34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

Evaluating MOSA Compliance in Defense Programs: Methodologies and Practical Approaches

Agenda

- Background
- Where are We Today? Practices and Tools
- Modular Open Systems Working Group (MOSWG)
- Assessing MOSA Tiger Team
- MOSA Pillars
- Identifying MOSA Criteria Categories
- Recommended Process
- Example Assessment
- Process Benefits

Background

Modular Open Systems Approach (MOSA) requirements are codified in law (10 United States Code (U.S.C) §4401 – §4403) for Department of Defense (DoD) acquisition weapon systems

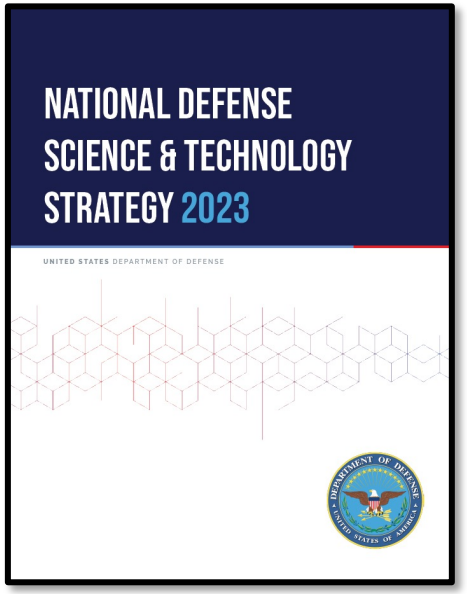
- All program managers can benefit from considering the requirements for modularity and open standards
  - DoD program sponsors and their associated Milestone Decision Authority (MDA) need consistent, quantitative, and repeatable measures to assess their program's compliance with statute
  - These measurements in turn will better enable them to continuously support DoD missions within a rapidly evolving battlespace

MOSA is a Priority in the Department of Defense

HON Heidi Shyu

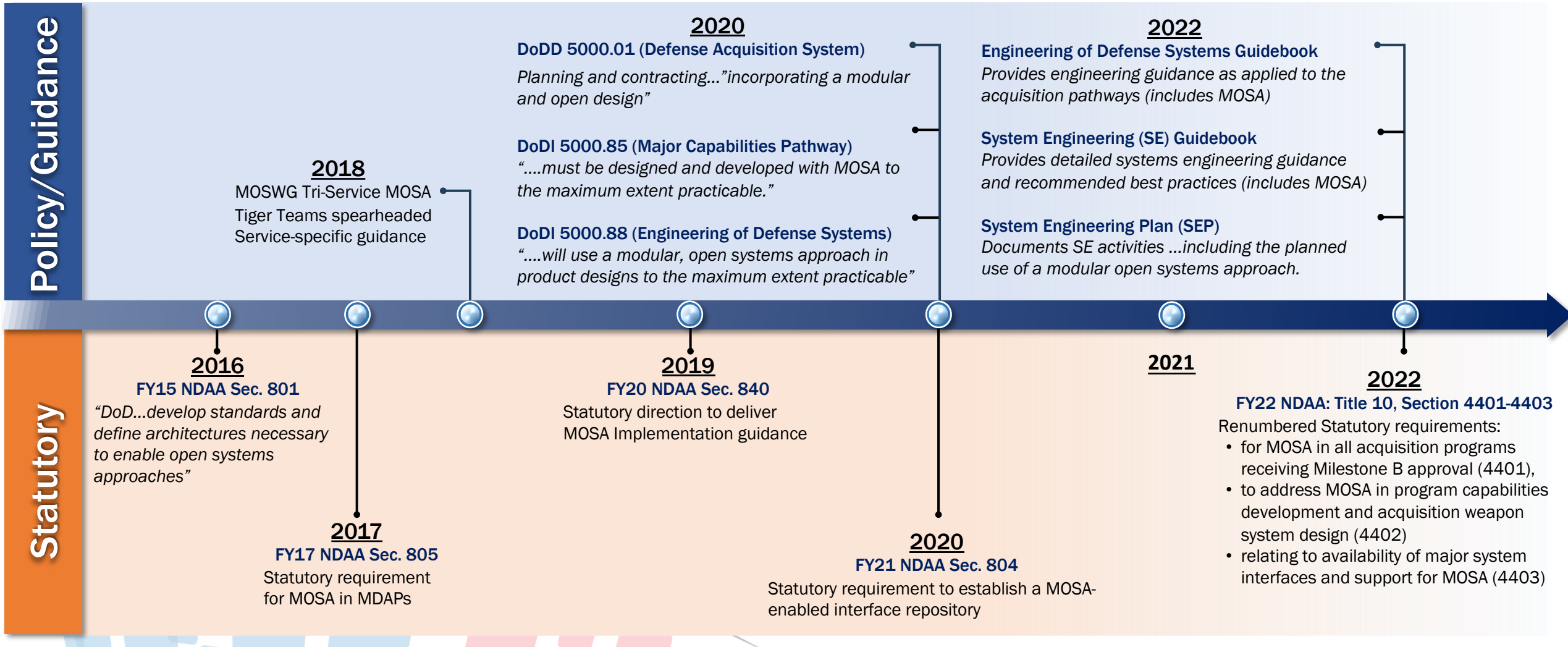
"As we embrace MOSA, we are not just adopting a new approach to defense systems; we are ushering in a new era of collaboration, competition, and innovation."

