Organizational Implications of Systems of Systems

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Software Engineering Institute

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Our Goals for this Tutorial

After attending the tutorial, participants should be able to:

1. Describe differences in system of systems (SoS) types that are relevant to making organizational and governance decisions

2. Describe the organizational implications of SoS participation

3. Describe the complexity and associated challenges organizations are faced with in an SoS context

4. Summarize methods that support organizations in the effective analysis of their SoS contexts
Who are you? What are your expectations?

Policy Maker?

Chief Systems Engineer?

Program Manager?

Portfolio Manager?

Engineering Technical Lead?

Other???

End User?
Terminology

**Governance**

means by which an enterprise secures the availability of capabilities for its use when and where it needs them, including the decision making authorities and rules by which decisions are made.

**Management**

process of designing and maintaining an environment in which individuals, working together in groups, efficiently accomplish selected aims (e.g., functions of planning, organizing, staffing, leading and controlling).

Each has organizational implications

Source for management and organization: Weihrich and Koontz, 2005
Galbraith STAR Model to Structure Discussions of Organizational Issues

We will come back to various aspects of this model as a framework for talking about organizational issues.

Adapted from *Designing Complex Organizations*, Jay Galbraith, Addison-Wesley, 1973.
Agenda

Basics of Systems of Systems
  • Perspectives of SoS Participants
  • SoS Types and Characteristics

Organizational Implications of Systems of Systems

Responding to Organizational Implications in Systems of Systems

Summary
Agenda

Basics of Systems of Systems
• Perspectives of SoS Participants
• SoS Types and Characteristics

Organizational Implications of Systems of Systems

Responding to Organizational Implications in Systems of Systems

Summary
What are Systems of Systems? Health IT Systems Example

A collaboration among technical systems and organizational (people) systems...

...in relation to some use

...within a changing, unpredictable context
What are Systems of Systems? Coalition Forces in Operational Context Example

A collaboration among technical systems and organizational (people) systems...

...in relation to some use

...within a changing, unpredictable context
What are Systems of Systems?
Wildland Fire Management Example

A collaboration among technical systems and organizational (people) systems...

...in relation to some use

...within a changing, unpredictable context
Multiple Perspectives on System of Systems -1

An SoS is a collection of integrated and interoperable hardware and software entities providing capabilities that fulfill specific functional and operational needs.

But...systems of systems are more than interoperating hardware and software systems.
Multiple Perspectives on System of Systems -2

An SoS is a collection of **people and organizational entities** involved in acquiring and composing “systems of systems” that provide capabilities to fulfill specified functional and operational needs.

**Development/Acquisition View**

Development staff, acquisition personnel

People systems are as important as technical systems
Multiple Perspectives on System of Systems -3

An SoS **provides capabilities** that enable a collection of operational users to achieve the effects they need to meet their business/mission goals

- Evolves to enable dynamically changing operational effects within the operational user’s context of use
- Is likely to use technical and organizational assets outside of the original design context

**Operational Effects/ Users View**
Key Point: Systems of Systems Result from Interrelationships

The composition of capabilities with users and operational processes that achieves desired operational effects for a particular context of use.

Aggregation of systems, hardware or software components, and other devices to provide operational capability.

The people, organizations, and interrelationships associated with building, acquiring, fielding, and evolving systems of systems.
Key Point: Systems of Systems Involve Social AND Technical Networks

Systems of systems involve understanding the networks of social and technical systems

- Paying insufficient attention to the social systems in which technical systems operate is a common failure pattern
- Social systems are open and non-deterministic in nature and require different approaches than many technical systems
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Organizational Implications of Systems of Systems

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Summary
Understanding the Relationships Implied by the SoS Perspectives
Relationship Characteristics of Systems of Systems

- Stakeholder volatility
- Stakeholder diversity
- Stakeholder autonomy
- Diversity of governance frameworks
- Centralization of control
- Flexibility/adaptability of governance frameworks
- Coherence of incentives

