



A Framework for Establishing System of Systems Governance

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Real World Governance... *or lack of there of*

Walt Disney World Resort

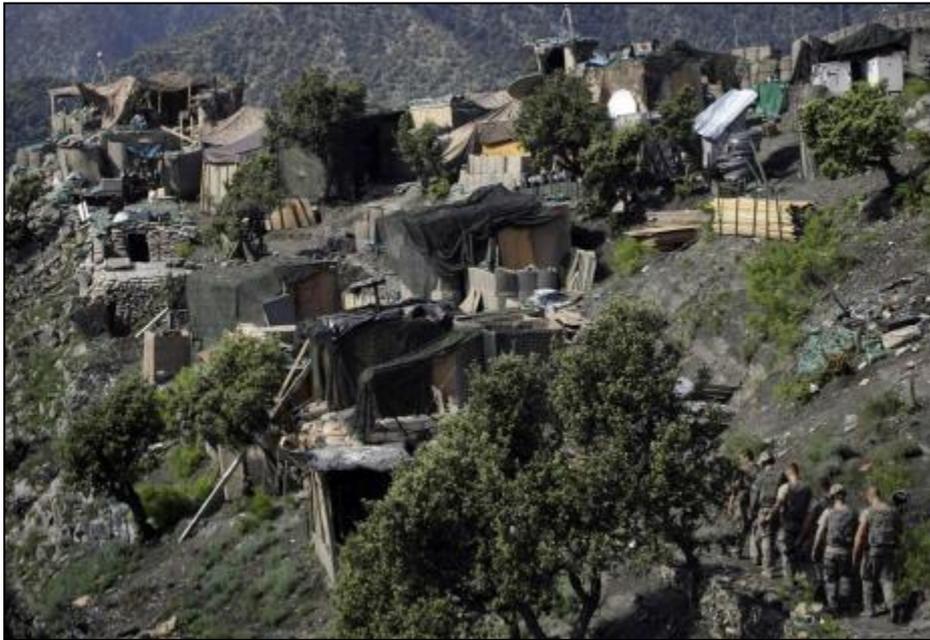


Business District Near Walt Disney World

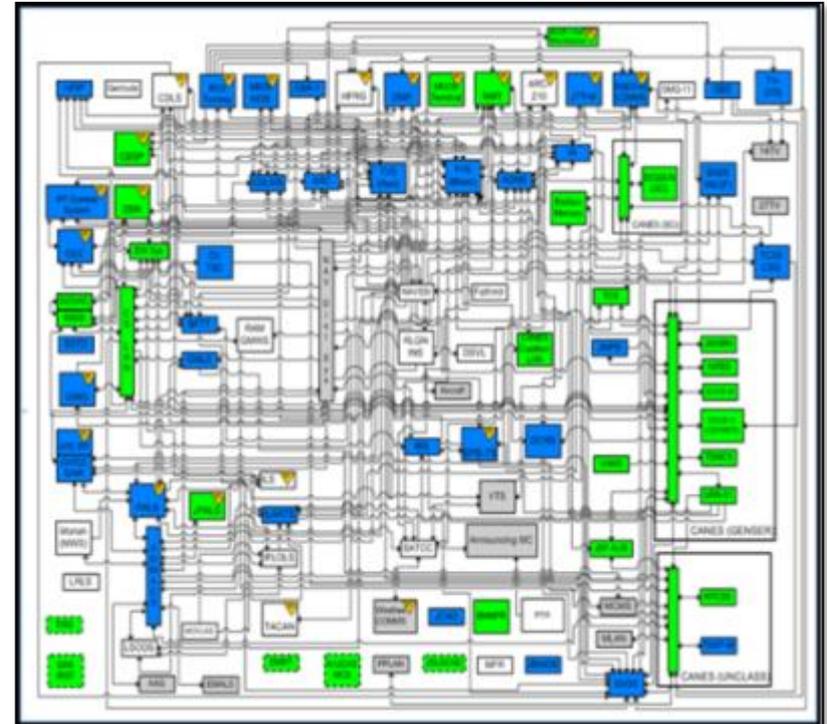


Lack of Governance in DoD

Army Example Forward Operating Base