2024 Department of Defense Engineer's Week Closing Remarks



"As highlighted by the NDS, the DoD needs to "overhaul its approach to force development, design, and business management practices," by ***transitioning to an approach that "incentivize(s) the design of open systems that can rapidly incorporate cutting-edge technologies,"*** *and "rewards rapid experimentation, acquisition, and fielding."*

MOSA: Statutory & Regulatory Background



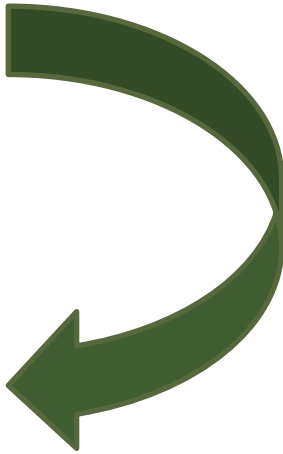
MOSA Vision

Ensure DoD architectures are modular and open to enhance competition, incorporate innovation, and support interoperability and rapid insertion of technology in DoD acquisitions

- Acquire systems that can be upgraded or modified to incorporate new technologies and respond to emerging threats
- Rely on architectures accessed from authoritative sources of truth that identify system components, component capabilities, the interfaces and standards used between components to identify upgradeable systems and reusable components.
- Identify standards which facilitate modularity and openness to enable consistent component replacement and interoperability
- Use relevant technology forecasts to field systems using tailorable modular and open system approaches for technology insertion that contribute to system success

