Proposed
Navy Software Acquisition Improvement Strategy
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DAHLGREN
Proposed
Software Acquisition Improvement Strategy

❖ Current State
- Problem
- Software Acquisition Strategy
- Recent Findings
- Summary and Conclusions

❖ Future State
- Improvement Recommendations
- Government Software Expertise
- Open Architecture
- Benefits

❖ Summary
Current Acquisition Strategy Reported Results:

- YR 2000: 84% of programs are late and over budget, and deliveries include only 61% of planned capabilities*

- YR 2004: 40% ($8 Billion) of DoD RDT&E Budget was spent on reworking software due to quality issues**

- YR 2009: DOD’s 95 major defense acquisition programs have seen their costs grow by an average of 26% and experienced an average schedule delay of almost 2 years***

Program Offices are Failing to Successfully Scope and Manage SW Intensive Programs

** 2004 General Accountability Office Report  
*** 2009 Opening Statement of Senator Carl Levin at Senate Armed Services Committee Hearing, March 3, 2009
Problem

- Software size, complexity, and reliance is continuing to significantly expand within DoD/Navy critical systems.
- DoD/Navy is Failing to Consistently Successfully Acquire Software Intensive Systems.

- 7 Key Acquisition Management Problems Exist*
  1. Lack of Effective Acquisition Management
  2. Immature Acquirer (Program Offices)
  3. Ineffective Requirements Management
  4. High Personnel Turnover in the Acquiring Organizations
  5. Cost and Schedule Estimation Accuracy
  6. Ineffective Utilization of EVMS for SW Systems
  7. Failure to Take Advantage of Lessons Learned

* 2007 ASN / RDA Software Process Improvement Initiative (SPII) As-Is Report for SW Acquisition Management

Loss of Government In-house Applied SW Expertise
DoD/ASN/RDA Policies Call for Gov’t SMEs to Define System Req’s, Support Milestone Reviews, and Validate the SW Artifacts Developed by Industry

Software Development Activities Conducted Primarily During the System Development and Demo Phase

- SW Req’s
- Multiple Levels and Increments
  - CSCI Detailed Design
  - CSCI Code & Unit-Test
  - CSCI FQT
  - SW Segment Integration
  - Segment Test
- Incremental SW Builds

RISKs
- Over-reliance on Industry for software Development
- Gov’t participation primarily via Milestone Reviews is not sufficient
- Gov’t sw engineer participation during sw development is minimal
- Gov’t is losing its applied software development expertise

Number of Systems that fail IOC testing is increasing

“The combination of personnel reductions and reduced RDT&E has seriously eroded the Department’s domain knowledge and produced an over reliance on contractors to perform core in-house technical functions”

-Department of the Navy Acquisition, D. Winter: SECNAV Memo Dated 10 Oct 08
Recent Findings & Recommendations

• 2008 GAO Report
  - Increased and Improved Government Oversight is Required

• 2008 DSB DTE Report
  - Key Factor is High % of Programs Failing IOTE is Loss of Experienced Management and Technical Personnel

• 2008 SECNAV Memo
  - DoD Must Maintain Technical Expertise at all Levels

• Informal on site visits and discussions with several Warfare Center Software Leads indicates that the majority of the critical software development is being contracted out to private Industry

Government Needs to Reconstitute In-House Technical Expertise
DOD/Navy Software Acquisition
Current State Summary

DOD System reliance on SW components, SW size and complexity, are all continuing to significantly increase. The goals of Open Architected systems are not being achieved (reusable, scalable, maintainable, ...)

1. Numerous studies document the high % of DOD/Navy System Cost, Schedule, and Technical Performance failures.
2. Number of DOD Systems that fail System Testing is increasing

Government is rapidly losing its:
- Applied SW development and technical expertise
- Ability to successfully manage SW intensive acquisition programs

“The combination of personnel reductions and reduced RDT&E has seriously eroded the Department’s domain knowledge and produced an over reliance on contractors to perform core in-house technical functions.”