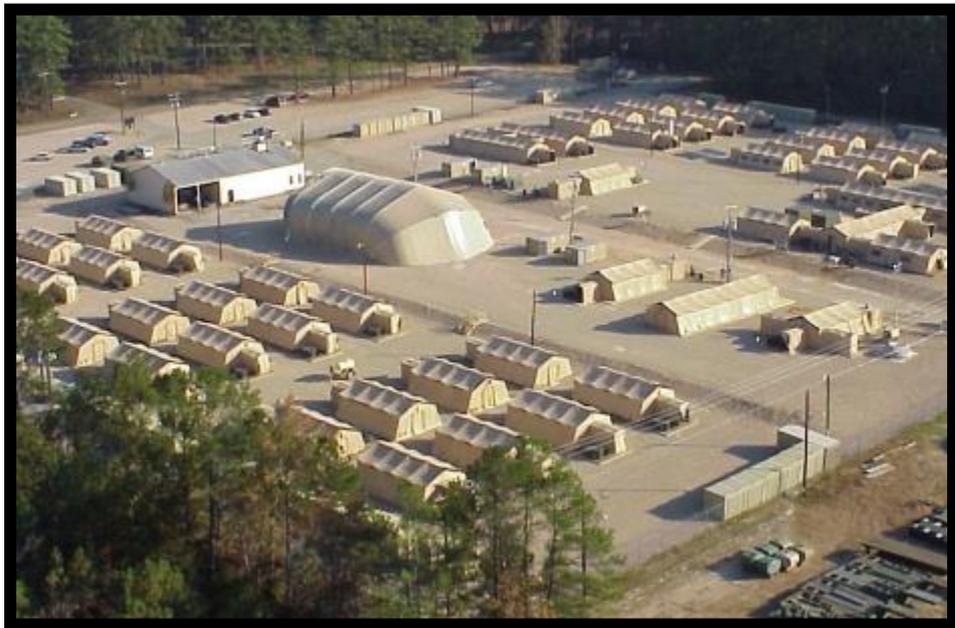
Navy Example IT Systems on a CVN



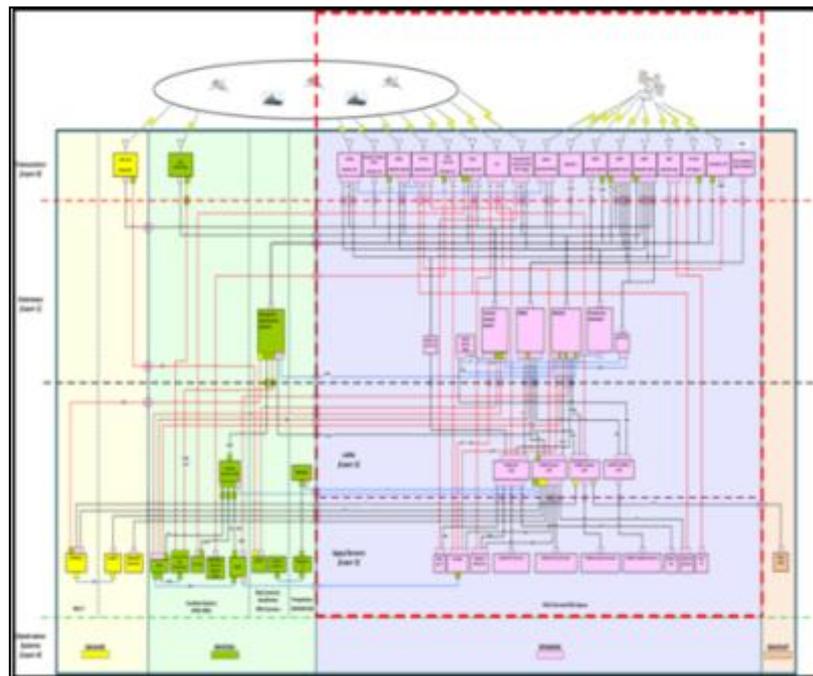
Poor governance leads to individual systems being implemented without consideration for the SoS as a whole.

Governance in DoD

Army Example SoS Base Camp



Navy Example CVN IT Systems with Technical Authority



A cornerstone of an effective SoS is a sound governance structure.