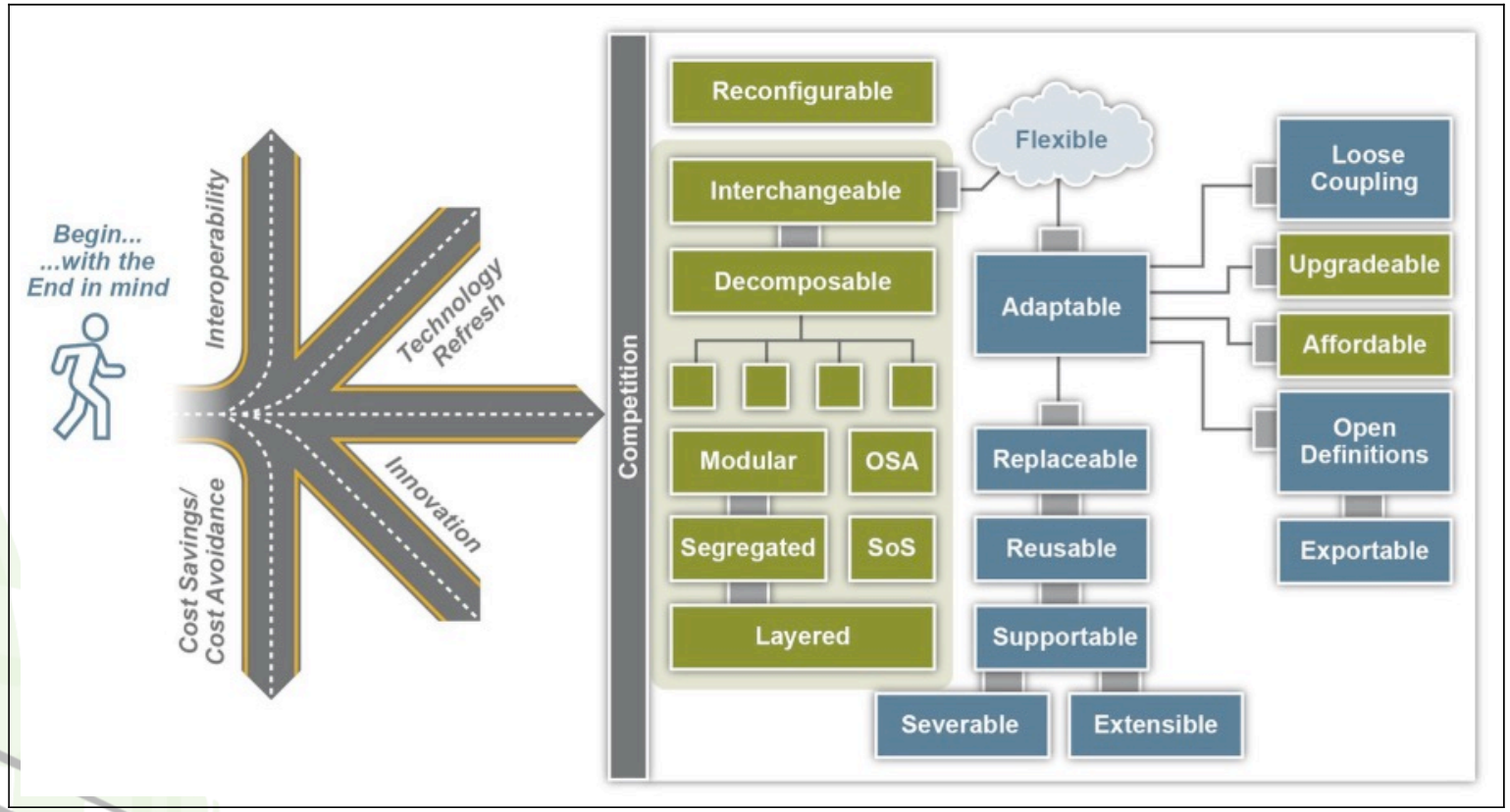
Problem Statement

- **Pain Point:** DoD lacks processes and methods and assessment criteria for evaluating MOSA strategies, designs, architectures, and implementations
- **Need:** DoD Program Managers across the Defense Acquisition life cycle need a *standardized methodology* to develop quantitative assessment criteria that evaluates modularity and openness in system and platform designs



Apply MOSA in Architecture and Designs to Drive Innovation

- **Standards** – Identify standards and specifications which facilitate modularity and openness
- **Architecture** – Rely on architectures accessed from authoritative sources of truth
- **Interfaces** – Acquire systems with modular system interfaces
- **Data Rights** – Use relevant technology forecasts to identify and appropriate technical data rights



By using modular design techniques, open standards, and architectures that enable open systems, programs can achieve MOSA benefits

Where We Are Today?

- All Military Departments (MILDEPs) have incorporated MOSA-Like criteria into their programs to some extent
- Each MILDEP has taken a unique approach
- Little to no standardization exists across the MILDEPs
- All MILDEPs incorporate multi-organizational consortiums (i.e., government, industry, academia, etc.)
- Services are attempting to incorporate MOSA into defense programs

Historical DoD MOSA Assessment Tools

- **PART** – Modular Open Systems Approach Program Assessment and Review Tool (OSD)
  - Adapted from the former OMB Program Assessment Rating Tool
- **OAAT** – Open Architecture Assessment Tool (Navy)
- **KOSS** – Key Open Subsystem Tool (Navy)
- **SEAM** – Systems Engineering Assessment Model (Air Force)
- **OA PNT** – Open Architecture Position Navigation and Timing (OSD)
  - STAKEHOLDERS: R&E, A&S, R&T, Army, Navy, AF, Joint Staff (JADC2), USD(P), CIO, USD(I), NSA, STRATCOM, NORTHCOM, CYBERCOM, CFO, D/OT&E, NGA, NRO, CAPE
- **Naval Open System Architecture Questionnaire**, June 2014 (Navy)

MOSA Assessment Tools Contain Subjective/Qualitative Criteria

MOSA Assessment Tools Aligning with P&G

- All current tools contain subjective/qualitative criteria
- Some provide scalars to convert the qualitative assessments into quantitative outcomes
- Some existing tools' criteria align well with those identified in policy and guidance (P&G)
  - Naval Open architecture assessment tool (OAAT)
  - Program assessment and review tool (PART)
- Tools attempt to quantify a program's compliance with MOSA standards

No Consistent Set of Tools Across MILDEPs

Standardization Efforts leverage MOSA Assessment Practices

- **VICTORY** – Army Vehicle Integration for C4ISR/EW Interoperability
- **CERDEC** – Army C5ISR Center, formerly the Communications-Electronics RD&E Center
- **CMOSS** – Army C4ISR/EW Modular Open Suite of Standards
- **FACE™** – Future Airborne Capability Environment
- **SOSA™** – Tri-Service Sensor Open Systems Architecture
- **OMS** – Air Force Open Mission Systems
- **HOST** – Hardware Open Systems Technologies
- **SCA** – Software Communications Architecture

All MILDEPs are successfully adopting MOSA standardization into their programs

Implementing MOSA: Connecting the Community

MOSWG is an open and collaborative working group of government, industry and academic experts

