Systems Engineering Approach to Integrated Combat Systems Development

Mr. Bill Bray
Executive Director
Program Executive Office, Integrated Warfare Systems
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The Need for Integrated Systems

Operational Environment

Humanitarian Assistance

Sub-Sonic Anti-Air & Anti-Surface Missiles

Super-Sonic Anti-Air & Anti-Surface Missiles

Advanced Super-Sonic Anti-Air & Anti-Ship Missiles

Short and Medium Range Ballistic Missiles

Persistent ISR

Intermediate Range Ballistic Missiles

Cyber Warfare

Anti-Ship Ballistic Missiles

Complex Threats Employing Advanced Technology in Challenging Environments

Rapidly evolving requirements drive Navy Capability Advancements

Integrated AAW & Situational Awareness

Area Air Defense in Clutter Environments

High Data Rate Battle Group Networks

Over Land Defense

Improved Self-Defense

Integrated Air and Missile Defense

Space Based BMD Tracking

Enhanced Shipboard Sensors (Radar + ES/EA)

Multi-Ship Resource Coordination

Direct Energy

Cyber Defense

UAV Integration

Rail Guns

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Implementing Open Architecture: Strategy, Interfaces and Open Standards

- Treat computing environment as a commodity
  - Select commercial mainstream COTS products that conform to well-established open system interface standards
  - Bundle specific COTS products for a given timeframe and revisit selections on a regular basis

- Isolate applications from high rate-of-change COTS through selection of standard APIs
  - Upgrade H/W and S/W independently and on different refresh intervals

- Transform application development from single-platform development to multi-platform portfolio
  - Objective architecture defines key interfaces that support extensibility and reuse goals based on common data model
  - Eliminate redundant software development efforts
# Evolution of Open Architecture

We are now focused here

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<th>COTS Infrastructure</th>
<th>Component-Based Software</th>
<th>Open Business Model</th>
<th>Common Core Architecture</th>
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**Characteristics:**
- Separation of Application/Infrastructure
- Commercial Standards
- Commodity Products

- Component-Based Designs
- Networked Applications
- Configurable Test Environments

- Open Business Practices
- Rapid Transition of New Capabilities to Systems
- Open Disclosure / Data Rights

- Common Objective Architecture / Interfaces
- Common Components, Frameworks, Services
- Common Precepts/Patterns/Standards

**Key Engineering Activities:**
- COTS Performance Characterization
- Prototypes / EDMs
- Planned Refresh Cycles

- Multi-Level Test and Evaluation
- KPP Validation
- Increased Reuse

- 3rd Party Developers
- Peer Reviews and Independent Assess
- Mentoring
- Fleet Involvement

- Align Existing Arch / Roadmaps
- Establish/Publish “Objective Arch”
- Establish/Publish Common Data Model

**Benefits / Evidence:**
- Increased Performance / Bandwidth
- Reduced Cost
- Decreased Dev Time
- Improved Testability
- Reduced Cost (Reuse)
- Scalability, Extensibility, Testability, ...

- Increased Number of Vendors/Opportunities
- Improved Transition of S&T to Fleet

- Improved Interoperability
- Cost Avoidance
- Reduced Training/Support

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TI 16 Enabled Consolidation

Today’s Technology Enables a 2:1 Reduction in Footprint With Remaining Margin for Processing and Storage

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TI 16 State Of The Practice Improvements

With Fewer Cabinets, TI 16 Architecture Continues the Upward Progress on Processing Margin

TI 16 Reverses Trends and Requires Less Power, Less Cooling, & Reduces Weight of the Computing Infrastructure

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AEGIS Common Source Library (CSL)
REUSE within Baseline configurations

“Fix Once… Use Many Times”

Key Elements of Common Development:
• Common Mission Capabilities
• Single Set of Specifications
• Common Program Plans
• Single Set of Processes & Metrics
• Integrated Team Structure
• Enterprise Products

AEGIS / MDA AB Cross Program Governance
In Place to Coordinate Multiple Programs Using CSL

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# Transitioning to Objective Architecture Based Combat System

## 2008
- Aegis designed as an integrated combat system
- Aegis ACB 08 / TI 08 decoupled hardware from software
- SSDS designed with federated combat system network and hardware decoupled from software
- SSDS ACB 08 adds open standard middleware
- Future capability improvements planned for both programs through Advanced Capability Build (ACB)

## 2012
- Aegis modernization (ACB 12) component level interfaces delivered at CDR (1Qtr FY10) and with each delivered computer program build
- SSDS interfaces already documented at component level
- Small number of common components integrated both Aegis & SSDS ACB 12

## 2014-2022
- Number of common components will increase with each ACB moving to a common software core for all Surface Navy Combat System

### Objective Architecture

Required and funded warfighting capabilities determine which components are modified.

*Number of components shown is limited for illustrative purposes. Refer to ADD or top level objective architecture for additional component decomposition*
The Objective Architecture provides a guide to implement new capabilities & integrate new CS elements in a manner that achieves reuse objectives and results in more flexible and extensible components.

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Combat System Objective Architecture

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Combat System of the Future (CSF)

C/S stations with standard interfaces and growth margins

- CS Infrastructure
  - Modular stations
  - Standard Interface
  - Multiple UV's
  - Mission Bay

Flexible Infrastructure (FI)

Weapon Module

- Swapable Payloads
- Scalable Arrays
- Data and Comms Plant
- Sensor & Comms

C/S computer program for multiple ships from a single library of components

Common computing, data and communications infrastructure for C/S

Robust development and test tools & sites to allow for decoupled payload - platform development

Common Source Library

“Fix Once... Use Many Times”

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Summary

• IWS has been proactive in implementing Open Architecture precepts and concepts to the Surface Navy
• Open Architecture implementation has introduced opportunities to drive down costs and be more effective in the acquisition and deployment of combat capability
• BUT, Open Architecture implementation is a long term effort with much left to accomplish
• Our focus going forward will be to:
  – Transition S&T into Programs of Records more effectively
  – Continue hardware footprint consolidation
  – Identify efficient and effective strategies and opportunities for software, component reuse
  – Mature systems engineering and business processes to support combat system development, reduce costs, and enable rapid deployment
  – Identify opportunities for Better Buying Power savings
QUESTIONS?