Engineering Complex Mission Capabilities through Lead Systems Integration

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"Our current system is like a machine to which we just keep adding important and wanted items but without a cohesive strategy for an elegant, interwoven system. Considered on their own, the addition and growth of individual elements may be useful. But when ownership organizations do not see how their contribution fits into the whole and think their element is an end-state in itself, effective communication and execution are inhibited."

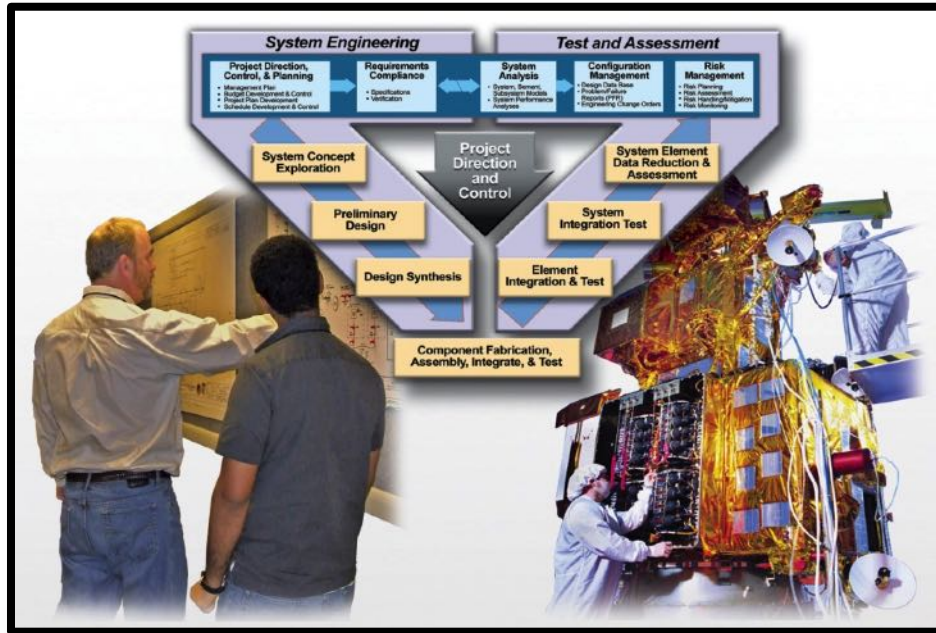- ADM William Gortney, ADM Harry Harris, USNI Proceedings, May 2014

Lead Systems Integration (LSI)

- **Lead Systems Integration** – An acquisition strategy that employs a series of methods, practices, and principles to increase the span of both management and engineering acquisition authority and control to acquire SoS or highly complex systems.

- In 2008 Public Law 110-181, Congress directed Secretary of Defense to:

