AIR FORCE MATERIEL COMMAND (AFMC)

GUIDEBOOK FOR IMPLEMENTING MODULAR OPEN SYSTEMS APPROACHES IN WEAPON SYSTEMS

Approved By:

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Distribution Statement A. Approved for Public Release

EXECUTIVE SUMMARY

The Department of Defense continues to expand upon policy requiring each Service to implement Modular Open Systems Approach (MOSA) techniques in Program Offices. However, the execution of MOSA techniques continues to vary widely between programs due to lack of guidance on how to execute policy directives. Without a foundational understanding of how to consistently apply a MOSA, Program Offices will not obtain the full benefit the DoD seeks to achieve:

- Significant cost savings or avoidance
- Schedule reduction and rapid deployment of new technology
- Opportunities for technical upgrades and refresh
- Interoperability, including system of systems interoperability and mission integration
- Other benefits during the sustainment phase of a major system

MOSA's central tenet is that by requiring common standards and interfaces in its major platforms, components, weapons, and systems, future acquisitions of new capabilities and upgrades to legacy systems can be accomplished faster and at lower costs. Through that basic requirement, MOSA can support greater competition, enhanced innovation, and more rapid technological refresh while reducing sustainment costs.

Each program will implement MOSA differently based on their unique needs, however, this Guidebook provides guidance on how AFMC Centers can apply MOSA techniques to their programs. This Guidebook was developed to:

- Provide a common starting point for both new Weapon Systems Programs and Legacy Weapon System Programs to apply MOSA principles to their development and modification efforts.
- Connect MOSA techniques to Digital Transformation and Model Based Acquisition objectives.
- Align with DoD, Department of the Air Force, and AFMC MOSA policy requirements.
- Decompose MOSA concepts into actionable steps that can be tailored to fit program needs and constraints.
- Align with traditional Acquisition schedule milestones and Adaptive Acquisition Framework alternatives including Agile Acquisition approaches.

Contents

1. Introduction

A Modular Open Systems Approach (MOSA), formerly known as Modular Open Systems Architecture, can be defined as a technical and business strategy for designing an affordable and adaptable system. A MOSA is the Department of Defense (DoD) preferred method for implementing open systems, and is required by United States law. Title 10 United States Code (U.S.C.) §4401, §4402 and §4403 (formerly Title 10 U.SC. §2446a., b., and c) define the requirement for MOSA in Major Defense Acquisition Programs and other relevant acquisition programs. These MOSA regulations are focused on Major Defense Acquisition Programs and other relevant acquisition programs, or more specifically systems with interfaces between platforms and major system components. All subordinate DoD requirements trace back to U.S.C. §4401, §4402 and §4403, but the DoD requirements lack assessment criteria to demonstrate the level of compliance with these legal requirements, so it can be difficult for programs to create a robust MOSA strategy. Poorly planned MOSA strategies may result in programs being vendor locked, or receiving contract bid responses that are cost prohibitive. Passing a general requirement to a Prime Contractor to develop a MOSA plan may achieve a minimum level of compliance with the law, but will likely result in undesirable results for the Program Manager. Having the appropriate open approach means programs utilize the proper building blocks (establishing an enabling environment, employing a modular design, designating key interfaces, selecting widely used consensus-based standards, and certifying conformance) and have the appropriate data rights, and security measures in place to achieve the DoD MOSA goals.

2. Purpose and Applicability

This Guidebook applies to new and legacy AFMC weapon system programs. The principles within should also be applied to mission critical non-weapon systems (systems of systems, families of systems) that can benefit greatly from MOSA (e.g., airfield damage recovery systems), but this Guidebook will not address Enterprise Information Technology (IT) systems. This document is intended to be used in conjunction with Center specific MOSA implementation guidance. This document includes different techniques for new development programs and for modifications of existing weapon systems. Modular Open Systems interface concepts apply to both hardware and software and consider the importance of both physical and functional decomposition of a system's architecture. After tracing the existing federal, DoD, and Department of the Air Force (DAF) level guidance, this Guidebook provides strategies for implementing MOSA in both programs that will be heavily government-owned and programs in which the government intends the Original Equipment Manufacturer (OEM), or Prime Contractor, to lead the solution architecture development.

3. Requirements Sources and Terminology

As previously stated, all MOSA requirements are derived from Title 10 U.S.C. of Federal Regulations (specifically, Title 10 U.S.C. Subtitle A, Part V, Subpart F, Chapter 327, Subchapter I §4401, §4402 and §4403).[1] These sections summarize the details of the Title 10 requirements, and then traces all existing DAF and DoD MOSA policy requirements back to Federal Law. After summarizing the existing MOSA policy, these sections define terminology used throughout the rest of the document.

3.1 Title 10 Requirements

MOSA requirements are based on federal statutes. Title 10 U.S.C. §4401 states, "A major defense acquisition program…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. Other defense acquisition programs shall also 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." Note the second sentence expands MOSA requirements beyond Major Defense Acquisition Programs. Many of the definitions used in this Guidebook come from U.S.C. §4401. See Table 3-1 below for a list of definitions.

Title 10 U.S.C. §4402 includes requirements to address MOSA in program capabilities development and acquisition weapon system design. MOSA must be considered in the Program Capability Document, Analysis of Alternatives, Acquisition Strategy, and Request for Proposals.

Title 10 U.S.C §4403 addresses requirements relating to modularity of major system interfaces and support for MOSA. military departments must "ensure that major system interfaces incorporate commercial standards and other widely supported consensus-based standards that are validated, published, and maintained by recognized standards organizations to the maximum extent practicable." Departments must also "ensure that sufficient systems engineering and development expertise and resources are available to support the use of a modular open system approach in requirements development and acquisition program planning and ensure that necessary planning, programming, and budgeting resources are provided to specify, identify, develop, and sustain the modular open system approach, associated major system interfaces, systems integration, and any additional program activities necessary to sustain innovation and interoperability."

3.2 National Defense Authorization Act (NDAA) Policy

Section 840 of the FY20 NDAA added to Title 10 Section §4402 by including a requirement that "The Secretaries of the military departments shall issue guidance to implement the requirements of this section (§4402).[2]"

Section 804 of the FY21 NDAA builds upon previous NDAA directives supporting MOSA by extending MOSA beyond the modification and development of major weapons systems.[3] There is an open Defense Federal Acquisition Regulation Supplement (DFARS) case (2021-D005) in the drat stage that plans to include implementation of section 804 of the FY21 NDAA into the DFARS language formally. The DFARS shall be consulted when generating contractual language for the most up to date regulations.

Previous NDAAs permitted the DoD to assert government purpose rights in technical data and computer software related to the interfaces between modules for major weapon systems even if developed at private expense. Section 804 now extends these rights to interfaces in all "modular" weapons systems and even directs DoD eventually to expand them to cover software-based non-weapon systems as well, including business systems and cybersecurity systems.

Section 804 enhances the implementation of MOSA principles by introducing the requirement for the creation of interface repositories. These repositories will be mentioned later in this Guidebook so the specific language is included here:

> Section 804 (c)
> (1) ESTABLISHMENT.— Not later than 90 days after the date of the enactment of this Act, the Under Secretary of Defense for Acquisition and Sustainment shall—
> (A) direct the Secretaries concerned and the heads of other appropriate Department of Defense components to establish and maintain repositories for interfaces, syntax and properties, documentation, and communication implementations delivered pursuant to the requirements established under subsection (a)(2)(B);
> (B) establish and maintain a comprehensive index of interfaces, syntax and properties, documentation, and communication implementations delivered pursuant to the requirements established under subsection (a)(2)(B) and maintained in the repositories required under subparagraph (A);
> (C) if practicable, establish and maintain an alternate reference repository of interfaces, syntax and properties, documentation, and communication implementations delivered pursuant to the requirements established under subsection (a)(2)(B).