Relationships among stakeholders

Relationships among goals/purpose

Relationships among constituents

- Constituent diversity
- Volatility of composition
- Constituent volatility
- Range of capability provided

- Independent evolution of constituents
- Volatility of demand
- Variety of demand
- Degree of emergence of capabilities

Context(s) of use
Example Context: Wildland Fire Management (WFM)

To manage wildland fires, complex decisions need to be made quickly over the course of a wildland fire event

- Failure to make informed decisions can result in loss of life, homes, and habitat
- Decision makers rely on information from numerous existing systems grouped into a dozen application areas (e.g., fire behavior, weather, smoke, economic and risk analysis, fuels management)
  - Limited integration of existing systems and data sources, but users increasingly need them integrated
  - Systems independently developed by different groups using different software languages, platforms, architectures, and design assumptions

Interoperation of science models, systems, people, and governmental organizations is rapidly expanding the science of wildland fire management
Characteristics: Stakeholder Relationships -1

**Stakeholder volatility**

- **low**
- **high**

WFM: dynamic relationships among stakeholders due to increased number, magnitude, and impact of fires. Each fire event has a new set of players.

**Stakeholder autonomy**

- **low**
- **high**

WFM: each agency and level of government has its own framework.

**Diversity of governance frameworks**

- **low**
- **high**

WFM: each agency and level of government has its own framework.
Characteristics: Stakeholder Relationships -2

**Centralization of control**
- Low: WFM: no single entity in charge; collaboration attempted through interagency working groups
- High

**Flexibility/adaptability of governance frameworks**
- Low: WFM: limited – organizations with no history of quick changes
- High

**Coherence of incentives**
- Low: WFM: limited – each organization has own priorities and incentives
- High
Characteristics: Goals/Purpose Relationships

**Degree of emergence of capabilities**
- **low**
- **high**

WFM: no single system provides all (or the majority) of capabilities needed to respond to a fire event.

**Volatility of demand**
- **low**
- **high**

WFM: each fire event changes its scale, scope, and behavior during the course of the event.

**Variety of demand**
- **low**
- **high**

WFM: each fire event is different in scale and scope as well as behavior.
Characteristics: Constituent Relationships -1

Constituent diversity
- WFM: wide range of types of systems with varying user interfaces and capabilities

Constituent volatility
- WFM: plethora of software systems and data available with new systems continually made available

Volatility of composition
- WFM: each fire event requires potentially a different set of systems and data
Characteristics: Constituent Relationships - 2

**Range of capability provided**
- Low: WFM: most of the systems are designed for a narrow range of demand situations
- High: WFM: uncoordinated releases of systems

**Independent evolution of constituents**
- Low: WFM: uncoordinated releases of systems
- High: WFM: uncoordinated releases of systems
Different SoS will have Different Characteristics

Even though A and B are both systems of systems, given their characteristics, they would not be governed in the same way.
Discussion Exercise -1

Characterize a system of systems that you are aware of along the 5 dimensions listed below and on the next slide. For each dimension,

- Provide a brief description of the dimension as it applies to your SoS
- Mark where on the slider bar you would place your SoS

Pair up with someone involved in a different system of systems. Discuss how similar and different your situations are based on these 5 dimensions.

**Stakeholder volatility:** how often do the stakeholders change? how much change?

**Centralization of control:** is there a strong single executive or decentralized federated control?
Discussion Exercise -2

**Coherence of incentives:** are all stakeholders striving for the same collective good? or are some stakeholders incentivized to satisfy their requirements to the exclusion of anyone else?

**Volutility of demand:** how often and to what degree do the situations the SoS responds to change, especially within the timeframe of the situations?

**Volutility of composition:** is there a single way to build the desired capability, or are there multiple (or changing) ways to assemble the constituent systems?
Patterns of Relationship Characteristics

Patterns are emerging that allow summarizing different profiles of relationship and other characteristics.

