Practical Software and Systems Measurement

Objective Information for Decision Makers

Measuring Modularity and Openness

19 September 2019

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Measuring Modularity and Openness

BACKGROUND

Modular Open Systems Approach (MOSA)

Objective: To design systems with highly cohesive, loosely coupled, and severable modules that can be competed separately and acquired from independent vendors

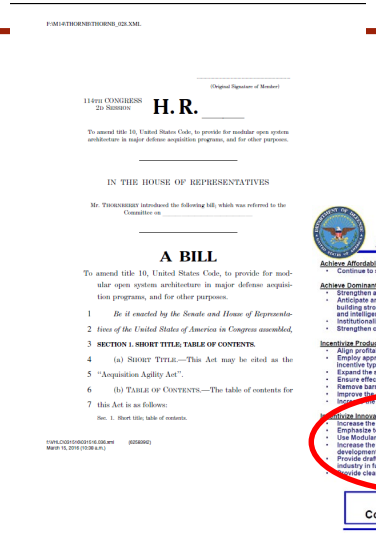
- **Allows DoD to acquire warfighting capabilities, including systems, subsystems, software components, and services, with more flexibility and competition.**
- **MOSA implies the use of modular open systems architecture, a structure in which system interfaces share common, widely accepted standards, with which conformance can be verified.**

An integrated business and technical strategy to achieve competitive and affordable acquisition and sustainment over the system life cycle

Source: *ODASD Systems Engineering website:* https://www.acq.osd.mil/se/initiatives/init_mosa.html

Drivers for MOSA Adoption

- **Acquisition Reform driving Openness into DoD acquired systems**
  - National Defense Authorization Act required implementation of MOSA for major DoD acquisitions by 2019
- **DoD is implementing on Major Defense Acquisition Programs (MDAP)**
  - Driven by rapid evolution in technology and threats that require much faster cycle time for fielding and modifying warfighting capabilities
  - MOSA can accelerate and simplify incremental deliveries of new capabilities into systems.
- **DoD has developed guidance for acquiring "open" systems**


114TH CONGRESS
2D SESSION

H. R. _____

To amend title 10, United States Code, to provide for modular open system architecture in major defense acquisition programs, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

A BILL

To amend title 10, United States Code, to provide for modular open system architecture in major defense acquisition programs, and for other purposes.

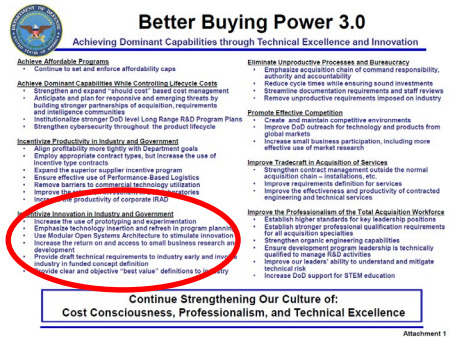
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

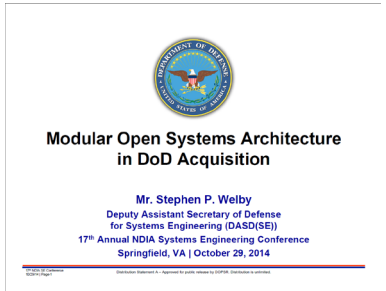
SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

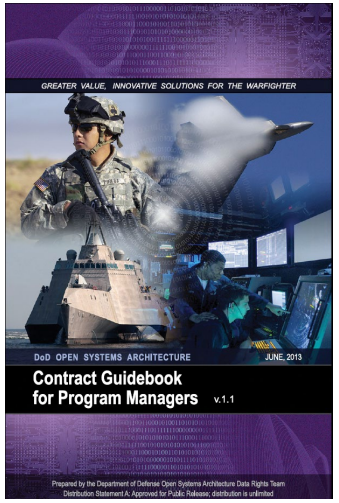
(a) SHORT TITLE.—This Act may be cited as the "Acquisition Agility Act".