Exchange of best practices across the DoD, Industry, and academy

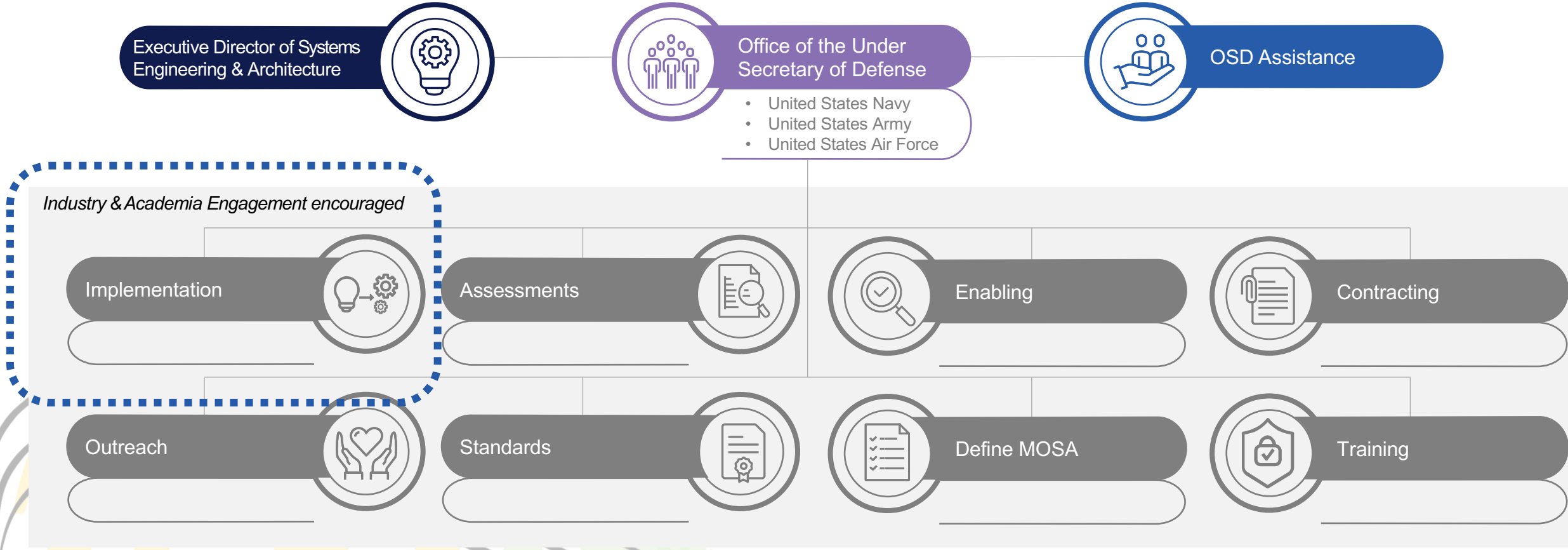
Types of Products

- Standards and Architecture guidance
- Recommendations for contractual language for implementing MOSA
- Assessment criteria to support evaluation of MOSA
- Common definitions and terms for MOSA
- Library of MOSA standards, specifications, and guidance

Completed Actions to Establish the Assessing MOSA Tiger Team

- ✓ **Identified Criteria:** During the April 2021 Modular Open Systems Working Group (MOSWG) Steering Group meeting, the Assessing MOSA Tiger Team reported an impasse in developing specific MOSA evaluation criteria that would be representative for all Services and program types. Consensus was to identify general criteria categories.
- ✓ **OUSD(R&E) Recommended Options:**
  - OUSD(R&E) to proceed with a proposed methodology using the 5 MOSA pillars as categories. Moreover, within each category, OUSD(R&E) to map general (high-level) criteria categories identified in law, policy, DoD directives, and currently in use along with their specific definition.
  - Each service to be responsible for developing specific quantitative and/or qualitative criteria within these categories (with scoring scales), tailored to their specific program(s) being evaluated
- ✓ **MOSWG Steering Group Action:** The MOSWG Steering Group recommended the Assessing MOSA Tiger Team focus their efforts on the recommended option.

Modular Open System Working Group



MOSWG Other Focus Interests

- MOSA Business Case
- MOSA Conformance
- MOSA Training
- Reference Architectures

Future Pain Point
Tiger Teams, TBD

Foundational MOSA Tenets: 5 MOSA Pillars

- To ensure consistency throughout OUSD(R&E), the Assessing MOSA Tiger Team coordinated with the Enabling MOSA Tiger Team to identify and define the 5 MOSA Pillars.
- These 5 Pillars are common across the pain point tiger teams and form a representative set of MOSA Criteria Categories.

5 MOSA Pillars Defined

Establish Enabling Environment

Establishes requirements, business practices, development, acquisition, test and evaluation, and strategies that support MOSA

Employ Modular Design

Accurately isolates functionality during the design process to simplify development, maintenance, changes, and upgrades.

Designate Key Interfaces

Decouples the interface and Service implementation so that they can maintain separate life cycles. In order for components to decouple their inner workings from each other but be able to leverage the capability provided by each highly cohesive service, developers expose openly available key interfaces to other components.

Select Open Standards

Open standards allows developers to leverage commercially developed technologies, increasing competition. Additionally, they offer faster upgrades at reduced cost and complexity. Fielded systems are more affordable and maintainable.

Certify Conformance

Developers need to verify and validate their MOSA strategy and requirements, ensuring conformance to selected internal and external open interface standards.

Establish an Enabling Environment

Establish MOSA goals

Expand capabilities and interoperability by establishing MOSA life cycle costs and continuous development, release, monitoring, and performance goals.

Adopt MOSA

Transform requirements; business, management, technical, and acquisition practices; estimation and end user engagement strategies; contracts, data, licenses, and property rights; plans; and other key areas to align with MOSA principles.

Include MOSA in contracts and data rights planning

Consider a MOSA and an Open Systems Architecture (OSA) in contracts and data rights planning to reduce costs while balancing risk and ensuring proper government data rights.

Embrace an agile development culture

Plan for and implement an agile development methodology, and continuously deploy functionality in frequent, small releases based on sponsor and end user feedback.

Embrace automation

Plan to use an automated development and testing pipeline, enabling Continuous Integration/Continuous Delivery (CI/CD) and continuous operations.