Section 804 (c) requires reference to Section 804(a)(2)(B):

> (B) each relevant Department of Defense contract entered into after the date on which the regulations and guidance required under paragraph (1 {a year after release of the NDAA}) are implemented includes requirements for the delivery of modular system interfaces for modular systems deemed relevant in the acquisition strategy or documentation referred to in subparagraph (A), including—
> (i) software-defined interface syntax and properties, specifically governing how values are validly passed and received between major subsystems and components, in machine-readable format;

(ii) a machine-readable definition of the relationship between the delivered interface and existing common standards or interfaces available in the interface repositories established pursuant to subsection (c); and
(iii) documentation with functional descriptions of software-defined interfaces, conveying semantic meaning of interface elements, such as the function of a given interface field;

3.3 Department of Defense MOSA Policy

The DoD *Engineering of Defense Systems* instruction (DoDI 5000.88) calls for the technical approach for system design to "incorporate a modular open systems approach to the maximum extent practicable" in Major Design Acquisition Programs, Acquisition Category (ACAT) II, and ACAT III programs, and stresses "all other programs should consider implementing MOSA.[4]" Section 3.7.a puts the responsibility for the MOSA on the Lead Systems Engineer (LSE), working for and under the direction of the Program Manager (PM). If practicable, the PM will establish and manage the technical baseline as a digital authoritative source of truth. Unlike documents that can become out of date, an authoritative source is an environment like a model repository that contains key elements of a system technical baseline traced from its current state to other points along the lifecycle. The LSE will document the MOSA in the digital authoritative source of truth for the program. Program Managers (PMs) are responsible for ensuring Requests for Proposal for development or production contracts include compliance with MOSA-enabling interfaces and the PM is responsible for acquiring appropriate data rights and using appropriate business models that allow major systems components to be severable "at the appropriate level for incremental addition, removal, or replacement over the system's life-cycle." The Lead System Engineer is also directed to "use consensus-based standards for interfaces, unless unavailable or unsuitable, and provide open sharing of definitions to interdependent programs." At Milestone B in the Acquisition Lifecycle, the PM provides the Milestone Decision Authority (MDA) the program's open systems approach. "The PM will provide justification to the MDA if MOSA is not used. The MDA will review and determine whether or not the justification to not use MOSA is appropriate."

The DoD *Major Capability Acquisition* instruction (DoDI 5000.85) includes MOSA requirements in Section 3C.3.(5).[5] MOSA is required "to the maximum extent feasible and cost effective." "In general, the acquisition strategy for a system should identify where, why and how MOSA will be used in the program." Programs using MOSA must clearly describe:

- How MOSA will be used, including business and technical considerations
- Differentiation between the major system platform and major system components
- The evolution of capabilities that will be added, removed, or replaced in future increments
- Additional major system components that may be added in the future
- How Intellectual Property (IP)-related issues will be addressed

- The integration and configuration management approach ensuring the system can operate in applicable cyber threat environments

The MDA must ensure Requests for Proposal in the Engineering Manufacturing and Development and Production and Deployment phases describe the MOSA.

3.4 Air Force MOSA Policy

Air Force Instruction (AFI) 63-101/20-101, *Integrated Life Cycle Management*, emphasizes MOSA's importance and value in the "design and development of modular, interoperable systems that allow components to be added, modified, replaced, removed and supported by different vendors throughout each system's life cycle.[6]" This AFI provides both general and specific MOSA guidance to the PM and LSE. The AFI charges the PM with specific responsibilities for:

- Ensuring that the program intellectual property strategy can support a MOSA approach. Examples of documents that serve this purpose include the performance work statement or statement of work for development, production, deployment, and sustainment (for all applicable phases) includes appropriate intellectual property requirements, access, and necessary deliverables, or options for data, software, and equipment deliverables.
- Documenting justifications for not utilizing MOSA in the Acquisition Strategy in order to obtain Milestone Decision Authority (MDA) approval or redirection.
- Applying MOSA and Open Technology Development to the system architecture design wherever feasible.

Section 5.4.17 states "The PM applies the Modular Open Systems Approach and Open Technology Development wherever feasible. The Chief Engineer uses the technical architecture and market research of potential technologies and sources of supply to craft an open system approach that maximizes technology reuse and system interoperability, and that reduces dependency on proprietary data and total life cycle costs." Note: The AFI term "Chief Engineer" is synonymous with the DoDI 5000.02T term "Lead Systems Engineer (LSE)."

AFMC 63-1201 is currently being updated to include reference for Centers to utilize this Guidebook when creating or modifying weapon systems.

3.5 Terms and Definitions

This Guidebook uses terms and keyword descriptions from important academic publications, commercial references, Department of Defense policies, and U.S. government legislation that relate to the implementation of MOSA. Table 3-1 provides a glossary of terms and definitions used in this Guidebook to ensure conceptual and operational use of these terms is carefully and precisely defined. Non-US Government sources have been provided only for informational purposes and are not authoritative.

Table 3-1 Terms and Definitions

Term	Definition	Source
Architecture	An architecture is the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time	DAU Glossary[7]
Compliance	The process of adhering to policies and decisions. Policies can be derived from internal directives, procedures and requirements, or from external laws, regulations, standards and agreements.	Gartner[8]
Conformance Requirements	The Conformance Requirements documents the body of knowledge that a Candidate must possess to achieve certification. Conformance is often a binary assessment, where a program has fully implemented all requirements of a standard to become conformant.	The Open Group[9]
Critical Components	A component which is, or contains, information and communications technology (ICT), including hardware, software, and firmware, whether custom, commercial, or otherwise developed, and which delivers or protects mission critical functionality of a system or which, because of the system's design, may introduce vulnerability to the mission critical functions of an applicable system.	DoDI 5200.44, Protection of Mission Critical Functions to Achieve Trusted Systems and Networks (TSN)
Government Reference Architecture (GRA)	A Government Reference Architecture is a reference architecture provided by the government to guide the system design, development, production, and sustainment processes.	DoD Mission Engineering Guide, November 2020[10]
High Cohesion	All of the internals of a system are needed to implement that system's single function or concept. The system does not implement any unrelated requirements. In other words, the system's internals are necessary and sufficient.	Carnegie Mellon University Model Open System Architecture
Interface	The functional and physical characteristics required to exist at a common boundary or connection between persons, between systems, or between persons and systems. A system external to the system being analyzed that provides a common boundary or service that is necessary for the other system to perform its mission in an un-degraded mode, e.g., a system that supplies power, cooling, heating, air services, or input signals.	DAU Glossary
Key Interface	Interfaces that are of special interest to the Government for a variety of reasons such as: rapid changes in technology; rapid changes in threat systems; exists in multiple variants; has multiple, long term, viable sources; rapid changes in requirements; provides something critical; or isolates US-only systems. Not all Key Interfaces are "open." Some may be connected to Mission Critical Components or Commercial Off the Shelf (COTS) products that were not created with consensus-based standards. Key Interfaces are the interfaces for the identified relevant modular systems.	This term is used in the DoD Systems Engineering Guidebook, but not fully defined.
Low Coupling	It has few interfaces with other systems and these interfaces are relatively simple. Modular Systems do not interface with other systems unless the interface is necessary for the systems to meet their requirements.	Carnegie Mellon University Model Open System Architecture
Machine-Readable Format	A format that can be easily processed by a computer without human intervention.	FY21 National Defense Authorization Act Section 804

Major System Component	A high level subsystem or assembly, including hardware, software, or an integrated assembly of both, that can be mounted or installed on a major system platform through modular system interfaces; and includes a subsystem or assembly that is likely to have additional capability requirements, is likely to change because of evolving technology or threat, is needed for interoperability, facilitates incremental deployment of capabilities, or is expected to be replaced by another major system component.	Title 10 §4401 (formerly) §2446a
Major System Platform	The highest level structure of a major weapon system that is not physically mounted or installed onto a higher level structure and on which a major system component can be physically mounted or installed.	Title 10 §4401 (formerly) §2446a
Modular Open Systems Approach (MOSA)	An integrated business and technical strategy that employs a modular design that uses modular system interfaces between major systems, major system components, and modular systems.	Title 10 §4401 (formerly) §2446a
Modular System	A weapon system or weapon system component that is able to execute without requiring coincident execution of other specific weapon systems or components; can communicate across component boundaries and through interfaces; and functions as a module that can be separated, recombined, and connected with other weapon systems or weapon system components in order to achieve various effects, missions, or capabilities. *Note: Modules within a system are only considered "open" if they make use of consensus-based standards.	Title 10 §4401 (formerly) §2446a
Modular System Interface	A shared boundary between major systems, major system components, or modular systems, defined by various physical, logical, and functional characteristics, such as electrical, mechanical, fluidic, optical, radio frequency, data, networking, or software elements.	Title 10 §4401 (formerly) §2446a
Reference Architecture (RA)	A Reference Architecture is an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions.	DoD Reference Architecture Description, June 2010[11]
Service Oriented Architecture	A set of principles and methodologies for designing and developing software in the form of interoperable services. These services are well-defined business functions that are built as software components (i.e., discrete pieces of code and/or data structures) that can be reused for different purposes.	NIST Glossary
Single Abstraction	A term meaning each module models the important aspects of a single capability or concept	Carnegie Mellon University Model Open System Architecture
Solution Architecture	A framework or structure that portrays the relationships among all the elements of something that answers a problem. It describes the fundamental organization of a system, embodied in its components, their relationships with each other and the environment, and the principles governing its design and evolution. Solution architecture instantiations are guided and constrained by all or part of a Reference Architecture where the generalized and logical abstract elements of the Reference Architecture are replaced by real world, physical elements according to the specified rules, principles, standards and specifications.	Department of Defense Architecture Framework (DoDAF) Version 2.0

Vendor Lock	The situation in which customers are dependent on a single manufacturer or supplier for some product and cannot move to another vendor without substantial costs and/or inconvenience. This dependency is typically a result of standards that are controlled by the vendor. It can grant the vendor some extent of monopoly power.	http://dodcio.defense.gov/Open-Source-Software-FAQ

4. Steps to Implementing MOSA

4.1 New vs. Legacy Programs

The starting point for implementing a MOSA is different for weapon systems that are at the beginning of the Acquisition Lifecycle compared to Legacy weapon systems, or weapon systems that are in the sustainment phase and likely to have stable architectures outside of modification programs.

