Get the Most Out of MOSA: Begin With the End in Mind

Dr. Steven A. Davidson
Chief Scientist for Systems Architecture

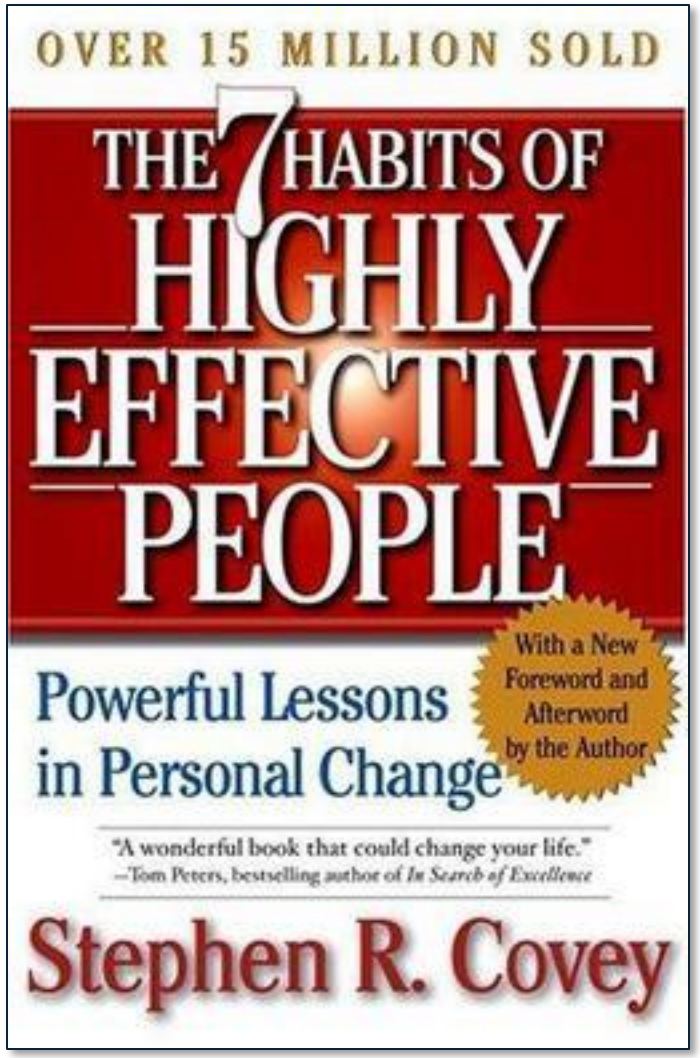
September 18, 2023

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD™

Advice from an Expert

1. **Be proactive**
2. **Begin with the end in mind**
3. **First things first**
4. **Think win-win**
5. **Seek first to understand, then to be understood**
6. **Synergize**
7. **Sharpen the Saw; Growth**

Envision what you want in the future so you can work and plan towards it… To be effective you need to act based on principles… All things are created twice. Before we act, we should act in our minds first. Before we create something, we measure twice. This is what the principle is about. Do not just act; think first…



Why We Create an Architecture First

If you don't know where you are going, any road will get you there

- Lewis Carroll in *Alice's Adventures in Wonderland*

"Would you tell me, please, which way I ought to go from here?"

"That depends a good deal on where you want to get to," said the Cat.

"I don't much care where–" said Alice.

"Then it doesn't matter which way you go," said the Cat.

"–so long as I get SOMEWHERE," Alice added as an explanation.

"Oh, you're sure to do that," said the Cat, "if you only walk long enough."

