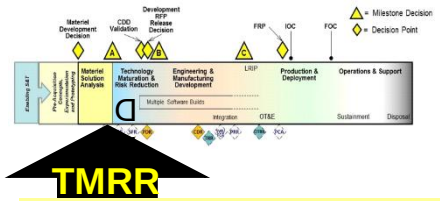
Key activities during TMRR

TMRR Activity	Questions
Perform Technology Maturation. The AS identifies technologies requiring further maturation before they can be implemented within a solution. Technology maturation involves design, development, integration and testing., ……	• Can the technologies addressed in the technologies **affect the modularity or open interfaces** of <**specific component(s)**>? o If so, are the modularity/interfaces of the <specific component(s)> considered in the technology maturation activities? o If not, what are the risks to the ability to achieve the expected benefits of MOSA for the <specific component(s)>?
Perform Prototyping. Prototyping is an engineering technique employed for several reasons: to reduce risk, inform requirements and encourage competition.	• Does the TMRR prototyping address **the modularity/interfaces** include MOSA (e.g., modularity and open system/standard interfaces of components and loose coupling of components), particularly the <**specific component(s)**> identified for the system? • Does the TMRR prototyping demonstrate the suitability of having "frameworks" and protocols for modularity, and the performance of those frameworks/protocols? o ….. • If **competition, innovation, or cost savings are among the prototyping goals**, are **MOSA elements explicitly** included in the prototype evaluation criteria? o ……
Perform System Trade Analysis. The Systems Engineer assesses alternatives with respect to performance, cost, schedule and risk, and makes a recommendation to the PM. The SE assessment should consider the full range of relevant factors, ……	• Do trade factors include MOSA elements such as interfaces or modularity particularly as related to the <**specific component**(s)> identified for **modularity/open interfaces** for this system? o …… • Do trade factors include **affordability, technology refresh, or interoperability**? How are the <specific component(s)> identified for modularity/open interfaces addressed in these trade studies?
Develop System Architecture.	• To what extent does the system's architecture identify functional allocation, functional dependency, distinct functional grouping of components that allows for loose coupling, and reflect the modularity/open systems for the <specific component(s)> identified for this system?

Questions to help ensure MOSA considerations are addressed

Snapshot example: Address these questions for each opportunity to benefit from MOSA

MOSA Considerations: Tech Maturation and Risk Reduction



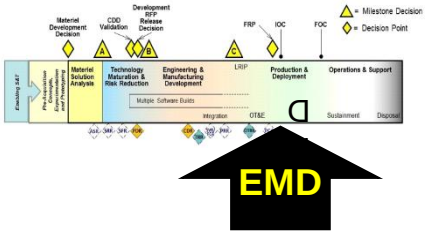
- **Questions about the preliminary design to assess the extent to which it supports *key design considerations* for the specific components identified for modularity**

Example Questions

- Do the **architecture/preliminary specification** of the system include requirements for modularity and open systems approaches to allow for incorporation of new or improved capabilities without necessitating large changes to other elements of the system over the system lifecycle, particularly as this applies to the <*identified component*>?
- Do **prototyping** recommendations address MOSA-related requirements or solutions for enhanced competition, including areas of uncertainty or risk, feasibility of high-level conceptual designs, or the discovery or refinement of requirements?
- Do the **acquisition strategy, the systems engineering plan, the life cycle support plan and the testing strategy** address the need for modularity for the <*identified component*> to achieve enhanced competitiveness?

Are the factors to achieve desired MOSA benefits included in acquisition strategy, SE Plan and T&E strategy, lifecycle support strategy, RFP and preliminary design?

MOSA Considerations: Engineering, Manufacturing and Development



- **Questions about how the plans for the *detailed design and developmental test* incorporate MOSA considerations for the specific components identified for modularity and openness to assure *design and development* will achieve expected benefits**

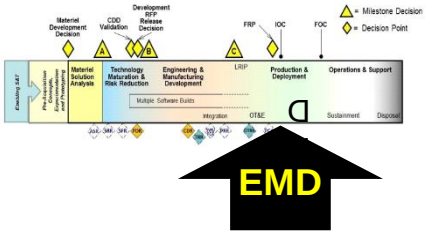
Key activities during TMRR

EMD Responsibility/Activity	MOSA Questions
Responsibility	
• Managing the system design to satisfy the **operational requirements**, within the constraints of cost and schedule, and to evaluate the system design, identify deficiencies and make recommendations for corrective action.	• Is due consideration given to the **modularity and open interfaces** of <**specific component**(s)> of the system as the system design is being refined to satisfy the operational requirements within cost and schedule constraints? • Have **the implications of the design changes to the MOSA objectives** for the <specific component(s)> of the systems been assessed? • Have alternative design approaches been considered that preserve MOSA objectives and requirements when modularity and openness of a <specific component(s)>been eliminated due to programmatic or other constraints?
• Conducting or supporting the technical evaluation in support of **source selection** for the EMD contract award.	• Do the **source selection technical evaluation criteria include modularity and open interfaces** for the <specific component(s)> ? • Do the source selection criteria include consideration of the proposers' capability to meet the system's MOSA objectives and requirements for the <specific component(s)> of the system?
• Maintaining **requirements traceability** and linkage to the initial product baseline.	• Are all **requirements for modularity and open interfaces** for the <specific component(s)> **traceable** and linked to the initial product baseline?
• Tracking and reporting initial product baseline changes after CDR and recommend the path forward in accordance with the **Configuration Management (CM)** process, ...	• Is attention paid to tracking and reporting of initial product baseline changes that **impact for modularity and open interfaces** for the <specific component(s)>? • Have the implications of the design changes on the for modularity and open interfaces for the <specific component(s)> been assessed?

