# Identifying Governance Best Practices in Systems-of-Systems Acquisition

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# Project Objectives

- Build on prior CSIS research on managing complex systems

- Outline challenges and root causes in managing the acquisition of complex systems

- Use the CSIS eight-attribute complex systems governance framework to analyze case studies

- Identify best practices in the governance of systems-of-systems acquisition

# Project Methodology – Three Phase Approach

- **Phase 1** – Data Collection and Processing of SoS Governance Best Practices
  - o Data collection employed <u>primary research</u> (i.e., in-person interviews) and <u>secondary research</u> (i.e., full review of public literature), and <u>qualitative categorization of case studies</u>

- **Phase 2** – Data Validation and Analysis of Findings
  - o Research team analyzed data gathered in Phase 1 and drafted technical report

- **Phase 3** – Conclusion and Visualization of Findings
  - o Best practices emerged from Phase 2 data analysis

# Project Methodology – Case Study Analysis

## CSIS Eight-Attribute Governance Framework

- Level of organizational focus

- Decision-making authority

- Enforcement

- Integration of functional end-user needs

- Knowledge ownership/access to knowledge

- Workforce

- Incentive structure

- Risk assessment/risk management
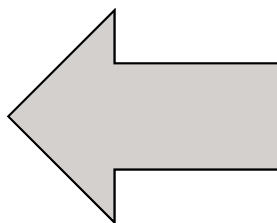
## Seven Case Studies

**Traditional Governance**
- Future Combat System (FCS)
- Integrated Deepwater System (Deepwater)

**Enterprise Governance**
- Counter Rocket, Artillery, and Mortar (C-RAM)
- Distributed Common Ground System (DCGS)
- Global Nuclear Detection System (GNDS)
- Harvest Hawk
- Maritime Domain Awareness (MDA)

*Each of the seven case studies was analyzed using a framework of eight governance attributes to assess which attributes most heavily influence mission success in acquisition*

# Definitions

- **Complex Systems**: systems in which multiple components interact with, and exert influence on, one another and the various factors in their external environments over time

- **Defense Systems of Systems**: systems consisting of multiple sub-systems and components that are typically developed and managed by more than one organization

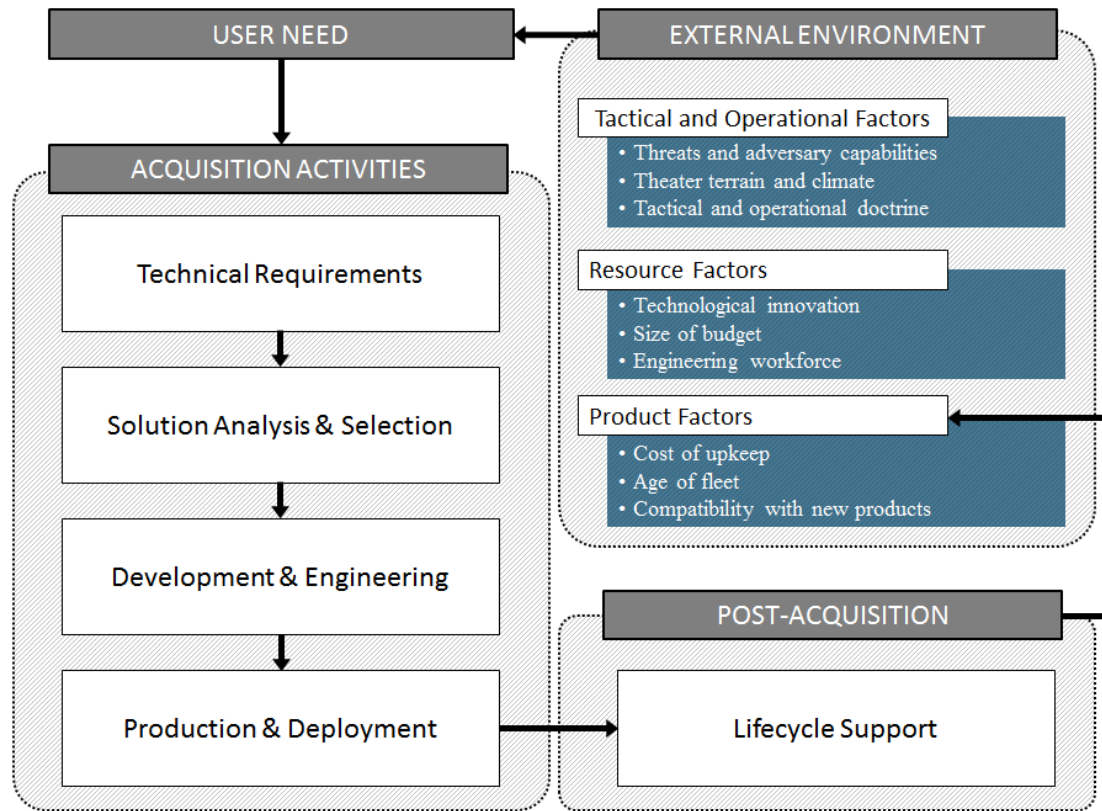Complexity ❯ Case Studies ❯ Best Practices ❯ Next Steps