MITRE

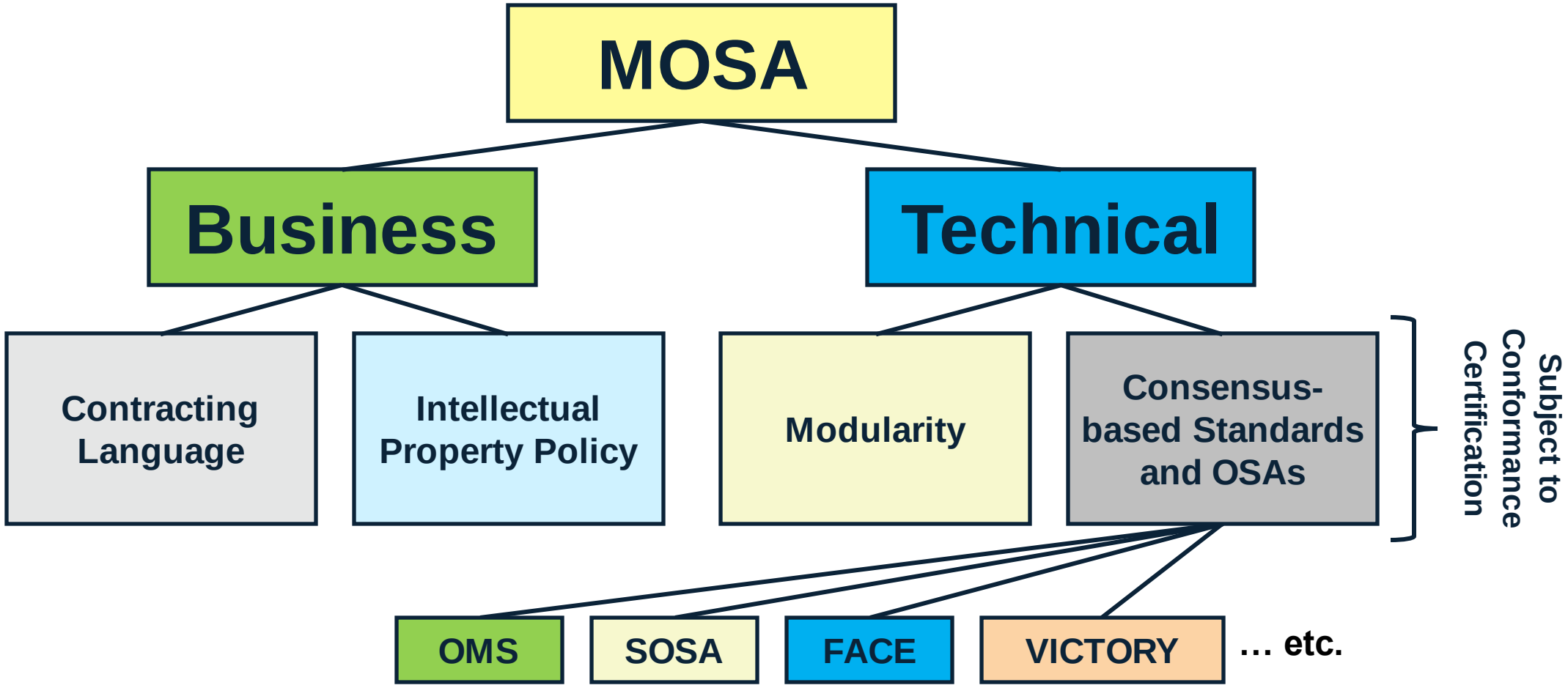
Modular Open Systems Approach

"An integrated **business and technical** strategy that employs a **modular design** and, where appropriate, defines key **interfaces** using **widely supported, consensus-based standards** that are published and maintained by a recognized industry standards organization."

- A Modular Open Systems Approach (MOSA) to Acquisition, Open Systems Joint Task Force (OSJTF), September 2004

Decomposing the Modular Open Systems Approach

"… an integrated business and technical strategy …"



Derived from "SOSA 101"