Establish requirements, business practices, development, acquisition, test and evaluation, and strategies that support MOSA

Employ Modular Design

Modularize components

Separate components into scalable, reusable modules consisting of self-contained functional elements. Horizontally scale instances of the same component without interrupting user sessions, losing data, or needing to restart other services.

Isolate critical capability

The architecture provides failure isolation. When a module fails, the rest of the system remains available except for the single service provided by the failing module.

Module independence

Modules are independent of technology choices. Developers can use or change each module to different technologies without affecting others. The only constant between the modules is the interfaces.

Modularize software

Modules are immutable and disposable. Developers can deploy the same software module into any environment, knowing it is the same exact code everywhere.

Embrace modular services and data

Modules run as unprivileged users. Services and data calls avoid requiring administrative privileges, providing just enough permissions to run the service, or query, or update a particular data set the user can access.

Accurately isolating functionality during the design process simplifies development, maintenance, changes, and upgrades – providing the ability to upgrade or change functions rapidly, with limited or no impact to the rest of the system

Designate Key Modular System Interfaces (MSIs)

Decouple interfaces

Sufficiently decouple the interface and service implementation so that they can maintain separate life cycles.

Publish well-defined documentation

Document and version control the interfaces. Make them available to others.

Leverage trusted interfaces

Use well understood interfaces. Do not reinvent the wheel and use the right interface for each service.

Manage change and configuration

New interface versions do not break previous versions. A change to one component does not require changes to all other components; new interfaces should be backward compatible.

Expose openly available key MSIs to other components, where components decouple their inner workings from each other, but are able to leverage the capability provided by highly cohesive services.

Select Open Standards

Prioritize consensus-based standards

Prioritize open standards published by internationally recognized groups.

Utilize APIs

Expose software and data services via applied programming interfaces (APIs), while simultaneously protecting and controlling those services.

Consider legal implications

Use open licenses without restrictions and without requirements that could place the government in legal risk.

Secure Interfaces

Choose secure interfaces that use open encryption ciphers certified to Federal Information Processing Standard (FIPS) 140-2 cryptographic standards.

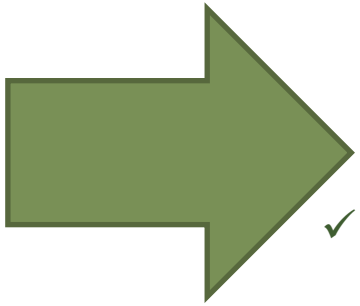
Leverage Department registries

Ensure IT standards align with the DoD Information Technology Standards Registry (DISR) and government standards are consistent with the Defense Standardization Program Office (DSPO) ASSIST database.

Open standards allows developers to leverage commercially developed technologies, increase competition and potentially enable rapid upgrades at reduced cost and complexity.