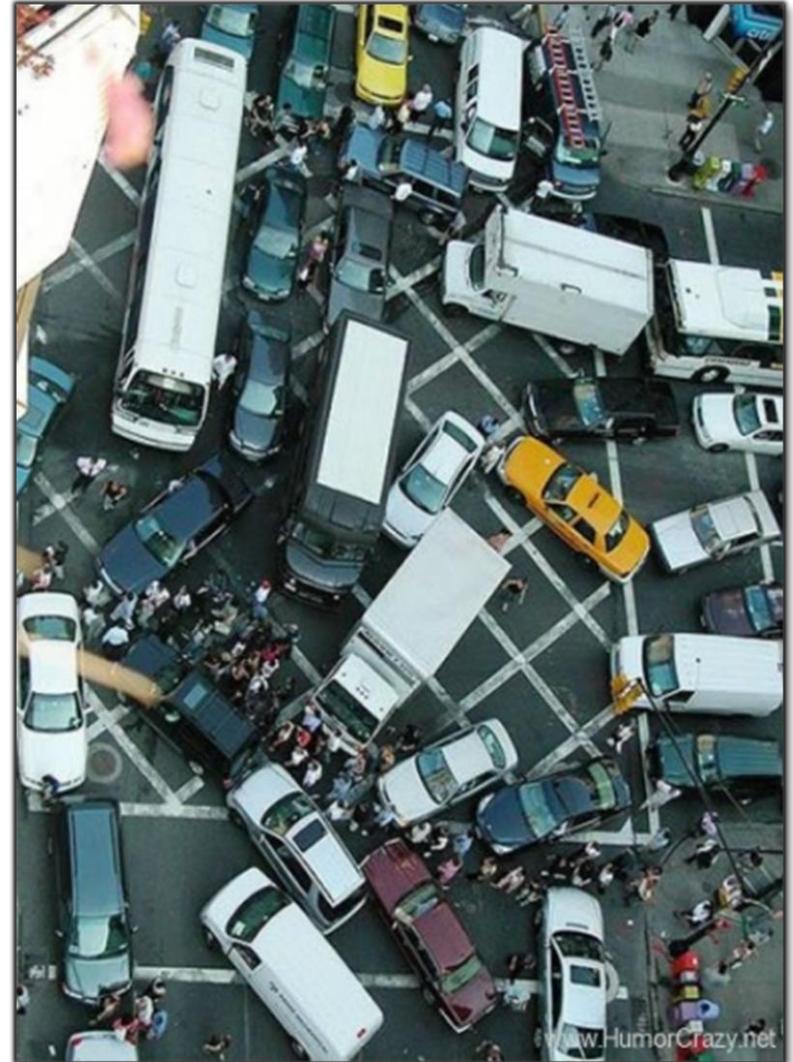
SoS Definition

- **System of Systems (SoS)**- a set or arrangement of system that results when independent, and task-oriented systems are integrated into a larger systems construct, that delivers unique capabilities and functions in support of missions that cannot be achieved by individual systems alone.



System of Systems Governance

Governance – the organization, set of rules, policies, and decision-making criteria that will guide a System of Systems (SoS) to achieving its goals and objectives.



SoS Governance Development Process

**When developing SoS governance ...
One size does not fit all.**

- Understand your situation ... Evaluate the SoS Type and Characteristics
 - The actual SoS types are often different than commonly believed
 - Special considerations are often identified to be factored into SoS governance development.
- Apply the Criteria-Based Governance Framework
 - Aid to develop the “right” governance model