(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

Sec. 1. Short title; table of contents.

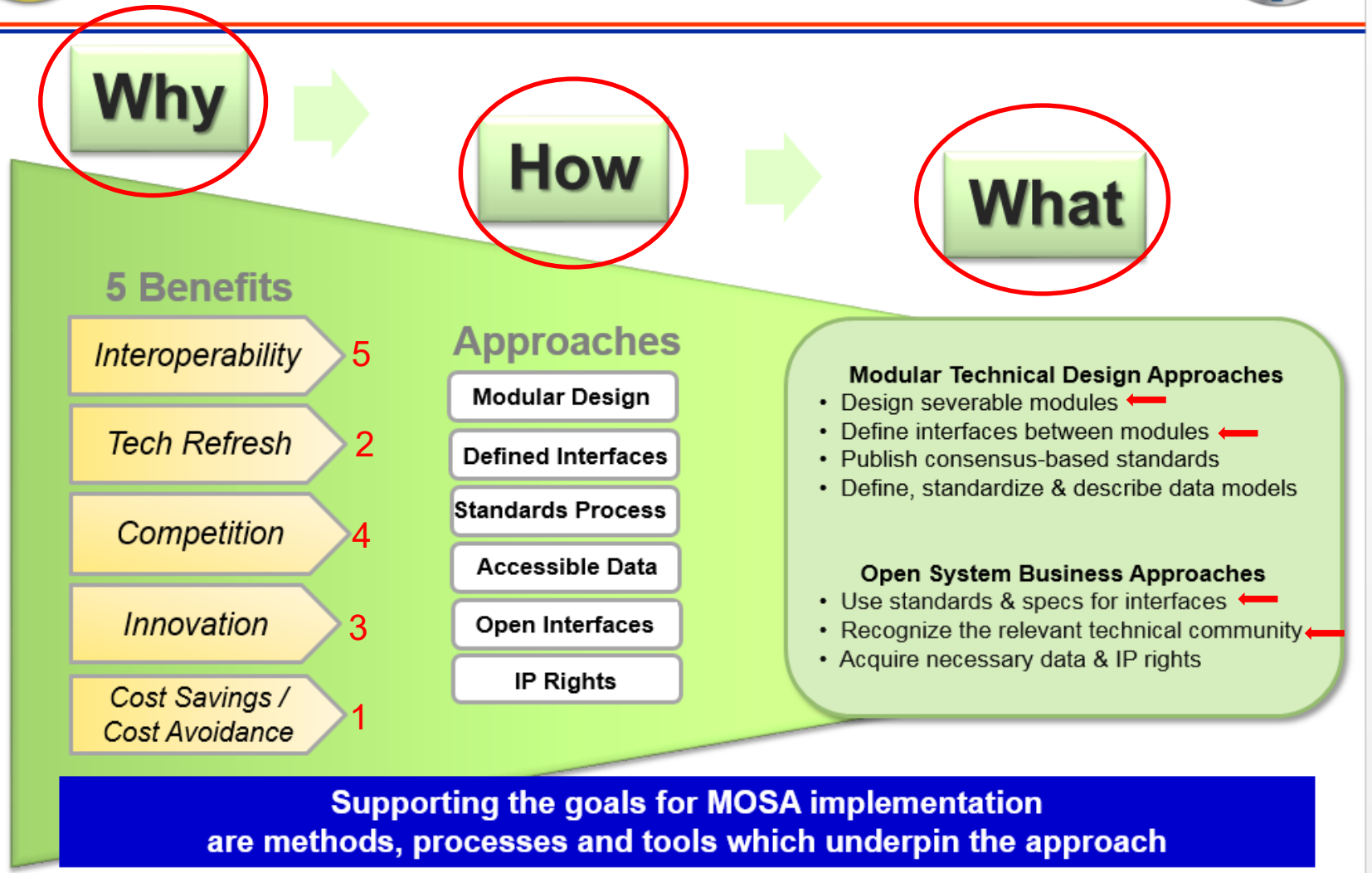






Source: *Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee* www.incose.org/symp2018

