NDIA SE Division Architecture Committee MOSA Project Status

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Architecture Committee Progress 2017

- **Membership up to 32 total members, representing 15 Govt. and industry organizations**
- **Bi-Weekly Meetings**
- **(New) Access to Mitre Shared Storage Repository for NDIA SE Arch. Committee**
- **Developing MOSA (Modular Open Systems *Approach*) Body of Knowledge**
  - Extensive MOSA Source Material
  - Upcoming White Paper
  - NDIA SE Division Conference Presentations (2) by Comm.
  - Subsequent Artifacts & Reviews (incl. SE BoK Section)

In the National News – Aug 3, 2017

Pat Shanahan, the newly installed deputy secretary of defense overseeing the reorganization of the former chief weapon buyer into two new positions, said **speed and rapid enhancement of existing systems with emerging technologies** is a personal goal.

He will be pushing from the top of the acquisition structure for **requiring that new weapons and systems be capable of accepting "rapid enhancement,"** Shanahan told defense reporters during an Aug. 2 roundtable at the Pentagon.

"I think about the guys who have a Tesla and overnight while you're sleeping a software upgrade comes along and the car gets smarter or fixes a quality problem," he said. "Not everything is about a software update. **How can we be more modular? Can we do plug-and-play?**"

Ref: "New Acquisition Structure Emphasizes Rapid Tech Insertion Through Open Architecture"
Defense Daily 08/03/2017
Author: Dan Parsons

Questions/Thoughts Our Work Could Address:

1. **Is it hard for people to conduct MBSE?**
   a. If so, why?
   b. Can we use an architecture framework to do MBSE?
   c. What techniques in MBSE will capture metrics?
2. **How to judge quality of modularity for Open Systems in ACAT-I programs?**
3. **How to populate a taxonomy (Scheme of Classifications) under the metadata of a model?**
4. **How does one create a high-level architecture under the constraints of MOSA?**
   a. What are MOSA constraints?
   b. Are they constrains or considerations part of the normal design process in complex systems. MOSA may be an enabler rather than a constraint.
5. **What Systems Thinking is involved in partitioning a system?**

Questions/Thoughts Our Work Could Address:

6. **Our Architecting Committee should think of MBSE as an enabler, but focus our efforts on Architecting.**
7. **How does automation influence architecting?**
8. **Model-Based Engineering has been done in silos: MBSE is different in that it's a collective endeavor**
9. **What does the digital environment look like for a system architectural-type model? (will depend on the context; i.e., ship vs. Jeep vs. airplane versus subsystem, assembly, software module, etc.)**
10. **What enabling technology, standards, and methods should be employed?**
    a. Are these very different depending on level in the system. e.g. Battle Force versus a software module in a system?

Questions Our Work Could Answer (Cont.):

11. (Is Re-Use of models a worthy objective for this committee? Would a model repository be useful? How would a repository be used by the acquirer & supplier communities?)
12. Should a lower-level standard (below MIL-STD-881C) be created to define the lower-level taxonomies?
13. What common framework(s) should the NDIA SE Arch. Committee recommend to enable re-use?
14. Where is the role of functions addressed in the Open Systems approach?
15. Standards (IEEE-15288, and others (list needed), tools, taxonomies, and frameworks) – How are these used to facilitate implementation of MOSA?
16. How would MOSA be supported in a MBSE or Digital Engineering Environment?
17. What are the rules set and value indicator(s) of quality?

MOSA White Paper Outline

(References to be Cited Where Available)

- **Objectives of MOSA (Ref: Phil Zimmerman Briefing/Perspective)**
  - Cost Reduction
  - Inter-operability
  - Technology Refresh
  - Innovation
  - Increased Competition
- **Additional Benefits of MOSA**
  - Producibility
  - All Additional ilities
  - Multi-Mission Adaptability (e.g., Product Line Approach)
  - Benefits not limited to just weapon systems:
    - LVC can benefit
    - Computational prototype environments can benefit

MOSA White Paper Outline (Cont.)