Benefits to Government

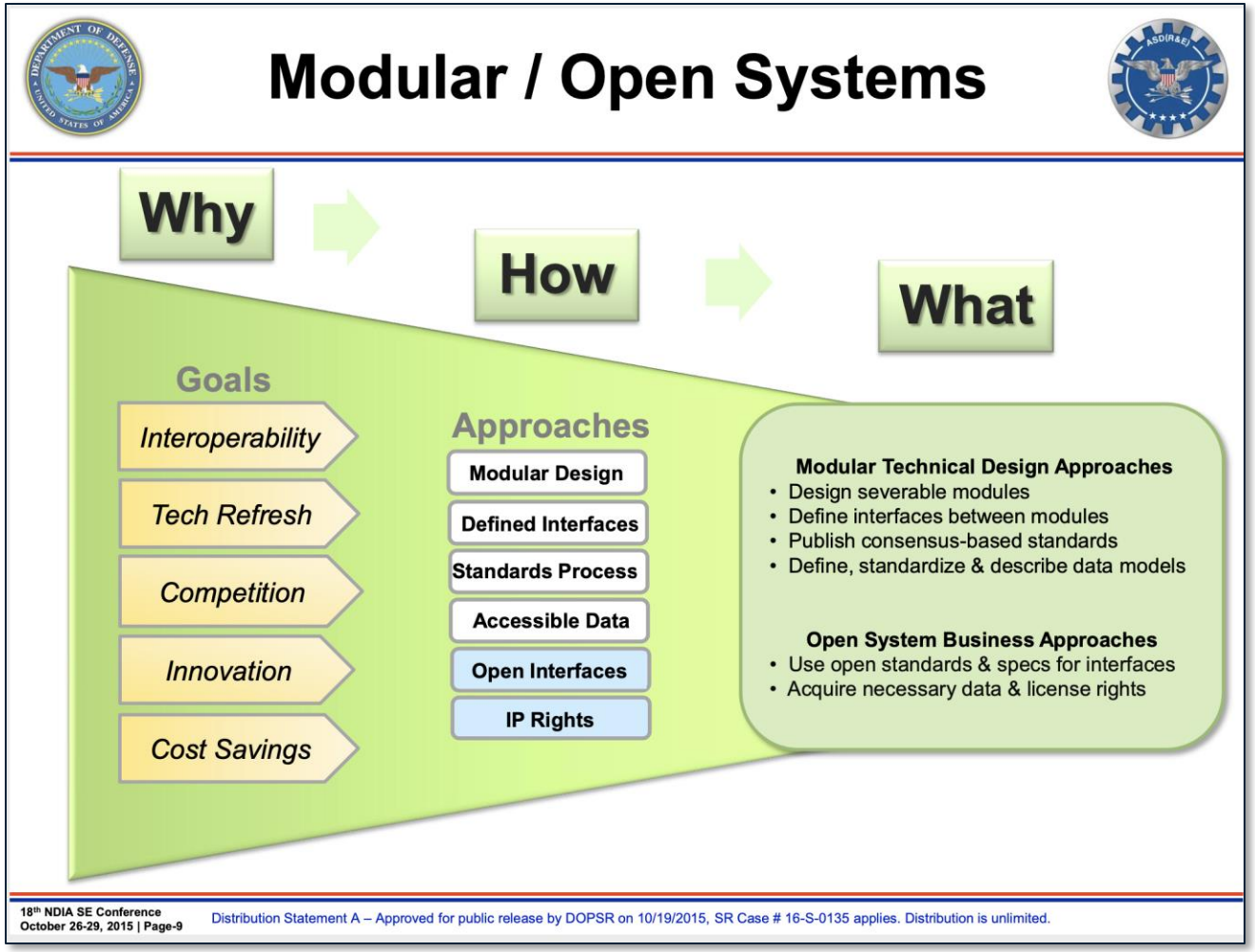
Improve interoperability – severable software and hardware modules that can be changed independently.

Facilitate technology refresh – delivery of new capabilities or replacement technology without requiring change to all elements in the entire system.

Enhance competition – open architecture with severable modules, allowing elements to be openly competed.

Incorporate innovation – operational flexibility to configure and reconfigure available assets to meet rapidly changing operational requirements.

Enable cost savings/cost avoidance – reuse of technology, modules, and/or elements from any supplier across the acquisition life cycle.



MOSA is a Win-Win for Government and Industry

Government (Acquirer)

Faster/more efficient and more cost-effective acquisition

- Adherence to the NDAA'17 MOSA mandate
- Standardized system composition, known interfaces
- Easier tech transition

Improved Lifecycle and supportability

- Commonality and reuse of components across systems
- Tech insertion (new capability)
- Tech insertion (obsolescence)

Interoperability and interchangeability

- Between systems
- Within systems
- Across DoD deployed Product Families

Industry (Provider)

Reduces development cost, risk and time

- Leverage proven modular decomposition
- Leverage known interface definitions (no need to invent)
- Leverage standards-based tooling

Creates opportunities for strategic sourcing

- COTS vendors
- Small businesses and non-traditional suppliers can integrate components into prime systems

Facilitates Product Family Development

- Base Product Family Architectures on the Reference Architecture
- Leverage inherent composability, reuse
- Provides incentives for R&D investment