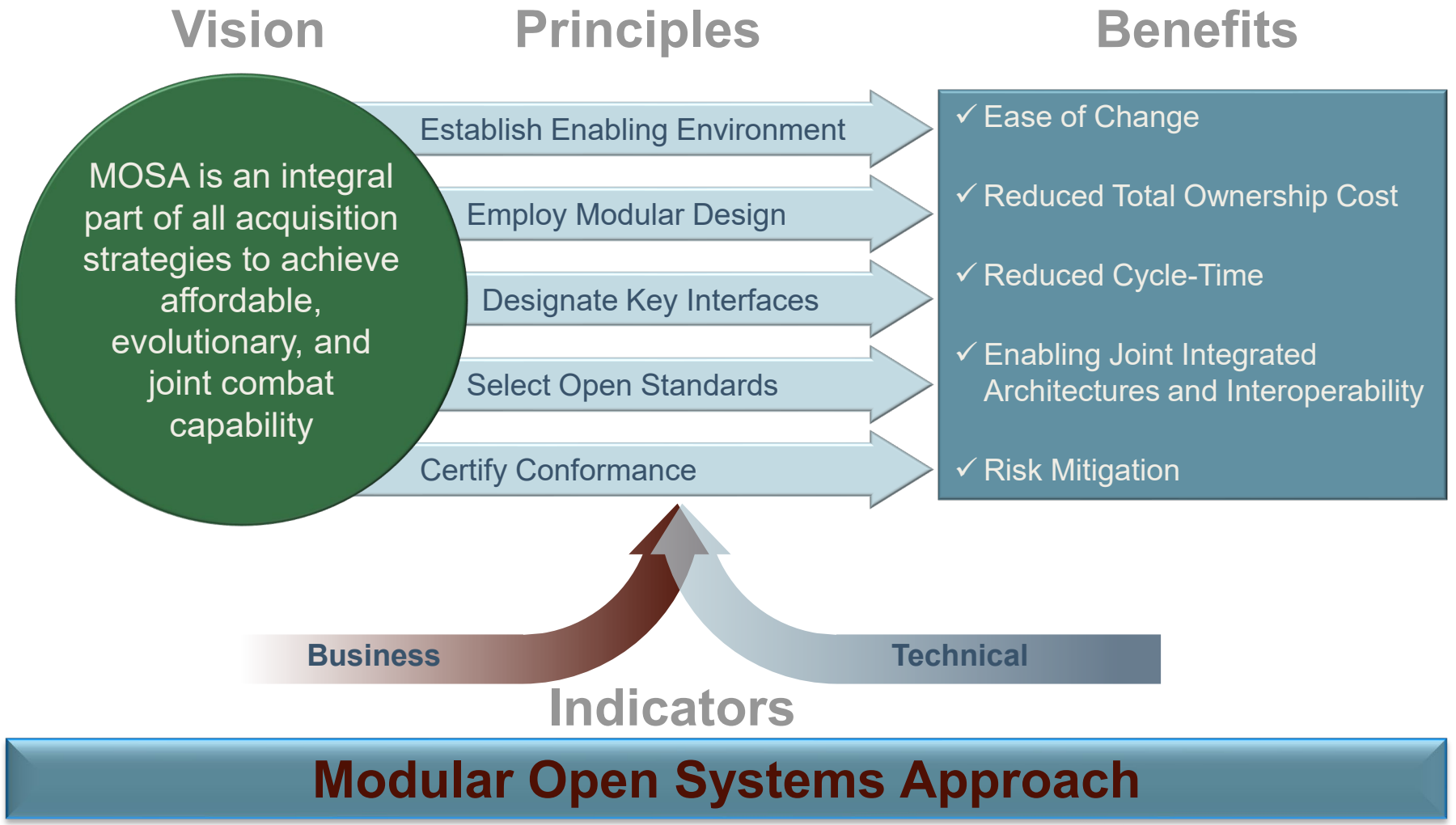
Modular Open Systems Approaches



Key MOSA Implementation Questions

- How can we measure Modularity of an Architecture?
- What are ways of measuring Openness of Interfaces?
- How do we maintain balance between Gov't ownership of Data Rights/ IP and Contractor investments?