- **System Depositions and Design Level Consideration**
- **Modularity (e.g., Technical Side of MOSA)**
  - Influences of Interoperability Needs
  - Types of Modularity
  - Partitioning
  - Interfaces
    - Openness of Interfaces
    - Types of interfaces (e.g., Electrical vs. Software)
  - Metrics of Modularity
- **Openness (e.g., Business Side of MOSA)**
  - Data Rights
  - Intellectual Property
  - Systems
    - Physical Data Model Openness
    - Point-to-Point Protocols Openness
    - Distributed (i.e., Data Bus) Interface Openness
  - Software & Digital Environment
    - Conceptual/Behavioral Data Model Openness
    - Logical Data Model Openness
  - Influence of Standards
    - Well Defined vs. Closed
  - Metrics of Openness

MOSA White Paper Outline (Cont.)

- **Managing a MOSA Environment**
  - Government Perspective (i.e., government's interest in saving money)
  - Contracting Community Perspective (i.e., contractors' business model and need to generate a profit)
  - Balancing both perspectives for a Win-Win situation
    - Government vs. Contracting Community
    - Govt recognizing the need for a strong contractor supply base and contractors' recognizing MOSA-enabled opportunities from not only sustaining but growing their business models; how each can win under these conditions
  - Influence of Defining MOSA differing requirement/challenges at various levels in the SoS (e.g. Battle Force versus Software Module): Quantifying MOSA
  - Methodology for Measuring MOSA
    - Value Judgments of Modularity and Openness
- **Architecting for Modularity**
- **Acquisition Lifecycle (e.g., Acquirer) vs. Technical Life cycle (e.g., Contractor / Supplier)**

MOSA White Paper Outline (Cont.)

- **Government Ownership of the Technical Baseline (GOTB)**
  - Effects of Model-Based Systems Engineering / Documentation
    - Data Item Description of Model-Based Documentation
    - Configuration Management of the Baseline via the Model Database vs. Paper-Based Technical Specifications
  - Impact on MOSA: Configuration Management and Future Development
- **Positions**

  <Need a framework of areas (system partitions) that have standard definition (e.g., FACE) for consideration of a MOSA implementation>
    - Standard interface definitions for major subsystems (e.g., Radar, Comm, Nav, etc.)
- **Examples of Existing MOSA Implementations**
- **Recommendations by NDIA SE Architecture Committee**
- **Appendix**
  - Background/History of MOSA
  - Influences of Standards
    - ISO/IEC/IEEE-42010 Architecture Description
    - ISO/IEC/IEEE-42020 Architecture Processes
    - ISO/IEC/IEEE-42030 Architecture Evaluation
    - MIL-STD-881C

MOSA and Interoperability

- **Open and Modular Design &/vs. Interoperability**
  - How is Interoperability a Benefit of MOSA?
  - Interoperability Considerations
    - SoS Elements (e.g. Between warfighting units in a mission, between C4ISR systems, between intra-platform systems, between software modules (APPs), etc.)
    - Mission Focus: SoS Focus, Subsystem Focus, Software focus? Different Interoperability and Modularity requirement/opportunities at different levels in the Joint Force SoS.
    - Deterministic Participants
    - Unanticipated Participation
  - How Interoperability Benefits from MOSA
    - Interoperability needs to occur at all levels of the Joint Force SoS. Management becomes the issue at different levels of the SoS in that control of the interfaces is always a management challenge especially as you go up in system levels. (JITC controls/tests communications links between Joint Units. Inter-module communications within the software of a particular system is generally within the purview of the individual PM). Proper partitioning of the system into various system/subsystem modules is critical to interoperability.

- **Interoperability is a Legacy of Open Systems Design-Level Thinking (e.g., Open Interfaces at the Bus Level)**
  - Vision of Interchangeable Systems Across Services
  - Emergence of Coordinated Services
  - Question as to Whether MOSA Addresses the Interoperability Problem
    - Interoperability occurs at the interfaces between the modules or interchange of modules. Modules can be a ship or a software applications and the requirements, management challenge, and issues vary greatly depending upon system level.

Back-up / Reserved

MOSA - Additional Considerations

- **Various Perspectives & Goals**
  - Verifying Openness via *Fully Documented and Disclosed* ICDs *and/or* Logical or Physical Data Model (Interface Definitions are Key Data Source)
  - Balanced Management Approach (Govt's goals against Industry's goals) Needed for MOSA Success with goal of benefiting both perspectives
  - Time frame is long-term in achieving a mutually-beneficial outcome
    - Standards processes are long and hard
  - Technology needed to accommodate the new technologies
  - Significant goal of acquirer is to encourage innovation, cost savings, and broader use by industry
  - Significant goal of supplier is to achieve increased market share / new business / expanded product line
  - Good stakeholders' analysis must be part of the process (e.g., deny red team innovations while enhancing blue team)