MOSA Means Changes to the Acquisition Process

- MOSA doesn't just happen. It requires:
  - Assertive government commitment and oversight so vendors don't dictate the design direction
  - Strong accountability for the **relevant** technical baseline of the key interfaces (physical and logical)
  - A MOSA systems engineer "champion" with responsibilities and authorities

- Government has **more** to do and **less** to do
  - More to do:
    - Preparation: Clearly understanding the MOSA landscape
    - Planning the lifecycle (which is where you get the most MOSA bang for the buck)
    - Framing the acquisition so that suppliers understand the MOSA objectives
  - Less to do:
    - RFP specification: You don't need to specify the design – convey OSA and intent – key interface specification
    - Babysitting the developer: They must adhere to the OSA and pass Conformance testing (not a substitute for DT/OT)
    - Haggling over IP: MOSA provides a framework

MOSA Acquisition Approach: What's Different

- Call out modularity with well-defined/key-interfaces (verified at interface level)
  - Contracting language must stipulate adherence to MOSA – clearly state what matters
- The focus in a MOSA-enabled RFP is on describing how the OSA fits into the acquisition
  - Don't need to inundate supplier with minute requirements (no "wall of shalls") – let the OSA do it
- Contracting language protects Intellectual Property
  - Doesn't mandate rights of content inside module (Gray Box Concept – coming up)

Architecture vs. Design

Modules

Interfaces

Acquirer

Architecture: "The fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution*"

Provider

Design: The result of transforming requirements into specified characteristics or into the specification of a product process or system**

It's an instantiation of the architecture — and there can be multiple designs that conform to the same architecture

---

* From ISO/IEC 42010 - IEEE Std 1471-2000 "Systems and software engineering — Recommended practice for architectural description of software-intensive systems

** Based on ISO 9000:2005 – "Plain English Definitions"

Derived from "SOSA 101"

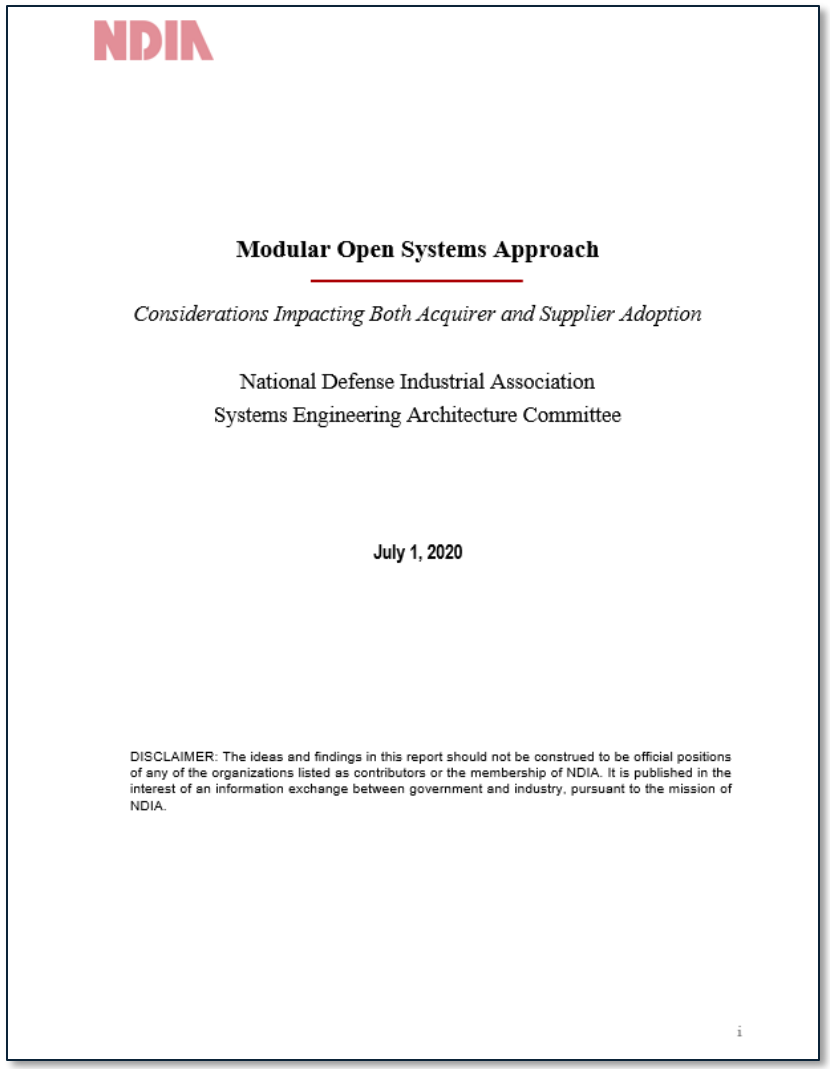
Gray Box Concept – a Key Part of your Approach to Intellectual Property