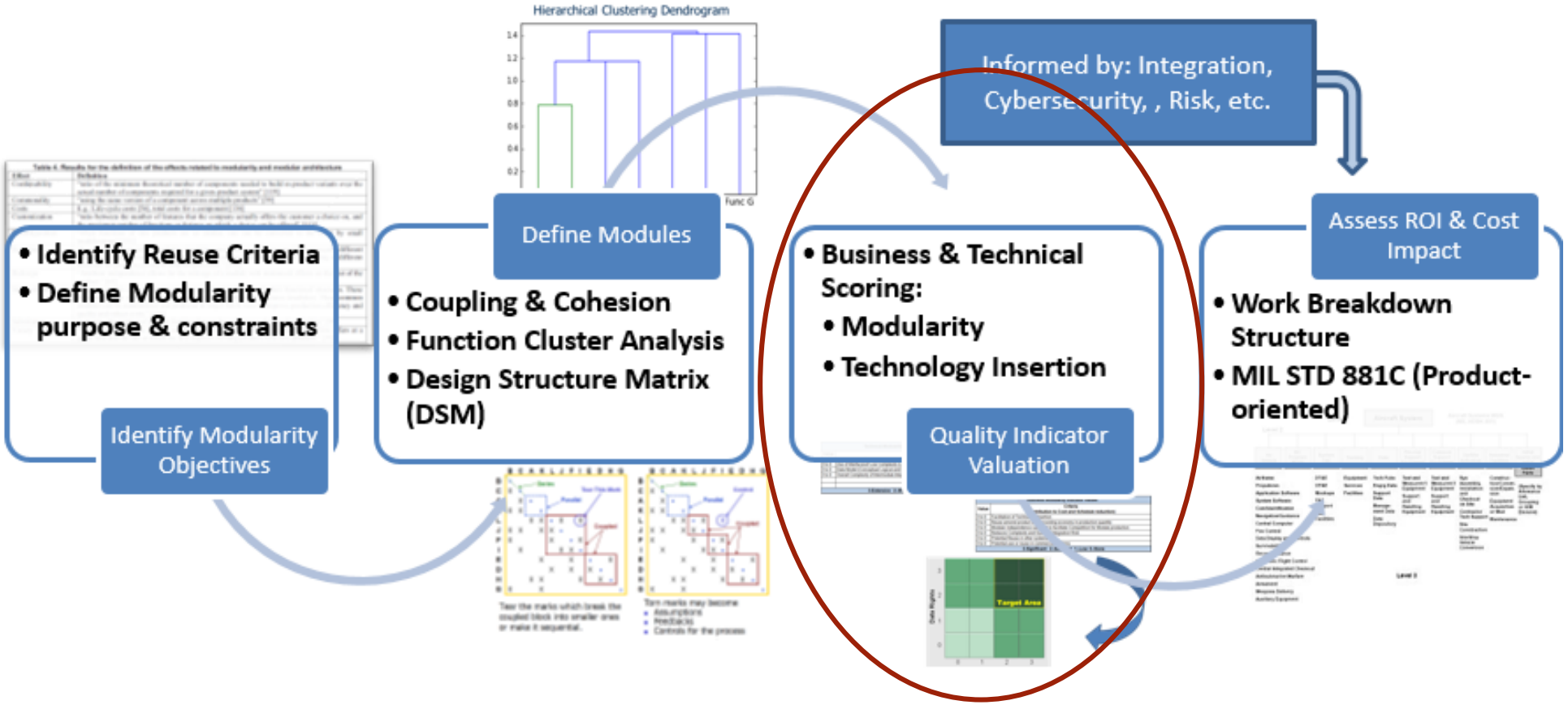
Guidance to Gov't PMs (Capture & Execution)