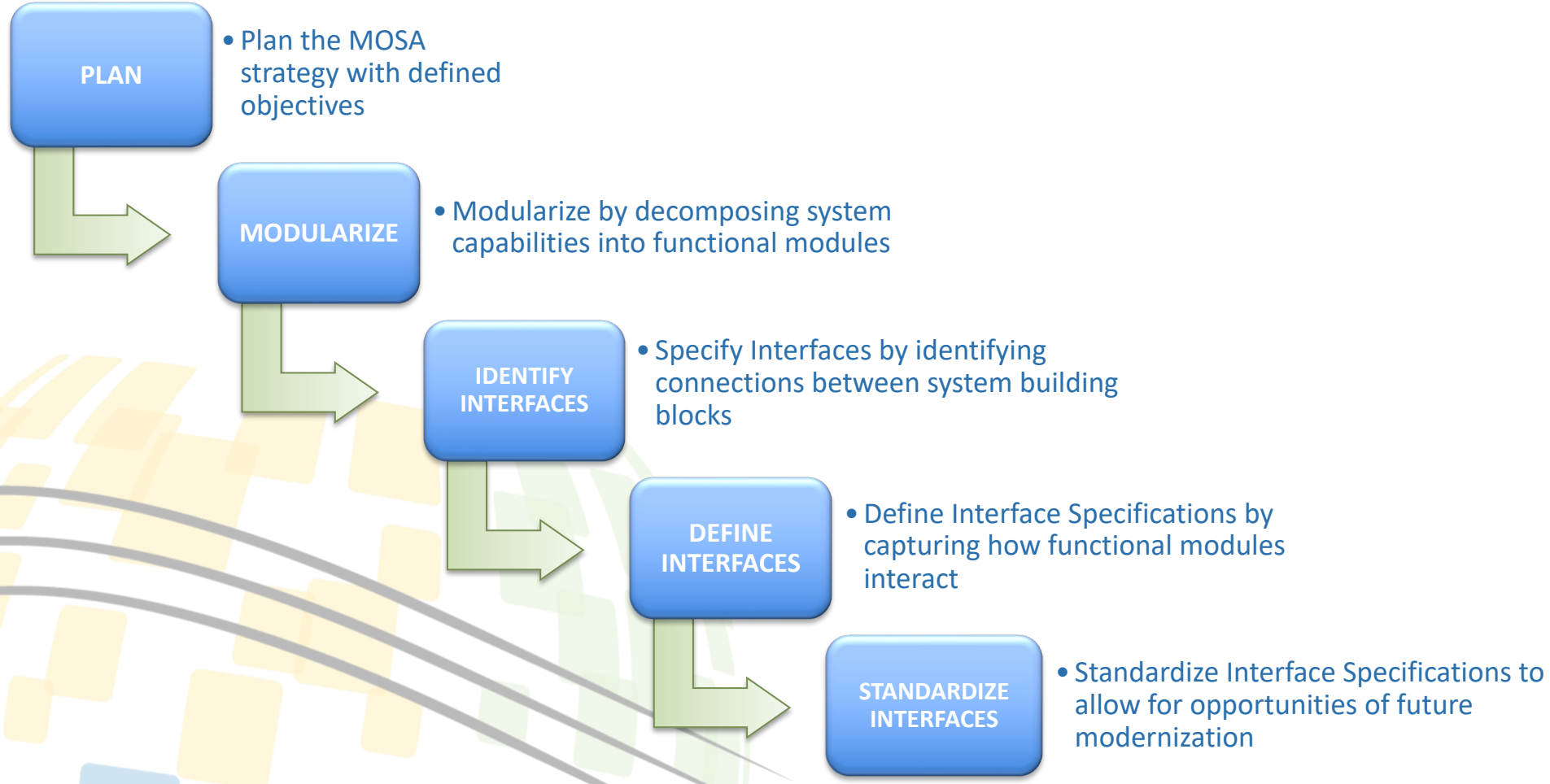
Certify Conformance

- Verify and validate MOSA strategy and requirements, ensuring conformance to selected internal and external open interface standards.



- ✓ Acquisition Documents; Systems Engineering Plan (SEP), Capability Development Document (CDD), Acquisition Strategy/Plan (AS/AP), and Product Support Strategy (PSS)
- ✓ System/Software Architecture; Contractor Work Breakdown Structure (CWBS), System/Segment Design Document (S/SDD), Software Architecture Description (SAD), and Software Design Document (SDD) Contract Data Requirements Lists (CDRLs)
- ✓ Performance Specifications; System/Subsystem Specification (S/SS), and Software Requirements Specification (SRS) CDRLs
- ✓ Major System Interfaces; Initial Capabilities Document (ICD), Interface Requirements Specification (IRS), and Interface Design Description (IDD) CDRLs
- ✓ Verification/Validation; Checklists, and S/W Test Reports CDRLs

Steps for Implementing MOSA

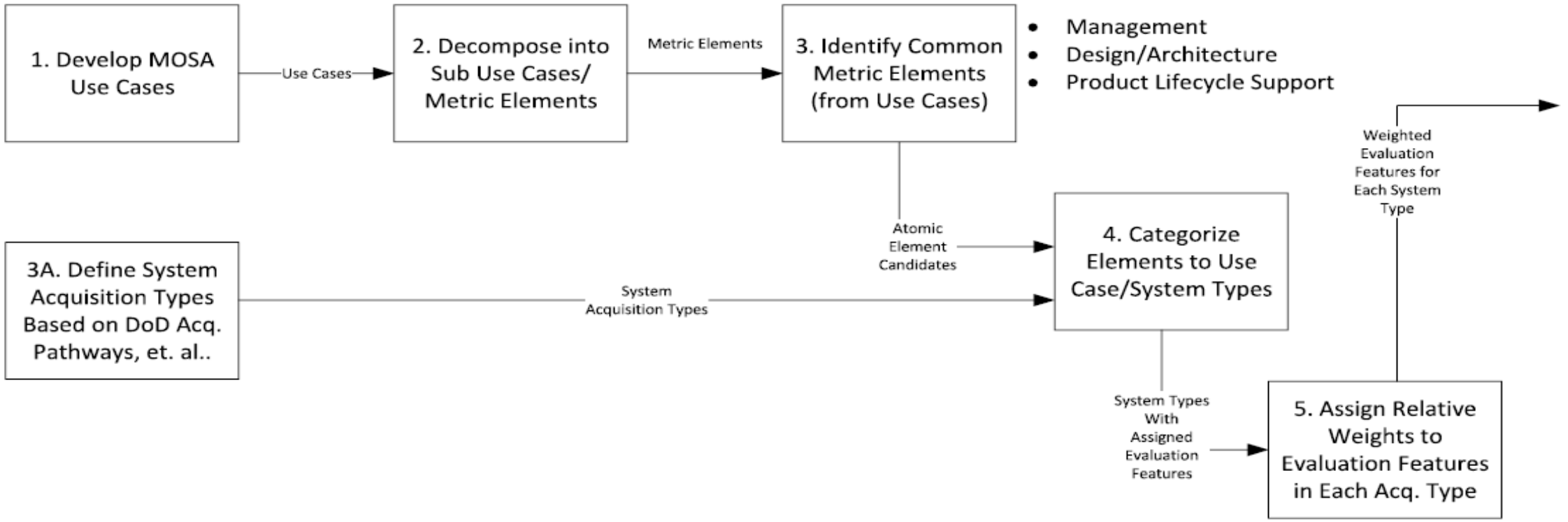


Source: MOSA Reference Frameworks in Defense Acquisition Programs (Published May 2020)