Questions to help ensure MOSA considerations are addressed

Snapshot example: Address these questions for each opportunity to benefit from MOSA

MOSA Considerations: Engineering, Manufacturing and Development



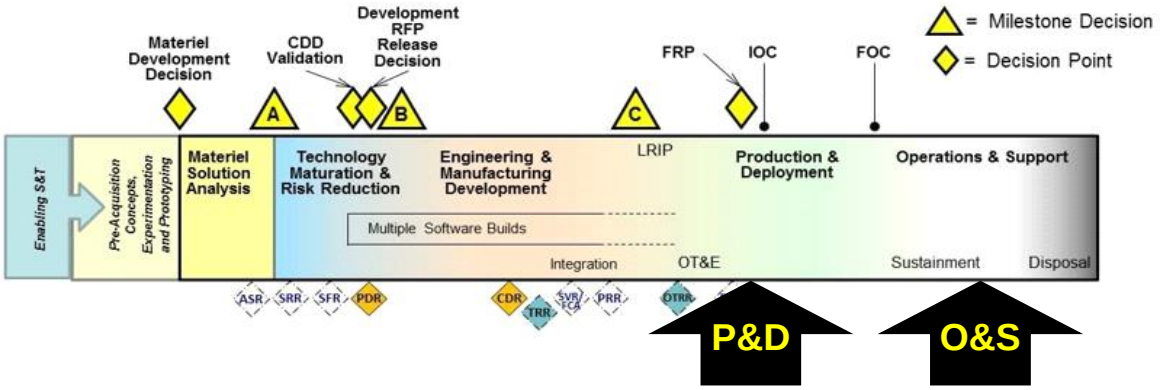
- **Questions about how the plans for the *detailed design and developmental test* incorporate MOSA considerations for the specific components identified for modularity and openness to assure *design and development* will achieve expected benefits**

Example Questions

- Have alternative design approaches been considered that preserve MOSA objectives and requirements when modularity and openness of a <specific component(s)>been eliminated due to programmatic or other constraints?
- Do the source selection technical evaluation criteria include modularity and open interfaces for the <specific component(s)> identify for this system?
- Are all requirements for modularity and open interfaces for the <specific component(s)> traceable and linked to the initial product baseline?
- Have the implications of the design changes on the for modularity and open interfaces for the <specific component(s)> been assessed?

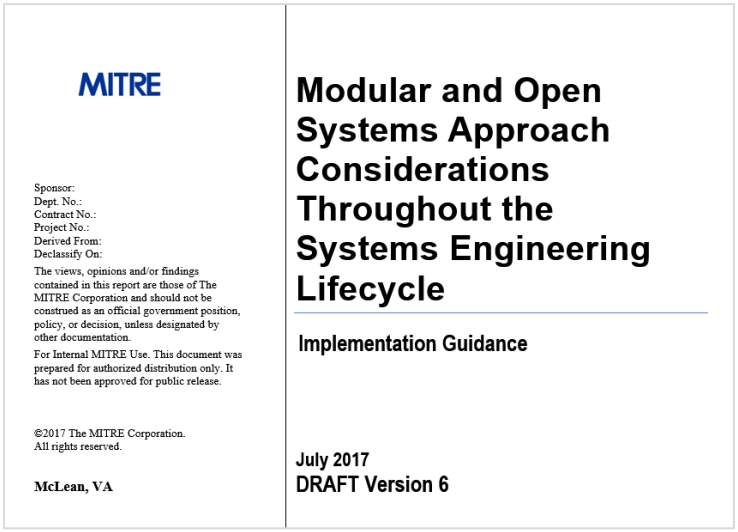
Does the detailed design & developmental test incorporate MOSA considerations, to assure design and development will achieve expected benefits?

Considerations Continue Through the Full Life Cycle



- **Similar tables of considerations are included for Production & Deployment and Operations & Support stages**
  - **P&D: Does production include continued review, testing and evaluation to ensure the product as produced implements the modularity and openness as designed?**
  - **O&S: How is support and evolutional adaption of the system structured to take advantage of the MOSA characteristics expected to benefit the system?**

Summary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McLean, VA

Modular and Open Systems Approach Considerations Throughout the Systems Engineering Lifecycle

Implementation Guidance

July 2017
DRAFT Version 6

- **MOSA is recognized as having benefit for defense systems**
- **Application of MOSA should be focused on achieving benefits which specifically apply to the system under development**
- **Addressing MOSA as an integral part of systems engineering throughout the system life cycle ensures MOSA considerations are explicitly addressed in critical decisions**

Systems Engineering: Critical to Defense Acquisition










Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

DASD, Systems Engineering
http://www.acq.osd.mil/se

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