Source: Program Manager's Guide: A Modular Open Systems Approach (MOSA) to Acquisition, Sept. 2004

Key MOSA Concepts

Methodology Concept – Acquiring/ Developing a MOSA solution



Source: Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee www.incose.org/symp2018

Key MOSA Concepts (1 of 2)

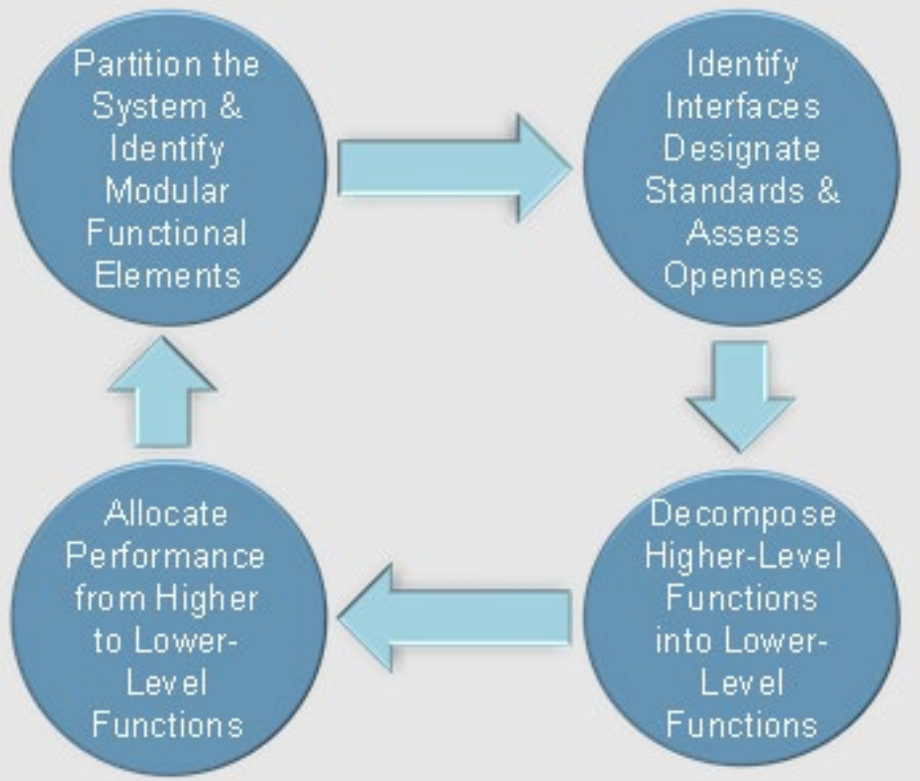
Openness of Interfaces

- **Business Aspects of Openness**
  - Intellectual Property (IP) and Data Rights
  - Balancing the Government's desire to own the technical baseline with the Contractors' need to create IP and profits
- **Technical Aspects of Openness**
  - Interfaces among System Elements
    - Standards-Based or
    - Well-Defined/ Fully Disclosed
- **Openness Measures are critical**

Key MOSA Concepts (2 of 2)

Architecting for Modularity

- **Iterative & Recursive Architecture Design Process**
  - Results in an architecture partitioned into Modules
- **Architecture partitioning factors**
  - Disciplined definition of functional partitions
  - High Cohesion: Minimizing inter-partition dependencies
  - Loose Coupling: Functionality can be easily broken away from the rest of the architecture to enable change
  - Open Interfaces: Connect the Modules to each other
  - Technology insertion opportunities: Enabling ease of change; focus on critical/ most quickly changing areas
  - Measures of Cohesion and Coupling; how do we do this?