US DoD has proposed a set that provide a working framework of patterns.
# Types of System of Systems

<table>
<thead>
<tr>
<th>Management authority</th>
<th>Directed</th>
<th>Acknowledged</th>
<th>Collaborative</th>
<th>Virtual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrally managed</td>
<td>A designated manager and resources</td>
<td>Central stakeholders collectively decide how to provide or deny service</td>
<td>No central authority</td>
<td></td>
</tr>
<tr>
<td>One stakeholder has dominance</td>
<td>One stakeholder given dominance</td>
<td>Relatively few dominant stakeholders</td>
<td>Many stakeholders, none dominant</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SoS purpose</th>
<th>Directed</th>
<th>Acknowledged</th>
<th>Collaborative</th>
<th>Virtual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems are integrated and built to fulfill specific purposes</td>
<td>Recognized objectives</td>
<td>System constituents voluntarily agree to fulfill central purposes</td>
<td>No centrally agreed purpose; large-scale behavior emerges from constituent systems able to integrate</td>
<td></td>
</tr>
<tr>
<td>Changes negotiated between the SoS and the constituent systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Independence of constituent systems | None | Retain independent ownership | Retain independent ownership | Retain independent ownership |

Using Relationship Characteristics to Profile Different SoS Types

A more robust profiling of an SoS pattern would look at all relationship characteristics.

For this tutorial, we will focus on this subset:

- Stakeholder volatility
- Centralization of control
- Coherence of incentives
- Volatility of demand
- Volatility of composition

Profiles do not concentrate on what is possible; they concentrate on what is common.

We do not expect that all SoS of a certain type will have all of their characteristics falling within the boundaries we have set.
Notional Relationships Profile: Directed SoS

**Stakeholder volatility:** degree to which stakeholders are different, and frequency with which stakeholders change

**Centralization of control:** degree of centralization of decision and implementation authority

**Coherence of incentives:** degree to which stakeholders are incentivized toward the SoS goal vs. local goals

**Volatility of demand:** frequency of scope of changes in context across situations and within a single situation

**Volatility of composition:** degree and frequency of change in the way(s) that a desired capability is composed
Notional Relationships Profile: Acknowledged SoS

**Stakeholder volatility:** degree to which stakeholders are different, and frequency with which stakeholders change

- **Low**
- **High**

**Centralization of control:** degree of centralization of decision and implementation authority

- **Low**
- **High**

**Coherence of incentives:** degree to which stakeholders are incentivized toward the SoS goal vs. local goals

- **Low**
- **High**

**Volatility of demand:** frequency of scope of changes in context across situations and within a single situation

- **Low**
- **High**

**Volatility of composition:** degree and frequency of change in the way(s) that a desired capability is composed

- **Low**
- **High**
Notional Relationships Profile: Collaborative SoS

**Stakeholder volatility:** degree to which stakeholders are different, and frequency with which stakeholders change

- Low
- High

**Centralization of control:** degree of centralization of decision and implementation authority

- Low
- High

**Coherence of incentives:** degree to which stakeholders are incentivized toward the SoS goal vs. local goals

- Low
- High

**Volatility of demand:** frequency of scope of changes in context across situations and within a single situation

- Low
- High

**Volatility of composition:** degree and frequency of change in the way(s) that a desired capability is composed

- Low
- High
Relationships Profile: Wildland Fire Management

**Stakeholder volatility:** degree to which stakeholders are different, and frequency with which stakeholders change

- Low
- High

**Centralization of control:** degree of centralization of decision and implementation authority

- Low
- High

**Coherence of incentives:** degree to which stakeholders are incentivized toward the SoS goal vs. local goals

- Low
- High

**Volatility of demand:** frequency of scope of changes in context across situations and within a single situation

- Low
- High

**Volatility of composition:** degree and frequency of change in the way(s) that a desired capability is composed

- Low
- High
Key Points -1

There are four major types of SoS patterns identified by the US DoD that are useful for profiling SoS types

- Directed
- Acknowledged
- Collaborative
- Virtual

Relationship characteristics are useful for creating these profiles of SoS

- Relationships among stakeholders
- Relationships among goals and purpose
- Relationships among constituent systems

