‘A’ is for Acquisition of Systems and Software

Presentation for DC SPIN

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Acknowledgments and Disclaimer

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  – Software Productivity Consortium

• This presentation does not reflect policies, strategies, positions, or decisions of any of these credited parties
Presentation Goal

- Ensure baseline understanding of Federal Government (e.g., DoD) acquisition models and their commercial applicability
- Show relationships within acquisitions for customer-contractor relationships, system architecture, and engineering life cycle
- Describe system and software acquisition in a process improvement context
Agenda

• Acquisition Issues “Nightmare”
• Context: Process Improvement and CMMs
• Acquisition Documents (blueprints)
• Acquisition Models
  – SE: Systems Engineering and Development
  – SI: Systems Integration
  – TSIR: Total Systems Integration Responsibility
  – TSPR: Total Systems Performance Responsibility
• Discussion and Q&A (throughout)
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

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

UpStart Systems
Process Improvement Lament

• How does the contractor process maturity affect performance?
• Can a CMM Level 5 work for a Level 1?
• Does the prime contractor integrate subcontractor processes or insist on its own?
• When the acquisition model changes, what happens to the OSSPs?
CMM “Quagmire”

- “Quagmire” introduced by Software Productivity Consortium papers
- CMM-SW
- CMMI: SW, SE, IPPD/IPT, SA
  - Correction: Not SA: SS (Supplier Sourcing)
- SA-CMM
- FAA-iCMM: SW, SE, SA
- “Evolutionary” Guidance
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

RFI -> RFP -> Proposal

BAFO -> Contract

Teaming Agreements -> Subcontracts
Systems Life Cycle Eye Test

Systems-Level Program Management

Unplanned iterations slow the pipeline
Client’s 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

CCB

UpStart Systems

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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.**
Client Organization

Client

Trust Agents

R&D

(S)COTS

Delivery

IV&V

Prime Contractor X

Prime Contractor Y

Prime Contractor Z

Subcontractor A

Subcontractor B
System Engineering Service

• System development and delivery in standard contract projects

• System Engineering Services provided by an overarching, but advisory, prime contractor
  – Architecture
  – Schedule Integration
  – Quality Issues
System Integrator (SI) Definition

• A strategy that is implemented by a contractor team which is responsible for system integration across the system life cycle with special responsibilities during the integration phase.
• A strong, trusting relationship between a government agency or major program and its exclusive system integrator prime contractor:
  – Exploiting the core competencies of each organization
  – Based on a detailed SOW and set of requirements within the scope of program management, system engineering, and system integration
  – Including responsibilities for system requirements, Architecture, and an Integrated Master Plan
  – Including specific responsibilities for interaction with other government contractors, resulting in clear, actionable recommendations to be decided and taken by a government agency
SI Roles for Client

- Develops, uses, improves, and monitors the use of the architecture, as approved and controlled by client, as the system blueprint for all contractors, including relationship of requirements to (S)COTS products (with SCOTS-specific roles) and to approved technologies.
- Develops, uses, improves, and monitors the use of an Integrated Master Plan, including the monitoring of subordinate project plans, across the system life cycle from research through retirement.
- Monitors all system acquisition, engineering, and integration, including leading process improvement, as conducted by client, itself, and other contractors, including monitoring the functions allocated to research, SCOTS-specific, and “trusted agent” contracts.
- Manages IT provisioning and operations, to provide the system infrastructure for all system life cycle phases, including integration testing, exercises, and operations.
- Manages from requirements and prioritization provided by client, participates in requirements elicitation, performs requirements allocation and recommends prioritization across acquisitions and system contractors, provides IV&V to client for the system of systems.
SI during “SI” Phase

SI contracts or CLINs provide “responsibility” for specific SI projects (tasks) identified by client based on the System Architecture, its Architecture Migration Strategy, and the Integrated Master Plan
- System Integration of pieces with known attributes through the system integration phase
- With pieces from other contractors, (S)COTS vendors, and the Government
- From the successful end of separate system tests of each of the pieces
- Through the configuration and deployment of the integrated systems, including entry to operational (production) use
- *With certain key exceptions, especially at key control points during the integration phase that are not even under client’s control*
TSIR Definition

• A strategy that is implemented by a contractor team which is responsible for system integration across the system life cycle with special responsibilities and control during the integration and deployment phases.