    – Size and Train the workforce to perform Inherently governmental functions

    – Minimize and eventually eliminate contractors as LSI

Lead Systems Integration (LSI)
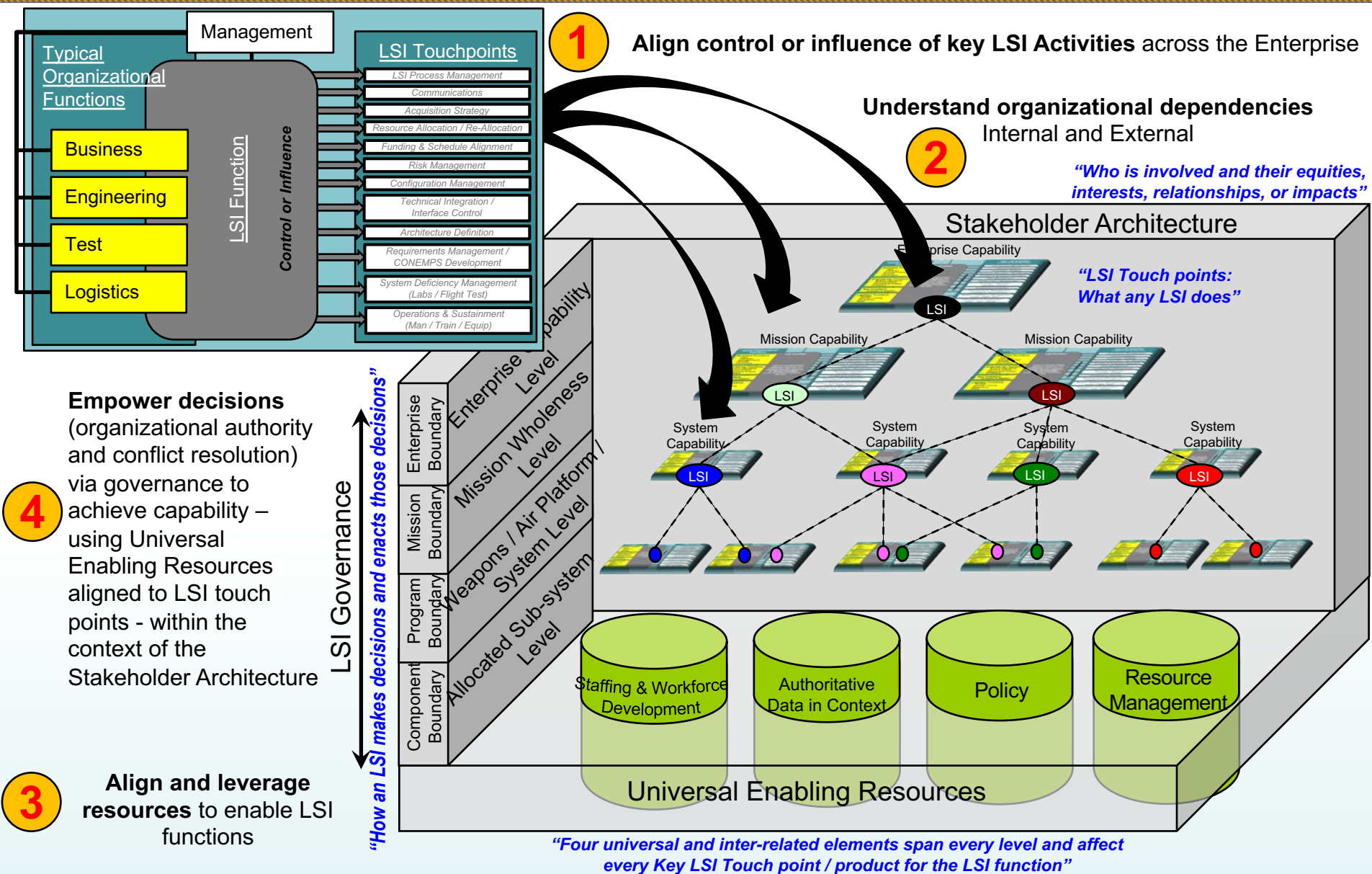

Graphic Source: www.meicompany.com

- **LSI Function** - Assert and execute system, SoS, and stakeholder trade space to affordably optimize Integrated Warfighting Capabilities across the SoS lifecycle.
  - The roles of the LSI are similar to the roles of any Systems Engineer (SE) or System Integrator (SI). The primary difference is the span of design and integration authority that persists throughout system or SoS acquisition and lifecycle.
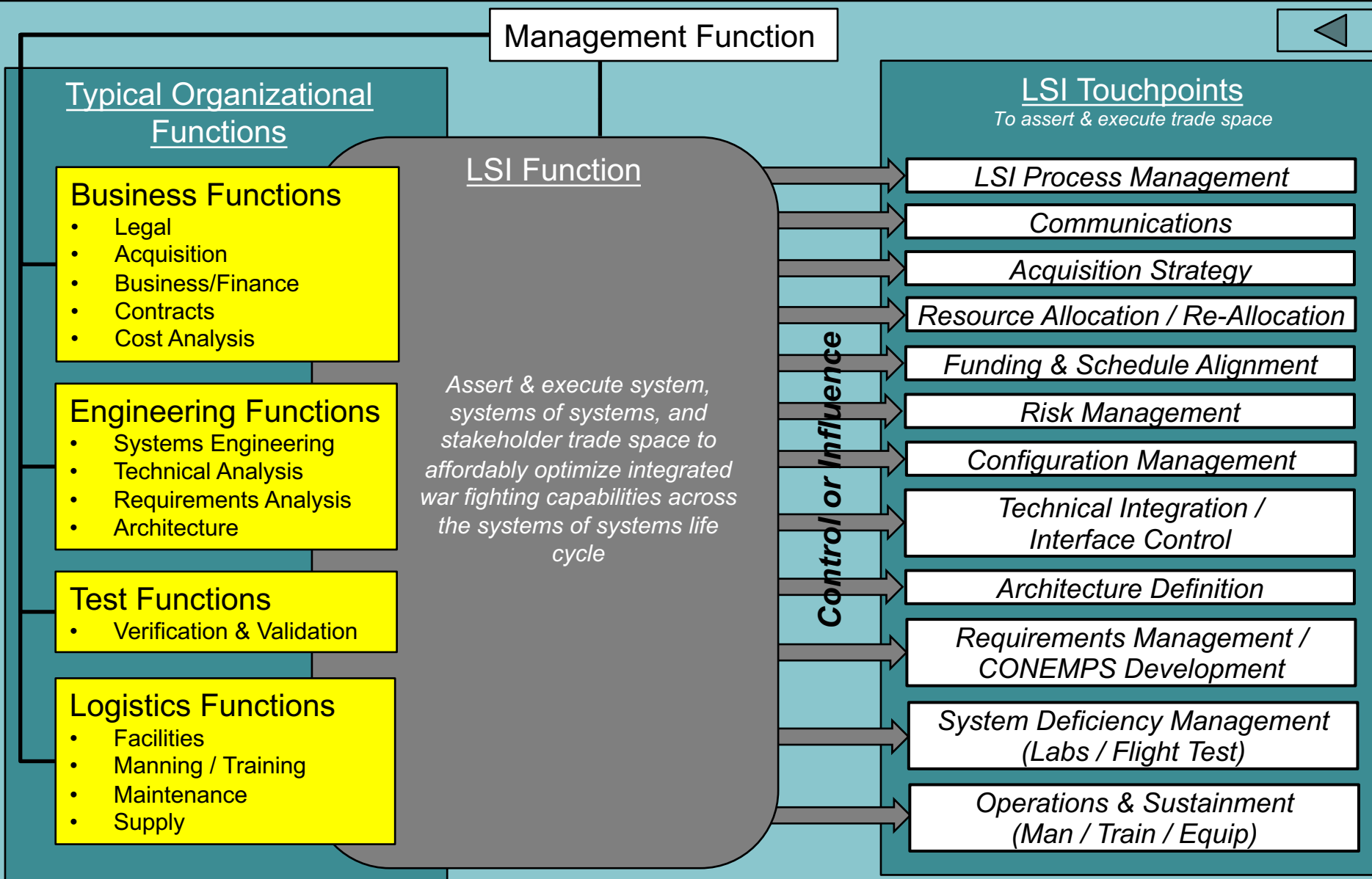
Key objectives: Affordability; Speed to the Warfighter; Agility; Maximize the Value of Complex System.