Different SoS types exhibit different relationship characteristics profiles

Understanding SoS characteristics profiles helps to understand the implications of the different types of SoS
### Key Points -2

<table>
<thead>
<tr>
<th>Director SoS</th>
<th>Acknowledged SoS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is most similar to traditional systems</td>
<td>Are more prevalent in SoS situations with less demand and compositional volatility</td>
</tr>
<tr>
<td></td>
<td>Still show centralization of authority, but weaker than a Directed SoS, due to independent ownership and evolution of the constituent systems</td>
</tr>
<tr>
<td></td>
<td>Have lower coherence of incentives and higher volatility/diversity of stakeholders than Directed SoS</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Collaborative SoS</th>
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</thead>
<tbody>
<tr>
<td>Are more prevalent in more volatile demand and compositional situations</td>
<td>Are decentralized in terms of authority, with situational authority granted to “leaders” of different elements</td>
</tr>
<tr>
<td>Are especially challenging because of the tendency toward low coherence of incentives</td>
<td>Have the fewest successful governance and management patterns</td>
</tr>
</tbody>
</table>
Agenda

Basics of Systems of Systems
- Perspectives of SoS Participants
- SoS Types and Characteristics

Organizational Implications of Systems of Systems
Responding to Organizational Implications in Systems of Systems

Summary
# Trends that are Affecting Today’s Organizations

<table>
<thead>
<tr>
<th>Industrial Age Emphasis</th>
<th>Post-Modern Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value creation via heavy industry and physical products</td>
<td>Value creation via ideas, knowledge, intellect, innovation</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Services</td>
</tr>
<tr>
<td>Products consumed</td>
<td>Experiences consumed</td>
</tr>
<tr>
<td>Possession and ownership</td>
<td>Connections and relationships</td>
</tr>
<tr>
<td>Tangible value</td>
<td>Intangible value</td>
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</tbody>
</table>

### Implications

- Development of new business models—e.g., Google, eBay, online insurance sales and claims processing
- Appearance of new communities—e.g., blogs, online journals, open source community production
- Acceleration of competitive pressures—faster innovation cycles, lower half-life of products and services, and faster commoditization of intelligent products
- Relationship-based vs. ownership-based assets—requires more nimble business strategies
Responding to an Increasingly Turbulent, Post-Modern World

- Customers and users need more specialized solutions in ever-shorter time frames, continuously adapted to their changing and evolving situations.
- Suppliers and capabilities have to become more flexible to respond to unanticipated demand.

**Product-Based**

Users want products with features and functions that can be provided in a way that is unaffected by how they are used.

**Solution-Based**

Users want integrated solutions of products and services that are customized to their context, but in a way that can be specified beforehand.

**User Experience-Based**

Users want integrated solutions that are customized in ways that change and evolve throughout the life of the mission that they support.

Governance and Management Must Accommodate Increasing Complexity

- Number, type, and roles of participants are increasingly diverse, reflecting differing vested interests and sovereign boundaries.
- Scarce resources and the need for concurrent uses make a single decision authority increasingly ineffective.

**Single Task “System”**

A single program directs composition
—little potential for conflict

**Single Enterprise**

A real or virtual entity directs how multiple entities collaborate to compose multiple programs
—resolves potential conflicts by imposing constraints

**Multiple Enterprises**

Multiple real or virtual directing entities making competing demands on SoS
—conflict resolution requires negotiating mutual constraints

Requires a fundamental shift
Understanding Supply Complexity and Response to Demand

Increasing need for context/situation-dependent response

Increasing diversity and independence of collaborators

Response to Demand

<table>
<thead>
<tr>
<th>Product Based</th>
<th>Solution Based</th>
<th>User Experience Based</th>
</tr>
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<tbody>
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Supply Complexity

- Single Task System
- Single Enterprise
- Multiple Enterprises
This Presents a Double Challenge

Challenge 1: Collaborating effectively across boundaries

Challenge 2: Collaborating across boundaries to provide flexible responses to dynamic and unanticipated situations

Wildland Fire Example and its Double Challenge

**Challenge 1:** Responding to wildland fire situations requires using systems designed, built, and owned by different organizations (e.g. weather, land use, logistics, fire prediction).

