Applying CMMI, Software Architecture Principles, and Process Improvement in a DoD Acquisition

SEPG Conference
March 2007
Presentation Overview

Brief background of the Common Link Integration Processing (CLIP) program

Discuss techniques used in acquisition to support CLIP’s goals and objectives

Lessons learned from the acquisition
CLIP Program Background
CLIP Background

- Cooperative Navy and Air Force program to develop common tactical data link (TDL) message processing software for air, ship, and shore platforms
- Provides non-invasive TDL functionality for TDL-disadvantaged platforms
- Facilitates communications between TDLs and IP-based communications to enable Network Centric Warfare
- Developed in 4 increments with increasing message processing and host platform interfaces
- Open, layer architecture design is Software Communication Architecture (SCA) compliant and can be hosted on multiple computing environments
CLIP Goals and Objectives

- Enhanced interoperability
- Lower cost and faster time to fielding
- Insulate Host from terminal/radio and TDL standards changes
- Provide a common link-independent host interface
- Architecture supports key architectural qualities
- Based on a software product line development approach
Acquisition Strategies Used for CLIP
Strategy Used in Acquisition

Pre-Contract

- Acquisition Planning Workshop
- DoD 5000 Acquisition Documents for Milestone B
- Development of an acquisition timeline
- CDRL development/definition

Contract monitoring

- Evaluation/Appraisal techniques
- Risk management
- CDRL review
Coordinated Use of SEI Methods and Training in CLIP Acquisition

The ATAM-based evaluation should cover the ability of the architecture to support future increments.

When detailed design is complete

Increment 1

Increment 2

Increment 3

Joint Training in Software Architecture, ATAM Evaluation, and CMMI

SCAMPI B appraisal (annual)

Software Product Line Approach

QAW #1

RFP

Acq Planning Workshop

This QAW is conducted with government stakeholders.

QAW Report

QAW #2

ATAM #1

Software Architecture Documentation (SAD)

QAW Report

Contract Award

Increment 1

ATAM #2

SAD

Increment 2

ATAM #3

SAD

Increment 3

RFP Preparation

QAW Report

Competitive Solicitation

Source Selection

Contract Performance Phase

Acquisition Planning and Preparation

Coordinated Use of SEI Methods and Training in CLIP Acquisition
Key DoD 5000 Acquisition Documents

- Acquisition Strategy/Plan (AS/AP)
- Test and Evaluation Master Plan (TEMP)
- Source Selection Plan (SSP)
- System Engineering Plan (SEP)
- Request for Proposal (RFP)
System Engineering Plan

Initially tried to model CMMI v1.1

Next tried mapping EIA-632 to the program’s CDRLs—too complicated/confusing and resource intensive

Guided by OSD for System Engineering Plan

Revised System Engineering Plan focused on 4 process areas

- Risk management
- Measurement and analysis
- Architecture evaluation (technical solution)
- Interface control (product integration)
Request for Proposal - 1

Section B

- Identified program milestones and associated exit criteria with ties to award fee

Statement of Work (SOW)

- IEEE/EIA 12207 Software Life Cycle Processes
- Capability Maturity Model Integration (CMMI)
- Quality Attribute Workshop (QAW)
- Architecture Tradeoff Analysis Method (ATAM)
Request for Proposal - 2

Sections L and M

• Technical solution, Program Management Plan (PMP), Process Improvement Plan (PIP), Integrated Master Schedule (IMS), Risk Management Plan (RMP)

Contract Data Requirements List (CDRLs)

• MilStd 498, IEEE 828, 1028, 1016, 12207, EIA-632, ISO/IEC-15288
### IEEE/EIA 12207 Software Life Cycle Processes

<table>
<thead>
<tr>
<th>Process implementation</th>
<th>Software Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Requirements Analysis</td>
<td>Software Qualification Testing</td>
</tr>
<tr>
<td><strong>System Architectural Design</strong></td>
<td>System Integration</td>
</tr>
<tr>
<td><strong>Software Requirements Analysis</strong></td>
<td>System Qualification Testing</td>
</tr>
<tr>
<td>Software Architecture Design</td>
<td><strong>Software Installation</strong></td>
</tr>
<tr>
<td>Software Detailed Design</td>
<td>Software Acceptance Support</td>
</tr>
<tr>
<td>Software Coding and Testing</td>
<td></td>
</tr>
</tbody>
</table>
CMMI Requirements - 1

• CMMI- SE/SW/IPPD/SS v1.1 (staged representation)

• Prime contractor shall have or obtain and maintain a minimum of SEI CMMI maturity Level 3 (Note: not current SEI guidance)

• Contractor team (subcontracted and interdivisional work) shall have a minimum combined maturity level of CMMI Level 2 rating

• If Contractor and team not at required levels at contract award, it shall be achieved within 12 months
On-site Government appraisal of Contractor’s processes no later than 9 months after contract award

- Compare proposal to actual CLIP program processes/practices
- Baseline capabilities for future

**PIP**

- For achieving and maintaining the required process discipline
- Commitment to process improvement
- Identifies current assessed CMMI levels of Contractor and team

**Annual SCAMPI B appraisals**

- Verify Contractor is following their processes
- Measure continuous process improvement
CLIP Timeline

1) System Requirements Document
2) Quality Attribute Workshop
3) System Architecture and Requirements Allocation Description
4) Software Development Plan
5) Program Management Plan
6) Configuration Management Plan
7) Process Improvement Plan
8) Risk Management Plan
9) Requirements Traceability Matrix
10) System Engineering Management Plan

1) Software Requirements Specification
2) Interface Requirements Specification
3) Software Architecture Description
4) Updated Requirements Traceability Matrix

LEGEND
System Requirements Review (SRS), Integrated Baseline Review (IBR)
Preliminary Design Review (PDR), Critical Design Review (CDR)
Test Readiness Review (TRR), Program Acceptance Test (PAT)
System Integration Test (SIT), CLIP Acceptance Test (CAT)
Delivery Readiness Review (DRR)

All aspects of the Earned Value Management System were addressed.