4.1.1 Starting Points for New Programs

Weapon System programs at the beginning of the Acquisition Cycle are starting with a clean slate and have the maximum ability to implement MOSA concepts into their design. Figure 4-1 shows steps to address a MOSA outlined throughout Section 4 and compares it to where in the Acquisition lifecycle (discussed in Section 5) those steps can apply. An example is how modular decomposition, and identification of Key Interfaces and data rights needs should precede drafting an Acquisition Strategy to ensure IP rights are incorporated into the Strategy.

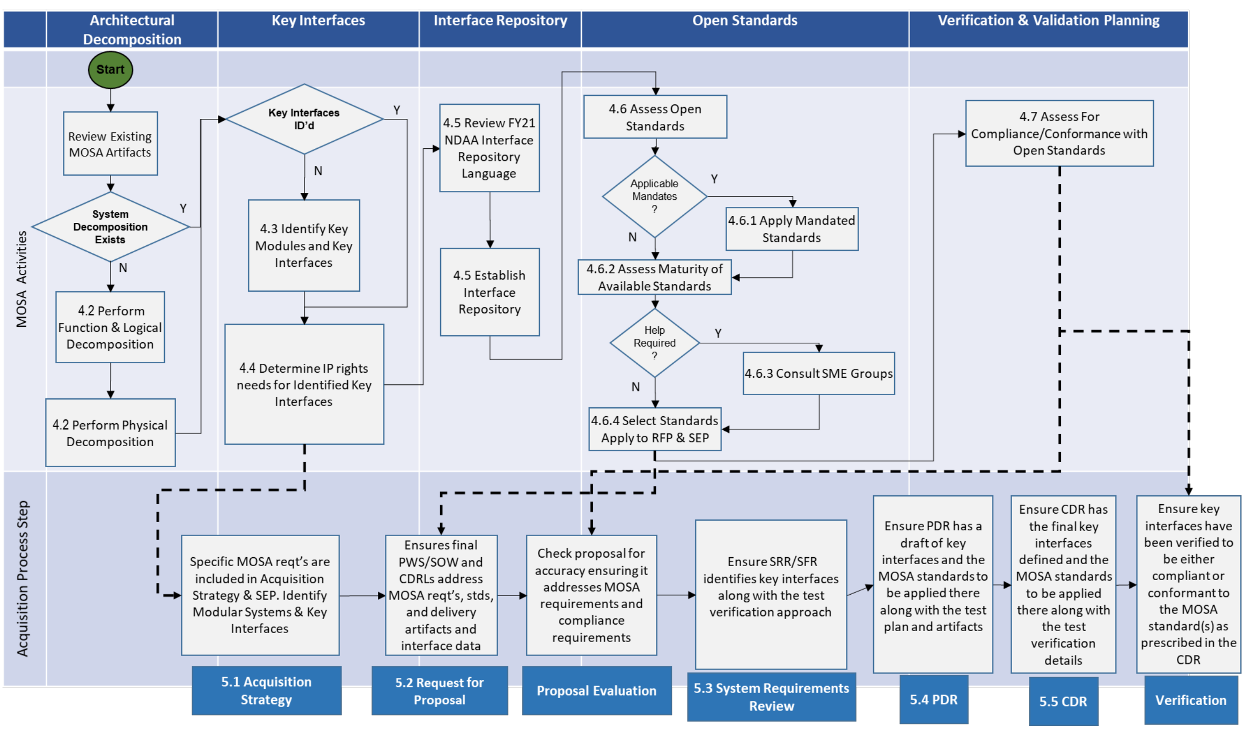

Figure 4-1 MOSA Process for Major Capability Acquisition. Dashed lines show how the output of the MOSA processes described in Section 4 map to the inputs of the Acquisition Process Steps in Section 5.

The engineering team on a new program should consult with the PM and determine if funding has been requested for Model Based Systems Engineering (MBSE) tools and data storage. While a digital strategy is not required to implement MOSA, guidance exists to link how the use of a digital strategy and MBSE can enhance MOSA efforts. The 2018 DoD Digital Engineering Strategy encourages planning for models to support engineering activities and decision making across the lifecycle.[12] Once the digital environment and MBSE tools are instantiated, they should be used to create a modular decomposition of the weapon system. See section 4.2 Modular Decomposition for further details.

4.1.2 Starting Points for Legacy Programs

This section applies to legacy programs that have not previously implemented a MOSA strategy. Once a program has entered the sustainment phase, the likelihood of a significant overhaul of the architecture is low, so the MOSA strategy will be limited in scope with a roadmap for potential expansion. Legacy Air Force programs tend to have architectures with low cohesion and high coupling (many functions highly intertwined), so the MOSA for highly coupled architectures should consider the following:

- What is the Expected Service Life of the system?
  - Programs nearing end of life within 5 years with little to no future modifications planned may not benefit from altering their architecture to include MOSA interfaces
- Is the modification replacing obsolete components?
  - Obsolescence has become a large cost driver on legacy programs and Open Architecture Standards specifically target hardware or software abstraction techniques that allow for cost effective hardware replacement
- Can the modification be executed in such a way as to open a portion of the overall architecture?
  - Modification programs may not allow for the application of MOSA enabling standards at all interfaces, but an assessment should be conducted to see which interfaces can be "opened"
- What future modifications are projected for the weapon system?
  - An example of an incremental MOSA is during an upgrade of a sensor subsystem the Mission System portion of the architecture is converted from a deterministic architecture to a Service Oriented Architecture. An element of mission processing can be converted to handle integration with subsystems using the publish-and-subscribe methodology reducing the integration work and regression test cases needed during further integration efforts. Then each new subsystem modification on the platform reduces the coupling and allows for better modularity.
- What is the threat environment for the weapon system?

- Rapidly evolving threat environments can be overcome with systems properly modularized for rapid upgrade.

Legacy programs should consult the Systems Engineering Plan (SEP) or Acquisition Strategy to see the MOSA strategy for the program. If one does not exist, it should be written to describe how the program can address incremental changes to the architecture to build in open interfaces during modifications. If a MOSA cannot be incorporated into a legacy system, ensure the rationale is documented in the SEP. After the MOSA strategy is written for inclusion in the SEP, the components being modified or added should be decomposed (see Section 4.2). If the program office is procuring a capability without understanding the physical solution, logical and functional decompositions should be created to provide a starting point for discussing MOSA requirements with contractors. Failing to provide a contractor functional and/or logical decomposition of the system may limit the government's ability to clearly articulate which interfaces they wish to be targeted to be open.

4.2 Modular Decomposition

Decomposition is the dividing of an entity into smaller pieces or constituents. It is one of the most power tools in our toolset for dealing with complexity. Before including MOSA requirements in the RFP (Figure 4-1Step 1.1), it is important for the program team to understand the decomposition of the architecture in mind. Modular Decomposition should be accomplished with open interfaces in mind, but foremost with an emphasis on separating functions into logical and physical modules that can be tested independently of each other. At a minimum, weapon systems shall have modularization determined between platforms and major system components. This level of decomposition is required to meet Title 10 requirements. However, with the advancement of MOSA enabling standards, programs should strive to decompose their architecture to a lower level of indenture to allow for more control over component and software interfaces. The NDAA and other DoD documents use the term Modular System Interfaces. Common frameworks, such as Mil-STD-881 "Work Breakdown Structures for Defense Materiel Items" or Joint Service Specification Guides (JSSG) (e.g., JSSG 2001, 2009) can help programs determine the level of indenture that the Systems Engineer can effectively manage. Mil-STD-881 and the JSSGs can be found on ASSIST (https://assist.dla.mil/online/start/index.cfm). Logical and/or functional decomposition should be performed prior to physical decomposition, so that functional partitioning can be accounted for during physical decomposition. Weapon System Government Reference Architectures (GRAs) are available to help programs understand what MOSA enabling standards are available to apply to interfaces. Consult the DAF Digital Guide for available GRAs (https://usaf.dps.mil/teams/afmcde/SitePages/Government-Reference-Architecture.aspx).

