System of Systems Architecture and TSPR Contractor Model

Conference on the Acquisition of Software-Intensive Systems
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Presentation Goal

• Base discussion a recent 10-month study for a key intelligence agency (without attribution)
• Identify acquisition issues driving the agency PMOs for mission critical IT systems
• Show relationship between System-of-Systems Architecture and TSPR Acquisition Model
• How well does the TSPR approach respond to the software-intensive acquisition issues?
Agenda

• Acquisition Organization Pressures
• Very Quick View of System-of-Systems and its Architecture(s)
• TSPR – Total System Performance Responsibility Contracting
  – Overarching Systems Integrator
• Acquisition Process Changes
## Acquisition Issues “Nightmare”

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**UpStart Systems**

Conf on the ACQ of SW-Intensive Systems
Acquisition PMO Issues

- Limited trained, skilled acquisition management team struggling with multiple systems contracts
- Attempting process improvement without key core competencies
- Hoping to gain control while outsourcing critical functions and decisions
- Unanticipated impacts on acquisition processes and controls
- Massive management and technical control changes
Traditional Acquisition Documents

- Statement of Objectives (SOO)
- Operational Requirements Document (ORD)
- Statement of Requirements (SOR)
- Systems Operations Concept (SOC)

- Statement of Work (SOW)
- Concept of Operations (CONCOPS)
- System Requirements Document (SRD)
- System Architecture (“as is” and “to be”)
Acquisition Overview

RFQ → Quote

RFQ

RFI → RFP → Proposal → BAFO → Contract

Teaming Agreements

Subcontracts
Agency Program Management

System of Systems Program Management

Architecture Management

Quality Assurance

Process Management

Systems-Level Program Management

Pre-Acquisition → Acquisition: System Contractor Selection → Systems Engineering (System Acquisition) → Systems Integration (across contract lines) → Systems and Network (IS / IT) Operations → Business Ops → Systems Maintenance

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Conf on the ACQ of SW-Intensive Systems
System of Systems Architecture

After Behind the Wizard's Curtain, Figure 2-1
Conf on the ACQ of SW-Intensive Systems
Client Organization
TSPR and Requirements

Client Responsibility

ORD, CONOPS, SOO & SOR

Client reviews and approves only the System Architecture

TSPR Responsibility

System Architecture

CONOPS, SOO, SOR

TSPR produces, reviews, and approves the top-level reqts docs.

Element Reqs. Documents (ERDs)

SOC

Data Arch Sys Arch Tech Arch Ops Arch and Standards

System Element x

System Element y

System Element z...

SLC Work Packages

TSPR conducts all technical reviews below the Architecture level and has approval authority.

Delivery Contractor Responsibility

UpStart Systems

Conf on the ACQ of SW-Intensive Systems
TSPR and Architecture

- **Client Responsibility**: Reviews and Approves only the System Architecture

- **TSPR Responsibility**: Produces, reviews, and approves the top-level requirements documents

- **System Architecture**: Operational View (CONOPS)

- **Element Requirements Documents (ERDs)**
  - Element x
  - Element y
  - Element z

- **System Delivery Contractor Responsibility**: TSPR conducts all technical reviews below the Architecture level and has approval authority

- **SLC Work Packages**
  - Element x: SLC Work Packages
  - Element y: SLC Work Packages
  - Element z: SLC Work Packages

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**UpStart Systems**

Conf on the ACQ of SW-Intensive Systems
TSPR Integrated Master Plan

Client Responsibility
Reviews TSPR against performance targets, incentive plans, and critical milestones, in the Integrated Master Plan.

ORD, SOO, SOC, and SOR

TSPR Contract with Performance Targets and Goals

TSPR Responsibility
TSPR reviews and approves plans for element and component delivery; monitors and reviews detailed status.