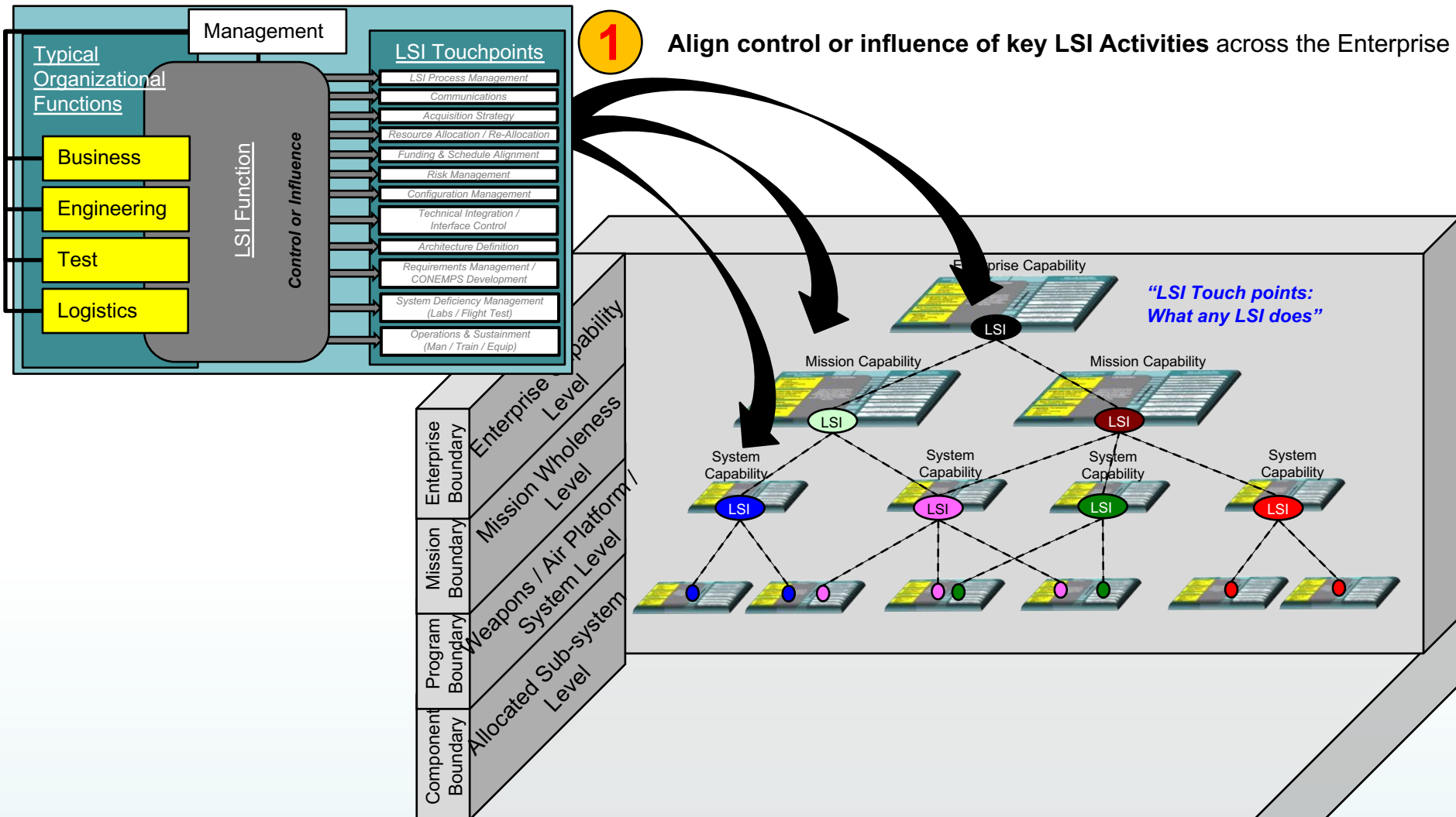# LSI Mission: Affordably Optimize Integrated Warfighting Capabilities across the Systems of Systems Life Cycle

Management

Typical Organizational Functions

- Business
- Engineering
- Test
- Logistics

LSI Function

Control or Influence

LSI Touchpoints
- LSI Process Management
- Communications
- Acquisition Strategy
- Resource Allocation / Re-Allocation
- Funding & Schedule Alignment
- Risk Management
- Configuration Management
- Technical Integration / Interface Control
- Architecture Definition
- Requirements Management / CONEMPS Development
- System Deficiency Management (Labs / Flight Test)
- Operations & Sustainment (Man / Train / Equip)

1 **Align control or influence of key LSI Activities** across the Enterprise

2 **Understand organizational dependencies** Internal and External

"Who is involved and their equities, interests, relationships, or impacts"

"LSI Touch points: What any LSI does"

Stakeholder Architecture

Enterprise Capability

Mission Capability · Mission Capability

System Capability · System Capability · System Capability · System Capability

LSI Governance

"How an LSI makes decisions and enacts those decisions"

Enterprise Boundary — Enterprise Capability Level

Mission Boundary — Mission Wholeness Level

Program Boundary — Weapons / Air Platform / System Level

Component Boundary — Allocated Sub-system Level

4 **Empower decisions** (organizational authority and conflict resolution) via governance to achieve capability – using Universal Enabling Resources aligned to LSI touch points - within the context of the Stakeholder Architecture

3 **Align and leverage resources** to enable LSI functions

Universal Enabling Resources
- Staffing & Workforce Development
- Authoritative Data in Context
- Policy
- Resource Management

"Four universal and inter-related elements span every level and affect every Key LSI Touch point / product for the LSI function"

Lead Systems Integration (LSI) Touchpoints

Management Function

Typical Organizational Functions

Business Functions
- Legal
- Acquisition
- Business/Finance
- Contracts
- Cost Analysis

Engineering Functions
- Systems Engineering
- Technical Analysis
- Requirements Analysis
- Architecture

Test Functions
- Verification & Validation

Logistics Functions
- Facilities
- Manning / Training
- Maintenance
- Supply

LSI Function

Assert & execute system, systems of systems, and stakeholder trade space to affordably optimize integrated war fighting capabilities across the systems of systems life cycle

Control or Influence

LSI Touchpoints
To assert & execute trade space

- *LSI Process Management*
- *Communications*
- *Acquisition Strategy*
- *Resource Allocation / Re-Allocation*
- *Funding & Schedule Alignment*
- *Risk Management*
- *Configuration Management*
- *Technical Integration / Interface Control*
- *Architecture Definition*
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- *Operations & Sustainment (Man / Train / Equip)*

LSI Touchpoints in the Enterprise LSI Framework

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LSI Function — *Control or Influence*

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"LSI Touch points: What any LSI does"

Enterprise Capability — LSI

Mission Capability — LSI   Mission Capability — LSI

System Capability — LSI   System Capability — LSI   System Capability — LSI   System Capability — LSI

Enterprise Boundary — Enterprise Capability Level
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LSI Touchpoints: highest payoff points of control or influence – aligned across the enterprise

LSI Application: Multiple Levels

Tiers of LSI Roles (Govt SE Trade Space)

Lead System Integration

- **Lead System Integration** (LSI) is an **acquisition strategy** that employs a series of **methods, practices, and principles** to increase the span of both **management** and **engineering** acquisition **authority** and **control** to acquire SoS / highly complex systems.
  - **Scalable** Application to:
    – Systems of Systems (SoS)
    – Complex Systems
    – System Elements
  - **Tailorable** Approach Adjusted to:
    – Program Type
    – Number of External Organizations
    – Desired Level of Program Control
    – Program Complexity and Risk Level

Collaborative ➡ Acknowledged ➡ Directed

Enterprise LSI Framework "Levels"

LSI Vision Statement / Purpose: "Why an LSI exists"

"Affordably Optimize Integrated Warfighting Capabilities across the Systems of Systems Life Cycle"

Government LSI may apply at multiple levels across multiple programs and stakeholders with operational / managerial dependence