Modular decomposition will identify relevant modular systems. These should be identified in response to a threat assessment or in support of a sustainment strategy and include the proper application of security measures.

- An intelligence supportability analysis (ISA) performed by the Materiel Intelligence Enterprise (MIE), which may include threat assessments such as a Validated Online Lifecycle Threat (VOLT) report or Critical Intelligence Parameter (CIP) updates, can lead to identification of modules of the system that will need to be modernized, upgraded, added, or removed in the future to address an adapting, evolving threat.
- The Product Support Strategy for the system will help identify relevant modular systems. If the intent is to be able to replace components of the system, either due to tech refresh or Diminishing Manufacturing Sources and Material Shortages, without reliance on the OEM, these components should be identified as relevant modular systems.

4.2.1 Identify Modeling Tools to Support Modular Decomposition

Systems Engineering Modeling tools have the ability to decompose functional architectures and trace those functions back to system or subsystem requirements. Legacy programs that have one-off functional decompositions, which were performed on paper or in a tool like Microsoft PowerPoint, should explore if the program budget is sufficient to allow for the porting of their one-off functional decompositions into a modeling tool. Then functional decompositions can be linked to the physical decompositions of the systems. The SAF/AQ Digital Building Code guidance is to "build and maintain model-based representations of systems in commercial-off-the-shelf (COTS) architecture tools using Systems Modeling Language (SysML), or an equivalent modeling language.[13]" The Digital Building code is available on the Air Force Digital Guide (https://usaf.dps.mil/teams/afmcde/SitePages/Air-Force-Vision.aspx). The Digital Building Code is intended to be a living set of thoughtful standards, regularly updated and maintained as the Air Force conducts digital transformation and as technologies continue to evolve.

4.2.2 Logical Decomposition

Logical decomposition is the process of creating logical components that perform functions. It is less specific than a physical decomposition because the physical decomposition takes into account the actual devices that a logical decomposition operate on. Logical decomposition is the process of creating the detailed requirements that enable programs to meet stakeholder needs. The process of logical decomposition identifies what should be achieved by the system at each level of indenture. The Work Breakdown Structure is an example of a logical decomposition by organizing development activities based on system and product decompositions. For weapon systems, logical decompositions can aid a program office, by allowing for capabilities to be identified without tying specific components to those elements of a system. Figure 4-2 below shows a simplistic logical decomposition for an uncrewed air system. The vehicle can be decomposed into its logical components, such as propulsion, without identifying what type of engine drives the vehicle. This type of breakdown is good for programs to understand their capability needs without having identified what subsystems specifically will satisfy those needs. For instance, Intelligence, Surveillance, and Reconnaissance (ISR) platforms will need a suite of sensors, but each may have different specific sensors based on their mission requirements and use cases. Engineering teams should identify the level of indenture (how far into a weapon system) to decompose while creating a logical decomposition. Some programs may be procuring a simple weather radar system and only care about the radar-to-platform interface. Other programs may have complex radar needs and further decompose into radar capabilities in the event technology upgrades are planned that affect components or software within the radar. MOSA enabling standards for radar specific interfaces may be used on programs that desire more specific control over the interfaces within the subsystem.

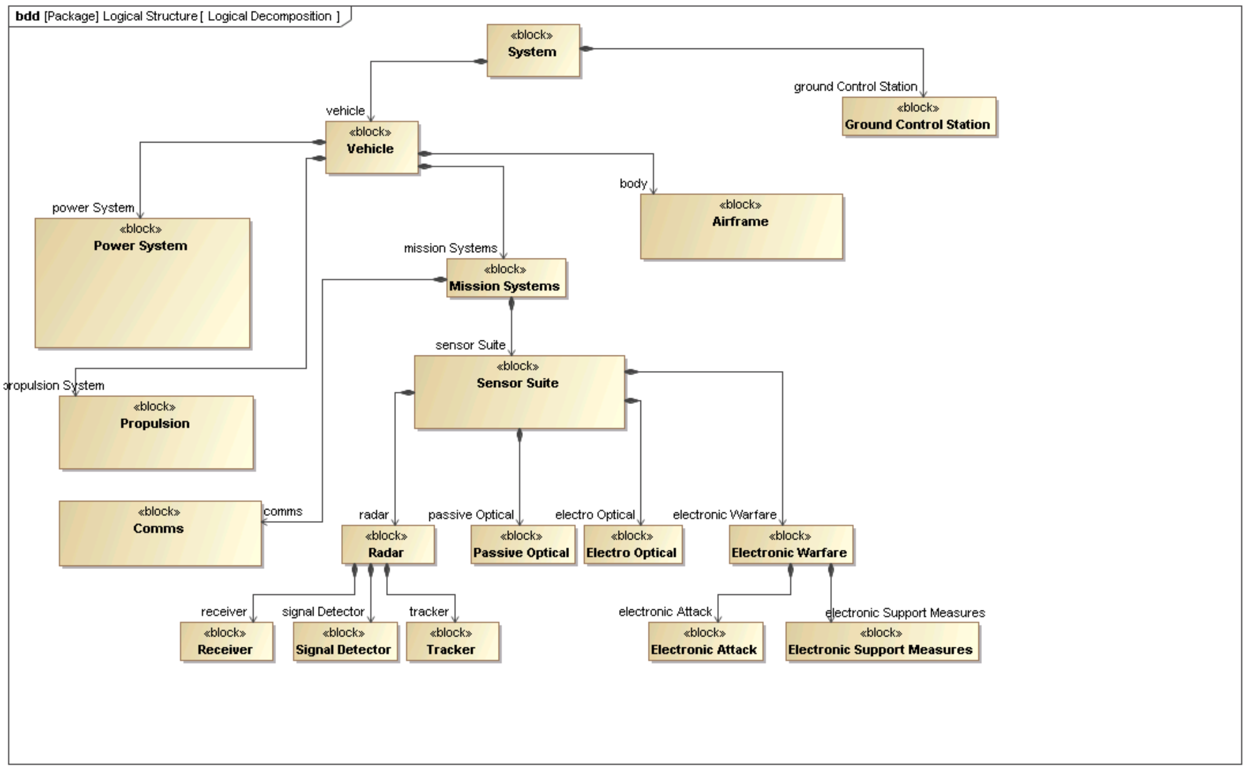

Figure 4-2 Example Logical Decomposition

4.2.3 Functional Decomposition

Functional decomposition refers broadly to the process of resolving a functional relationship into its constituent parts in such a way that the original function can be reconstructed from those parts. Functional decomposition should precede physical decomposition. Weapon systems should attempt to functionally partition safety critical and nuclear surety functionality from the rest of the architecture to the maximum extent practicable. Conducting functional decomposition first allows for the identification of software components and hardware components that should be federated to reduce the need for regression testing of safety/nuclear critical functionality when non-critical functionality is upgraded, modified, or replaced. Proper federation of critical and non-critical functions positions a program for constant lifecycle savings by significantly cutting unnecessary test cost and schedule. See Figure 4-3 below for a simplistic example of a functional decomposition. In the example, some functions are identified as safety critical. These functions are partitioned, as possible, in hardware or software to reduce their impact on modifications to non-safety critical functions. Modification programs need to look at the functionality of the components being modified or added to the system to identify if any coupled functions can be decoupled or if critical functions can be separated from non-critical functions in a component.