Types of SoS



Virtual

**No Centralized
Management
Authority**

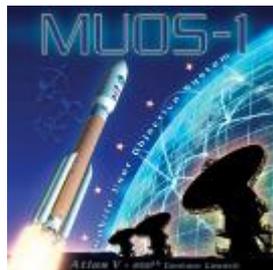


Collaborative

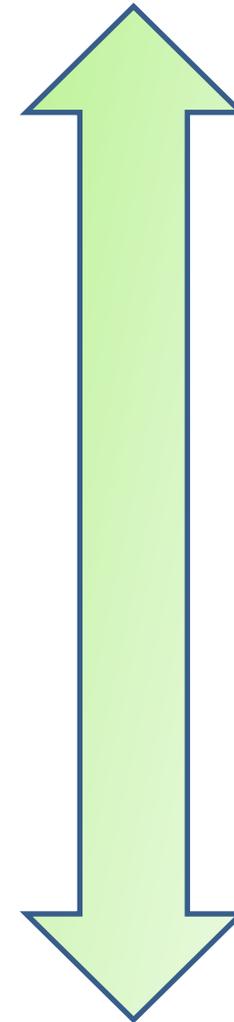


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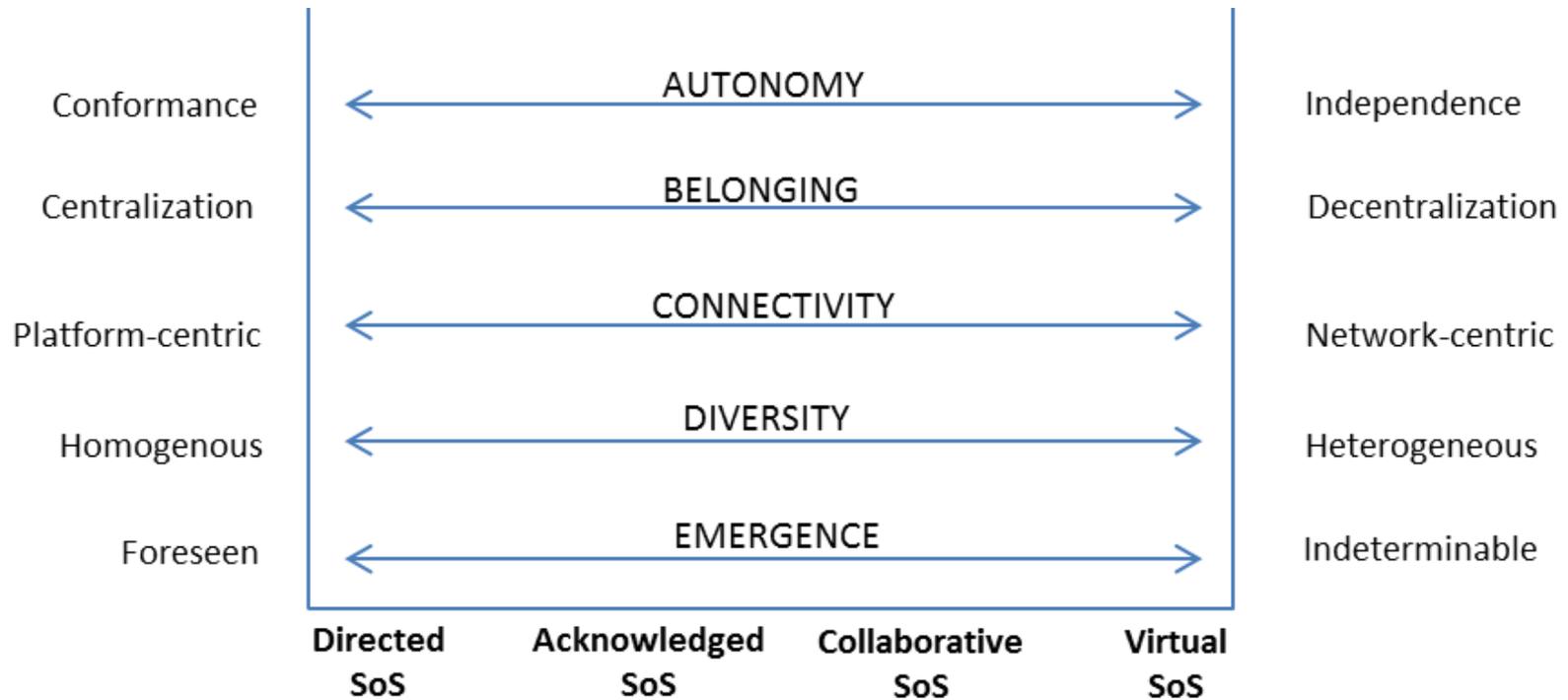
**Centralized
Management
Authority**