MEASURING OPENNESS

An Approach to Measuring Openness of each Architectural Interface

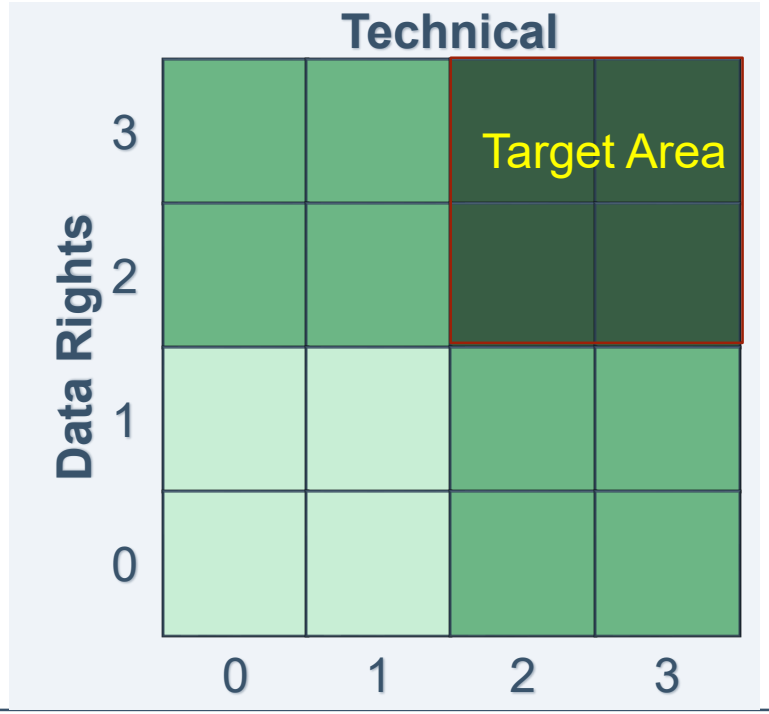
Business (Data Rights) Openness Values

Value	Criteria
3	Unlimited data right available with no IP claims
2	Government proposed data rights available
1	Proprietary interfaces with negotiated data rights
0	Proprietary interface with no data rights assessment

Technical Openness Values

Value	Criteria
3	Commercial or DoD Standard
2	Fully disclosed with well-defined and documents design (e.g. program interface ICD)
1	Proprietary interface with good documentation (e.g. MS APIs)
0	Undisclosed Proprietary interface

- Triplets [Physical layer, logical layer, data right]
- Example MilStd-1553 with a program specific message set
- Would evaluate to [3,2,3] Average the first two values when placing on a two dimensional matrix



Inspired by Open Architecture Assessment Model (see backups)

Measurement Challenge

Measurement methodology measures only individual interface openness

- **Still need to measure openness of the module (system element)**
  - Coupling – the degree to which the elements inside a module belong together
  - Cohesion – the relationship of or degree of dependence of one module to another module

- **A numerical value calculated from the # of interfaces and individual openness ratings**
  - Addresses both coupling and cohesion

MEASURING MODULARITY

Proposed Measurements

- NDIA approach similar to openness measurements
- Technical dimension and business dimension

Technical Modularity Quality Indicator Values	
Value	**Criteria**
3 to 0	Use of Loosely Coupled Interfaces between Modules
3 to 0	Use of Interfaces of Low Complexity (Logical and Physical)
3 to 0	Use of Data Model (Conceptual Logical and Physical) in Interface design and documentation
3 to 0	Overall minimization of Complexity of Inter-module Integration
3-Extensive 2--Moderate 1--Low 0--None	