Unclassified

SOURCE: NPS Cohort 2 Report, 2015

- **Descriptions of layers**
  - **Component Boundary** (Allocated Sub-system level)
  - **Program Boundary** (Weapons / Air Platform / System Level)
  - **Mission Boundary** (Mission Wholeness Level)
  - **Enterprise Boundary** (Enterprise Capability Level)
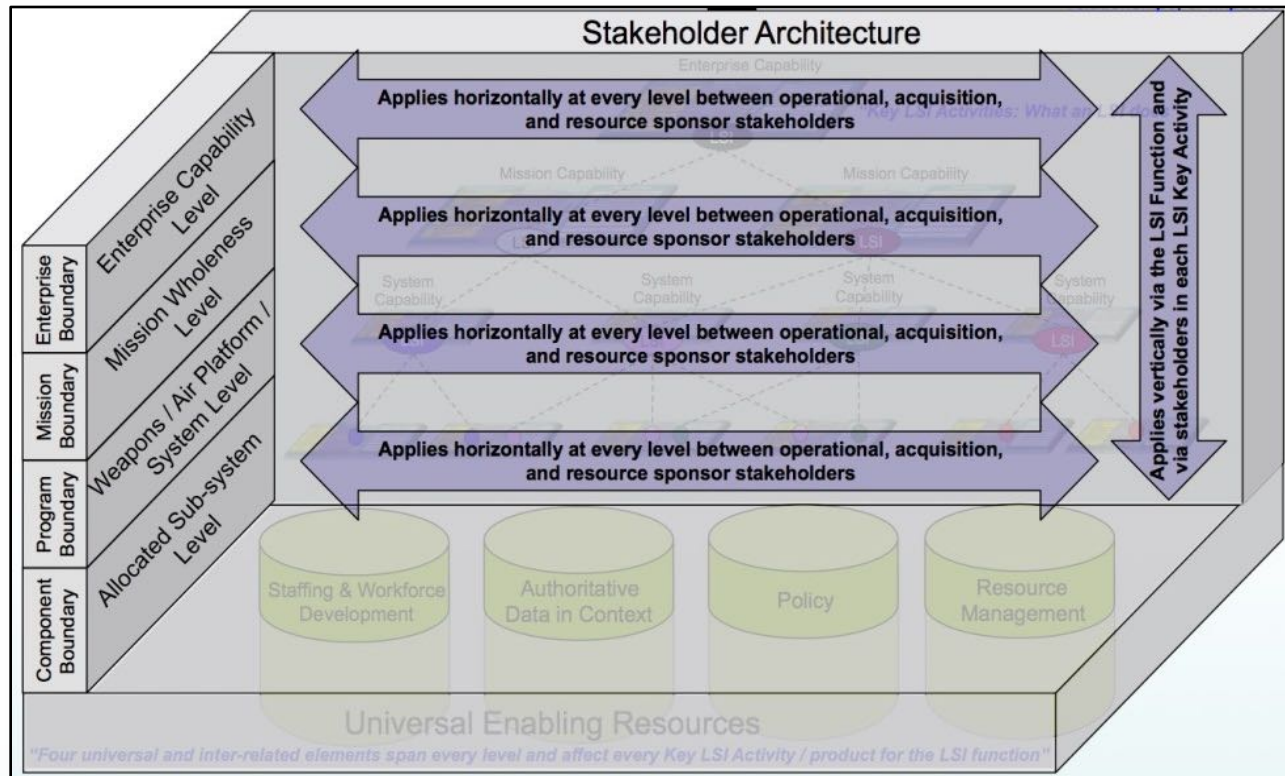
- Stakeholder "Architecture" in the Enterprise LSI Framework provides a resource for the LSI to **identify and manage stakeholders both horizontally and vertically**

- Stakeholder "Architecture" **supports LSI-unique execution across any of the LSI touch points**…and what resources they trade or use to support the LSI effort

① Align control or influence of key LSI Activities across the Enterprise

② Understand organizational dependencies
Internal and External

"Who is involved and their equities, interests, relationships, or impacts"

"LSI Touch points: What any LSI does"

Stakeholder Architecture
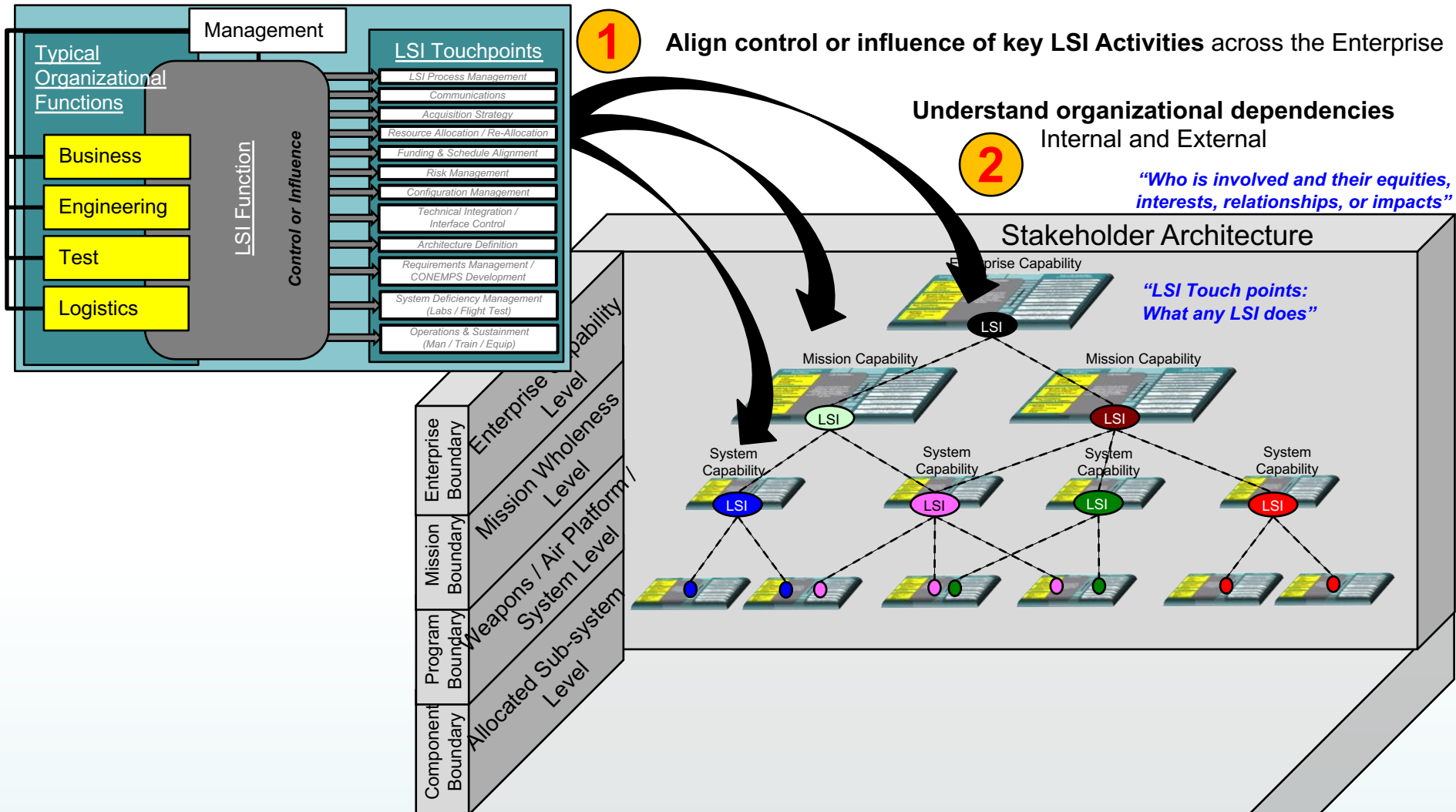
Stakeholder "Architecture" / Management: Who is involved and their equities, interests, relationships, or impacts

