Integrating Business and Engineering Strategy Through Modular Open Systems Approach

Cyrus Azani ■ *Col. Kenneth Flowers, USA*

The Modular Open Systems Approach is an integrated business and engineering strategy to maintain the superiority of U.S. military forces within tightening budget constraints and the unprecedented rate of technological change. MOSA makes possible the effective application of business practices and successful engineering of systems through exploitation of technological change and by providing the capability to easily and effectively reconfigure and integrate systems into integrated and interoperable joint warfighting systems of systems. Leveraging the commercial industry investment on new technologies, practices, and products results in a faster response to technological change. Adaptive and agile open and modular architectures for systems and systems of systems facilitate the effective integration of systems into larger meta-systems. Generally speaking, MOSA supports program teams in the acquisition community to:

- Reduce development cycle time and product support costs
- Design for affordable reconfiguration, modernization, and change
- Effectively integrate and/or retrofit earlier increments with later increments within an evolutionary acquisition context
- Develop agile, robust, and adaptive systems and integrated architectures needed for assembling a joint, network-centric, and reconfigurable force.

MOSA Policies and Directions

The main Department of Defense MOSA policy and directions are stated in DoD Directive 5000.1; an under secretary of defense (acquisition, technology and logistics) directive dated April 4, 2004; and an instruction memorandum by the director of defense systems (AT&L) dated June 7, 2004.

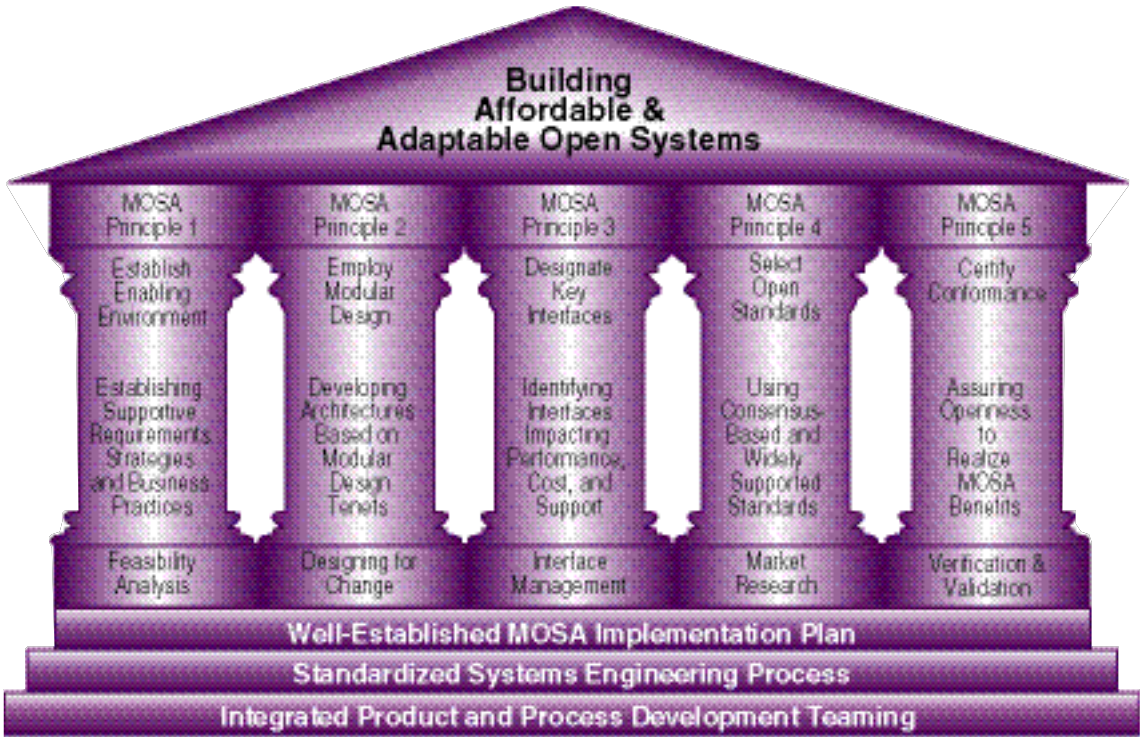
DoDD 5000.1 directs all acquisition programs to employ MOSA as part of their application of systems engineering.