- Functions within Modules are defined and known
- Behaviors exhibited by the Modules defined and known
- Interfaces between Modules are defined and known
- What is not defined and known is how the Functions (Modules) are instantiated → Modules are not Black Boxes

An acquirer that wishes to replace (upgrade) a Module later, only needs to know the functionality (the "what") and the Module's open interfaces, but does not need to know "the how" the implementation was achieved

MOSA allows the developer to protect their IP -- and therefore removes disincentives for investment in innovative solutions

NDIA White Paper: Considerations Impacting Both Acquirer and Supplier Adoption – with Recommendations



NDIA

Modular Open Systems Approach

Considerations Impacting Both Acquirer and Supplier Adoption

National Defense Industrial Association
Systems Engineering Architecture Committee

July 1, 2020

DISCLAIMER: The ideas and findings in this report should not be construed to be official positions of any of the organizations listed as contributors or the membership of NDIA. It is published in the interest of an information exchange between government and industry, pursuant to the mission of NDIA.

i

A. Government and industry need to work together to define a MOSA implementation for mutual benefit

B. A structured approach is needed in responding to congressional language mandating the use of MOSA

C. Properly implemented MOSA can provide numerous benefits: increased competition, reduced costs and new synergistic capabilities and missions

D. MOSA is an enabler on which Mission Engineering, Digital Engineering and System Security Engineering can build

E. Understanding how to apply open interfaces is critical in fostering innovation, competition, and protection of Intellectual Property

https://www.ndia.org/-/media/sites/ndia/divisions/systems-engineering/se-monthly-meetings/division-papers/ndia-mosa-white-paper-final-release--ndia-architecture-committee--2020.pdf

MITRE

NDIA Recommendations to Implement a MOSA Strategy within an Acquisition

1. Develop MOSA strategy Prior to RFP
2. Define MOSA implementation approach
3. Define placement of Interfaces and Modules within the System of Systems
4. Define an architectural lexicon and/or reference architecture for discussing the various levels of system decomposition and design
5. Implement MOSA as part of a larger and more robust Digital Engineering strategy
6. Incorporate cybersecurity strategy in a MOSA application at the time of initial design, not as a later addition.
7. Ensure DoD and industry work together to define how to evaluate MOSA
8. Develop and implement enablers with appropriate investment to affect culture change required for successful widespread adoption of MOSA principles
9. Create a Library of MOSA Systems and Interfaces
10. Define a means for comparing and specifying standards and interfaces for a MOSA- enabled environment

Begin with the End in Mind #1: Develop MOSA Strategy Prior to RFP

Answer the following questions:

1. What do intend to get out of the MOSA; what is your near- and long-term intent?
    - Possible options include (not limited to):
        - Incremental upgrade
        - Interoperability
        - Foster innovation (Gray Box concept)
        - Reduced logistics/supportability cost
        - Encourage reuse across programs
2. How do you know you did it right – what evidence do you hope to have that proves it worked?
    - Possible options include (not limited to):
        - Providers fully document and validate their interfaces
        - Testing confirms interoperability can be
        - There is a visible supply chain of alternate approaches
        - Commonality (training and depot supplies)
        - Other programs sign on