Stakeholder Architecture

"Four universal and inter-related elements span every level and affect every Key LSI Activity / product for the LSI function"

Universal Enabling Resources
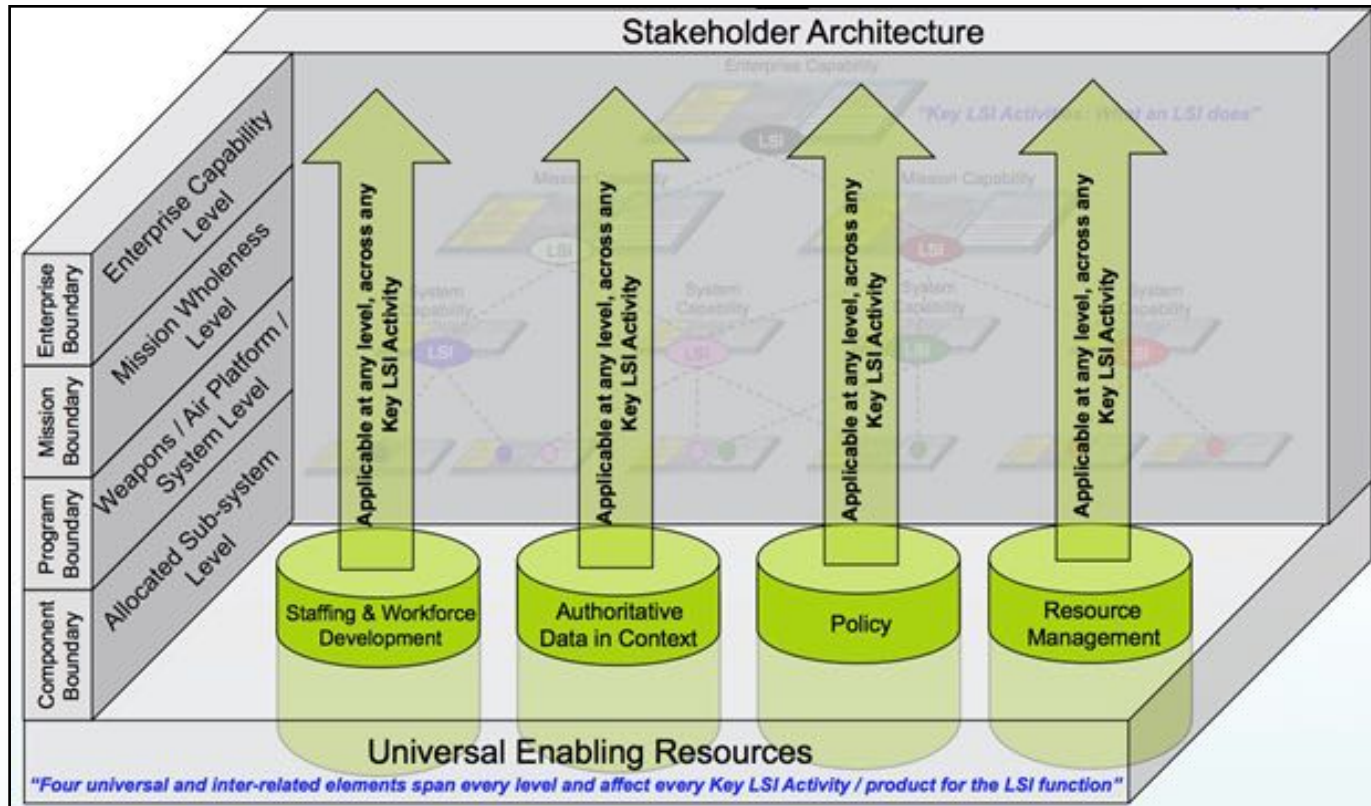
SOURCE: NPS
Cohort 2 Report, 2015

- "Universal Enabling Resources" are **resources any LSI uses to support LSI-unique execution at each of the "LSI touchpoints"** – to assert and execute trade space

- These **four fundamental enablers apply at any level** in the Enterprise LSI Framework

Universal Enabling Resources in the Enterprise LSI Framework

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Component Boundary

3 **Align and leverage resources** to enable LSI functions

- Staffing & Workforce Development
- Authoritative Data in Context
- Policy
- Resource Management

Universal Enabling Resources

Universal Enabling Resources: four universal and inter-related elements span every level and affect every LSI touch point required for the LSI function and mission

"Governance is the structure and relationships among key stakeholders that determine an organization's direction and performance."

Invigorating Defense Governance, A Beyond Goldwater-Nichols Phase 4 Report: Kathleen H. Hicks, March 2008

- Provide the **set of decision-making criteria, policies, processes, and actions that guide the responsible organizations** (within the stakeholder architecture) to achieve Enterprise SoS goals and objectives

- Define **communication paths and decision authority** within the stakeholder "architecture" for conflict resolution

- Charter decision bodies to **alter the actions of individuals and organizations** in support of the LSI effort

- Governance **derives from the agreements between key stakeholders**, at all levels of LSI, on how to achieve a common goal

LSI Governance Challenges (1)

LSI Governance Challenges (2)

LSI Governance challenge: Pivot from "program/platform" focus to SoS mission / capability focus – across independent, collaborative stakeholders – without "revolutionary organizational change"

Governance Objectives in the Enterprise LSI Framework

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LSI Governance challenge: Pivot from "program/platform" focus to SoS mission / capability focus – across independent, collaborative stakeholders – without "revolutionary organizational change"

- ✓ **Distribution of Authority**, focused on acquisition of capabilities

- ✓ **Conflict Resolution**, arbitrated by key stakeholders most capable to address enterprise goals

- ✓ **Maintaining Stakeholder "Architecture"** since governance flows directly from stakeholder relationships

