System of Systems Architecture and TSPR Contractor Model

Conference on the Acquisition of Software-Intensive Systems
January 29, 2003

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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”

Client Organization
Client Core Competencies
Client Mission and Strategy
Roadmap
Governance and IPTs
Client eBusiness Transition
Client R&D Investments
Trusted Agents
IV&V Contractor
Checks and Balances
Industrial Base

Process Improvement (Maturity, Capability)

Of Client
Of Contractors
CMM-SW
CMMI
SA-CMM
FAA-iCMM
Other Models

Other
Incentives
Transition

System of Systems
Architecture
As a Goal or Standard?
System Safety and Security
Technology Adoption
(S)COTS Products

Life Cycle
Project Definition
System Delivery
System Operations and Maintenance
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 → Teaming Agreements
RFI → RFP
RFP → Proposal
Proposal → BAFO
BAFO → Contract
Contract → 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 → Systems Maintenance

Business Ops
System of Systems Architecture

After *Behind the Wizard's Curtain*, Figure 2-1

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

Client
Responsibility

ORD, CONOPS, SOO & SOR

Client reviews and approves only the System Architecture

TSPR
Responsibility

Data Arch
Sys Arch
Tech Arch
Ops Arch
and Standards

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

Requirements
Decomposition

CONOPS
SOO
SOR
CONOPS
SOW
SRD

System Architecture

Element Reqts.
Documents
(ERDs)

SOC

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

System Element x

SLC Work Packages

Delivery
Contractor
Responsibility

System Element y

SLC Work Packages

System Element z

SLC Work Packages

UpStart
Systems

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

Client Responsibility
ORD, SOO, SOC, and SOR
Reviews and Approves only the System Architecture

TSPR Responsibility
System Architecture
Element Requirements Documents (ERDs)

Element x
Element y
Element z

Operational View (CONOPS)
TSPR produces, reviews, and approves the top-level requirements documents

System Delivery
SLC Work Packages
TSPR conducts all technical reviews below the Architecture level and has approval authority

Contractor Responsibility

UpStart Systems

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**TSPR Integrated Master Plan**

- **Client Responsibility**
  - Reviews TSPR against performance targets, incentive plans, and critical milestones, in the Integrated Master Plan.
  - TSPR Contract with Performance Targets and Goals

- **TSPR Responsibility**
  - TSPR reviews and approves plans for element and component delivery; monitors and reviews detailed status.
  - Lower-level Plan integration and inter-project commitments

- **System Integrated Master 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.

- **Element Plan x**, **Element Plan y**, **Element Plan z**

**UpStart Systems**
TSPR Subcontracts

Client Responsibility

TSPR Prime Contract

Single system delivery contract supported by Trusted Agents

TSPR Contract CLIN and Task Allocation

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

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 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

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.
Control Spectrum

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.
Architectural Transition

• 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