Business Modularity Indicator Values	
Value	**Criteria (Contribution to Cost and Schedule Improvement)**
3 to 0	Facilitation of Technology Insertion
3 to 0	Reuse amonst product lines providing economy in production quantity
3 to 0	Modular independence sufficient to facilitate Competition for Module production
3 to 0	Reduces Complexity and Systems Integration Risk
3 to 0	Potential Reuse in other systems
3 to 0	Potential use or reuse in commercial systems
3-Significant 2--Moderate 1--Low 0--None	

Tables from: *Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee* www.incose.org/symp2018

An Approach to Measuring Modularity

Business Modularity Indicator Values	
Value	**Criteria (Contribution to Cost and Schedule reduction)**
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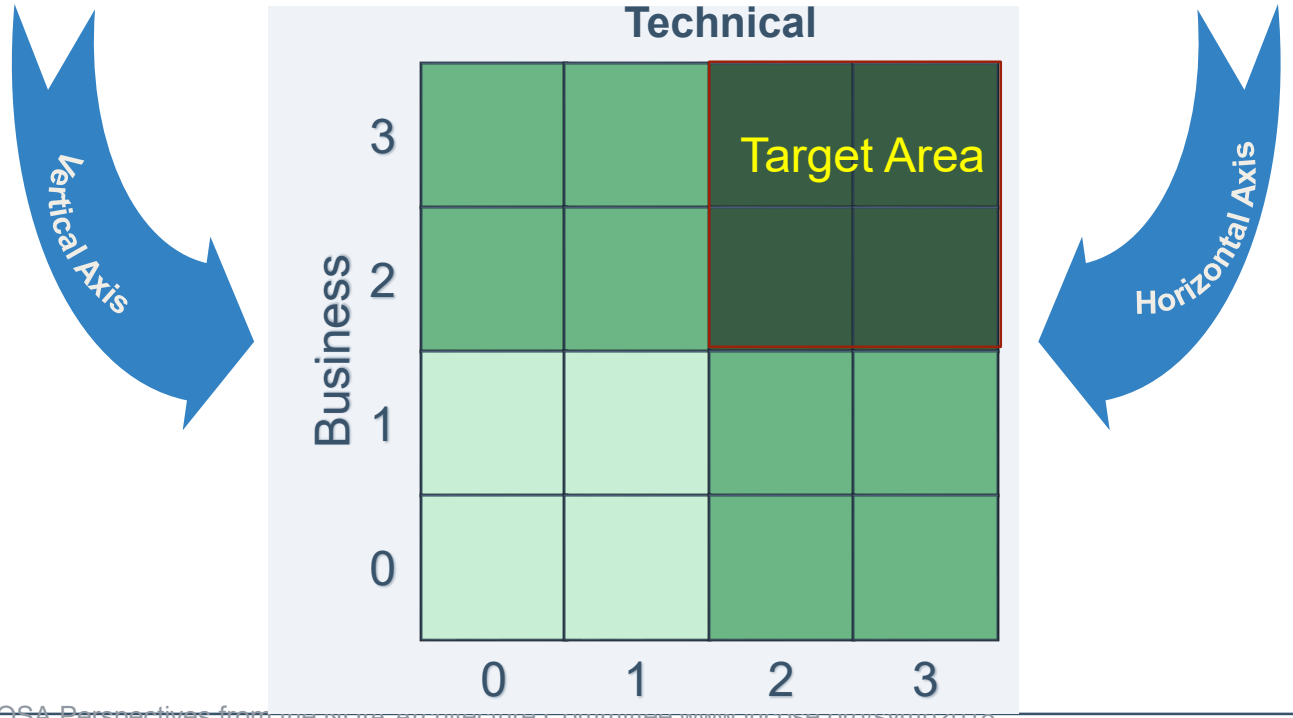

Source: Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee www.incose.org/symp2018