System Integrated Master Plan

Lower-level Plan integration and inter-project commitments

Element Plan x
Element Plan y
Element Plan z

Architecture Migration Plan

System Delivery Contractor Responsibility
Element Delivery Project Plans roll up into the Integrated Master Plan. TSPR monitors costs, schedules, requirements, deliverables, services, and risks.
TSPR Subcontracts

Client Responsibility

TSPR Prime Contract

TSPR Contract CLIN and Task Allocation

Contract A

Contract B

Contract C

Ax CLINs and SubKs

Ay CLINs and SubKs

Bx CLINs and SubKs

By CLINs and SubKs

Bz CLINs and SubKs

Cy CLINs and SubKs

Cz CLINs and SubKs

System Delivery Contractor Responsibility

TSPR uses its own resources or subcontracts

Single system delivery contract supported by Trusted Agents

TSPR chooses any subcontract type for products and services; may have multiple contracts with some providers

TSPR may allow any or all of its subcontractors to use one or more subcontractors of its own to meet its contractual obligations to the TSPR.

Whether or not subcontractors are competitively awarded depends upon the flexibility provided to the TSPR and its subcontractors by the client.
TSPR “End-to-End”

- End-to-end responsibility means:
  - Control of all of the system components from the beginning to the end of any system interaction or transaction
  - Control of the system engineering life cycle
    - From the elicitation of detailed requirements through the operation of the deployed system through system retirement
    - *With certain key exceptions, especially at key control points during the integration phase that are not even under client’s control*
Acquisition Changes

• Long term partnership with dominant prime
• Less of technology control
• Less of contractor community control
• Fewer contract deliverables reviews and approvals (open loop implementation?)
• Dependency on TSPR incentives for influence in lieu of control
• Complex commitment process for integration with external systems
• Non-traditional acquisition, program, and technical management skills still required
Backup Slides
Acronyms (reference)

- ASCON  Associate Contractor
- CLIN  Contract Line Item Number (item itself)
- CMM  Capability Maturity Model
- CMMI  Capability Maturity Model Integrated
- CMM-SW  Capability Maturity Model for Software
- CONOPS  Concept of Operations
- COTS  Commercial Off-the-Shelf (product)
- FAA  Federal Aviation Administration
- iCMM  Integrated CMM from FAA (see CMMI)
- IEC  International Electrotechnical Commission
- IPPD  Integrated Product and Process Development
- IPT  Integrated Product Teams
- ISO  International Standards Organization
- IV&V  Independent Verification and Validation
- O&M  Operations and Maintenance
- ORD  Operational Requirement Document
- OSSP  Organizational Standard Software Process
- R&D  Research and Development
- RFI  Request for Information
- RFP  Request for Proposal
- RFQ  Request for Quote
- S&S  Safety and Security
- (S)COTS  Standard Commercial Off-the-Shelf (product)
- SA  Software / System Acquisition
- SE  System Engineering
- SI  System Integration
- SOO  Statement of Objectives
- SOC  System Operating Capability
- SOR  Statement of Requirements
- SOW  Statement of Work
- SRD  System Requirement Document
- SubK  Subcontract
- SW  Software
- TSIR  Total System Integration Responsibility
- TSPR  Total System Performance Responsibility
Systems Life Cycle Eye Test

Systems-Level Program Management

Pre-Acquisition → Acquisition → Systems Engineering → Systems Integration → Operations → Maintenance

Unplanned iterations slow the pipeline
Four Acquisition Models

• The “Four Horsemen”
  – System Engineering (SE)
  – System Integration (SI)
  – Total System Integration Responsibility (TSIR)
  – Total System Performance Responsibility (TSPR)

• To transition *smoothly* from Systems Engineering to TSPR, use the other two
TSPR, TSIR, and SI Intent (Theory)

• Total System Performance Responsibility (TSPR)
  – A contract team is responsible for performance of end-to-end system capabilities, from the development of detailed requirements, through deployment and operations

• Total System Integration Responsibility (TSIR)
  – A contract team is responsible for delivery of an end-to-end system that has pieces already developed and available (constraining the approach) from Associate Contractors (ASCONS), (S)COTS vendors, or the Government, from the end of system test (beginning of system integration) through deployment

• System Integration (SI) including System Engineering (SE)
  – A contract team is responsible to prepare for system integration through deployment and to recommend to the government effective and efficient standards, plans, decisions, and actions to ensure successful system integration

Note: TSPR and TSIR introductory phrases are based heavily on TSPR presentation by Al Hoheb, Systems Planning and Engineering, The Aerospace Corporation, 20 March 1998.
At the left end, more control is retained by client.
At the right end, more control is allocated to the Prime Contractor.