# The level of complexity in DoD programs seems to be rising

- **By Default**: rising complexity of external systems (i.e., technology industries, threat environments, etc.)

- **By Design**: growing interest within defense on improving how DoD satisfies its mission objectives

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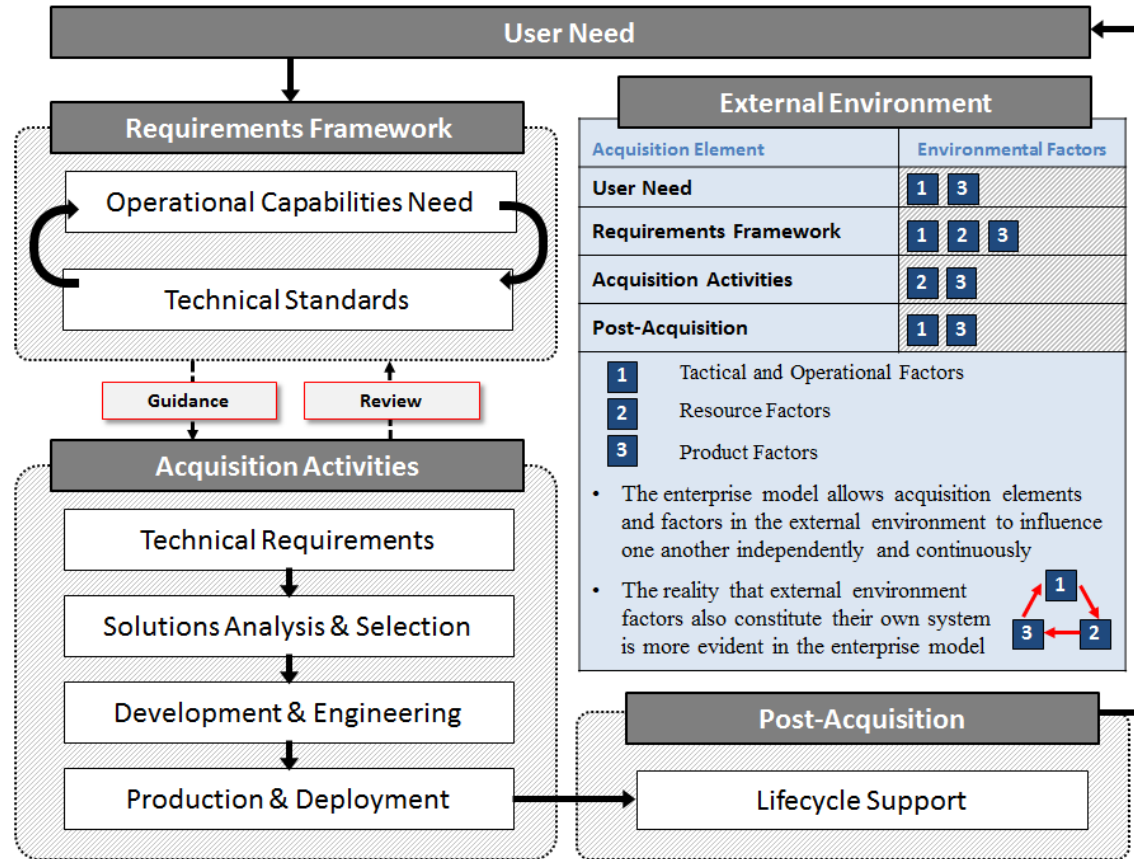# What problems does complexity present?

