Implementing an Open Business Model and Open Architecture Approach to Enable Agile Technology Selection

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Overview

- Software technology insertion goals
- Enabling software technology insertion
  - Process
  - Business Models
- Mine Warfare software program technology insertion current initiatives
  - MEDAL
  - PMA
- Importance of systems engineering to support technology insertion
Emerging GIG Infrastructure

MIWC
- Present in either DESRON or PHIBRON staff
- Each Platform deploys its assets to detect, locate and prosecute any mines.

MIW Reachback support
- Data can be provided from a variety of sources.
- MIW Information is processed and available via SIPRNET

MIWC Staff
- Receive data from all LCS assets
- IOT maintain COP and determine prosecution sequence of MILCOs.
- Maintain authoritative data set ongoing operation

MIW MM OIC’s
- May be working collaboratively
- Pushes all MILCO, environmental and mine data to MIWC

Enterprise Support
- National assets (LRS) monitor enemy activities
- UAVs (BAMS) provide surveillance data
- Pushes all data of interest to MIWC

Integrated Operations

MIW FUTURE

Hostile Mine Storage Facility
Levels of Interoperability

- **Co-location**
  - Two individual systems located & operating side by side but not capable of sharing data (ie no common data formats)

- **Co-generation**
  - Two individual systems operating side by side or apart sharing common data files via manual media exchange generating functionality in parallel

- **Co-netted**
  - Two individual systems side by side or apart sharing common data across a system/network for their own individual purposes

- **Co-operation**
  - Two systems connected, sharing data, and producing operational products for consumption by any user

Geographic Operations ➔

Sequenced Operations ➔

Integrated Operations ➔

CAPABILITY

TIME

US/UK

Navy/DoD

Navy/Navy

US/NATO
Software Improvement Goals

- Agility
- Interoperability
- Competition
- Improved Capability
- Reduced Overall Costs
- Increased Transition Speed
Introduction

- Through adoption of a common Open Business Model involving scalable Open Architectures with identified Technology Insertions points, it is possible to create an effective government and industry partnership to support rapid capability improvements to software systems and eventual migration of capability to unmanned vehicles.

  • Enabled by reusable services and common standards, which together support a decrease in the required integration time of new technologies and enable the ability for multiple systems to interoperate on the battlefield.

  • Requires industry participation in an inclusive business model and align to a common Service Oriented Architecture (SOA) to achieve an affordable and consistent foundation for the transition of future capability improvements.

- Technology improvements to software capability are required to ultimately migrate capability to sensors to enable autonomous capability
Technology Framework

Technology Insertion
(best of breed technologies)

Open Business
(competitive environment / wide industry base)

Open Architecture
(open standards/ easy technology upgrade)
Technology Framework

Technology Strategy

Technology Plan

Technology Insertion Process

Business Processes

Technical Processes

Business Plan

Technical Plan

Business Strategy

Technical Strategy

Open Business

Open Architecture
Technology Framework

Determine Technology Gaps
(Capability/Capability Gaps)
Articulated by Warfighter

Define Tech. Investment Plan
(Funded Technology Programs)
Portfolio of adequate breadth & managed risk

Enable Technology Selection
(Peer Review, Verification & Validation)
Increased agility, Improved speed to transition

Communicate Need
(Info ‘Packages’, Industry Days)
Detailed description of needed functionality

Define Ownership Approach
(Organized Data Rights, Licensing)
Allow (partial) industry ownership

Outline Strategy for Competition
(Concurrent contract vehicles in acquisition strategy)
Increased competition, Reduced costs

Comply with Net-Centricity
(NESI Checklist, Modularity, IA)
Repeated SW assessments for Adherence to standards

Publish Technical Guidance
(Specified SW Framework, Standards Used)
Reduced Technology Integration Costs

Develop Common Technical Approach
(Taxonomy/Data Model, Compatible architecture)
Develop a Community of Interest focused on Improving Interoperability

Open Business

Open Architecture
**Spiral Technology Development Model**

Software development kits (SDKs), virtual test-bed, research website

Current Focus to develop process and future OBM tools/processes

Prototype

Migration to SOA prototype

Software updates

Web-based Prototype

Pre-release developmental version

Fielded version

version release  version release  version release

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Mr. Robert Gold, the Deputy Under Secretary of Defense for Science and Technology (DUSD (S&T)) categorizes software technologies into five variants:

1. Unprecedented Functionality,
2. Off-The-Shelf Components,
3. Enabling Run-Time,
4. Aggregation of Components, and
5. Enabling Development

Each of these flavors of technologies must be addressed and appropriately managed through the transition process.

Transparent architectures and well defined business models for software programs must be appropriately ‘open’ to address each of these types of technologies.
Potential Open Business Models

“Living Labs” such as Google, Apple, IBM, or open source software communities such as GNU/Linux etc. recognize the power of a collaborative research community and a structured process for technology maturity.
**MIW Open Business Model Vision**

- **MEDAL B11**
  - CES
  - POR
  - Open Model Data Services

- **MEDAL EA**
  - Open Model Data Service

- **PMA**
  - OMDS

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**MCM Data Fusion Techniques**

- Using Multiple Unmanned Sensors & Modules

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**Phase 1**

- Data Fusion
- Improved Planning
- Improved Evaluation
- MCM CES BAA
- Replanning (Running Estimate)
- Temporal Planning
- Through the Sensor
- Data Fusion

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**Phase 2**

- Buried Mine Sensor Development
- Marine & UxV Tactical ISR Dynamic Replanning
- MCM Capacity Spiral 2 Systems for LCS

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**TTA Level A**

**TTA Level B**

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**Academia/Industry**

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**ONR**

**NPS**

**NSWC-PC**

**NAVY**

**NRL**

**Open Model Data Service**

**Open Model Data Service**
**MCM CES - 1st Step into Automation**

Based on the Commander’s Estimate of the Situation process

- A formal process to ensure the Commander adopts a COA that is:
  - Adequate
  - Feasible
  - Acceptable

- **Main Features**
  - Task Orientation
  - Enemy Options are carefully considered
  - The decision is based on an analysis of interactions of the enemy’s COAs and own COAs.