Directed

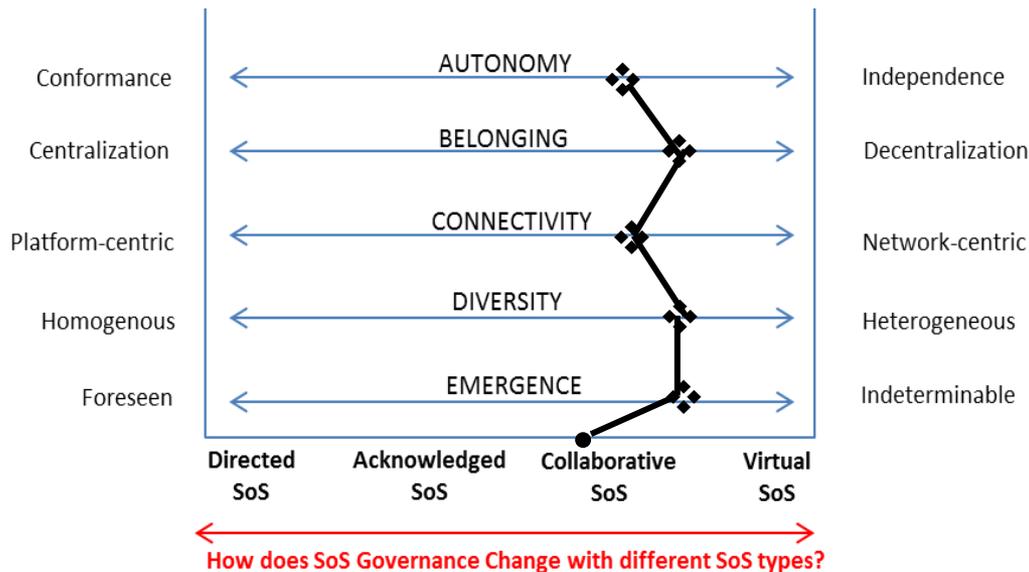


SoS Types & Characteristics



← How does SoS Governance Change with different SoS types? →

Typical Joint-Service SoS



Department of Defense (DoD) SoS resembles a Collaborative SoS

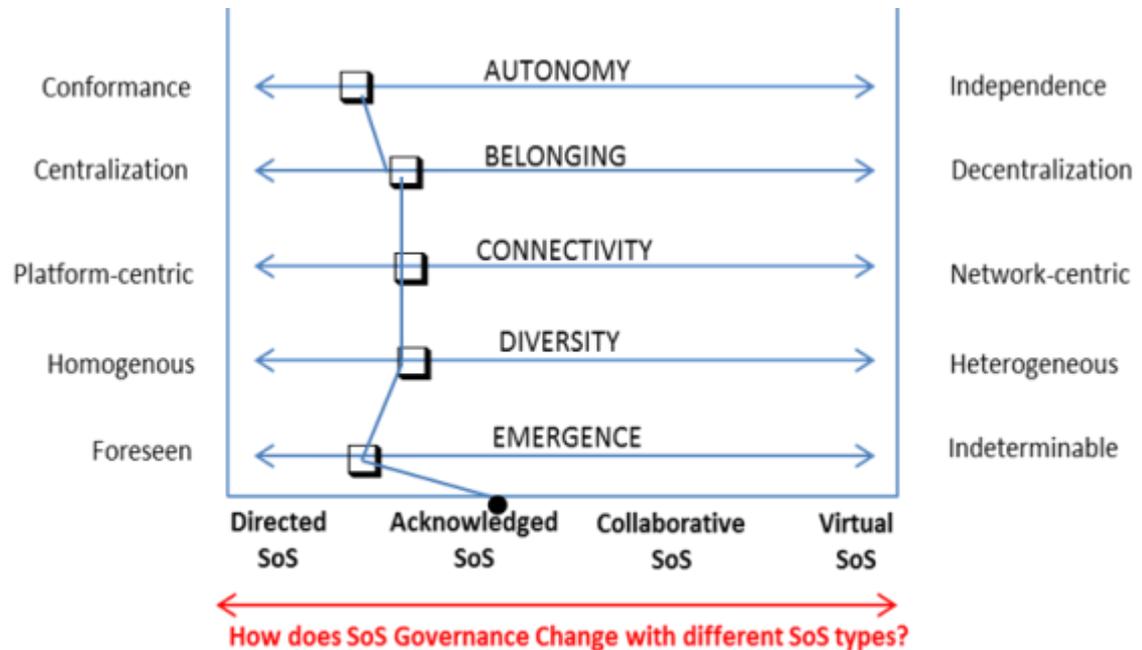
- Autonomy and connectivity less defined
- Diversity more heterogeneous
- Belonging more decentralized
- Emergence more likely to occur from happenstance than design

❖ DoD SoS with constituent systems coming from different services and agencies

Typical Single Service SoS

Single Service SoS resembles an Acknowledged SoS

- Autonomy, belonging, and connectivity more defined
- Diversity will be reduced due to a common engineering service philosophy
- Emergence more likely to be designed