Begin with the End in Mind #2: Define your MOSA Implementation Approach

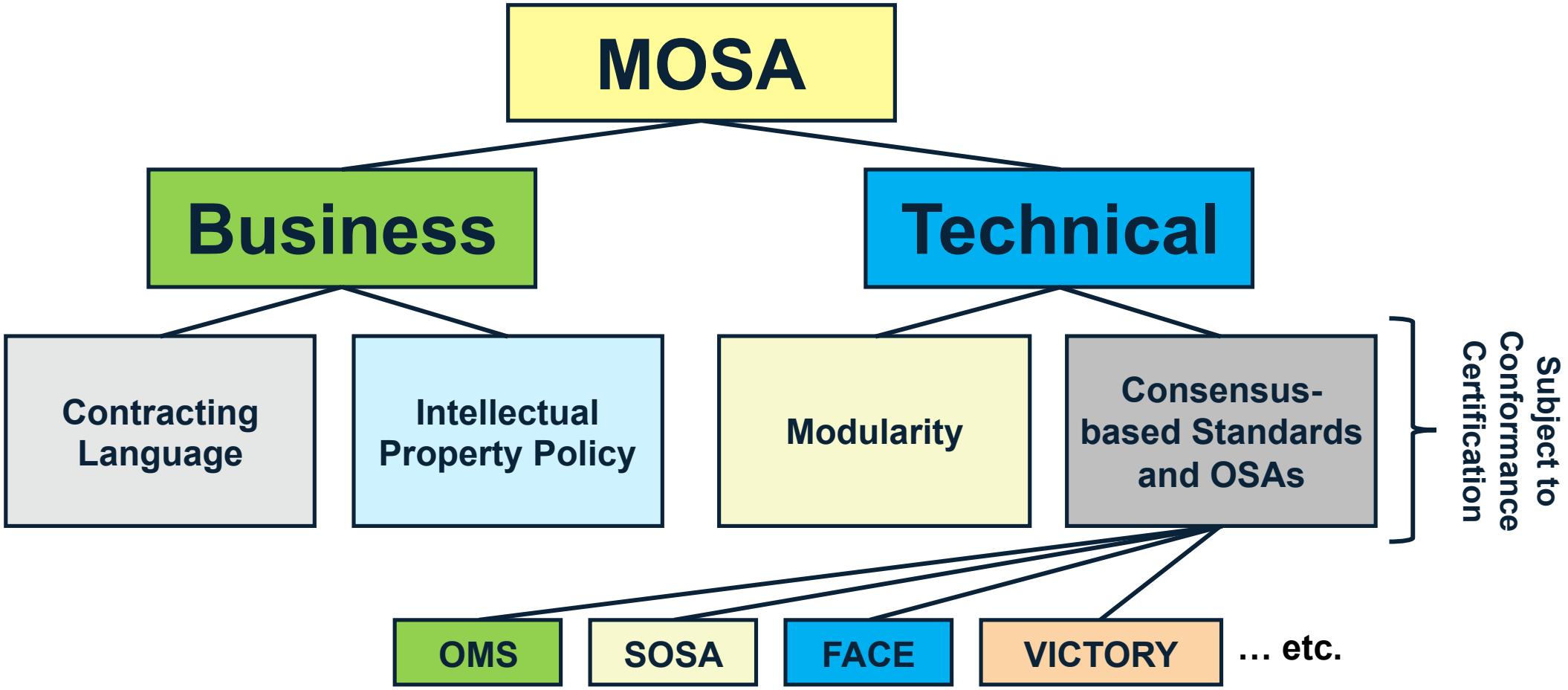
To meet your objectives in #1, define where you want to break your system up into modular entitles → defines your open interfaces

Identify what standards and open systems architectures (OSAs) map to your needs

Determine the IP approach can you use to encourage innovation, entice bidders, and feed your long-term objectives