“In order to acquire the DON platforms and weapons systems in a responsible manner, it is imperative the DON maintain technical domain expertise at all levels of the acquisition infrastructure

2008, Oct 10, SECNAV MEMO: Department of the Navy Acquisition, D. Winter
Conclusions / Imperatives

- The Government Must Maintain Applied Software Development Expertise in order to be a Smart Buyer of SW intensive Systems

- There Must be a Fair Balance Struck Between all of the Following:
  - Industry’s Right and Requirement to Make a Fair and Deserved Profit
  - Government’s Responsibility to Provide the War Fighter With the Highly Reliable, Safe, and Adaptive Systems
  - Government’s Responsibility to Spend the Tax Payers Dollars Effectively and Efficiently

It is Imperative that the Gov’t Maintain the In-house Applied SW Technical Expertise Required to Successfully Acquire SW Intensive Systems
Proposed Software Acquisition Strategy

Future State

Reduce the rate of increase of SW size and complexity by developing truly Open Architecture based reusable software components

Increase gov’t in-house sw expertise and leadership

Decrease the % of DOD/Navy System Cost, Schedule, and Technical Performance failures

Recommendations

1. Reconstitute the Navy’s in-house applied sw development expertise; establish sw pipe-line

2. Utilize government and industry software development Integrated Product Teams

Statement A: Approved for Public Release; Distribution is Unlimited
Future State: Strategy Recommendation
Reconstitute Navy In-House Software Expertise Pipe-Line

Challenge 1
- Non SW Background

Challenge 2
- Maintaining Navy in-house SW expertise requires that an appropriate subset of critical SW be developed in-house. There is no defined criteria or process for assigning SW development to in-house engineers.

Management: System(s) Level
Division (100 to 250) Head
Warfare Center Program Manager

Management: Component Level
Branch (25 to 40) Head

Management: CSC(s) Level
SW Group (4 to 10) Leadership

Computer SW Configuration Item (CSCI)
- Lead CSCI Architecture Design and Code
- Cross Discipline IPT participation
- Complex Tech Problem Resolution

Segment and Component Level Development
- Lead Architecture Design and Implementation
- Cross Organization/Function IPT Leadership and Participation
- Lead Technology insertion

Technical Leadership and Oversight
Systems and Domain Level
- AoA Leadership and Execution
- Cost and Schedule Assessment
- Tech Approach Leadership & Approval

“Technological Assignment Loop-Back”

“In order to acquire the DON platforms and weapons systems in a responsible manner, it is imperative the DoN maintain technical domain expertise at all levels of the acquisition infrastructure”.

-Department of the Navy Acquisition, D. Winter: SECNAV Memo Dated 10 Oct 08

Statement A: Approved for Public Release; Distribution is Unlimited
Future State: Strategy Recommendation
Gov’t In-House Software Expert Responsibilities

- Ownership of the Objective Architecture
  - Determine which SW Components Should be Reused, Modified, or Developed

- Developing a Subset of the Critical and Complex SW Components
  - Maintain Expertise with Complex System Functionality,
  - Maintain Expertise with Latest Software Development Technologies and Methodologies

- Leading Integrated Gov’t and Industry SW Development Teams
  - In-House SW Experts have SW Design Technical Approval Authority
  - Ensure SW meets Open Architecture objectives
  - Ensuring Industry Adheres to Best SW Development Practices

The Proposed Government And Industry Software Teaming Strategy is already being Successfully Utilized for Some Critical Fire Control Systems
Future State
SW Development Responsibility Allocation

- Industry will still develop the majority of the software
- Government in-house SW Experts will provide more SW Leadership and Authority

Industry will still develop a majority of the SW; but with Gov’t Software SME oversight and **insight**
Future State Goals
Software Evolution to Open Architecture (OA)

CURRENT: Stove Pipes

Platform “1” Unique Development’ SW growth

Limited SW Re-use between systems/platforms

Platform “N” Unique Development’ SW growth

Few Open Arch based designs and software

FUTURE: OA Based Multi-Platform Capable

New Capability
New OA SW Components

Modified SW Components

Open Arch
Reusable SW Components

Open Arch
Reusable SW Components

Open Arch
Reusable SW Components

Open Arch
Reusable SW Components

Open Arch
Reusable SW Components

Open Arch
Reusable SW Components

SW stored in Gov’t Owned Common SW Repository

Establish truly OA based reusable, scalable, modular, and maintainable components

Statement A: Approved for Public Release; Distribution is Unlimited
Future State
Challenge: Open Architecture Software

Composability
The System Provides Recombinant Components that can be Selected and Assembled in Various Combinations to Satisfy Specific Requirements