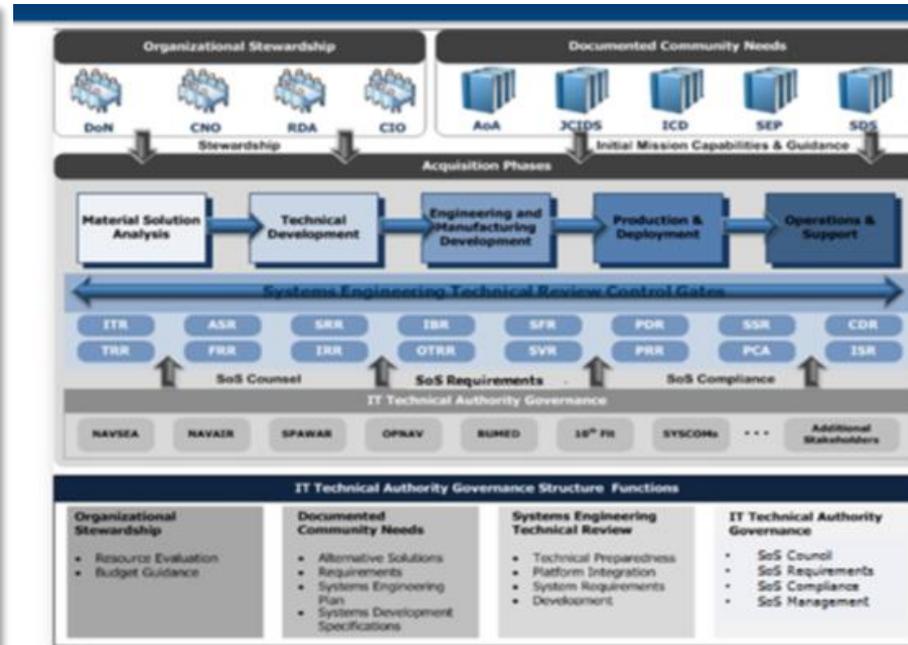


- Single Service SoS with constituent systems coming from a single service

Criteria-Based Governance Framework

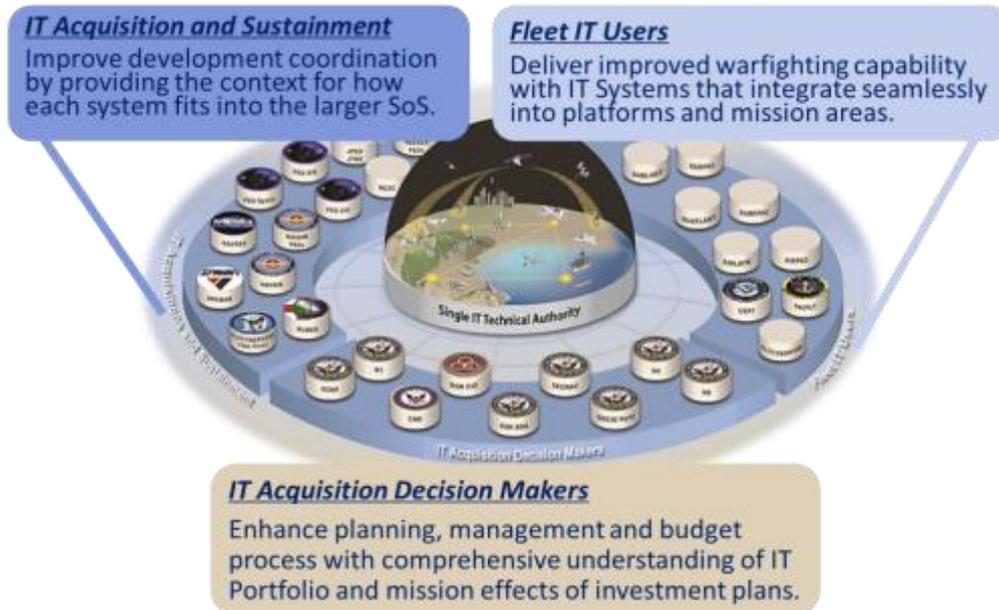
Criteria 1: Organizational Structure, Standards and Policies

- The organizational structure, standards, policies, and the management environment must be understood to develop effective governance.
- To be successful, the governance must be consistent with the organization.



- **Virtual SoS (such as the Internet)** organizational structures are loosely defined, therefore the governance is limited to general (overarching) standards.
- **Directed SoS (such as a Space SoS)** organizational structures are very well defined, therefore governance tightly couples the constituent systems.

Criteria-Based Governance Framework



Criteria 2: Governance Composition and Principles

- Determines the degree of participation, responsiveness, consensus, inclusiveness, and accountability needed in the governance strategy.

- **Virtual SoS**, participation is limited to standards committees. Typical SoS participants not included in the decisions of suggested changes.
- **Directed SoS**, a high degree of participation, inclusiveness, responsiveness, and consensus.