- ✓ **Communication** – LSI as the conduit of authoritative data – "shared common understanding"

- ✓ **LSI Governance Charter** documents roles, responsibilities, authority, conflict resolution plans, and agreements - including empowered resource management authority - to incentivize stakeholders to think and act differently

Governance Considerations in the Enterprise LSI Framework

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Enterprise Capability Level
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Weapons / Air Platform / System Level
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Enterprise Boundary
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Program Boundary
Component Boundary

LSI Governance

"How an LSI makes decisions and enacts those decisions"

Empower decisions (organizational authority and conflict resolution) via governance to ④ achieve capability – using Universal Enabling Resources aligned to LSI touch points - within the context of the Stakeholder Architecture

③ **Align and leverage resources** to enable LSI functions

Universal Enabling Resources
- Staffing & Workforce Development
- Authoritative Data in Context
- Policy
- Resource Management

Governance Considerations: "The Framework in Motion"
How any LSI makes decisions and enacts those decisions

The Enterprise LSI Framework: A potential Government LSI enabler to "think and act differently"

Align control or influence of key LSI activities across vertical and horizontal organizational boundaries via common, "high payoff" LSI touchpoints

Understand organizational interdependencies via Stakeholder "Architecture" / Management

Align and leverage organizational resources to enable inherently governmental LSI functions

Empower decisions via governance (authority and conflict resolution)

Future Work

- Explore other strategies and approaches that might also address the SoS and complex system challenges. Strategies to date:
  - Lead Systems Integration (LSI)
  - Navy Integration and Interoperability (I&I)
  - Marine Corps I&I
  - Information Technology Technical Authority (IT TA)
- Research questions:
  - What is the correlation between Navy I&I, *USMC I&I, IT TA*, and LSI?
  - How can correlating the various development and acquisition processes for SoS, and complex systems, facilitate acquisition strategies that improve the belonging, connectivity, and integration of SoS and complex systems to better satisfy mission objectives?
  - How does the correlated LSI model apply across non-Navy development and acquisition, and within the Department of Defense?

- ## LSI Process Management
  - Accountable for mission wholeness, the **LSI should define how it interfaces with legacy processes across multiple stakeholders** to meet unique LSI capability and trade space objectives

- ## Communication
  - Internal and external communications manages multiple stakeholders
  - **React with agility** to requirements, design, or stakeholder, emergence
  - **"Shared common understanding"** of assumptions, limitations, and constraints
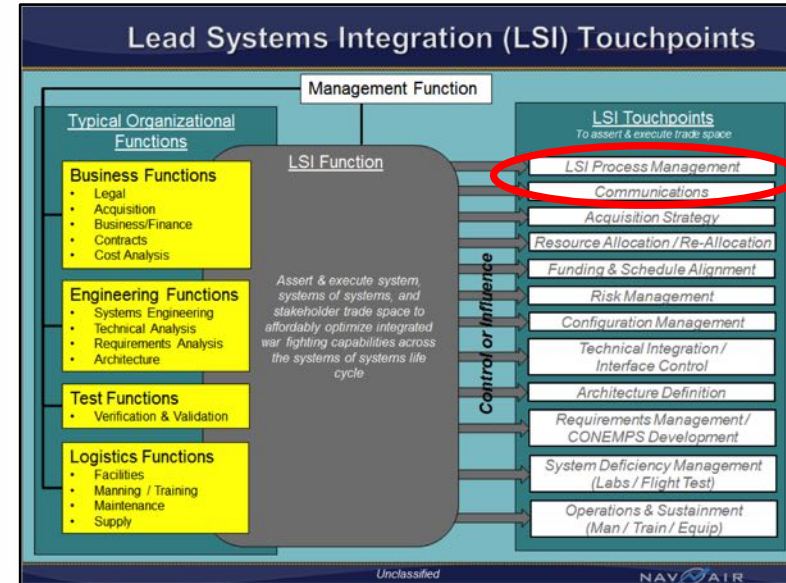
Legacy Processes vs. LSI inject points

Communications…

Lead Systems Integration (LSI) Touchpoints

- ## "Super-" Acquisition Strategy
  - LSI should **define & implement overarching acquisition strategy across multiple stakeholders and programs** to achieve Systems of Systems capability objectives within resource constraints

- ## Enterprise Resource Allocation / Re-Allocation
  - LSI is **primary arbitrator of resource allocations** between composite SoS elements and stakeholders
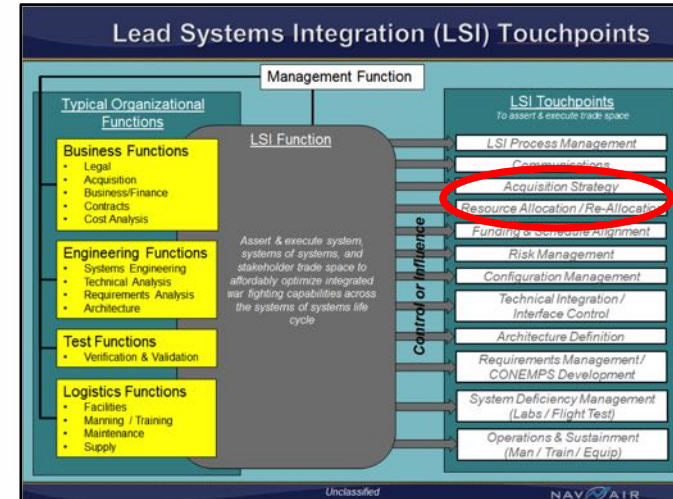
- **Enterprise Funding & Schedule Alignment**
  - LSI should consider **dynamic funding changes** across multiple programs it may not control
  - LSI must **align multiple asynchronous schedules** it may not control
  - LSI may create and use a resource loaded Integrated Master Schedule

Lead Systems Integration (LSI) Touchpoints
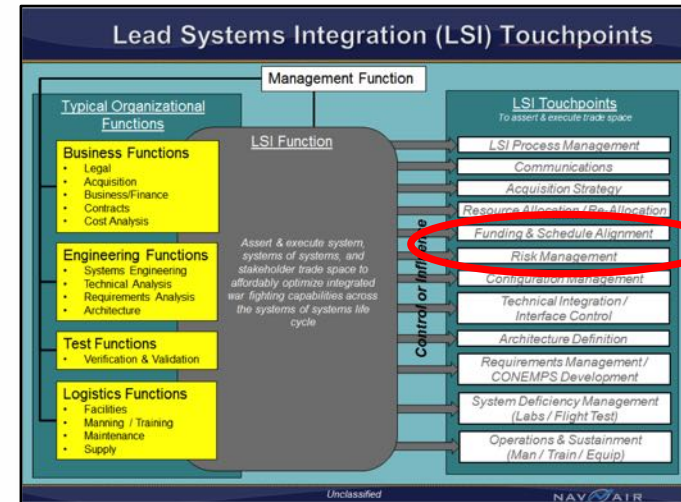
- **Codependent Systems of Systems Risk Management**
  - LSI **visibility to risks, issues, and opportunities across sub-programs / sub-systems** making up the capability enables SoS trade space management
  - LSI should have a way to **combine & normalize risks** across different program risk rating systems to inform trade space management