• TSIR contract team is responsible for delivery of an end-to-end system that has pieces already developed and available (constraining the approach) from other government contractors, (S)COTS vendors, or the government.

• TSIR has control over system integration (including development to support integration), system integration test, security certification (through the appropriate agencies), training, exercises, deployment, and operations, but not maintenance of integrated parts

• This discussion of TSIR includes embedded risk mitigation that modifies the standard TSIR roles and responsibilities:
  – TSIR is a superset of the SI approach (defined below)
  – TSIR includes responsibility for creating and updating the System Architecture and the Integrated Master Plan
TSIR Role for Client

- Develops, uses, improves, and monitors the use of the architecture, as approved and controlled by client, as the System blueprint for all contractors, including relationship of requirements to (S)COTS products (with SCOTS-specific roles) and to approved technologies.

- Develops, uses, improves, and monitors the use of an Integrated Master Plan, including the monitoring of subordinate project plans, across the System life cycle from research through retirement.

- Monitors all System system acquisition, engineering, and integration, including leading process improvement, as conducted by client, itself, and other contractors, including monitoring the functions allocated to research, SCOTS-specific, and “trusted agent” contracts, but controls the Integrated Master Plan from end of system test through operations, excluding maintenance of integrated System parts.

- Manages IT provisioning and operations, to provide the client infrastructure for all system life cycle phases, including integration testing, exercises, and operations.

- Manages from requirements and prioritization provided by client, participates in requirements elicitation, performs requirements allocation and recommends prioritization across acquisitions and system contractors, provides IV&V to client for the system.
TSIR “Total SI”

- TSIR contracts or CLINs provide “total responsibility” for
  - System Integration of pieces with known attributes through the system integration phase
  - With pieces from other contractors, (S)COTS vendors, and the Government
  - From the successful end of separate system tests of each of the pieces
  - Through the configuration and deployment of the integrated systems, including entry to operational (production) use
  - \textit{With certain key exceptions, especially at key control points during the integration phase that are not even under client’s control}
TSIR and Architecture Migration

• Overall Integrated Master Plan for the Client’s System is based on the Architecture Migration Strategy
  – Addition of new systems (within the “system of systems”)
  – Implementation of prioritized, funded requirements through enhancements to existing systems within the top-level system elements
    • Extending the needs that can become feasible requirements through qualification of new and improved technologies and COTS/SCOTS products
  – Maintenance of stable systems through repair of identifiable defects
  – Retirement of outdated, unstable, hard-to-maintain, and superseded systems

• TSIR has responsibility to organize and conduct the integration of new and updated systems into the client’s system, according to the Integrated Master Plan and Architecture Migration Strategy
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, and turnover to operations)
  – Based on system-level requirements and delegation of authority and substantial control the TSPR prime contractor for detailed requirements and implementation within broad schedule and cost constraints and detailed quality objectives
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 and Requirements

Client Responsibility

ORD, CONOPS, SOO & SOR

Client reviews and approves only the System Architecture

TSPR Responsibility

System Architecture

Data Arch
Sys Arch
Tech Arch
Ops Arch
Standards

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

Elements

Element Reqts. Documents (ERDs)

System Element x

System Element y

System Element z

SOC

Delivery Contractor Responsibility

SLC Work Packages

SLC Work Packages

SLC Work Packages

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

UpStart Systems
TSPR and Architecture

Client Responsibility
- Reviews and Approves only the System Architecture

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

System Architecture
- Element Requirements Documents (ERDs)

System Delivery

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

Element x
- SLC Work Packages

Element y
- SLC Work Packages

Element z
- SLC Work Packages

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

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

ORD, SOO, SOC, and SOR
TSPR Contract with Performance Targets and Goals
Lower-level Plan integration and inter-project commitments
Architecture Migration Plan

System Integrated Master Plan
Element Plan x
Element Plan y
Element Plan z
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
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.
Q&A Reminder
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
Backup Slides