Criteria-Based Governance Framework

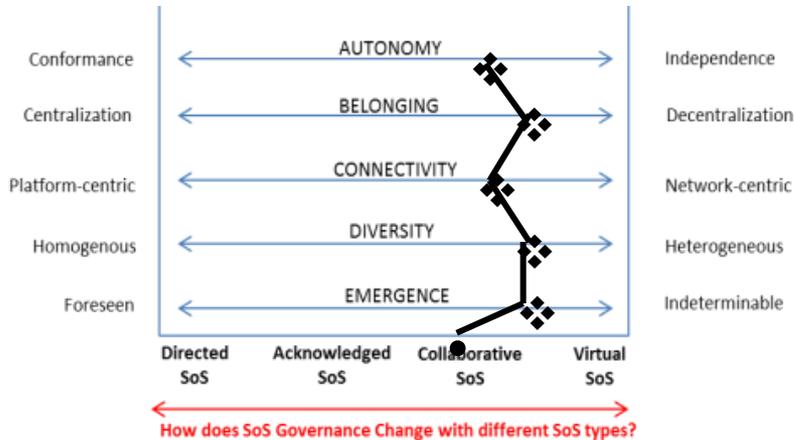


Criteria 3: Encapsulation

- Refers to how transparent the governance decisions are, and how enforcement is managed within the SoS.

- **Virtual SoS**, governance, decisions, and enforcement are made by a small number of stakeholders. Most stakeholders don't care how decisions are made or how the rules are enforced as long as they can achieve their missions and goals.
- **Directed SoS**, stakeholders are closer to the decision-making and enforcement process. Therefore, the governance strategy is required to be more inclusive and transparent.

Typical Joint Service SoS

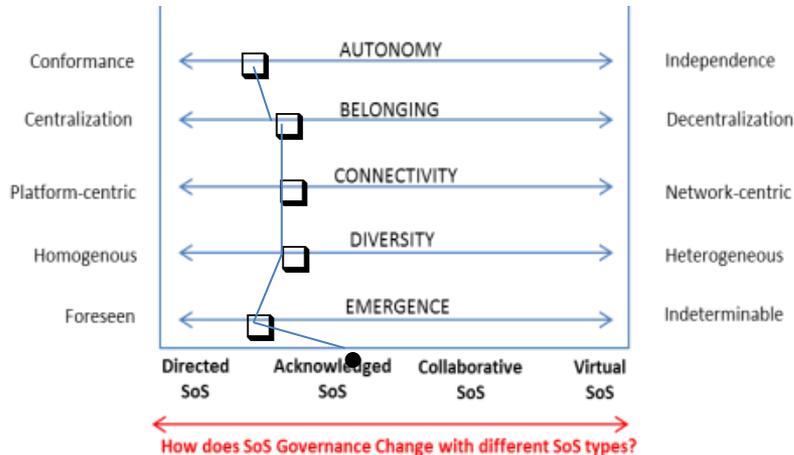


Governance strategy should emphasize closer collaboration with service elements. However, due to service and agency autonomy, the best a DoD governance strategy can hope for is a collaborative relationship.

- ❖ DoD SoS with constituent systems coming from different services and agencies

| | |
|---|---|
| <p>Criteria 1: Organizational Structure, Standards, and Policies</p> | <p>DoD and the services have similar organizational structures, standards, and policies. However, given the multiple services and agencies, constituent systems are not likely to be as tightly coupled as individual services SoS.</p> |
| <p>Criteria 2: Governance Composition and Principles</p> | <p>Constituent systems are contributed from services and agencies. Therefore, from a DoD perspective, systems may appear with a high degree of independence.</p> |
| <p>Criteria 3: Encapsulation</p> | <p>Operations of the SoS are likely to be tightly coupled due to Joint control; technical direction and budget not tightly coupled.</p> |
| <p>Criteria 4: Governance Effectiveness and Interoperability</p> | <p>Interoperability (hence effectiveness) is dependent on interoperability standards established by the services of the constituent systems.</p> |