- **Asynchronous Configuration Management**
  - LSI should **establish/maintain overall SoS CM baseline** throughout the product / systems life cycle for all baselines
    - Capability, Performance, Functional, Allocated, Product
  - **Multiple SoS CM baselines** supporting the LSI's overall baseline **may change dynamically** and may be beyond the LSI's control
  - LSI should constantly **monitor and communicate** to ensure the SoS capability is still maintained

- **Enterprise Technical Integration & Interface Management**
  - Technical trade space is **managed at the interfaces**
  - **Dynamically changing technical maturity of systems** in a SoS complicate the LSI effort
  - Consider a **dedicated individual or team** in proportion to the size and level of the LSI effort
  - Selection of appropriate IP, Data rights, MOSA are LSI enablers to **ensure ease of use and technology**

Lead Systems Integration (LSI) Touchpoints
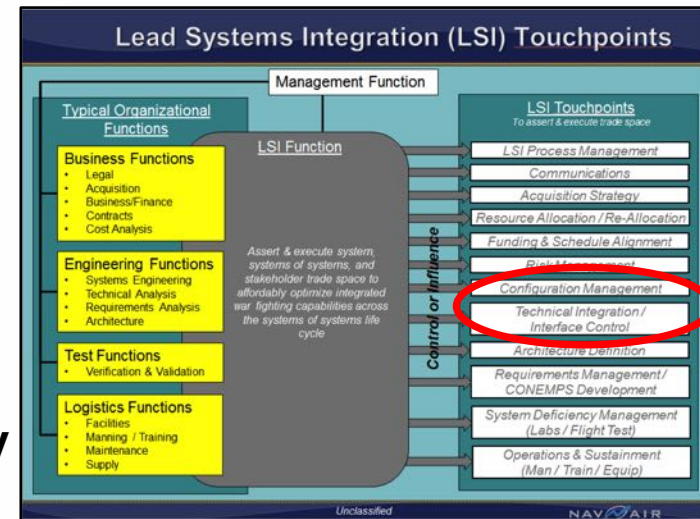
- **Enterprise Architecture Definition**
  - LSI should **"own"** overall architecture
  - Architecture **defines LSI interfaces** for trade space management across SoS
  - May involve **different architecture tools used by different stakeholders**
    - LSI enabler: **common architecture tools** resourced and maintained across SoS life cycle
  - Requires **architecture configuration management** across databases

- **Enterprise Requirements Mgmt / Concepts of Employment**
  - SoS stakeholders **may have different Assumptions, Limitations, or Constraints** (ALCs) about expected use of systems
  - Requirements for component SoS or stakeholders **may change dynamically or "emerge" over time** during decomposition/integration
    - Allocation of requirements / resources **iterative & ongoing** across elements LSI may not control
  - LSI should **align ALCs at the capability level**
    - CONEMPS energize early warfighter/resource sponsor stakeholder involvement

Lead Systems Integration (LSI) Touchpoints
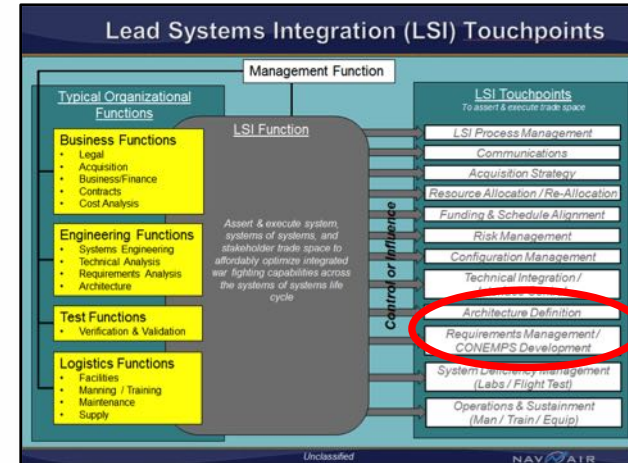
- **Systems of Systems Deficiency Management**
  - Laboratory, flight test, & V&V activities are **key challenge in complex SoS environments**
  - LSI must determine **impact of deficiencies at the SoS level** from constituent systems and stakeholders deficiency management systems
  - Adoption of existing laboratory / simulation / **Live, Virtual, Constructive** (LVC) environments / system deficiency management methodologies & tools is an **LSI enabler**


Lead Systems Integration (LSI) Touchpoints
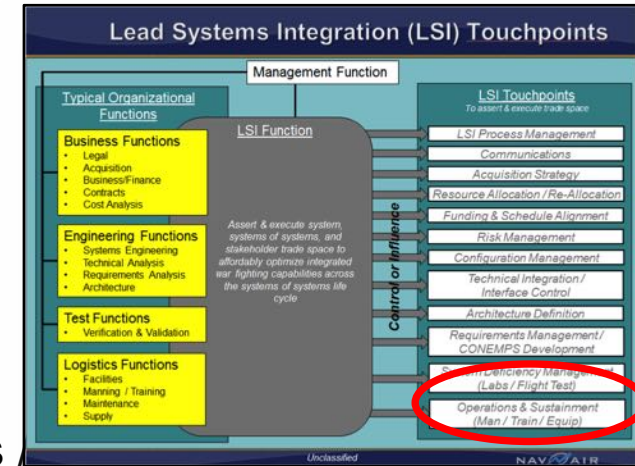
- **Operations and Sustainment (Man / Train / Equip)**
  - **Support system architecture is equally as critical** as engineering-based functional, operational, or mission architectures
  - **Assess existing stakeholder / constituent system DOTMLPF synergies** to minimize logistics footprint
  - **Resource (and monitor) sustainment cost evaluations** continually during systems of systems development and throughout lifecycle

* DOTMLPF (Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities)

- LSI may need to **rebalance overall staffing** from Prime contractors to Government as Government takes on additional roles and responsibilities

- Operating in a complex SoS environment and executing LSI efforts requires **additional depth of focus and tailored enhanced knowledge, skills, and experiences** beyond traditional programs