© 2006 Carnegie Mellon University
SEI Proprietary; Distribution: Director’s Office Permission Required
Contract Monitoring Activities

Quality Attribute Workshop
  • Requirement development and refinement

Annual SCAMPI B appraisals

Architecture Tradeoff Analysis Method
  • Technical solution

Joint training

Peer review participation

IPT communications/participation
Coordinated Use of SEI Methods and Training in CLIP Acquisition

- Acquisition Planning and Preparation
  - QAW Report
- Competitive Solicitation
  - RFP
  - QAW #1
  - RFP Preparation
- Source Selection
  - Contract Award
  - QAW #2
  - ATAM #1
- Contract Performance Phase
  - Increment 1
  - SAD
  - ATAM #2
  - Increment 2
  - SAD
  - ATAM #3
  - Increment 3
  - SAD
  - Eval. Report #1
  - Eval. Report #2
  - Eval. Report #3

The ATAM-based evaluation should cover the ability of the architecture to support future increments.

When detailed design is complete.

Joint Training in Software Architecture, ATAM Evaluation, and CMMI

SCAMPI B appraisal (annual)

Software Product Line Approach

Summarize Architecture Evaluation

Technical Proposals

Software Architecture Documentation (SAD)

QAW Report

Contract Award

QAW #2

ATAM #1

Increment 1

When detailed design is complete.
Quality Attributes Workshop

Provides a common forum for discussing quality attribute requirements and architectural implications

Gain stakeholder buy-in

Two QAWs were held

- Pre-RFP QAW – used to develop/refine requirements and develop technical evaluation questions and criteria for RFP
- Post-contract award QAW – used to gain a shared vision for the CLIP architecture and support requirement refinement
SCAMPI

Annual SCAMPI B appraisals of the contractor will be performed to determine their conformance to their processes.

Introduction to CMMI training course was taken by CLIP Program Office and Contractor personnel.

Six CLIP Program Office participated on SCAMPI B appraisal team.

SCAMPI evaluation team also include a SSTC SEPO representative and one of the contractor’s sub-contractor.
<table>
<thead>
<tr>
<th>Category</th>
<th>CMMI Process Areas</th>
</tr>
</thead>
</table>
| Process Management | Organizational Process Focus  
                      Organizational Process Definition  
                      Organizational Training  
                      Organizational Process Performance  
                      Organizational Innovation and Deployment                                      |
| Project Management | Project Planning  
                      Project Monitoring and Control  
                      Supplier Agreement Management  
                      Integrated Project Management for IPPD  
                      Risk Management  
                      Integrated Teaming  
                      Integrated Supplier Management  
                      Quantitative Project Management                                         |
| Engineering      | Requirements Management  
                      Requirements Development  
                      Technical Solution  
                      Product Integration  
                      Verification  
                      Validation                                               |
| Support          | Configuration Management  
                      Process and Product Quality Assurance  
                      Measurement and Analysis  
                      Decision Analysis and Resolution  
                      Organizational Environment for Integration  
                      Causal Analysis and Resolution                                      |
Architecture Tradeoff Analysis Method

- Increase communication among stakeholders
- Clarify quality attribute requirements
- Identify software risks early in the development cycle
- Provide documented basis for architectural decisions
Risk Management

The Risk Management Plan was the first CDRL submitted and signed off on because of its importance to the program

Joint risk management process

Monthly Risk Review Boards

Open communication (risk is not a 4-letter word)

Value to the program by providing visibility to other program offices and senior management
CDRL Implementation Concerns

Delivery aspects of CDRLs

- Frequency
- Date of First Submission
- Date of Subsequent Submission are filled in

Ability of the program office to support the reviews

How are communications between CDRL developers and the associated program office IPT representatives?

The review process was revised between PDR and CDR milestones to improve the process to make sure the content of the documents satisfied the expectations of both sides.
Lessons Learned
RFP and Proposal Review Lessons

Cost realization of proposals
Source selection plan
Number of CDRLs and which are important
Having a concept of a technical solution
Software estimation and productivity factors
Proposal presentations
Contract Monitoring Lessons

Identify a few important metrics
Direct team focus to concentrate on metrics
Software estimation and productivity factors
Summary

Pro-active planning at the RFP stage lays the foundation for the contract monitoring phase

Cost proposals are very difficult to develop and even more difficult provide cost realism to, so the program office needs to convey as clear and complete picture of the acquisition, as possible, in the RFP

Identify the three or four most important items for the government program office to try to accomplish during the acquisition and focus on those items

Communication between the program office and the contractor’s team needs to be continuously after contract award, like risk management, so that expectations can be set appropriately within the program, as well as for those external to the program.
Contact Information

Tim Morrow
4500 Fifth Avenue
Pittsburgh, PA 15668
412.434.3797
tbm@sei.cmu.edu
http://www.sei.cmu.edu