Defining and Scoping via Questions

- **Questions our work could potentially answer; e.g.:**
  - Phil Zimmerman's Question: "What **program examples** can we bring forward where MOSA/ OSA was implemented?"
  - MOSA Terminology
  - MOSA Bibliography/ Resource list
  - MOSA Maturity Metric, e.g.
    - Measuring key MOSA drivers like:
      - Modularity of an Architecture: Partitioning Criteria (e.g., partitions leading to appropriate number of interfaces or minimized complexity of information exchange in interfaces.)
      - Openness of an Interface
      - Goodness of a program's MOSA management plan
      - Etc.
  - What is the Scope of the Architecting Effort?
    - Is Modularity (system and software partitioning) and Open standards just part of the Architecting/Design process like Survivability, Availability, Affordability, Complexity Management, Upgradeability and Operability? All of these may influence Module definition (partitioning) and open standards.
  - How do we define the levels of an architecture (taxonomy currently established by MIL-STD-881C; Guidelines Used as Basis for Cost Estimating and Establishing Line Items Used for an Acquisition Budget)?
    - What Taxonomic Breakdowns are standardized within the services below the MIL-STD-881C level? e.g. the ESWBS (Electronic Ship WBS) at NAVSEA and Air WBS in NAVAIR? How are these lower levels managed, updated and maintained?
    - MIL-STD-881C is monitored by CAPE (Cost Estimating Organization that monitors and maintains)
  - What standards and modules are involved?

Possible White Paper Recommendations / Factors for Recommendations

- **MOSA community must identify measures for openness and modularity.**
  - NDIA Arch. Committee planning to define Openness and Modularity measures
  - Metrics (e.g. for Openness) can ultimately lead to a minimum level of adherence in order to "Check the Box"
  - Ref: Body of work by NCOIC (Network-Centric Operations Industry Consortium) was done to support metrics concepts. They produced a model called SCOPE. (Hans Polzer was a key contributor)
- **Identify what "goodness" means for MOSA**
  - Thresholds for modularity
  - Thresholds for openness
  - Boundaries between open levels of a system and closed levels.
- **New way of thinking needed for working in digital (or non-paper-based) environments**
  - Run reports in tools against current technical baseline
  - Digital artifacts to evaluate the baseline (i.e., technical means of communication and cohesion).
  - Determine the "digital usefulness" of the architectural products
    - Question validity of certain DoDAF views
    - Role of functions, activities, interface exchange requirements, and other architectural elements (i.e., architectural content). – not traditional documents that constitute a review milestone.
    - Architectures need to show up in the specifications
  - Teach the language of the architectural frameworks (i.e., what to call the content of today's specs.)
- **Need to stay at the "Architectural Level" rather than dive into the detail design**
- **Need to define what we mean by "Architecture" (i.e., how is it different or the same as model, simulation, etc.) Ref: Tom Murphy's paper**
  - Other misused terms are: T&E, M&S, V-V&A

Recommendations

- Implement MOSA when a desired outcome is to
  1) avoid cost (e.g., appropriately applied re-use conditions) or
  2) save cost over a system lifecycle (e.g., system upgrades and functionality improvements)
- Don't implement MOSA for the sake of MOSA
  - Can lead to unintended consequences and more expensive outcomes, such as added cost to support development of a re-usable design which is expected to never be re-used.
- Maintain a library of MOSA-compliant designs
  - MOSA is Contributing to Standardizing Re-Useable Modules
- Implement MOSA as part of a larger and more robust Digital Engineering strategy
  - MOSA is Contributing to Model-Based Documentation via Capturing Functional and Physical Design
- Levels of Detail Need to Be Defined in the SoS, with MOSA Call-outs Explicitly Made for Each Level
  - MOSA Guidance cannot be generalized; it is dependent upon the design level of interest. Potential levels of consideration are Joint Force, Service-Unique, followed by Platform or Machine/System Level (Ref: MIL-STD-881C)
  - For purposes of this MOSA analysis and white paper, the government has primary interests at the higher levels of the SoS while the contracting/supplier community has primary interests at the platform or Machine/System Level and below.
- Incorporate MOSA in Technical Reviews
  - Evaluate Levels of Conformance to 1) Modularity and 2) Openness
    - Possibly use model for openness of interfaces
    - KOSS: "How-to" of Modularity – Subjective Guidance for modularity in system architecture