Identifying MOSA Criteria Categories

- A set of example Criteria Categories were identified from:
  - Criteria in Law and Policy
  - Current MOSA Standards
  - Current MOSA Criteria
  - MOSA Metrics Sub-Committee of the National Defense Industrial Association (NDIA) Systems Engineering Division's Architecture Committee
- These criteria are not exhaustive
- MILDEPs were encouraged to develop additional criteria that are appropriate for individual MILDEPs and program(s), but must ensure criteria are incorporated (mapped to) the appropriate MOSA pillar

MOSA Metrics Determination and Resolution Process



Source: National Defense Industrial Association (NDIA) SE Division, Systems Architecture Committee, July 2020

Recommended Process

- **OUSD(R&E) Recommendation:**
  - Criteria be evaluated on a 0-5 scale to allow a quantitative scoring and life-cycle measurement (where 0 is no/minimal capability and the 5 represents total/maximum capability for criterion).
  - Uses Multi-Attribute Utility Theory (MAUT) for scoring
  - Example:

Establishing Enabling Environment: To What Extent are MOSA requirements documented?

0 – No documentation supporting MOSA requirements

1 – Minimal documentation. Approximately 10% of complete MOSA required documents

2 – 25% complete

3 – 50% complete

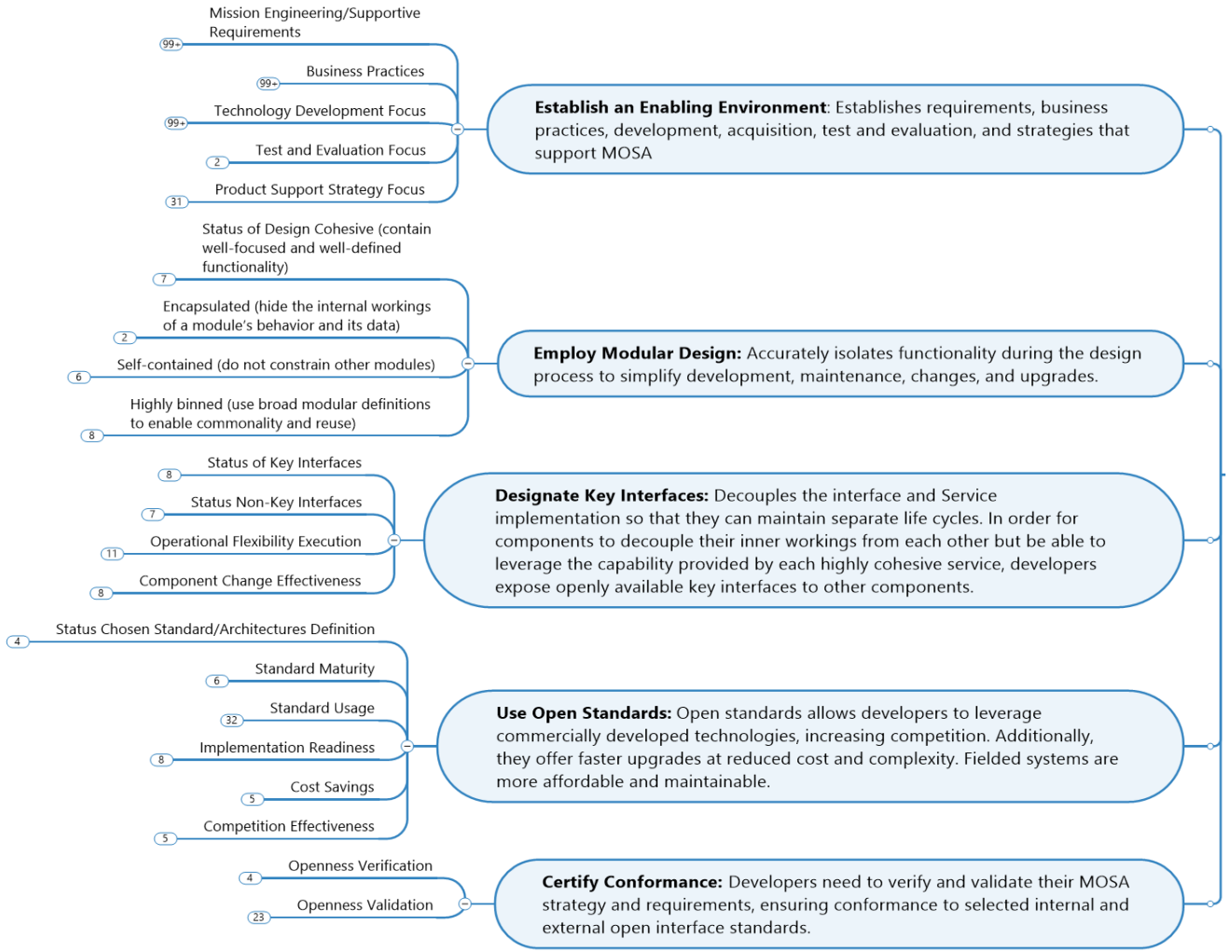
4 – 75% complete

5 – Complete set of MOSA required documents

Recommended Process (continued)