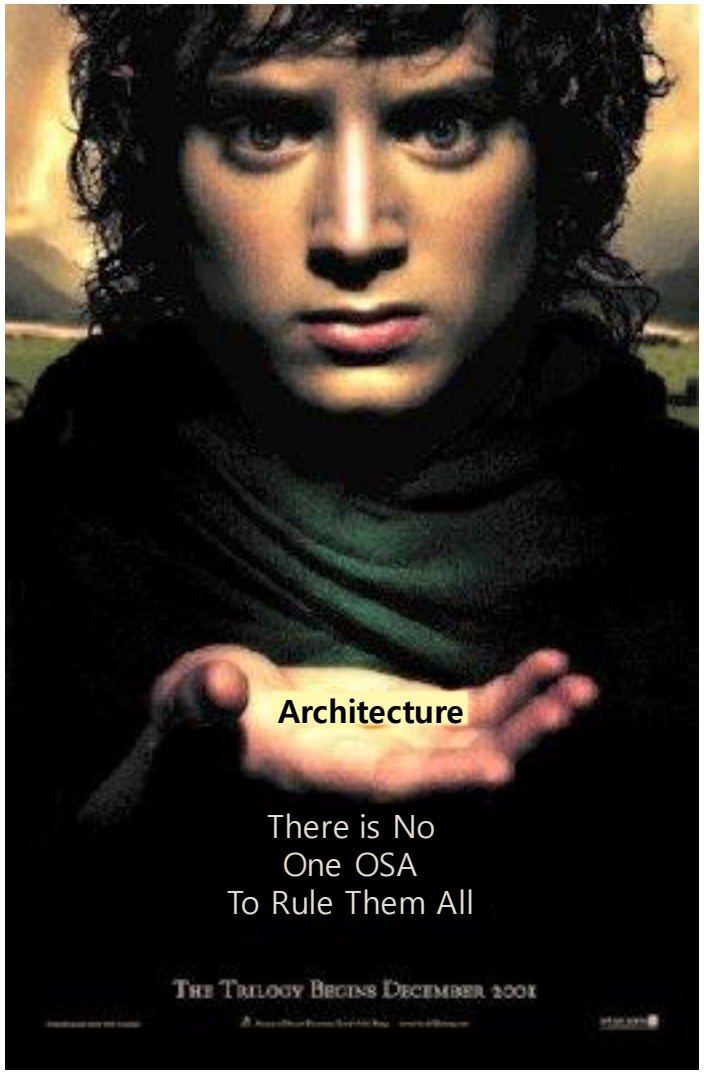
Decomposing the Modular Open Systems Approach

"… an integrated business and technical strategy …"



Derived from "SOSA 101"

Pick the OSA that Matches the Circumstance



- Every OSA was created to solve a particular problem (serve a different purpose)
- Different OSAs operate in different technical domains, address different aspects of systems
  - Can be complementary – multiple OSAs in use in a single system
- It is important to select the OSA best matched to the application (what problem are you solving?), environment, and community (they have their favorites)

Open Architectures / Open Standards / and the Opposite

(not a complete list – just the "important" ones)

	Architectures	Interface Standards
Open	• OMS (Open Mission Systems) • VICTORY (Vehicular Integration for C4ISR/EW Interoperability) • FACE (Future Airborne Capability Environment) • SOSA (Sensor Open Systems Architecture) • OCS (Open Communications Subsystem) • COARPs (Common Open Architecture Radar Programs Specification) • WOSA (Weapon Open Systems Architecture) • Big Iron • CANES (Consolidated Afloat Networks and Enterprise Services)	• UAI (Universal Armaments Interface) • UCI (Universal C2 Interface) • IEEE xxx (many fit into this category) • USB (many fit into this category) • RS-232, -422, etc.
Published	• MBE (MOSA Back End) • MORA (Modular Open RF Architecture) • CMOSS (C4ISR Modular Open Suite of Standards)	• MIL-STD-xxxx – lots fit into this bin • STANAG-xxxx – lots fit into this too • Lightning (on iPhones) • Acme Corporation Open _____

Color Key:
Multi-Service
Army
Navy
Air Force
Commercial

MITRE

The Open in Open Systems Architecture

Open: Three criteria* (need all three):

1. Widely-available, published definitions
2. Consensus-based, typically set by a recognized standards-body, so that interested parties can shape it through a governance process that enables stakeholders to influence and effect the development and evolution
3. Has conformance/compliance validation process

Simply publishing something does not make it “open”

* Synthesized from a great deal of MOSA documentation

Derived from “SOSA 101”

Different OSAs Address Different Aspects of a System

- Inside the Box
  - Those that are used to make up the internal composition of a system
  - Examples: FACE, SOSA, MORA, WOSA, MBE, COARPs

- Box-to-Box
  - Those that are used to integrate subsystems into a larger whole
  - Examples: OMS/UCI, VICTORY, UCS

Mixing and Matching OSAs can be Very Effective

MITRE

Begin with the End in Mind #3: Get the Architecture Right

Define an architectural lexicon and/or reference architecture for discussing the various levels of system decomposition and design