Maintainability
The Ease With Which Maintenance of a Functional Unit can be Performed in Accordance With Prescribed Requirements

Interoperability
Ability of Two or More Subsystem to Exchange Information and Utilize that Information

Extensibility
Ability to add new Capabilities to System Components, or to add Components and Subsystems to a System

Open Standards
Standards that are Widely Used, Consensus Based, Published and Maintained by Recognized Industry Standards Organizations

Modularity
Partitioning into Discrete, Scalable, and Self-Contained Units of Functionality, With Well Defined Interfaces

Reusability
Ability for an Artifact to Provide the Same Capability in Multiple Contexts

Diagram Key
- is Enabled by
- - is Facilitated by

These OA "ITIES" Cannot be Easily Verified by System Testing.... Government In-House SW Expertise Insight Into Design and Code is Required to Ensure Reusable Software

Designing and Coding for These "ITIES" is the Key to Saving Significant $$$$$$$$

* Reference: OA Architectural Principles and Guidelines v 1.5.6, 2008, IBM, Eric M. Nelson, Acquisition Community Website (ACC) DAU Navy OA Website

Statement A: Approved for Public Release; Distribution is Unlimited
Current State Challenge:
Levels of SW Complexity / Devil is in the Details

Gov’t technical insight only at the Func, Comp, Segment levels is not sufficient to ensure & meet OA goals

Gov’t SW SMEs must ensure OA req’s are met at the detailed SW design level for:
- Open Standards
- Maintainability
- Reuse
- Interoperability
- Modularity
- Composability
- Extensibility

Gov’t SW SMEs must understand the technical design for:
- Data / File Management
- Threading / Tasking Hierarchy
- Initialization / Termination
- Time Critical & Deterministic
- Intra & Inter Process Comm’s
- Fault Processing
- Process Prioritization

A single erroneous SLOC can crash the entire system
Open Architecture: Example
Reusable, Maintainable, Scalable Software Design

**Weapon System X**

**Segments**
- Command and Control System Segment
- Weapon Control System (WCS) Segment
- Missile Segment

**CSCIs**
- Launcher/Missile Manager CSCI
- Other CSCIs

**OBJECTS**
- Generic Launcher Object
- Other Objects

- Surface Platform Launcher A
- Surface Platform Launcher B
- Submarine Platform Launcher N
- FMS Platform Launcher X
- Future Platform Launcher Y

Object Oriented Design
Reusable, Scalable, Maintainable

Platform & Launcher Unique Objects
Future State: Benefits

- By establishing the government sw expertise pipe-line; the government will have the sw expertise required to address the current state Acquisition Challenges and
  - Improve software technical approach/maturity identification and assessment

- Improve software requirements change management and assessment of the associated impacts to cost, schedule, technical performance and risk

- Maintain system and software architecture corporate knowledge as program office leadership turns over, and as system development responsibility transitions to different private industry contractors

- Improve software cost estimation and tracking (EVMS)
  - Lead process improvement efforts based on applied experience and historical data

- Ensure OA based reliable, maintainable, reusable, scalable, & modular software
Summary

- DoD / Navy Systems’ Software Size and Complexity is Significantly Increasing

- Navy Applied In-House SW Expertise is Decreasing
  - Program Offices do Not Have the Applied SW Expertise Required to Consistently Successfully Acquire SW Intensive Systems

- Must Reconstitute and Maintain the Navy’s In-House SW Development Expertise
  - Must Maintain Applied SW Expertise and Experience Developing Complex SW With Real-Time, Safety Critical, Multi-Threaded/Process, Complex Interfaces and Algorithms
  - Requires that a Subset of the Complex and Critical Software be Developed In-House

Developing Government SW SMEs will Enable Navy’s Goal of Open Architected Systems and Improve the Ability to Consistently and Successfully Deliver Systems That Meet Cost, Schedule, and Technical Performance Goals
Current Acquisition State Summary