In each case, the Prime develops the Architecture, maintains a comprehensive Integrated Master Plan, and manages IT Infrastructure, in response to the Problem Statements. The Client retains an appropriate level of SA, SE, and SI support from independent trusted agents.
TSPR Definition

- **A systematic and tailored management** strategy that is implemented by a contractor team which is responsible for the performance of end-to-end system capabilities.
- **A strategic partnership** between a government agency or major program and its exclusive (total) systems development prime contractor:
  - Exploiting the core competencies of each organization
  - Including System Acquisition (through subcontractors), System Engineering (including System Architecture), and System Integration (including final testing, exercises, deployment, operations, and maintenance)
  - Based on (1) operation concepts, general objectives, and top-level requirements including **system performance** and (2) allocation of **authority** and substantial **control** to the TSPR Prime Contractor for detailed requirements and implementation within broad schedule and cost constraints and detailed quality objectives.
TSPR Roles

- Develops, uses, improves, and enforces the architecture, as approved by client, as the systems blueprint for all contractors, including relationship of requirements to (S)COTS products (with SCOTS-specific roles) and to approved technologies
- Delivers (S)COTS-based and mission-specific solutions in system life cycle from requirements allocation through O&M
- Develops and manages to the integrated master plan across the system life cycle from after research investment through retirement
- Manages system acquisition, engineering, and integration, including process improvement, through itself and subcontractors, including IT infrastructure provisioning and management, except for functions allocated to research, SCOTS-specific, (I)V&V S&S, and “trusted agent” (advisors) contracts which it monitors
- Manages from top-level requirements and prioritization provided by client (ORD-level) and runs the requirements elicitation, requirements management, and prioritization processes (SRD-level) for individual systems projects
TSPR Roles for Client

- Develops, uses, improves, and enforces the architecture, as approved by Client, as the systems blueprint for all contractors, including relationship of requirements to (S)COTS products (with SCOTS-specific roles)
- **Delivers** (S)COTS-based and mission-specific solutions in system life cycle from requirements allocation through O&M
- Develops and manages to the integrated master plan across the System life cycle from after research investment through retirement
- **Manages** system acquisition, engineering, and integration through itself and subcontractors, including IT infrastructure provisioning and management, except for functions allocated to research, SCOTS-specific, (I)V&V S&S, and “trusted agents” (advisory contractors)
- **Manages** from top-level requirements and prioritization provided by Client (ORD-level) and runs the requirements elicitation, requirements management, and prioritization processes (SRD-level) for individual systems projects
TSPR Transition

- TSPR cannot be introduced immediately with full TSPR responsibility and accountability because its risks with respect to the current system implementation and ongoing projects would be too great.
- In the simple model, TSPR shadows the SE contractor and takes over the responsibilities as a SES (System Engineering Support) Contractor.
- Then it transitions to take over SI responsibilities for incremental parts of the system, overlapping with some SES functions.
- Then it transitions to take over TSIR responsibilities for incremental parts of the system, overlapping with some SES and SI functions.
- Then it transitions to take over TSPR responsibilities for incremental parts of the system, overlapping with some SES, SI, and TSIR functions.
A more realistic model for the TSPR transition takes advantage of prioritization within the System Architecture, as in the Architecture Migration Strategy, starting at the time the TSPR contract starts:

- New parts that have to be delivered with or without (S)COTS components
- High priority parts due to high priority requirements to be met or existing high risk conditions with impact on high priority parts
- Medium priority parts due to priority and risk, including heritage systems that will continue in the Architecture
- Low priority parts due to priority and risk, including legacy systems that will continue in the Architecture
- Parts in maintenance or “unattended” mode that need little attention, based on failure and maintenance records; this includes (S)COTS products and infrastructure components
- Parts (typically legacy or heritage) that are scheduled for rapid replacement and low-level maintenance (rapid retirement) that may never become the TSPR’s responsibility
Architectural Migration

- New, funded systems have highest priority, otherwise resources and funding would address enhancement or maintenance of other systems
- Enhancement of existing systems meets new and emerging customer requirements with new and improved technologies, (S)COTS products, and special development
- Maintenance of existing systems addresses repairs and achieving existing commitments for requirements implementation and deployment
- Near-retirement systems can be addressed through existing contractors without System Prime involvement
- IT Infrastructure Operations support configuration and operation of existing and improving System Infrastructure Elements for prototyping, testing, and operations