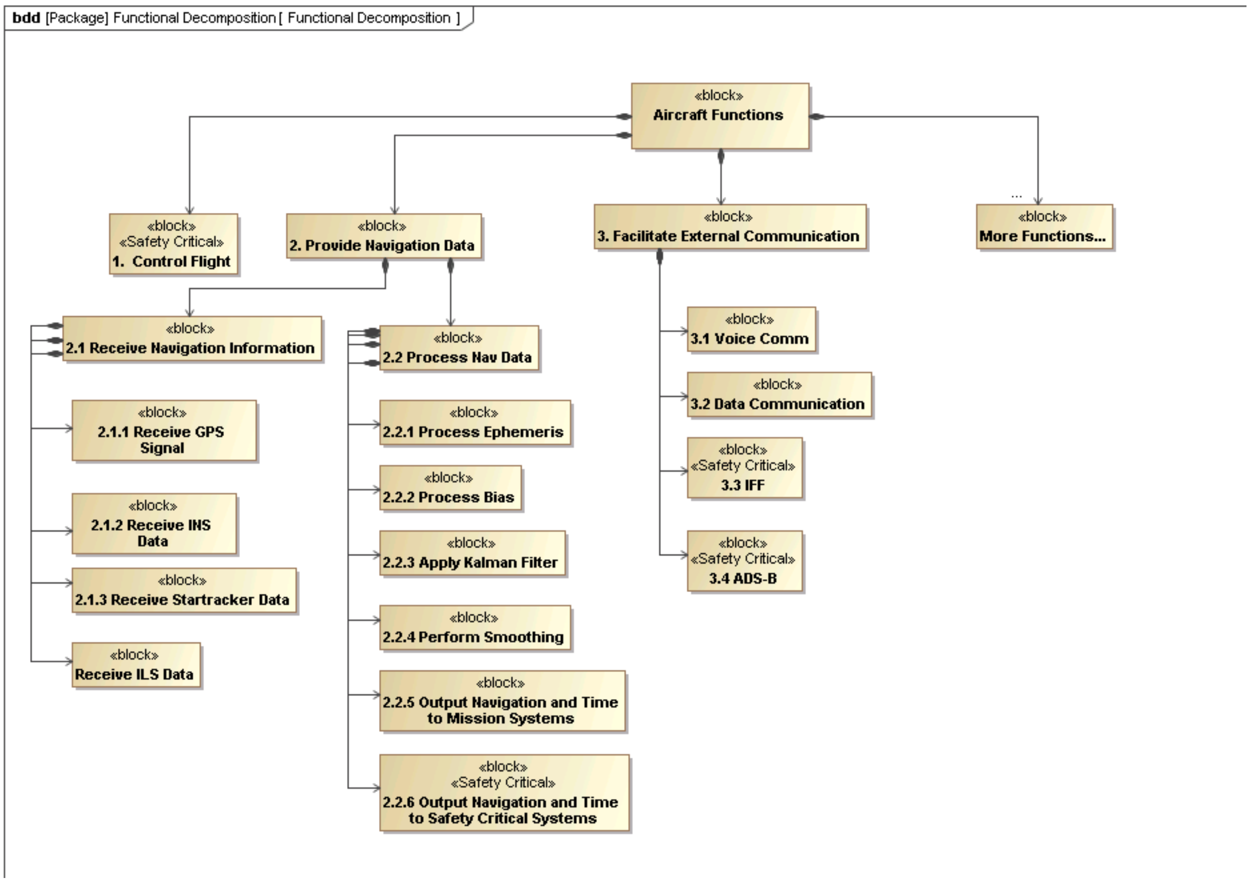

Figure 4-3 Example Functional Decomposition

4.2.4 Government Weapon System Reference Architectures

After the program office engineering team performs the functional decomposition, they should consult the Digital Guide (https://usaf.dps.mil/teams/afmcde) for a list of available Weapon System Government Reference Architectures. There are many Government Reference Architectures for functional areas such as Navigation, Avionics, Air-launched Weapons, and more. These Government Reference Architectures can help programs perform physical decomposition, and, in some cases, identify interface information, such as physical connectors and/or data.

4.2.5 Physical Decomposition

Program offices may perform some physical decomposition of the weapon system, or may task the responsibility of the physical decomposition to the contractor. It is during the physical decomposition phase that open interface standards can be tied to components of the weapon system. Multiple logical or functional capabilities may be achieved through one physical component (e.g., a multi-function sensor that combines electro optical, passive optical, and synthetic aperture radar). During physical decomposition the determination of Key Interfaces becomes important. Key Interfaces are explained in more detail in Section 4.3.

Logical, Functional, and Physical decompositions should be created to work together. For complex weapon systems where there are several software modules within a physical component, it may be beneficial to combine a physical and functional decomposition to show the interfaces between software modules within a physical component, or to show interfaces between software modules between different physical components. Due to the varying capabilities and mission requirements for Air Force weapon systems, there is no single checklist applicable to every program to ensure the modular decomposition is done correctly. However, there are style guides available for programs using Model Based Systems Engineering tools to create their decomposition diagrams. Consult the Air Force Digital Guide for the latest available MBSE Guidebook and Style Guides (https://usaf.dps.mil/teams/afmcde).

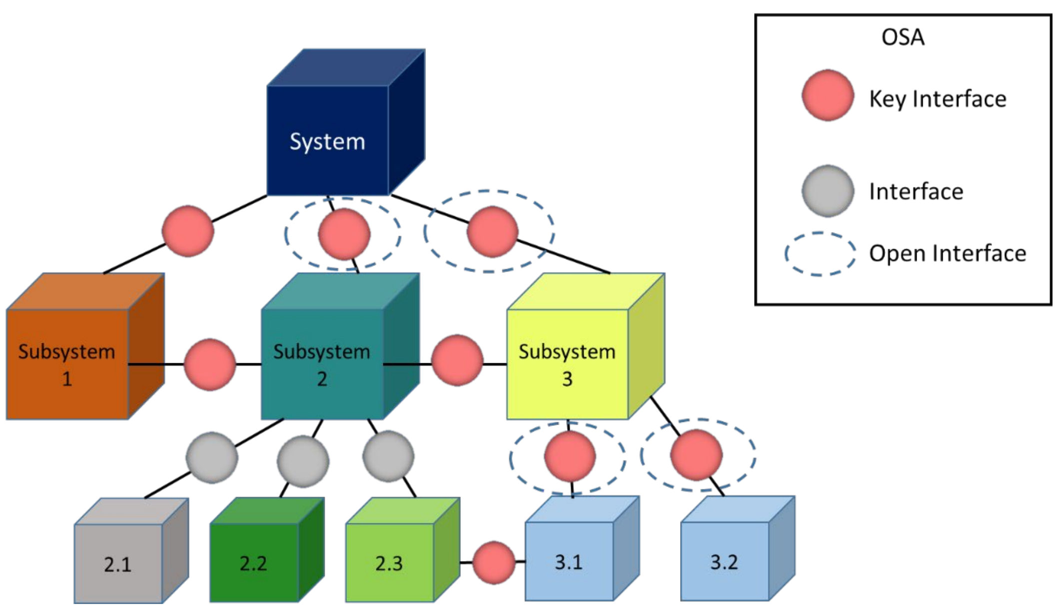

Figure 4-4 Example Physical Decomposition

4.3 Identify Key Modules, Key Interfaces vs. Non-Key Modules and Interfaces

Key Modules are modules with associated Key Interfaces. Program Offices should ensure that binding contractual requirements are in place that require delivery of all necessary technical data and computer software with sufficient rights to meet the Government's requirements. Programs should keep in mind that the Government may be entitled to at least Government Purpose Rights (GPR) in interface data and software, including that required for Key Interfaces, and should attempt to maximize the use of MOSA enabling standards at Key Interfaces to create Open Key Interfaces. The Program Protection Plan and Technology Readiness assessment are good sources for programs to use to help identify key interfaces. It is important to understand the terminology used when communicating about system interfaces. Key Interfaces are the interfaces that are deemed by the program office to be physical or functional interfaces that are connected to critical components or components of the weapon system that are likely to require modification or replacement during sustainment. An example of a key physical interface is a connector or wire. An example of a key functional interface would be the data exchanged between platforms, components, or data exchanged within a component between two or more Computer Software Configuration Items (CSCIs). Key Interfaces are important to a Program Office, but labeling an interface as a Key Interface does not mean the module interface is guaranteed to be open. Some Key Interfaces may connect to COTS components. In those instances, the Government may not require open interface standard to the COTS component and acquiring a higher level of rights, e.g., GPR, may be unnecessary and the benefits of such higher level of rights may be outweighed by the potential cost. Figure 4-4 above shows an example of a simplistic physical decomposition that identifies different types of interfaces. The system is decomposed into different modules, so the interfaces are modular interfaces, but not all interfaces are identified as Key Interfaces.