**Challenge 2:** Wildland fires specialists (users of the systems) need the capability to combine different systems in varying ways depending on the particular characteristics of a given fire, through the changing life of that fire event.
Discussion Exercise: Where is Your Organization in Relation to the Double Challenge?

Response to Demand

Product Based | Solution Based | User Experience Based

Supply Complexity

Multiple Enterprises | Single Enterprise | Single Task System

Where does it need to be?
Governance Implications and SoS Types

Supply Complexity
- Single Task System
- Single Enterprise
- Multiple Enterprises
- Product Based
- Solution Based
- User Experience Based
- Center driven
- Edge driven
- Collaborative
- Acknowledged
- Directed - “the comfort zone”
- Very limited experience and no body of knowledge and practices
- Some experience and practices
- Well established bodies of knowledge and practices for governance, management, engineering

Response to Demand
- Product Based
- Solution Based
- User Experience Based

SoS Organizational Implications Tutorial
SoSP GA Team, October 2009
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Organizational Implications of the Double Challenge: Leveraging the Galbraith Star Model

Adapted from Designing Complex Organizations, Jay Galbraith, Addison-Wesley, 1973.
**Selected Organizational Implications—Strategy**

<table>
<thead>
<tr>
<th>Directed</th>
<th>Acknowledged</th>
<th>Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning based on variety of products and services being offered to the collaboration under traditional terms and conditions</td>
<td>Positioning based on predetermined sets of solutions for defined customer sets that fit the collaboration overall goals</td>
<td>Positioning based on providing deep customer-oriented services wherever needed throughout the collaboration</td>
</tr>
</tbody>
</table>
## Selected Organizational Implications—Structure

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Hierarchical organizational structures that mimic constituent internal structures are most common. Some staff will be uncomfortable if “their” organizational framework is not the one being followed.</td>
<td>Matrix structures are common at SoS (e.g., CCBs &amp; IPTs). More emphasis on the roles people play within the collaboration than on their job function within a single organization.</td>
<td>Significant governance decisions occur in the customer context via distributed governance mechanisms. “Badgeless” environments where a person’s organizational affiliation is subsumed to the larger collaboration goal.</td>
</tr>
</tbody>
</table>
### Selected Organizational Implications—Processes

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A subset of important SoS processes require cross-organizational interoperation (i.e. CM); central authority determines the SoS process framework and enforces adherence.</td>
<td>Bilateral agreements between constituents and the acknowledged SoS leader are facilitated by the leader, but they don’t have traditional authority to enforce; alternate adherence incentives are needed.</td>
<td>Combination of bilateral and multi-lateral process agreements for processes considered mutually important for collaboration interoperation are required among constituents; adherence cannot be enforced easily.</td>
</tr>
</tbody>
</table>
**Organizational Implications—Rewards, People**

<table>
<thead>
<tr>
<th></th>
<th>Directed</th>
<th>Acknowledged</th>
<th>Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rewards</strong></td>
<td>Reward staff who sacrifice their traditional constituent practices to comply with the central authority’s governance and management mechanisms</td>
<td>Similar reward structures to Directed, plus ensure that those building and delivering multi-system solutions are motivated to communicate effectively with external (to their organization) SoS constituents</td>
<td>Include significant rewards for furthering the goals of the collaboration, not just those of the individual SoS constituent; plus ensure that those interacting closely with the customers are motivated to communicate effectively with relevant external SoS constituents</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>Technical skills required across multiple systems; management skills focus on integration of multiple organizational units</td>
<td>Technical skills required for building solutions based on multiple products; management skills that are needed include operating across organizational boundaries</td>
<td>Ability to learn new systems quickly is paramount technical skill; consulting skills are prevalent: negotiation and influencing skills are critical to successful governance and management</td>
</tr>
</tbody>
</table>
Current State for Wildland Fire Management