- High payoff skill areas:
  - SMEs with **knowledge across programs** and an understanding of how various programs and components come together to accomplish **missions and capabilities**
  - SoS skills across **LSI touchpoint areas**
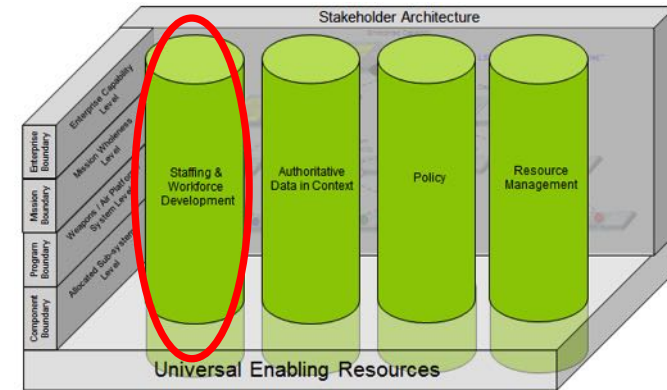
"Four universal and inter-related elements span every level and affect every Key LSI Activity / product for the LSI function"

Sources: "LSI Calibration" brief to NPS Cohort #2, 2014, and "Lead Systems Integrator Role for Government", 2010, Stu Young

- Everyone must have the **same data**; know which data is **"good" data**; and **have that data interpreted** as it applies to the LSI's capability ("so what" impacts of raw data)

"Four universal and inter-related elements span every level and affect every Key LSI Activity / product for the LSI function"

- "Authoritative Data in Context" includes a **comprehensive integrated set of programmatic, technical, and stakeholder data** that enables a **shared common understanding** of trade space
  - Shared common understanding of the trade space enables LSI executive-level decision making
  - Scope and detail of data varies by level of LSI

- LSI data should be **integrated – and configuration managed**

- LSI data also benefits from **enterprise Taxonomy management**
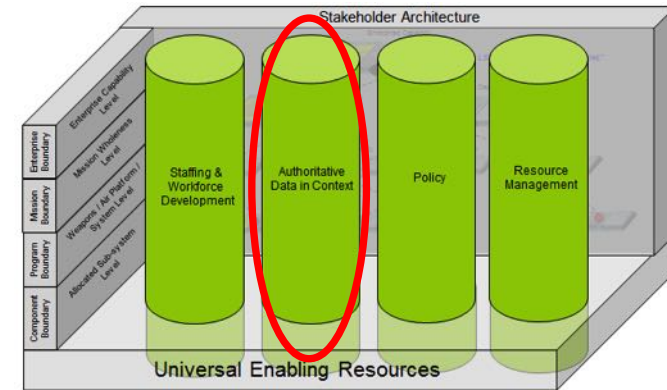
- LSI should consider **technical, organizational, and legal policy guidance and constraints**
  - i.e. Public law, civil mandates, legal rulings, competency/ SYSCOM policies, and certification requirements
  - Is it a law, is it policy, or is it folklore?
  - "Policy" enables and bounds LSI's ability to assert and execute trade space

- Policy elements and effects on an LSI **may be different at each boundary level**
  - Enterprise capability, Mission wholeness, System levels…

- Policy can be an **enabler for LSI governance**
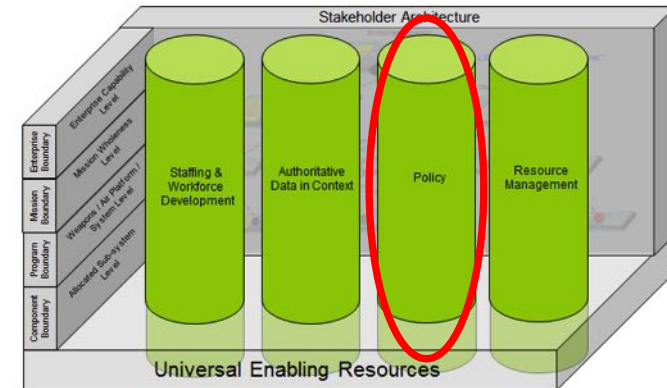
**Understand and leverage policy
Challenge assumptions**

"Four universal and inter-related elements span every level and affect every Key LSI Activity / product for the LSI function"

LSI Contracting and Financial Policy Considerations

- Contracting Policy Considerations:
  - Erosion of Government Expertise
  - Contractual Decision Making
  - Subcontractor Requirements
  - Roles and Responsibilities Education
  - National Team Concept
  - Congressional Oversight
  - Organizational Collaboration
  - Prime Contractor 'Profit Pressures'
  - Concentration of Prime Contractor Power

- Financial Policy Considerations:
  - Requirements tradespace
  - Schedule management
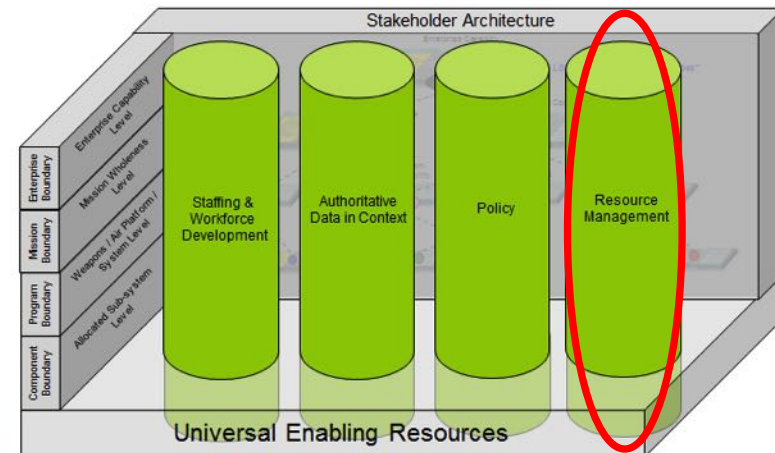 - Performance allocation
  - Cost reductions
  - Warfighter Needs

- Government LSI can **enable (or constrain) any LSI touchpoint** – or the total system / capability trade space - by **controlling or influencing resources**
  - Cost (Financial)
  - Schedule (Timing)
  - Performance (Capability)

Stakeholder Architecture

Staffing & Workforce Development | Authoritative Data in Context | Policy | Resource Management

Universal Enabling Resources

"Four universal and inter-related elements span every level and affect every Key LSI Activity / product for the LSI function"

- Addresses **Resource Availability** at any level of the Enterprise LSI Framework

- Accounted for in available tradespace
  - Comprehensively and commonly assessed