The USD (AT&L) memorandum directs Services to develop a coordinated business and technical approach to MOSA across their respective programs to progress toward joint integrated warfare. It also designates the Open Systems Joint Task Force (OSJTF) as the DoD lead for MOSA and directs the task force to establish and chair the MOSA review team to synchronize MOSA implementation across the Services and DoD agencies to leverage open systems benefits across joint integrated warfare systems. It further directs all programs subject to milestone review to brief their MOSA implementation status to the milestone decision authority.

The effectiveness of MOSA is largely determined by the degree to which it is an integral part of a sound systems engineering process.

The director of defense systems instruction memorandum describes how requirements stated in the USD (AT&L) directive should be addressed for systems and systems of systems in the formal acquisition process. Based on the instruction, acquisition programs should address MOSA early in their program and acquisition planning and discuss MOSA implementation in the context of their overall acquisition strategy and, to the extent feasible, in their technology development strategy. The memorandum in-

Azani is Northrop Grumman senior systems engineer providing technical support to the Open Systems Joint Task Force since 1996. He holds a doctorate in systems engineering and engineering management. Flowers is director, Open Systems Joint Task Force.



structs program managers to use either the MOSA program assessment and rating tool (PART), which is an adaptation of the Office of Management and Budget tool for rating programs across the federal government, or an equivalent method of assessment to generate objective data on MOSA implementation progress.

Planning for MOSA Implementation

MOSA implementation should be based on upfront planning and initiated early in the program and acquisition planning. The essential elements and the supportive technical and business practices needed to develop affordable and adaptable open systems are depicted graphically above. Needed are an integrated product and process development (IPPD) team approach; application of sound systems engineering processes; and development of a MOSA implementation plan that, at a minimum, addresses the following five fundamental principles (discussed in detail later):

- Identify and analyze capabilities and strategies that could most effectively be pursued by open systems design solutions
- Assess the feasibility of open systems design solutions
- Establish metrics/tools to assess MOSA implementation progress
- Use MOSA principles to develop an open architecture
- Establish a procedure to identify and resolve MOSA implementation issues and report the unresolved issues to Milestone Decision Authority.

The effectiveness of MOSA is largely determined by the degree to which it is an integral part of a sound systems engineering process. Programs and contractors are encouraged to use popular systems engineering standards (EIA 632, ISO 15288, IEEE 1220, for example) as the foundation for applying MOSA. The preferred strategy for applying these standards and implementing MOSA is to employ an IPPD team composed of government and industry representatives and, at a minimum, including those who specify, design, build, test, operate, and maintain DoD systems. Team responsibilities include selecting standardized systems engineering processes and establishing a plan for implementing MOSA. Other responsibilities are overall coordination of MOSA-related activities and ensuring effective implementation of MOSA principles. The MOSA implementation plan is a roadmap with specific objectives, tasks, principles, and milestones for putting MOSA into practice.

Pinpointing MOSA-enabled Capabilities and Strategies

Identifying specific operational and performance capabilities and strategies that could be enabled by open systems design is an important MOSA planning activity. There are many acquisition strategies, operational capabilities, and performance requirements that lend themselves to the use of open systems in a program, among them:

- Evolutionary acquisition and spiral development
- Requirements that place great emphasis on long-term sustainment and affordability
- Capability to constitute and reconfigure functionally compatible forces and systems
- Seamless, high speed, digital information exchange among diverse warfighting elements
- Overarching capabilities for a mission area that form a system of systems
- Application of an integrated approach for adding future capabilities and advanced technologies with minimum

impact on existing systems
- Modular contracting strategies.

Open Systems Design Feasibility

The MOSA is not a panacea, and programs shouldn't blindly follow the concept. Programs should make a business case for implementing open systems solutions after carefully analyzing capabilities and strategies contained in capability development documents and their acquisition strategy to ensure they lend themselves to the development of an open architecture. They may use a dynamic business case analysis model and apply market research findings to evaluate the appropriateness and feasibility of open systems. Business case models should take into consideration evolving capability requirements and the changes in technology to evaluate the total life-cycle costs of designing the system as an open rather than a closed system. Programs should use market research and analysis to identify technologies, standards, and compliant products needed to develop an open system.

