Open Architecture
Machinery Control Systems

ASNE Intelligent Ships Symposium

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Statement A: Distribution is Unlimited
Main Concepts for a New Approach to MCS

- A Business Case for OA MCS
- Zonal Architecture Improves Acquisition and Shipboard Performance
- Naval Open Architecture and Product Lines Applied to MCS
- Next Steps
Open Architecture Defined

**Naval Open Architecture:**

- Business practices
- Technical practices

**Produce Systems:**

- Based on open standards
- Published interfaces

**OA CORE PRINCIPLES**

- Modular, Loose Coupling, High Cohesion
- Design Disclosure and Data Rights
- Enterprise TOC Reduction and Reuse
- Transparency and Peer Reviews
- Competition and collaboration
- ROI and Strategic Investments

Can a qualified third party add, modify, replace, remove, or provide support for a component of a system, based only on openly published and available technical and functional specification of the component of that system.
The Business Case for OA MCS - Development

- Cost Avoidance in MCS Development and Ship Construction
  - Cross-Platform Product Reuse
  - Integrated Logistics Support
  - Incremental Testing
  - Improved Schedule Performance
  - Ship Construction Risk Reduction
- Improved Performance
  - Access to Innovation
  - Support for Automation
The Business Case for OA MCS – Life Cycle

- Cost Savings over the Life-Cycle
  - Common Training
  - Common Logistics
  - Distance Support
    - Transparency of Equipment Status Internal and External to the Ship
  - Reduction in Software Maintenance – MFOP

Current State of Practice

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OA Enables Competition for development and support
Zonal Architecture – Divide and Conquer

- Benefits of a Zonal Architecture
  - Enhanced Survivability
    - Local Control and Recovery
  - Information Assurance: Defense-in-Depth
  - Decompose Network Design for hierarchy of real-time performance
  - Ship Construction testing and integration risk reduction
  - Increased Maintainability and Troubleshooting
- Smart-loads minimize MCS design complexity
Zonal Architecture Characteristics

- Compartmentalization
- Data Decomposition
Additional Features of OA MCS

- Cross-platform reuse to increase cost performance
- Elimination of proprietary design environments
  - Soft PLCs
  - Common HMI
- Escape hardware and software vendor-lock
- Reduced Enterprise Cost
- Rapid access to innovation
  - Technology Insertion
- Transparency of Design Strategy and Resources
  - Objective Architecture Defines Global Strategy
  - Open Data Model to support integration of new components
  - SDKs and Test Harnesses reduce system integration risk and test effort
OA Applied to MCS

Classic Approach
- Independently Designed and Acquired on a Ship Class Basis
- CFE by the Ship Builder
  - Typically Subcontracted

OA MCS Approach
- General MCS Functional Decomposition
- Define the MCS Objective Architecture
- Define Supplier Market Boundaries
- Apply to a specific ship class
- Evolve the Family of Systems through Product Lines
- Establish an acquisition framework for incorporating innovation
  - APB/ACB methodologies for software upgrades
  - Technology Insertion strategies for hardware sustainment
- MCS Reusable Modules as GFE for modification and redelivery

Naval Open Architecture:
- Business practices
- Technical practices

Produce Systems:
- Based on open standards
- Published interfaces
Open Product Lines – the Next Step in the OA Revolution

- Product Line Focus: Build once, use subsequent variations
  - Lower Cost to Upgrade
  - Higher Quality
  - Cross-platform utility
  - Forward/Backward compatibility

- Reuse
  - Open and managed reused components – strategic reuse
  - Published architecture that specifies how features and behaviors are varied between products
  - Assets can be competed as technology advances and/or mission needs change
  - Reusable test scripts, plans, assets and harnesses shorten process and simplify execution

Product Lines – Cross-platform use via variation points

Product Line Management

- Engineers
  - Requirements
- Architects
  - Design Models
- Developers
  - Source Code
- Testing & Validation
  - Test Cases

Reusable Core Assets

- Shipclass ‘A’
- Shipclass ‘B’
- Shipclass ‘C’
We are not alone

- Several OA efforts in the Navy that are launching points for Open Product Lines and OA MCS
  - PEO IWS: Combat Systems Objective Architecture
  - PEO SUBS: SWFTS Objective Architecture
  - PEO U&W: Future Airborne Capability Environment
  - PEO C4I: Common Afloat Network Enterprise Services
  - DASN RDT&E: Naval Enterprise OA
  - Industry Consortia: Open PLC
  - ASW and MPRF COI’s: Data Modeling
  - OMG: Real Time Data Distribution Service
Guiding Principles

- Reusable, multi-platform, Product Line Modules
- Alignment of MCS Boundaries with physical ship zones
  - Zonal Survivability
  - Improved Construction Performance
- Partition functionality among local, zonal and shipwide controls
  - Ship Construction Testing and System Checkout
- Control Environment Abstraction for configuration independence
- Network Connectivity off-board to enable distance support, status reporting, and eventually MFOP
- Use a hardware business model that uses the commercial market
  - Hardware/Software Independence
  - Technology Insertion production and sustainment model
Evolving Standards to Prevent/Escape Vendor Lock

- Naval Enterprise Architecture Description Document
- Open PLC standard - IEC 61131-3
- Distributed Control and Automation standard IEC 61499
- OMG Real Time Data Distribution Service (DDS) standard
- Understand and use Government Rights to Data

https://acc.dau.mil/oa
Next Steps

- Create a MCS Communication Standard and Data Message Content
  - Update MIL STD 1399
- Establish a MCS COI
  - Develop a MCS Data Model
- Write a MCS ADD
  - Evolution into an Naval Enterprise ADD
  - Build off PEOs IWS and Subs ADDs
- Contribute to the Cross-SYSCOM IA Defense-in-Depth Architecture
  - Distance Support reduces support cost; connectivity is needed
- Reusing products from Navy programs
  - Commonality Shelf Products
  - Common Display System/Common Processing System
Backup
ACB / TI Notional Model

- Requires transition to COTS computing via initial TI
- Each ACB builds on prior ACBs while adding new capabilities
- Transitioned ships receive new ACB every 2 years
- Every ship receives every other TI
Crawl, Walk, Run – Reducing Variation

- Capture the value of recent commonality studies
  - VME
  - PLC
  - Network
  - Protocols
  - Workstation
  - Topology
  - Functionality
  - Methodology

- Target the Cost Drivers
  - System Design and Test
  - Acquisition and Installation
  - ILS
  - Corrective Maintenance and Obsolescence