4.4 Identify MOSA Interfaces vs. Non-MOSA Interfaces

As stated in Section 4.3, all the interfaces in Figure 4-4 are modular interfaces. But there is a difference between MOSA interfaces and non-MOSA interfaces. For a modular interface to be considered a MOSA interface, the government must attain required technical data and computer software deliverables related to the interface with sufficient rights or an open standard is applied at the interface (functional or physical) to ensure sufficient rights. The Program Office may not need the same level of data rights to the interfaces that are not listed as Key Interfaces. In Figure 4-4, Subsystem 1 is shown as connected by a non-open Key Interface. This could be the case of a COTS subsystem connected to a platform, where the interface is important to the program, but the COTS product may be designed without use of open interface standards. The interface from the platform to Subsystem 1 is a Non-MOSA interface. The interfaces from the platform to Subsystem 2 and 3 are open either by the application of an open standard or the guarantee that the government has technical data and computer software deliverables with sufficient rights (e.g., the government has deliverable requirements and sufficient rights to the Application Program Interface for the software or the hardware interface information). Programs must understand where their Key Interfaces lie and which interfaces in their modular architecture should be "open".

4.5 Prepare Program Interface Repository

As mentioned in Section 3.2 the FY21 NDAA mandates that programs establish and maintain repositories for interfaces, syntax and properties, documentation, and communication implementations. Interface repositories should consist of the following:

(I) Software-defined interface syntax and properties, specifically governing how values are validly passed and received between major subsystems and components, in machine readable format;

(II) A machine-readable definition of the relationship between the delivered interface and existing common standards or interfaces available in Department interface repositories; and

(III) Documentation with functional descriptions of software-defined interfaces, conveying semantic meaning of interface elements, such as the function of a given interface field;

The FY21 NDAA calls for a DoD-level interface repository, but as of the publication of this Guidebook, a DoD-level interface repository does not yet exist. Thus, programs should maintain an interface repository in an accessible machine readable format so when the DoD level repository becomes available, program interface data can be transferred, or at minimum, a pointer to a program's interface repository can be provided for inclusion in the DoD repository.

4.6 Assess Applicable MOSA enabling standards

Programs first need to account for the DoD and DAF mandates when assessing MOSA enabling standards. Programs should also consider any Joint or International standards requirements for Joint Program or Foreign Military Sales. Programs should then assess the maturity level of MOSA enabling standards (see Section 4.6.2). MOSA enabling standards are designed to evolve over time, so program offices have the ability to influence MOSA enabling standards as they mature. A maturity assessment should also be conducted when choosing the right standards for a program. There are standards bodies and agencies that can help program offices by educating them on available standards and how they can be used. These assisting agencies are listed in Section 4.6.3. After seeking advice from standards bodies and creating a plan for standards adoptions, programs should ensure their standards choices are properly documented along with their MOSA. Each Open Standard has compliance or conformance requirements which must also be factored into test plans.

4.6.1 Identify Appropriate Mandates

The AFMC Centers may each implement MOSA mandates and requirements beyond this Guidebook, but this section will outline the DoD and DAF-level mandates for MOSA enabling standards.

In January 2019 the Tri-Service Chiefs released a memorandum titled "Modular Open Systems Approaches for our Weapon Systems is a Warfighting Imperative.[14]" The memorandum states, "MOSA supporting standards should be included in all requirements, programming and development activities for future weapon system modifications and new start development programs to the maximum extent possible." While no standard is strictly mandated, the following standards are encouraged: Open Mission Systems (OMS) / Universal Command and Control Interface (UCI), Sensor Open Systems Architecture (SOSA), Future Airborne Capability Environment (FACE), and Vehicular Integration for Command, Control, Communications, and Computers (C4) C4ISR/Electronic Warfare (EW) Interoperability (VICTORY).

At the DAF-level, SAF/AQ has released two different MOSA mandate memorandums. In October 2018, SAF/AQ released a memorandum titled "Use of Open Mission Systems/Universal Command and Control Interface.[15]" The memorandum specifies "We require all USAF programs use a Modular Open Systems Approach by implementing OMS/UCI to the maximum extent possible. Programs that are between Milestones A and B shall move to a MOSA by implementing OMS/UCI to the maximum extent practicable, as long as OMS/UCI implementation does not cause an increase in 3600 funding more than 15% over the Future Years Defense Program." The second memorandum released in August 2019 is entitled "Standardized Interface for USAF Air-to Ground Weapons: Universal Armament Interface (UAI)".[16] This mandate applies to all acquisitions of air-to-ground weapons, aircraft employing these weapons, carriage systems, and associated mission planning systems. The USAF mandates that all covered acquisitions implement UAI for new acquisitions or at the next weapon system upgrade related to air-to-ground weapons integration.

4.6.2 Assess Standards Maturity

Performing modular decomposition prior to choosing MOSA enabling standards to apply to a program allows program engineers to narrow their research of standards to those specific to the functional areas impacted by the program. Some functional areas, such as platform-to-subsystem interface, have mature standards. The FACE standard is a mature standard for platform-to-subsystem interface development that is used in safety critical weapon systems today. The OMS/UCI standards are in use by multiple USAF programs for non-safety critical subsystem-to-platform interfaces. In contrast to platform level integration standards, some functional areas have standards that are less mature and have not yet been proliferated to multiple weapon systems. EW is one functional area that has newer standards in development that are approaching hardware development or application development in different ways. It is important to ensure the pros and cons of these standards are understood so that the proper standard(s) can be selected for a program. Some important questions engineers can research when selecting standards are:

- Has leadership mandated the use or research of specific standards?
- Has the standard been applied during demonstrations similar to the needs of our program?
- Has the standard been used in any fielded systems?

- Does the organization that manages the standard have funding to support the standard's continued development in future years?
- Will this standard help increase the speed of capability insertion or modification?
- Does Industry have experience with the standard?
- Are there training materials available to provide to Program Office personnel and contractors to help them understand the standard?
- Are there available support organizations to help the Program Office understand the standard and assess contractor proposal responses?
- Is there a way for an adopting program to provide feedback and change requests to the organization that manages this standard, if gaps in the standard are identified?

Since it is unreasonable for every program to have experts in a wide variety of MOSA enabling standards, the best way to understand available standards options is to reach out to standards development bodies and DAF organizations that have established expertise in a variety of MOSA enabling standards.

4.6.3 Reach out to Standards Bodies for Subject Matter Expertise Assistance

There are two different types of organizations available to help programs assess and apply MOSA enabling standards requirements to their requests for information and proposals. The first category is organizations with a broad understanding of MOSA enabling standards that both manage standards and have an understanding of non-managed standards. The list of organizations with broad standards knowledge is below:

- 76th Software Engineering Group (SWEG): This Air Force Sustainment Center Office assists offices by providing expertise, as well as providing long term support to programs acting as a government integrator applying MOSA enabling standards. The 76th SWEG experts can be reached via their organizational email (76SWEG.MOSA@us.af.mil).
- Digital Acquisitions and Sustainment Office (DASO): The DASO is run out of the Air Force Lifecycle Management Center Armament Directorate. The DASO specializes in MOSA enabling standards and Government Reference Architectures for air-launched weapons. (AFLCMC.EBZ.DASO@us.af.mil)
- Open Architecture Management Office (OAMO): This Air Force Lifecycle Management Center Office manages several MOSA enabling standards contracts and is postured to provide guidance to offices across the DAF. The OAMO specializes in assisting programs with requirements development and assessment of contractor proposals. They also provide training for the standards maintained in their portfolio. The OAMO portfolio included control of the OMS/UCI standards, and support for the Common Open Architecture Radar Programs (COARPs) standard. The OAMO also contains subject matter experts (SMEs) involved with the Open Group, which manages the FACE and SOSA standards. For information on training events or to request assistance in developing program requirements, the OAMO can be reached via their organizational email (AFLCMC.XZ.OAMO@us.af.mil).

- MOSA Laboratory: The MOSA Lab is AFRL's team that specializes in MOSA research and development efforts. The AFRL MOSA Lab has members connected with several MOSA enabling standards efforts happening in the demonstration of advanced technologies. The MOSA Laboratory can be reached via their organizational email (AFRL.RYWA.MoastLab@us.af.mil). AFRL also has a Digital War Room SharePoint page https://usaf.dps.mil/teams/10722/DT/SitePages/AFRL-Digital-Hub.aspx.
- AFRL/RW Munitions Open Architecture Test and Evaluation Laboratory (MOATEL). MOATEL is resource for program offices within AFLCMC that maintains and is the authority for changes for the Weapon Open Systems Architecture (WOSA). The Weapon Open Systems Architecture (WOSA) will standardize the logical message construct across all future weapons, regardless of mission area or performance requirements, breaking vendor lock, and providing swift, modular, verifiable capability to the warfighter throughout lifecycles. The MOATEL provides technical expertise to program offices for acquisition strategies, and is the deliverable verification authority for WOSA and other Open Architecture artifacts. For more information on the MOATEL contact AFRL.RWWG.MOATEL@us.af.mil.