1. Complex systems of systems are larger than traditional systems

2. Each system interacts with other SoS systems, creating additional complexity

3. Output of a system is not equal to the sum of its parts

4. Complex systems operate outside the boundaries of traditional, linear approaches to acquisition governance and may present new governance challenges

# Traditional Model



USER NEED → EXTERNAL ENVIRONMENT

**ACQUISITION ACTIVITIES**
- Technical Requirements
- Solution Analysis & Selection
- Development & Engineering
- Production & Deployment

**EXTERNAL ENVIRONMENT**

**Tactical and Operational Factors**
- Threats and adversary capabilities
- Theater terrain and climate
- Tactical and operational doctrine

**Resource Factors**
- Technological innovation
- Size of budget
- Engineering workforce

**Product Factors**
- Cost of upkeep
- Age of fleet
- Compatibility with new products

**POST-ACQUISITION**
- Lifecycle Support

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# Enterprise Model

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# CSIS researched seven cases of SoS acquisition to analyze performance in governance attributes

**SoS Governance Case-Study Programs**

| Traditional Governance | Enterprise Governance |
|---|---|
| • Future Combat System (FCS)<br>• Integrated Deepwater System (Deepwater) | • Counter Rocket, Artillery, and Mortar (C-RAM)<br>• Distributed Common Ground System (DCGS)<br>• Global Nuclear Detection System (GNDS)<br>• Harvest Hawk<br>• Maritime Domain Awareness (MDA) |

*CSIS chose case studies that represented one of two approaches to acquisition governance: (1) Traditional Governance and (2) Enterprise Governance*

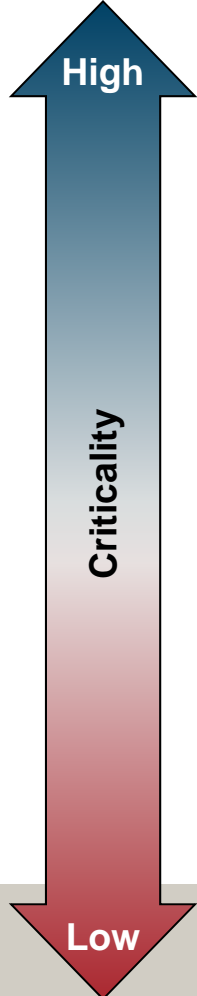Complexity ❯ Case Studies ❯ Best Practices ❯ Next Steps

# Case Study Analysis

| Case Study | Governance Attributes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Level of organizational focus | Integration of functional end-user needs | Decision-making authority | Enforcement | Workforce | Incentive structure | Knowledge Access and Ownership | Risk assessment/risk management |
| FCS | Unsatisfactory | Unsatisfactory | Satisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory |
| Deepwater (post-Reform) | Satisfactory | Satisfactory | High | Satisfactory | High | Satisfactory | Unsatisfactory | Unsatisfactory |
| C-RAM | High | High | High | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory |
| DCGS | High | Satisfactory | Satisfactory | High | Satisfactory | Unsatisfactory | High | No Significant Observations |
| GNDS | High | Unsatisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory | No Significant Observations | Unsatisfactory | Unsatisfactory |
| Harvest HAWK | High | High | High | Satisfactory | High | Unsatisfactory | High | Satisfactory |
| MDA | Unsatisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory | Satisfactory | Unsatisfactory | Unsatisfactory | Unsatisfactory |

**Legend**

- High Performance
- Satisfactory Performance
- Unsatisfactory Performance
- No Significant Observations

*CSIS analyzed case studies to identify those attributes most closely linked with mission success and the degree to which best practices could be inferred from the available data*

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# CSIS Eight-Attribute Governance Framework

| Attribute | Description |
|---|---|
| Level of Organizational Focus | The level at which SoS governance occurs within the organization. |
| Decision-Making Authority | The governance mechanisms for SoS delivery, including how budget is allocated, standards are set, tradeoffs are managed, and inconsistencies are adjudicated. |
| Enforcement | The mechanisms and level of oversight by which the objectives of the SoS capability to be delivered are ensured. |
| Integration of Functional End-User Needs | The mechanisms and frequency with which the functional needs of end-users are built into the system-of-systems, and at which points in the process this incorporation occurs. |
| Knowledge Access and Ownership | The accessibility of information regarding the operating environment, technical standards, and the other parts of the system-of-systems. |
| Workforce | The examination of SoS workforce structures, unity of mission, and capability development through use of contracting. |
| Incentive Structure | The alignment between the enterprise's goals and the incentive and reward structures of the stakeholders and organizations that implement them. |
| Risk Assessment | Risk assessments and management strategies tailored to mission accomplishment. |