- Product-based orientation in response to demand; centrally driven from the entities in control of the research and development resources.
- Development skill base have experience in operational roles.
- Limited soft skills associated with cross-organizational negotiation and communications.
- Extensive use of IPTs to inform and make development decisions across organizational boundaries.
- Unaligned reward systems: some community based recognition for interoperation across systems; contributions to operational mission are recognized.
- Which SoS processes need to interoperate have not been determined.
- Manual integration across systems is required.
Discussion Exercise: Wildland Fire Management As-Is and Should-Be

How do the descriptions of the wildland fire situation match with the descriptions of implications for Collaborative SoS?
## A Few Ideas for Selected SoS Constituent Roles

<table>
<thead>
<tr>
<th>Role</th>
<th>SoS Type</th>
<th>CIO</th>
<th>Portfolio Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Directed</td>
<td>Be aware of changes in the demand/collaboration environment that could affect central authority (e.g., new government regulations)</td>
<td>Try to ensure that the incentive structures for your individual programs don’t conflict with the overall goals for your portfolio</td>
</tr>
<tr>
<td></td>
<td>Acknowledged</td>
<td>Understand the limits of the decision making authority of the collaboration’s acknowledged leader</td>
<td>Look for leverage points across your portfolio that improve flexibility of the overall collaboration solution</td>
</tr>
<tr>
<td></td>
<td>Collaborative</td>
<td>Understand which decision areas truly need to be under your control and help to ensure that appropriate SoS constituents are granted decision-making authority in other areas (help ensure situational authority)</td>
<td>Recognize that many of your portfolio elements participate in SoS collaborations that have little to do with your portfolio and minimize governance approaches (i.e., mandatory reports with only one audience) that interfere in those relationships</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure staff is assigned to stay close to the customer context</td>
<td></td>
</tr>
</tbody>
</table>
# A Few Ideas for Selected SoS Constituent Roles -2

<table>
<thead>
<tr>
<th>Role</th>
<th>SoS Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Directed</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Program or Project Manager</td>
<td>Include all stakeholders, including those in operational environments, in design-time decision making</td>
</tr>
<tr>
<td>Technical Manager</td>
<td>Be prepared to make changes to your constituent system that may be suboptimal but are needed for the SoS as a whole</td>
</tr>
<tr>
<td>Operations Manager</td>
<td>Ensure that you are participating as actively as possible in the design-time decisions that will affect your operation downstream</td>
</tr>
</tbody>
</table>
Key Points -1

Suppliers and enterprises are being driven out of the comfort zone of traditional systems engineering by

- Multi-enterprises systems of systems with limited centralized authority
- Suppliers who are taking greater responsibility to provide solution- or experience-based value for users
- Suppliers who are dealing with greater complexity associated with providing experience-based value to users

How governance changes are implemented in complex systems of systems depends on the type of SoS and the culture of the organizations involved

Organizational implications range across multiple dimensions—People, Strategy, Processes, Reward Systems, and Structures—governance frameworks and management practices need to accommodate
Key Points -2

Era of the end user/operations group as second class citizens in terms of involvement in engineering and design is over!

• In SoS, the operational situation is increasingly key to composing/recomposing systems of systems to achieve mission or market objectives

• Increasing volatility in operations means that traditional requirements elicitation processes won’t work—the operational community is a primary connection to the evolving situational demands

• Hierarchical governance approaches do not give enough authority to staff working “at the edge” so they can be effective in working in customer/operational situations
Agenda

Basics of Systems of Systems
  • Perspectives of SoS Participants
  • SoS Types and Characteristics

Organizational Implications of Systems of Systems

Responding to Organizational Implications in Systems of Systems

Summary
To Respond to SoS Organizational Implications

**UNDERSTAND** how key aspects of our situation reflect SoS realities

**DETERMINE CHANGES** that are needed to our governance practices

**PREPARE TO ADOPT** those new practices effectively

**MAKE AND MONITOR CHANGES** to ensure that they are effective

- Leverage traditional organizational change approaches

SEI SoS Practice Governance and Acquisition (SoSP GA) team supports some of these activities
UNDERSTAND How Key Aspects of Situation Reflect SoS Realities