Typical Single Service SoS

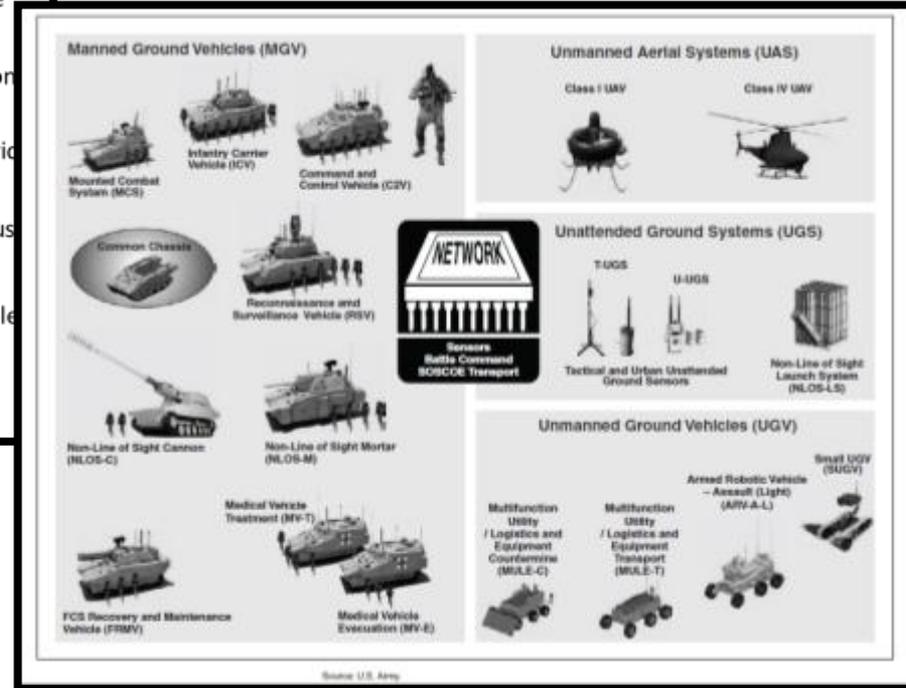


Governance strategy should be guarded against being overly prescriptive to ensure that maximum flexibility to configure constituent systems to meet the widest range of mission sets through independent, and SoS, operations.

- ❑ Single Service SoS with constituent systems coming from a single service

| | |
|--|---|
| Criteria 1: Organizational Structure, Standards, and Policies | Organizational structures, standards, and policies are tightly coupled due to their need to work together. |
| Criteria 2: Governance Composition and Principles | Constituent systems are more likely to operate together, thus have a higher degree of participation, consensus, and accountability. |
| Criteria 3: Encapsulation | Transparency and decisions are likely to be tightly coupled. |
| Criteria 4: Governance Effectiveness and Interoperability | Services establish interoperability standards, therefore constituent system contribution to the SoS should be tightly aligned to mission success. |

Governance Analysis of the Army's Future Combat System (FCS)



- FCS followed a Directed SoS path as constituent systems planned to be centrally developed.
- Systems were going to be controlled through a network suggesting a Collaborative or Virtual SoS.
- The Army's SoS culture is Acknowledged SoS.

Governance Considerations for the Navy's Information Technology Technical Authority (IT TA)



Criteria 1: Establish a governance structure to account for a Navy IT Baseline.

- Structure should be at multiple levels to manage the large organization complexities.

Criteria 2: Collaboration among PEOs, PMWs, and SYSCOMS is essential due to the tightly coupled constituent systems.

- Leverage existing forums where appropriate and adjust as needed.

Criteria 3: Employ a Naval Open Architecture concept for transparency, to support governance decisions, and for compliance enforcement.

- Allows program managers to have insight into other programs, and can help them make informed design decisions, and could lead to consolidation of the number of baselines in the Fleet.

Criteria 4: Defining, and enforcing, interface standards for interoperability needs to be one of the key tenets of IT TA Governance.

- It is only through successful governance that the provided capabilities will achieve mission success.

Conclusions

- Regardless of the SoS type, some degree of governance is required to ensure mission success.
- When developing governance structures, one size does not fit all.
 - Developers must understand the type of SoS they are working with.
- A criteria-based approach was developed in our paper.
 - These criteria are one approach, and we argue should serve as the core for any SoS governance.
 - Other criteria should also be considered.



Questions



SoS Characteristics

| <i>Behaves like a large integrated system</i> | Characteristic | <i>Behaves like several individual systems</i> |
|---|--|--|
| Conformance | Autonomy – the ability to make independent choices; the right to pursue reasons for being and fulfilling purposes through behaviors. | Independence |
| Centralized | Belonging – To be a member of a group; to have proper qualifications. | De-centralized |
| Platform-centric | Connectivity – The ability of a system to link with other systems. | Network-centric |
| Homogeneous | Diversity – Noticeable heterogeneity, having distinct or unlike elements or qualities in a group; the variation of social and cultural identities among people existing together in an operational setting. | Heterogeneous |
| Foreseen | Emergence – the appearance of new properties in the course of development, evaluation, and operations. | Indeterminable |