High

Criticality

Low

# Critical Best Practice #1: Level of Organizational Focus

- **Multi-Layered:** Should be focused at program-level, but supplemented by overarching enterprise-level governance and short authority chains

- **Example:** DCGS benefits from allowing sub-system acquisition efforts to develop some autonomy in capabilities decisions

# Critical Best Practice #2: Decision-Making Authority

- **At the Enterprise Level:** Central governance oversight body should hold "auditing" and enforcement powers in order to maintain commitment to SoS core objectives
  - o Also maintain directional decision-making authority to transmit emerging needs and to adjust mission objectives as the environment changes

- **At the Program Level:** Empower program manager to make decisions about technologies and sub-systems
  - o Standards and common operating environments installed at the enterprise level can serve as a formal mechanism for guiding program manager's decisions on capabilities

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# Critical Best Practice #3: Enforcement

- **Formal/Statutory:** DoD acquisition guidelines and directives inform the acquisition process
  - Enterprise-level authorities maintain ability to review and revise gate decisions as sub-systems evolve and as needs change

- **System-Specific:** Clear, system-specific reporting requirements are established based on technological maturity and projected development schedules to provide timely information to enterprise-level authority
  - One example of a custom enforcement mechanism is the executive review board used by DCGS to guide acquisition across the different families of systems

# Enabling Best Practice #1: Integration of Functional End-User Needs

- **Standards-Based Support:** The creation of universal standards for hardware and software empowers program managers to develop their own sub-systems solutions in compliance with established SoS standards
  - o E.g.: SOCOM used open-source DCGS software kernel to develop its own information network

- **Modular Support:** Kit-based, modular systems allow timely adjustments by program managers to changes in end-user needs and in the external environment
  - o E.g.: Modular mission "kits" allow users to switch out capabilities on the C-130J to use the Harvest HAWK for a variety of mission areas

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# Enabling Best Practice #2: Knowledge Access and Ownership

- **Facilitating Access:** Standards and network backbones should be freely shared amongst the community of users and developers to encourage user-level innovation and collaboration

- **Supporting Usage:** Enterprise-level leadership should be sensitive to the wide range of information-handling capacity and ability of different stakeholders throughout an organization to manage and understand information
  - o Leadership should also campaign to accommodate those stakeholder entities with lower information-handling capacity and ensure their interests are also incorporated into the information feedback loop

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# Enabling Best Practice #3: Workforce

- **Recruitment of End-Users:** Systems-level technical workforce should regularly include recent or one-time end-users in order to create greater symmetry between end capability and changing user needs

- **Programmatic/Technical Personnel Balance:** The needs of each program should dictate the balance of programmatic and technical personnel
  - Workforce is also a system, and technical and programmatic personnel interactions influence program outcomes
  - SoS-level technical workforce should also be small and agile to encourage rising above parochial interests

Complexity ❯ Case Studies ❯ Best Practices ❯ Next Steps

# Enabling Best Practice #4: Incentive Structure

- **Fostering Mission Commitment:** Should use budgetary and personnel levers to foster mission commitment and compliance with established standards

- **Reducing Barriers to Entry:** Competitor providers should be encouraged and empowered to enter an SoS acquisition effort in order to incentivize innovation among potential providers and incumbents

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# Enabling Best Practice #5: Risk Assessment

- **Recognizing the Permanence of Risk:** Risk is an unavoidable aspect of complexity, and much of it is not visible on the surface

  o While risk cannot be avoided, its impact can be mitigated through flexible and informed systems integration and sub-system development

- **Using Mature Technologies:** Critical technologies should be highly mature and commercial off-the-shelf (COTS) where possible

- **Monitoring Less Mature Technologies:** Clear, measurable metrics should be established to monitor less mature technologies and changes in the external environment

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# Next Steps

- **Gather feedback** from acquisition stakeholders and subject matter experts

- **Conduct additional research** to refine the proposed governance model, test its potential impact, and observe its applicability in other complexity challenges
    - o Can exceptional performance in enabling attributes make up for poor performance in the three critical attributes?
    - o What human capital planning helps ensure success in the three critical attributes, especially decision-making authority?
    - o How can the governance framework be applied to other complex problems, such as battlefield command and corporate governance?
    - o What quantitative modeling methods can be used to predict attribute shortfalls and simulate acquisition success and failure scenarios?

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