Critical Context Analysis (CCA)
- Identifies stakeholders outside known spheres of influence and exposes critical hidden relationships between organizations that could have impacts on governance approaches

Influence Mapping Analysis (IMA)
- Makes stakeholder and constituent expectations, constraints, and boundaries explicit
- Exposes the real nature and the actual implications of existing agreements among SoS constituents

Strategic Alternatives Analysis (SAA)
- Reveals the impact of candidate governance and acquisition approaches as a response to potential changes in external environment
DETERMINE CHANGES that are Needed to Governance Practices

SoS Focus Analysis (SFA)
• Indicates governance choices to achieve appropriate balance between technical and operational elements of a SoS (e.g., resource allocation, incentive policies, success criteria)

Governance Alignment Analysis (GAA)
• Identifies gaps between current and needed governance mechanisms and structures along eight critical dimensions (e.g., policy, collaboration)

Distributed Governance Analysis (DGA)
• Operationalizes agreements and extends them by specifying appropriate individuals, actions to be taken, and additional data (e.g., completion date, notifications on failure)
PREPARE TO ADOPT Those New Practices Effectively

Readiness & Fit Analysis (RFA)

- Uncovers risks and creates mitigation strategies that account for social realities of the organization when adopting new governance practices
### SoSP Methods for Governance & Acquisition

Optimize for One or More SoS Types

<table>
<thead>
<tr>
<th>Method</th>
<th>Directed</th>
<th>Acknowledged</th>
<th>Collaborative</th>
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</thead>
<tbody>
<tr>
<td>Critical Context Analysis</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Influence Mapping Analysis</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Strategic Alternatives Analysis</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SoS Focus Analysis</td>
<td></td>
<td>X</td>
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<td>Governance Alignment Analysis</td>
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<td>Distributed Governance Analysis</td>
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<td>Readiness &amp; Fit Analysis</td>
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Most methods can also be used outside their primary area.
Example Use of Selected Governance & Acquisition Methods: Wildland Fire

UNDERSTAND: characterize who is involved in the broad SoS context and critical stakeholders

Critical Context Analysis

UNDERSTAND: identify possible future demands and trends

Strategic Alternatives Analysis

DETERMINE CHANGES: establish use of existing systems and their alignment to their context of use

SoS Focus Analysis

DETERMINE CHANGES: determine needed balance of resources to operationalize SoS capabilities

Governance Alignment Analysis
Future Directions of SoSP Work in Governance & Acquisition

Develop governance and acquisition guidance for an SoS Practice Framework

- Analyze results from pilot uses for potential recommended practices

Refine the methods for specific problems of different SoS types

- Identify standard profiles to predict governance gaps common to different SoS situations

Pilot SoSP methods (e.g., Critical Context Analysis) in situations with different characteristics than previous pilots

- Expand our understanding of the applicable scope and scale for the methods
Agenda

Basics of Systems of Systems
  • Perspectives of SoS Participants
  • SoS Types and Characteristics

Organizational Implications of Systems of Systems

Responding to Organizational Implications in Systems of Systems

Summary
Key Takeaways

The shift in how systems are built, deployed, and used has implications for organizations

- Systems are rarely standalone; rather they are networks of socio-technical systems (of systems)

New bases for making organizational decisions are needed

- An SoS can be characterized by relationships of constituent systems, stakeholders, and goals and purpose—all within a particular context of use
- Understanding the type of SoS context you are in can help frame decisions

New governance structures and approaches are needed as capabilities of systems of systems cross sovereign enterprise boundaries

- Collaboration of constituent systems and stakeholders is required where a central authority realistically does not exist

SEI is adapting and packaging methods to facilitate the analysis of essential relationships across SoS types, particularly for Directed, Acknowledged, and Collaborative
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