References
**DOD/Navy SW Acquisition**  
**Current State Summary**

- **Cost & Schedule**
  - 1998: 16%
  - 2000: 39%
  - 2007: 61%
  - 2008: 84%

- **Performance**
  - 2003: 39%
  - 2007: 61%

- **Not Delivered**
  - 2007: 31%
  - 2008: 53%

**CrossTalk Article**

**Schedule**

- **On Time**
  - 36%

- **Late or Terminated**
  - 64%

**Cost**

- **RDTE Budget Spent on SW Rework**
  - 40%

- **8 Billion $**

**2008 GAO Report**
- 11 DOD program failures
- Increased and improved Gov't oversight is required

**2008 DSB DTE Report**
- High % of programs fail IOTE
- Key Factor: Loss of experienced management and technical personnel

**2008 SECNAV MEMO**
- DOD must maintain Technical expertise at all levels

**2007 ASN/RDA Software Process Improvement Initiative (SPII) As-Is Report**

- **For SW Acquisition Management**
  - 7 Key Problems
    1. Lack of effective acquisition management
    2. Immature acquirer (program offices)
    3. Ineffective requirements management
    4. High personnel turnover in the acquiring org’s
    5. Cost and schedule estimation accuracy
    6. Ineffective utilization of EVMS for SW systems
    7. Failure to take advantage of Lessons Learned.

**The DOD/Navy is not consistently successfully acquiring software intensive systems. The DOD/Navy needs to reconstitute its in-house applied sw expertise**

* 84% of program do not complete on budget nor schedule; 31% are canceled; remaining 53% have cost growth exceeding 89%; final product only includes 61% of planned features

2004 General Accountability Office released a report describing the results of a study to identify the practices used by leading companies to acquire software and to analyze the causes of poor outcomes of selected DOD programs. GAO reported:

“In recent years, DOD has attributed significant cost and schedule overruns of software-intensive systems to difficulties in developing and delivering software. DOD estimates that it spends about 40 percent of its Research, Development, Test, and Evaluation budget on software—$21 billion for fiscal year 2003. Furthermore, DOD and industry experience indicates that about $8 billion (40 percent) of that amount may be spent on reworking software because of quality-related issues.” (GAO. Stronger Management Practices are Needed to Improve DOD’s Software-Intensive Weapon Acquisitions. GAO-04-393. March 2004)

2007 SPII Software Acquisition Management (SAM) Team “As-Is State” Report

seven consistent primary problems:
1. Lack of effective acquisition management
2. Immature acquirer is challenged to assess developer performance
3. Ineffective requirements management
4. High personnel turnover in the acquiring organization
5. Cost and schedule estimation accuracy
6. Ineffective utilization of EVMS for software intensive acquisition programs.
7. Failure to take advantage of Best Practices and Lessons Learned.
  - “loss of a large number of the most experienced management and technical personnel .. without an adequate replacement pipeline” is one of the key contributors to the trend of a high percentage of DOD system operationally effective and suitability failures
  - “over time, in-house DOD offices of subject matter experts were drastically reduced, and in some cases, disestablished

• 2009 Opening Statement of Senator Carl Levin at Senate Armed Services Committee Hearing on DOD Acquisition of Major weapon Systems, March 3, 2009
  - DOD’s 95 major defense acquisition programs have seen their costs grow by an average of 26% and experienced an average schedule delay of almost 2 years

• OA Architectural Principles and Guidelines v 1.5.6, 2008, IBM, Eric M. Nelson, Acquisition Community Website (ACC) DAU Navy OA Website
• ASN/RDA: Assistant Secretary of the Navy Research Development and Acquisition
• ASR: Alternative System Review
• CDR: Critical Design Review
• CSC: Computer Software Component
• CSCL: Computer Software Configuration Item
• CMMI: Capability Maturity Model Integration
• DoD: Department of Defense
• DSB: Defense Science Board
• EVMS: Earned Value Management System
• FQT: Formal Qualification Test
• GAO: Government Accounting Office
• GOV'T: Government
• IEEE: Institute of Electrical and Electronics Engineers
• ITR: Initial Technical Review
• OA: Open Architecture
• OTRR: Operational Test Readiness Review
• PCR: Physical Configuration Review
• PDR: Preliminary Design Review
• PRR: Production Readiness Review
• RDT&E: Research Development Test and Engineering
• SFR: System Functional Review
• SLOC: Source Lines of Code
• SME: Subject Matter Experts
• SPII: Software Process Improvement Initiative
• SRR: System Requirements Review
• SVR: System Verification Review
• SW: Software
• TRR: Test Readiness Review
• WCS: Weapon Control System