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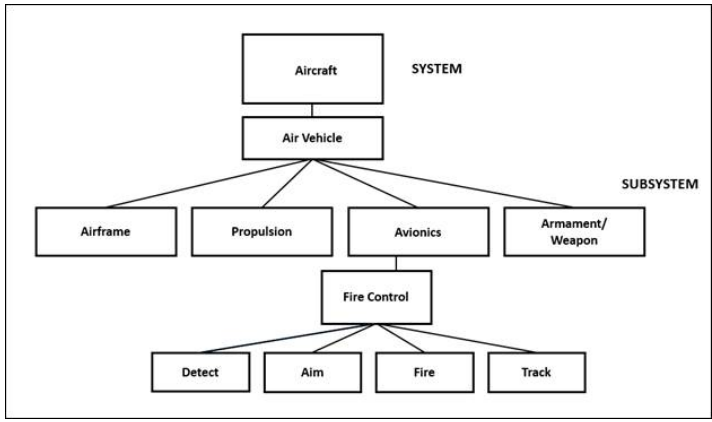
An Alternative

- **Use the factors in the tables in a standard K-T trade**
  - Factors are weighted by the Government Program office
    - Prior to contractor designs
- **Allows Government to prioritize the factors for each program**
- **Alleviates issues related to driving multiple factors into a two dimensional space**
- **Additional ideas welcome**

Criteria	Weight	Score (0-3)	Weighted Score
Technical *3-Extensive 2--Moderate 1--Low 0--None*			
Use of Loosely Coupled Interfaces between Modules			
Use of Interfaces of Low Complexity (Logical and Physical)			
Use of Data Model (Conceptual Logical and Physical) in Interface design and documentation			
Overall minimization of Complexity of Inter-module Integration			
Business *3-Significant 2--Moderate 1--Low 0--None*			
Facilitation of Technology Insertion			
Reuse amongst product lines providing economy in production quantity			
Modular independence sufficient to facilitate Competition for Module production			
Reduces Complexity and Systems Integration Risk			
Potential Reuse in other systems			
Potential use or reuse in commercial systems			
Total	100	---	

Modularity Challenges

- **System Group/ Taxonomies Considerations (from the NDIA Architecture Committee)**
- **The legislation specifies two different MOSA requirements sets for two different levels of operational systems.**
- **Propose considering MOSA requirements at three tiers or Groups:**
  - Group 1 – Mission Tier (Platform-to-Platform Interfaces)
  - Group 2 – Acquisition Tier (Major System-to-Major System Interfaces)
    - Focus on guidance found in Mil-STD 881 Work Breakdown Structures for Defense Materiel Items
  - Group 3 – Software (Computer Programs)
    - Unique requirements regarding definition of and control of interfaces, partitioning, and modularization;
    - Mil-STD-881 addresses software as CPCIs with the taxonomy to be defined by the designer
    - This is an area requiring further study



Group 2 – Acquisition Tier example

Source: Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee www.incose.org/symp2018

Sources

- Moshinsky, Edward, Challenges to Implementing MOSA for Major DoD Acquisition Programs, October 26, 2017
- Moshinsky, Edward, *Challenges to Implementing MOSA Perspectives from the NDIA Architecture Committee,* 28th Annual INCOSE International Symposium, July 7, 2018
- Moshinsky Edward, MOSA - Key Points for Implementation from the NDIA Architecture Committee, October 24, 2018
- Open Systems Joint Task Force, Program Manager's Guide: A Modular Open Systems Approach (MOSA) to Acquisition, Version 2.0, September 2004
- Zimmerman, Philomena, *Using the 5 Benefits of a Modular Open Systems Approach (MOSA) to Choose Enablers*, 19th Annual NDIA Systems Engineering Conference, October 26, 2016

About the Presenter

Paul Kohl is a FEAC Certified Enterprise Architect and System of Systems Information System Architect with Lockheed Martin Space. He has 30 years of system engineering experience in multiple domains and has been working with model based engineering techniques since 1998. He has held multiple engineering and architecture leadership positions on programs and proposals including chief engineer, chief architect, and engineering program manager and served as a model based engineering consultant to multiple program and customers.