DoD programs must address MOSA early in the program and acquisition planning processes to expedite and maximize MOSA benefits.

Tools to Assess MOSA Implementation Progress

Programs can either develop their own assessment tool or apply the MOSA PART to gauge their MOSA policy compliance. The MOSA PART is an analytic tool that evaluates responses to a set of interrelated questions to provide acquisition program executives with an objective, evidence-based assessment of the degree to which the MOSA has been implemented by programs. The degree of such compliance is presented in terms of a set of MOSA implementation questions or indicators related to each of the five fundamental MOSA principles. Besides indicators that measure the degree of adherence to MOSA principles, the tool also contains instructions for use; program assessment information; an introduction to MOSA; a section on definitions; and the assessment report and overall score generated in real time by the responses. The MOSA PART can be reviewed and downloaded at <www.acq.osd.mil/osjtf/html/whatsnu.html>.

A Closer Look at MOSA Principles

Principle 1—Establish an enabling environment

This principle lays the foundation for successful implementation of subsequent principles. To adhere to this principle, PMs must establish MOSA-supportive requirements; business practices; technology development, acquisition, test and evaluation; and product support strategies. PMs should also assign responsibility for MOSA implementation; ensure appropriate MOSA experience and training; conduct market research; establish MOSA-specific performance measures; and proactively identify and remove barriers or obstacles that can undermine effective MOSA implementation.

Principle 2—Employ modular design

Effective modular design is contingent upon adherence to four major modular design tenets that determine the degree to which modules are cohesive (contain well-focused and well-defined functionality); encapsulated (hide the internal workings of a module's behavior and its data); self-contained (do not constrain other modules); and highly binded (use broad modular definitions to enable commonality and reuse).

Principle 3—Designate key interfaces

To effectively manage hundreds—in some cases, thousands—of interfaces that exist within and among systems, designers should group key and non-key interfaces. Such distinction enables designers and configuration managers to distinguish among interfaces; between technologically stable and volatile modules; between highly reliable and more frequently failing modules; between modules that are essential for net-centricity and those that are not; and between modules that pass vital interoperability information and those with least interoperability impact.

Principle 4—Select open standards

In order to take full advantage of modularity in design, interface standards must be well-defined, mature, widely used, and readily available. Standards should be selected based on maturity, market acceptance, and allowance for future technology insertion. As a general rule, preference is given first to the use of open interface standards, second to the de facto interface standards, and finally to government and proprietary interface standards. Basing design strategies on widely supported open standards increases the chance of integrating future changes in a cost-effective manner.

Principle 5—Certify conformance

Openness of systems should be verified, validated, and ensured through rigorous and well-established assessment mechanisms, well-defined interface control and management, and proactive conformance testing. The PM, in coordination with the user, should prepare such validation and verification mechanisms as conformance certification and test plans to ensure that the system and its component modules conform to the external and internal open interfaces. This will enable plug-and-play of modules, net-centric information exchange, and reconfiguration of mission capability in response to new threats and technologies.

Identifying and Resolving MOSA Implementation Issues

The instruction memorandum stipulates that the MOSA implementation issues be identified and addressed through the integrated product team process and presented as issues to the MDA only when unresolved at a lower level. Examples of such issues are:

- Harsh environment within which a system must operate (e.g., excessive humidity or temperature extremes)
- Rigid requirements that call for design-specific solutions
- Absence of open standards or widely supported compliant products
- Very expensive test mechanisms
- Unforeseen performance or operational requirement changes that limit open systems development.

DoD programs must address MOSA early in the program and acquisition planning processes (at the concept and technology development phase) to expedite and maximize MOSA benefits. Concept studies should consider open systems implications on total ownership costs and development cycle time of alternative solutions. Moreover, if solutions call for commercial-off-the-shelf product use, system developers must ensure that the interfaces to such products remain open. Technology development projects should also, from the outset, identify the key interfaces between technology-embedded products to ensure continuing access to such technologies throughout the system life cycle.

The authors welcome comments and questions. Azani can be reached at cyrus.azani.ctr@osd.mil and Flowers at kenneth.flowers@osd.mil.