Potential Examples of Successful MOSA Application to Programs

- **F-35 Program (AF): Avionics Bus (IEEE-1394 Commercial Std. Open Bus was selected)**
  - Ref: Ed Moshinsky
  - What about the data standard (data model)?
- **ARCI (Navy)**
  - Ref: Ed Moshinsky
- **Ship Building Examples**
  - Ref: Tom Murphy's Material E-Mailed Earlier)
- **Victory (Army)**
  - Ref: Tom Murphy and Steve Welby Briefing to NDIA
- **FACE: Future Airborne Capability Environment Applications**
  - Ref: Tom Murphy
- **Unmanned Systems (OSD)**
  - Ref: Jane Orsulak
- **MIL-STD-881C Applications**

New Thought Items (Committee concurred with points 1 – 4 on June 14, 2017):

1. The challenge for any architecture is realizing robust agility in a design today to anticipate the future needs.
2. Architecture elements may require future opening of interfaces that cannot be anticipated today.
3. There is a limit to how far down the OA can be realized.
4. Open architectures cost more and likely take longer to develop in the beginning of a program than more tailored designs. Program and budgetary planning needs to account for this.
5. A Discussion on Open Systems Architecture: https://insights.sei.cmu.edu/sei_blog/2015/11/a-discussion-on-open-systems-architecture.html

Ideas Backlog for Arch. Committee Focus

1. **Bridging Requirements to the System Architecture/ Design via Functional Analysis**
   - Functions and the Functional Architecture are very critical elements of SE are not solidly defined in any education I've seen.
   - Functions/Functionality are necessary to bridge the requirements with the system design. Because of this, every person and/or organization has their own best practices, almost an art, and bridging the FA/SA between organizations is like trying to pass along different dialects.
   - If there was a best practices (guide) that could be shared, then organizations which have critical deliverables based around either a FA or a SA could talk easily among each other. Another benefit of a best practice guide is that a system architecture can be done once for one "-ility" such as reliability, and then shared with another "-ility" with ease.
   - I'm not sure if the (former) committee ever pursued that idea.

     - Submitted by: Agan, Kevin S CIV USARMY RDECOM ARL (US) kevin.s.agan.civ@mail.mil April 25, 2017

Ideas Backlog for Arch. Committee Focus

2. **Model Portability and MOSA: Goal is to enable rapid start-up and implementation of system architectures based on valid library models**
   - Physical architecture of system
   - Partition levels
   - Interfaces
   - Models
   - Level of detail
   - Challenge: Achieving MOSA compliance but with model portability
   - Functional and Physical Architecture Alignment
   - MIL-STD-881C Levels of Detail Should be Implemented
     - i.e., 3 levels, 4 levels, 5 levels, etc. of detail
   - Software CSCI's are different (e.g., can be defined in ways that are not optimum)

Mission Integration Requirements

- **The Secretary of Defense shall establish mission integration management activities for each mission area specified in subsection (b).**
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- **(b) COVERED MISSION AREAS-The mission areas specified in this subsection are mission areas that involve multiple Armed Forces and multiple programs and, at a minimum, include the following:**
- **(1) Close air support.**
- **(2) Air defense and offensive and defensive counter-air.**
- **(3) Interdiction.**
- **(4) Intelligence, surveillance, and reconnaissance.**
- **(5) Any other overlapping mission area of significance, as jointly designated by the Deputy Secretary of Defense and the Vice Chairman of the Joint Chiefs of Staff for purposes of this subsection.**
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- **(c) QUALIFICATIONS-Mission integration management activities shall be performed by qualified personnel from the acquisition and operational communities.**
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- **(d) RESPONSIBILITIES-The mission integration management activities for a mission area under this section shall include-**
- **(1) development of technical infrastructure for engineering, analysis, and test, including data, modeling, analytic tools, and simulations;**
- **(2) the conduct of tests, demonstrations, exercises, and focused experiments for compelling challenges and opportunities;**
- **(3) overseeing the implementation of section 2446c of title 10, United States Code;**
- **(4) sponsoring and overseeing research on and development of (including tests and demonstrations) automated tools for composing systems of systems on demand;**
- **(5) developing mission-based inputs for the requirements process, assessment of concepts, prototypes, design options, budgeting and resource allocation, and program and portfolio management; and**
- **(6) coordinating with commanders of the combatant commands on the development of concepts of operation and operational plans.**
-
- **v/r,**
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