The second category of assisting agencies are agencies that manage an individual open standard or reference architecture. A list of points of contact within these agencies can be found on the Air Force Digital Guide (https://usaf.dps.mil/teams/afmcde/SitePages/Government-Reference-Architecture.aspx). Program Offices should reach out to multiple assisting agencies to get as much information on standards of interest as possible. When inquiring about requirements for standards, engineers should also ask about methods to test for compliance with and conformance to these standards.

4.6.4 Select MOSA enabling standards and Document Approach in Systems Engineering Plan and Acquisition Strategy

Per DoDI 5000.88 Section 3.4.a(3) for Major Defense Acquisition Programs, ACAT II, and ACAT III programs, the SEP will contain elements including "The MOSA and program interdependencies with other programs and components, to include standardized interface and schedule dependencies." The SEP approval authority is the only one to waive the requirement for a program to document the MOSA in the SEP. It is recommended that programs include the following information in their MOSA section of the SEP:

- High level description of system decomposition approach (Functional, Logical, etc.)
- Listing of selected standards and rationale for why they were chosen
- Identification of misalignment in any standards (if any)
- Correction plan to rectify misalignment (e.g., modification request to standards body, translation, creation of wrappers)
- Listing of standards that were not selected and why they were not chosen

Programs should document what standards were not selected so that current and future engineers working on sustainment of the system will have access to the rationale for not using these standards in the event there is a change in the MDA or overarching policy.

4.7 Assess for Compliance/Conformance with Open Interface Standards

Standards bodies use two different terms for assessing the level of implementation of a particular standard. Conformance is often a binary assessment, where a program has fully implemented all requirements of a standard to become conformant. The Open Group requires full conformance of its standards. Compliance can be partial or complete. Some standards (e.g., OMS) have different levels of compliance allowing programs to have some flexibility in the level of requirements to levy on their contractors. Programs need to ensure they have planned for what level of testing and artifact review is necessary for vendors to demonstrate compliance or conformance to elected standards. Systems Engineers should ensure that the Request for Proposal includes deliverables for artifacts with sufficient rights. Program Managers should ensure delivery of MOSA documents are spelled out in the contract at time of award. For example, programs using the OMS standard need to ensure they specify delivery of the Platform Description Document, Subsystem Description Document, or software Service Contract documentation required by the standard as well as supporting test reports showing the components procured meet OMS verification requirements. The following are key verification activities to enable successful implementation of Open Architecture:

- Documentation Validation
- Modularity Requirements Verification
- Verification and Validation of Tool Development

Testing and evaluation planning must be done to ensure the appropriate provisions are in the contract to allow successful verification throughout the program. Determining the trade space for modularity is a key first step in setting up verification early in the program. Once an understanding of key domains intended for competition, schedule, cost, and performance requirements are identified, a testing plan can be incorporated into the program acquisition strategy.

5. Major Capability Acquisition Procedures Entry/Exit Criteria & Inputs/Outputs

5.1 Acquisition Strategy

5.1.1 Entry.

- The program manager will consider open systems architecture principles at the start of the program as soon as the Milestone Decision Authority provides direction via the Acquisition Decision Memorandum (ADM), or similar document that establishes program objectives, resources, and assigns authority and accountability.

- Documented use of MOSA, specifically addressing use of existing/mandated MOSA enabling standards and applicable GRAs under the technical/engineering section and technical data rights strategy section of the written acquisition strategy. Specifically, the written acquisition strategy will contain language which addresses the program's MOSA requirements, identifies relevant modular systems, and specifies the program's IP strategy per DoDI 5010.44.
- Leverage existing sources of Acquisition Strategy Guidance. For instance the Cryptologic and Cyber Systems Division (CCSD) MOSA Implementation Guide has exemplar ASP MOSA language in Appendix A https://usaf.dps.mil/teams/aetc-lak-cpsg/directorates/hnce/Implementation Guides/Forms/AllItems.aspx.

5.1.2 Exit.

- An approved Acquisition Strategy with no critical action items

5.2 Request for Proposal

5.2.1 Entry.

- Approved acquisition strategy addressing MOSA, identifying relevant modular systems, and including required deliverables and rights.
- Exemplar SOW, SOO as well as sample language for Sections L and M can be found in Appendix A https://usaf.dps.mil/teams/aetc-lak-cpsg/directorates/hnce/Implementation Guides/Forms/AllItems.aspx.
- Example tailorable interface contractual language can be found in the Acquisition and Sustainment Data Package Contracts Guidance document (paragraph 1.2.3) https://usaf.dps.mil/teams/afmcde/SitePages/ASDP-Contracts-Guidance.aspx
- Contractor delivers an Open System Management Plan (OSMP) as part of the proposal. Refer to Data Item Description (DID) DI-MGMT-82099, Open Systems Management Plan.

5.2.2 Exit:

- Draft SEP, including MOSA and identification of authoritative source of truth. Use latest SEP outline from the OSD Engineering Resources Page (https://ac.cto.mil/erpo/).
- Documented approach on use of open architectures (see Digital Guidebook reference 11.10) as system requirements in the Statement of Work (SOW)/Performance Work Statement (PWS) and System Requirements Document (SRD).

5.3 Systems Requirements Review/Systems Functional Review

5.3.1 Entry:

- Approved Information Support Plan (ISP) or SEP that addresses MOSA, applicable GRAs, use of digital engineering, and deliverables and rights.

- Approved SRD that addresses MOSA standards and requirements identified to the appropriate levels, such as, levels 1, 2, or 3 of the work breakdown structure.
- Approved SOW/PWS that addresses MOSA standards and requirements identified to the appropriate levels such as, levels 1, 2, or 3 of the work breakdown structure.
- Approved Modular Systems and Key Interfaces are identified and documented to support MOSA.
- Non-MOSA Interfaces are captured with rationale.
- Identified GRAs used and MOSA standard(s) applied at each Modular System Interface, as appropriate.
- Identified test methodologies to verify compliance with MOSA standard(s).
- Note, a best practice is to have the contractor deliver an updated Systems Engineering Master Plan (SEMP) and digital model at each review or significant event (if using agile development practices). Refer to DI-SESS-81785 for SEMP and DI-SESS-82364 for a Digital System Model.
- Per DAFI 63-113 Programs will employ a Modular Open Systems Approach into program protection review and analysis to the maximum extent possible.

5.3.2 Exit:

- Approved SRR/SFR minutes.
- Government validates list of MOSA and non-MOSA interfaces.
- Government grants waivers for specific non-MOSA interfaces.

5.4 Preliminary Design Review (PDR)

5.4.1 Entry.

- Identified Modular System Interfaces along with MOSA standard(s) required at each Modular System Interface.
- Defined Interface Control Documents (ICD)/Application
- Application Programming Interfaces (API) for Modular System Interface(s).
- Completed appropriate draft documentation or digital model for ICDs/APIs. For example, if OMS is the standard at the Modular System Interface, then the documentation would include such items as the mission package, service contract, the platform description document, etc.
- Updated SEP/SEMP with updated information on architecture and deliverables and rights.
- Lab and System test plans/procedures and artifacts were presented to the MDA, where applicable, that show MOSA implementation is compliant or conformant with the standard chosen and briefed at SRR/SFR.
- Note, a best practice is to have the contractor deliver an updated SEP and digital model at each review or significant event (if using agile development practices).
- Per DAFI 63-113 Programs will employ a Modular Open Systems Approach into program protection review and analysis to the maximum extent possible.

- Draft Contractor OSMP with appropriate verification and architecture analysis completed. (Architecture analysis preferred in a MBSE Format)

5.4.2 Exit:

- Approved PDR Minutes.
- Government approves contractor OSMP.

5.5 Critical Design Review

5.5.1 Entry.

- Completed ICDs/APIs for Modular System Interface(s).
- Updated System Specification to include identified interfaces (MBSE format is the preferred option for this deliverable).
- Update SEP/SEMP interfaces, architecture, and identified deliverables and rights for components (e.g., Line Replaceable Units or Shop Replaceable Units).
- Initial Draft of Test Plans and Procedures for lab testing and flight/ground testing requirements for modular systems.
- Completed ICD/API documentation.
- Completed test artifacts, where applicable, showing MOSA implementation is compliant with the standard(s) chosen and briefed at PDR.
- Per DoDI 5000.83_DAFI 63-113 Programs will employ MOSA methods and practices in program protection review and analysis to the maximum extent possible.