- **OUSD(R&E) Recommended Multi-Attribute Utility Theory (MAUT) for Scoring:** MAUT is a structured methodology designed to handle the tradeoffs among multiple objectives. Many MOSA models/tools used by the Services today utilize this process to provide a quantitative MOSA evaluation of their program(s). Although there are several COTS tools available to conduct MAUT, a simple Excel spread sheet is often the preferred tool.
- **Criteria Categories Example:** An example spreadsheet using a subset of the criteria categories is shown on the following slide.
  - The example shows the Pillars equally weighted. This is not always the case, and Pillars should be weighted according to Service and program needs.
  - The example only shows the Benefit (or performance) of a particular program's MOSA compliance. To completely evaluate a program, a Cost/Benefit analysis should be conducted using the program's calculated performance versus its life-cycle cost.

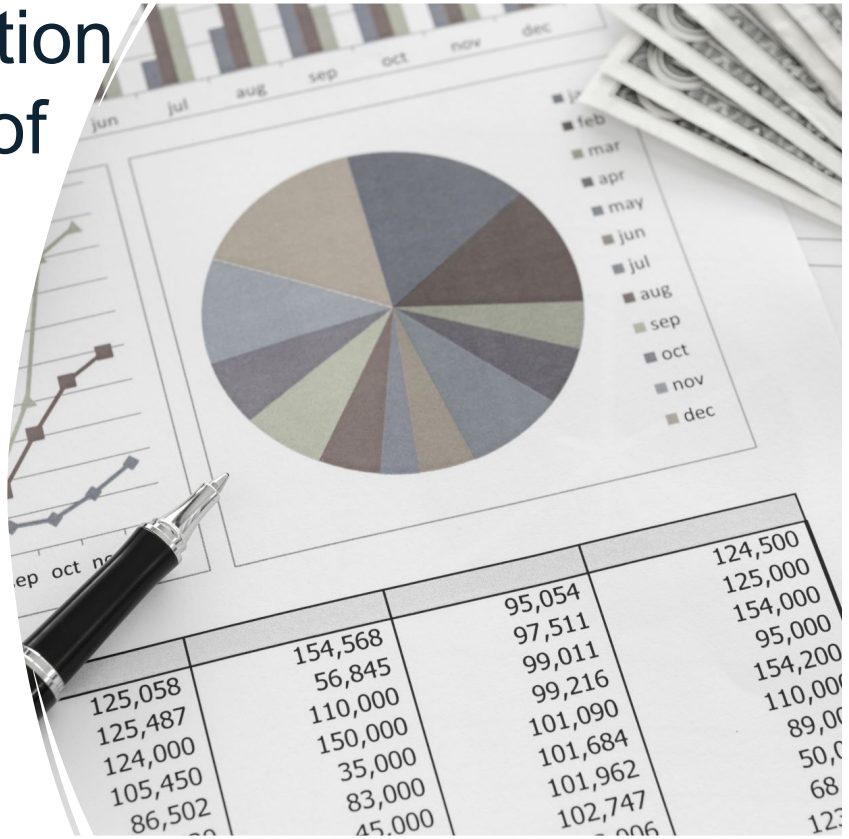
Consideration of Measuring MOSA Tenet Conformance



Program *X* MOSA Evaluation			
Criteria	**Pillar Weight**	**Score (0-5)**	**Weighted Score**
Establish Enabling Environment	0.2		
To what extent are MOSA requirements documented?		2	0.40
Establish and monitor MOSA life-cycle costs and performance goals		4	0.80
Is MOSA included in sustainment planning?		3	0.60
Extent to which MOSA is integrated into contracts and data rights strategy		5	1.00
Weighted Pillar Score			2.80
Employ Modular Design	0.2		
Are components separated into scalable, reusable modules consisting of self-contained functional elements?		4	0.80
To what extent does the system's architecture exhibit modular design characteristics?		5	1.00
Does the architecture provide failure isolation?		3	0.60
Weighted Pillar Score			2.40
Designate Key Interfaces	0.2		
Are key interfaces openly available to other components?		5	1.00
To what extent has the criteria for designating key interfaces been established?		5	1.00
To what extent has the program designated key interfaces?		5	1.00
Weighted Pillar Score			3.00
Select Open Standards	0.2		
Does the system use open licenses without restrictions and without requirements?		2	0.40
Are Open standards in alignment with IP/data rights strategy?		4	0.80
Weighted Pillar Score			1.20
Certify Conformance	0.2		
To what extent are MOSA standards and requirements verified and validated?		4	0.80
What is the program's level of MOSA Compliance?		5	1.00
How well are the MOSA goals for the program being reached?		2	0.40
Weighted Pillar Score			2.20
Overall Score for Program X (Sum of Weighted Pillar Scores)			11.60

Process Benefits Results

- Process is aligned with the recommendation from the MOSA Metrics Sub-Committee of the NDIA SE Architecture Committee
- Allows Services flexibility in developing criteria to meet their specific programs
- Provides standardization using MOSA Pillars as criteria categories
- Creates repeatable, quantifiable results



Seeking Service Partners to Validate Approach with a Current Program

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