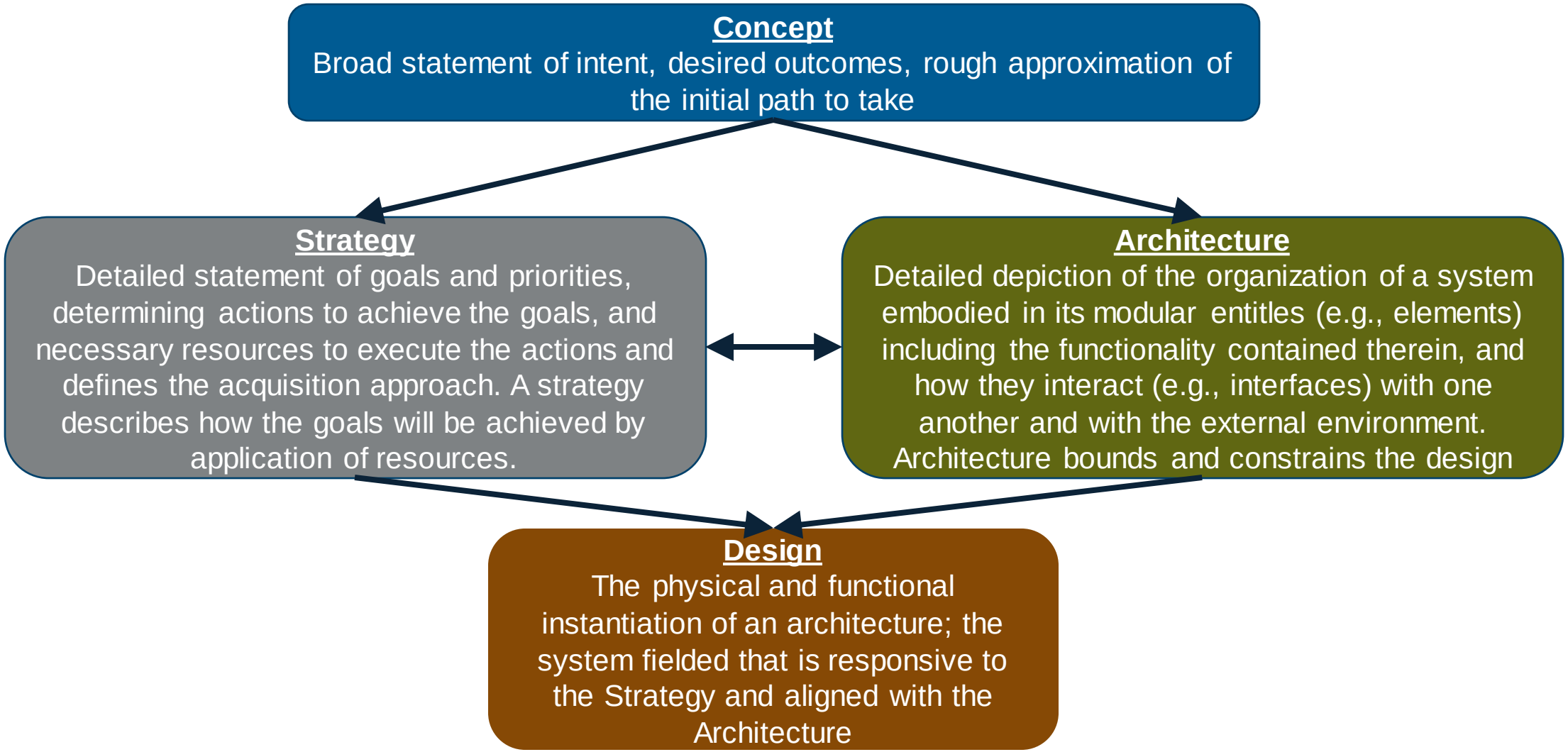
Ensure that your suppliers understand your preference for OSAs and approach – spell it out (and cite why)

Subset or tailor the OSAs to meet your programmatic MOSA needs

Make it clear in the RFP that it isn't an "all or nothing proposition"

- **You are making an evaluative decision**
- **More is better, but less than 100% isn't a deal breaker**

Concept Thru Design: How an Effective System is Made



Key Take-aways

- Success using MOSA starts from “Day 1” – Begin with the End in Mind
  - If you don’t know where you are going…
  - Ensure you understand why you are using MOSA
  - Statutory “check the box” will not benefit anyone
- Three key steps in the process (CLE019 has a lot more)
  1. Develop MOSA strategy Prior to RFP
  2. Define your MOSA implementation approach
  3. Define an architectural lexicon and/or reference architecture for discussing the various levels of system decomposition and design

Feel free to seek consultative support from government, FFRDC, and support contractor members of the MOSWG

MITRE