Note: a best practice is to have the contractor deliver an updated SEP and digital model at each review or significant event (if using agile development practices).

5.5.2 Exit:

- Approved CDR minutes.
- Government approves contractor OSMP.

6. Middle Tier Acquisition Procedures Entry/Exit Criteria & Inputs/Outputs

Middle Tier Acquisition Procedures Entry/Exit Criteria & Inputs/Outputs situated between the acquisition pathways of "urgent" and "tailorable traditional DoDI 5000.02," Middle Tier Acquisition (MTA) pathway is for programs that house mature prototypes from government and industry that should not require much additional development to begin production. MTA is intended to fill a gap in the defense acquisition system (DAS) for those capabilities that have a level of maturity to allow them to be rapidly prototyped within an acquisition program or fielded within 5 years of MTA program start. MTA provides a means to accelerate capability maturation before transitioning to another acquisition pathway or may be used to minimally develop a capability before rapidly fielding. Programs can take advantage of MTA for pre-Milestone C activities.

As part of the MTA approval process, leadership determines if a capability warrants one of three acquisition courses of action: rapid prototyping, rapid fielding, or both. With rapid prototyping, programs must field a prototype that can be demonstrated in an operational environment, and also ensure operational capability within five years of an approved requirement. Shorter development times may prohibit full implementation of MOSA enabling standards in a MOSA.

The rapid fielding designator, which inserts proven technologies into the field, requires production to begin within six months, and fielding to be completed within five years of an approved requirement. MTA programs should consider the maturity of available MOSA enabling standards and select from mature standards used on fielded systems, if time allows for application of such standards in their acquisition strategy. Contact the support organizations in Section 4.6.3 for assistance.

6.1 Middle Tier Acquisition Strategy

6.1.1 Entry.

- MTA programs are required to create an Acquisition Strategy. The Acquisition Strategy should include the MOSA details in a similar manner to a Major Capability Acquisition.
- For programs expected to exceed the MDAP dollar threshold and prior to the obligation of funds, USD(A&S) prior written approval is required to use the MTA pathway.

6.1.2 Exit.

- An approved Acquisition Strategy with no critical action items.
- Transition Plan, included as a part of the Acquisition Strategy, which provides a timeline for completion within 2 years of all necessary documentation required for transition. Since a quick development time may not leave enough time for programs to feed changes back to standards organizations, the Acquisition Strategy and Transition Plans should include plans for feeding changes back to standards organizations during sustainment. Future upgrades should include MOSA details, build on lessons learned, and keep the program aligned with evolving standards.
- Test Strategy, per paragraph 3.1.c. of the DoDI 5000.80 policy, the Components need to develop a process resulting in a test strategy or an assessment of test results, included in the acquisition strategy, documenting the evaluation of the demonstrated operational performance, to include validation of required cybersecurity and interoperability as applicable. The strategies will reflect these interoperability elements commensurate with the rapid prototyping or fielding program's purpose.
- The Program Manager is encouraged, to “tailor in” and streamline MOSA considerations, reviews, assessments, and other relevant documentation and information to align with the Urgent Capability Acquisition approach and remain consistent with the guidance for MTA in paragraph 2.6.b., DoDI 5000.80. Per DoDI 5000.80, paragraph 4.1.a, the

Decision Authority (DA) will approve MTA program documentation within their purview. Per footnote 4 and 5, the DA determines all necessary documentation required for transition. encourages Program Managers will “tailor- in” reviews, assessments, and relevant documentation that results in an acquisition strategy customized to their program's unique characteristics and risks for presentation to the DA for approval.

- Detailed OUSD(R&E) MOSA Engineering considerations for Urgent Capabilities will be addressed in a future iteration of the Engineering of Defense Systems Guidebook. Office of the Deputy Director for Engineering, Office of the Under Secretary of Defense for Research and Engineering. The most current version of this guidebook is February 2022.

6.2 Rapid Prototyping

6.2.1 Entry

- A signed Acquisition Decision Memorandum (ADM).
- For systems above the threshold as defined in Section 2302d of Title 10, U.S.C. (see further DoDI 5000.80, Table 1. MTA Entrance Documentation Deliverables):
- Approved Requirement
- Acquisition Strategy
- Cost Estimate
- Program Manager should evaluate and implement MOSA where feasible and cost-effective, explicitly addressing the use of MOSA enabling standards, applicable GRAs, relevant modular systems, and any associated data rights.
- Implementing MOSA for the rapid development of technology provides greater flexibility to insert new capabilities that provide a technological advantage to the warfighter. Moreover, MOSA provides the ability to separate the development of higher-risk prototype components and subsystem technology maturation efforts from the major system platform development efforts. MOSA is generally used to facilitate modularity in MDAP platforms in the traditional MCA pathway by maturing advanced technologies.

6.2.2 Exit.

- Using MOSA for MTA rapid development, prototyping, and experimentation of weapon system components or other technologies, including those based on commercial items and technologies, separate from acquisition programs of record, enables innovation and encourages competition when employing a modular design and open architecture, along with an open business model to facilitate incremental, modular development. In the MTA pathway, MOSA enables PMs to focus on developing more rapidly evolving technologies internal to the system.

- In accordance with DoDI 5000.80, S&T managers and lead systems engineers will provide a determination of program protection planning and implementation risks and mitigation as part of the design and technical risk assessment process.

In accordance with DoDI 5000.80, S&T managers and lead systems engineers will ensure operators are informed of the operational risks when the system is fielded.

6.3 Rapid Fielding

6.3.1 Entry

- A signed Acquisition Decision Memorandum (ADM).
- For systems above the threshold as defined in Section 2302d of Title 10, U.S.C. (see further DoDI 5000.80, Table 1. MTA Entrance Documentation Deliverables):
- Approved Requirement
- Acquisition Strategy
- Cost Estimate
- Lifecycle Sustainment Plan
- Implementing MOSA for the rapid fielding of proven technologies in new or upgraded systems is beneficial when minimal development is required. MOSA facilitates the development of modularly upgradable systems with flexible architectures, where designs can be competitively reconfigured, or technologically refreshed to respond to evolving or unstable conditions in the environment in which the system operates.

6.3.2 Exit.

- Adopting a modular technical design and an open system approach enables competition, platform independence, and reduces vendor lock. Additionally, hardware and software interfaces should use widely supported consensus-based standards that are appropriately defined and disclosed. This implementation of MOSA can provide operational flexibility to meet rapidly changing operational requirements and address emerging commercial technology, maturing technology from government labs, technology from defense prime research and development efforts, and technology from small business innovation research solutions. Additionally, employing modular open system architectures that include modular systems, standardized modular system interfaces and open specifications affords systems technical flexibility to field incremental updates and deploy new capabilities to the warfighter.
- In accordance with DoDI 5000.80, S&T managers and lead systems engineers will provide a determination of program protection planning and implementation risks and mitigation as part of the design and technical risk assessment process.
- In accordance with DoDI 5000.80, S&T managers and lead systems engineers will ensure operators are informed of the operational risks when the system is fielded.
- Update to Lifecycle Sustainment Plan, specifically including a defined pathway for MOSA-enabled evolution.

7. Software – Agile Process

DoDI 5000.87 specifies that programs using a Software Acquisition Pathway design "architecture strategies to enable a modular open systems approach that is interoperable with required systems." The MOSA for Software Acquisition programs should focus on the interfaces of software modules. The Program Office should strive to apply messaging standards between software modules or acquire data rights to the information passed between modules. Logical and functional decomposition of software elements are an integral part of the MOSA strategy for software acquisition programs (see Section 4.2.2 and 4.2.3). Ensuring proper functional decomposition of embedded software inside weapon systems also supports the creation of the Functional Thread Analysis, which is part of Airworthiness requirements for airborne weapon systems. Programs shall use Agile development processes per DoDI 5000.87. Software development programs should focus on ensuring their interfaces are captured in a machine-readable format to comply with the FY21 NDAA Section 804c requirement discussed in Section 3.2.

Appendix A: References

1. 10 USC Subtitle A, PART V, Subpart F, CHAPTER 327, Subchapter I: Modular Open System Approach in Development of Weapon Systems https://uscode.house.gov/view.xhtml?path=/prelim@title10/subtitleA/part5/subpartF/chapter327/subchapter1&edition=prelim
2. Public Law Number 115-92, National Defense Authorization Act for Fiscal Year 2020. https://www.congress.gov/bill/116th-congress/senate-bill/1790
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18. Contracting for Verifiable Modular Open Systems, SAF/AQ Memo, Mar 2019.