• From SEI website, as indicated
## SA-CMM Key Process Areas

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Key Process Areas</th>
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<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous Process Improvement</td>
<td>Acquisition Innovation Management&lt;br&gt;Continuous Process Improvement</td>
</tr>
<tr>
<td>4 Quantitative</td>
<td>Quantitative Management</td>
<td>Quantitative Acquisition Management&lt;br&gt;Quantitative Process Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Process Standardization</td>
<td>Training Program&lt;br&gt;Acquisition Risk Management&lt;br&gt;Contract Performance Management&lt;br&gt;Project Performance Management&lt;br&gt;User Requirements&lt;br&gt;Process Definition and Maintenance</td>
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<tr>
<td>2 Repeatable</td>
<td>Basic Project Management</td>
<td>Transition to Support Evaluation&lt;br&gt;Contract Tracking and Oversight&lt;br&gt;Project Management&lt;br&gt;Requirements Development and Mgt.&lt;br&gt;Solicitation&lt;br&gt;Software Acquisition Planning</td>
</tr>
<tr>
<td>1 Initial</td>
<td>Competent people and heroics</td>
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[UpStart Systems](http://www.sei.cmu.edu/arm/SA-CMM.html) for SW Acquisition CMM
Why was the Software Acquisition CMM (SA-CMM) not included in CMMI?

- To prove the prototype CMMI framework, the CMMI team felt it important first to focus on the system development process. Because of the important relationship with the acquisition process (see ISO/IEC 12207), the SA-CMM and the FAA iCMM were added as reference documents for CMMI framework development. Model coverage for supplier sourcing, focused on the processes of acquiring software-intensive systems in a development project environment, is now under development and piloting.

http://www.sei.cmu.edu/cmmi/comm/cmmi-faq.html
CMMI Version 1.1 Model

- March 1, 2002
- Another model has been added to the CMMI Version 1.1 Product Suite: CMMI for Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing (CMMI-SE/SW/IPPD/SS), V1.1. This model contains a discipline new to the CMMI Product Suite—Supplier Sourcing. The Version 1.1 CMMI models now available are
  - CMMI-SE/SW/IPPD/SS, V1.1
  - CMMI-SE/SW/IPPD, V1.1
  - CMMI-SE/SW, V1.1

http://www.sei.cmu.edu/cmmi/comm/ss-announce.html
Integrated Supplier Mgt. (ML3) Purpose

The purpose of Integrated Supplier Management is to proactively identify sources of products that may be used to satisfy the project’s requirements and to manage selected suppliers while maintaining a cooperative project-supplier relationship.
Integrated Supplier Management

Introductory Notes

- Integrated Supplier Management involves monitoring the new products available on the market, evaluating sources of products that might help satisfy project requirements, and using this information to select suppliers. Integrated Supplier Management also involves maintaining a cooperative project-supplier relationship, monitoring selected supplier processes, evaluating selected work products, and making appropriate adjustments in the supplier relationship and agreement.

- Integrated Supplier Management involves the following activities:
  - Identifying, analyzing, and selecting potential sources of products
  - Evaluating and determining the sources to be used for acquiring products
  - Monitoring and analyzing selected supplier processes
  - Evaluating selected supplier work products
  - Revising the supplier agreement or relationship as appropriate

- The Integrated Supplier Management process area builds on the concepts established in the Supplier Agreement Management process area by adding practices that emphasize a cooperative relationship with suppliers. Integrated Supplier Management is designed for situations in which projects use suppliers to perform functions that are critical to the success of the project. Analyzing sources and monitoring selected supplier processes and work products before delivery of the product to the project are two such functions described in this process area.
The supplier sourcing discipline involves monitoring the new products available on the market, evaluating sources that may help satisfy project requirements, using this information to select suppliers, and maintaining a cooperative project-supplier relationship. Effective supplier sourcing is described by the best practices contained in a new process area, Integrated Supplier Management (ISM), which is included in the Project Management process area category. Those of you already familiar with CMMI models will quickly notice how ISM builds on and expands on the practices in the Supplier Agreement Management (SAM) process area.

http://www.sei.cmu.edu/cmmi/comm/ss-announce.html
Supplier Sourcing - 2

- Supplier sourcing activities include identifying, analyzing, and selecting potential sources for products; determining the sources to be used for the products to be acquired, monitoring and analyzing selected supplier processes, evaluating selected work products, and revising the supplier agreement or relationships as appropriate. CMMI models containing the supplier sourcing discipline are designed for situations in which projects use suppliers to perform functions that are critical to the success of the project.

- Many supplier sourcing decisions can be made throughout a product’s life. The need for supplier sourcing can arise during a product’s operational and support phase as well as during its initial development phase.

http://www.sei.cmu.edu/cmmi/comm/ss-announce.html