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**Plan of Action & Milestones**

- **3-year OPNAV N852/PMS495 program**
  - FY06-FY08
- **Build 0 (EDM) → COMPLETED!**
  - Objective to confirm framework implementation and ROI of CES framework for tactical MCM
  - Focus future investment
  - Risk mitigation
  - “Add On” Software with MEDAL Build 10
  - Delivered June 07
- **IOC**
  - Integrated with MEDAL Enterprise Architecture
  - Delivery FY10 in EA

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**Overall Planning Timeline**

- **Order of Magnitude Improvement!**
  - 572 hr → 54 hr

**Return on Investment Results**

- **Investment:** $1.5 Million (half of total program budget)
- **Return:** 12.9 Planning Days Saved per Operational Plan
  - (572 staff man-hrs - 53.4 staff man-hrs)/(5 staff x 8 staff man-hrs per staff)
- **Intangible Returns:**
  - Ability of smaller staffs to conduct MCM planning through a reduction in training requirements
  - Utility for the application of Organic MCM systems, where small and inexperienced staffs must plan their own operations
  - Improved staff-to-staff coordination and communications
  - Standardized planning process
  - Better internal staff collaboration
Mine Warfare C2 Mission Timeline (notional)

Planning

Execution

PMA

Evaluation

Sorting Planning

Sweeping

Hunting

Detection/Classification

Identification

Reacquisition

Neutralization

Note: MEDAL does sortie planning for some systems
MEDAL
What is MEDAL?

An Integrated Mine Warfare Software Tool Kit providing:

- **Intelligence Preparation of the Environment (IPE)**
  - Access, display, employ, evaluate, update, & fuse extensive databases
  - Environmental, Mine Threat, & Surveyed Contact databases

![Bathymetry & Bottom Slope Plot](image1)
![Sonar Performance Prediction Plot](image2)
![Historical Route Survey Contact Plot](image3)
![Enemy OOB / Bathy Mine Threat Plot](image4)
![Bottom Physical Characteristics Plot](image5)
![Bottom Mosaic](image6)
What is MEDAL?

An Integrated Mine Warfare Software Tool Kit providing:

- **Tactical Planning & Evaluation**
  - Create, display, evaluate, optimize, transmit, & store tactical MCM plans for individual manned/unmanned systems, in specific environments, vs specific threats
  - Display, evaluate, combine, & store results of actual MCM efforts
  - Integrated the plans, effort, & results of all MCM tactical systems

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**Plan**
- Search Plan Specifications
  - Tasked Search Level = 64%
  - Area = Area 1
  - System/Settings = ABC/123
  - Threat = XYZ
  - Environment data = historical est.
- Result: Discrete track locations for this combination of mine, system/setting, & environment

**Evaluate**
- Picture of evaluation results
- Re Plan for gaps & level shortfalls

**Act**
- Reacquisition/ID or Neutralization Plans
- Tasked Contacts List
- Environment data
- Assault Breaching Plans

**Catalog Tactical Results**
- Picture of results cataloging
Why Transform?

Operational C2 Requirement ➔ Technical Approach

- **Better**
  - Provide more capability to users
    - Web services
  - Integration with enterprise-wide services increasing
    - Imagery, VNE-NCS, CJMTK/GO-1

- **Faster**
  - Rapidly transition technology from S&T community
  - Pushing software updates remotely

- **Cheaper**
  - Reduced costs
    - Fielding
    - SW updates
  - Growing number of MIW systems that exchange data
  - Evolving data exchange requirements
  - Platform and language independence

- **Easier**
  - Adoption of technical standards
    - Data format standardization (XML)
    - Standardized transport (web services)
    - Composable (service reuse)
  - Reduce fielded system maintenance by the fleet

- *Plus… fully embraces Dept of Defense initiatives*
  - OA
  - GIG/FORECEnet
  - NECC
  - NCOW
Net-Centric Sign In

MINEnet v1.0.0 - Sign In

Username

Password

Remember me

Sign In

Mine Warfare Essentials provides access to key MIW data to users. Users can create, request, or view Mine Threat Plots/MIW Areas. Users can also download Mine Threat Plots and MIW Areas as GeoTIFF.

Let's get started....

Conceptual only
Expeditionary Operations

Requirement to support expeditionary operations
**MEDAL Data Services**

**Basic Concept:** SOAP Data Service is deployed to a developer’s computer in a Tomcat container, accesses MEDAL database, provides all contact data, and returns contact data to MEDAL if required.
Data services are being created for both MEDAL Build 11, the current operational version, and MEDAL EA, the next generation MEDAL.

These services allow easy and complete access to MEDAL data enabling researchers and developers to leverage existing data and capabilities in support of their individual efforts to improve MIW C4I.
MEDAL Research Framework

- Decision Theory/ Knowledge Management/ HSI
- Asset/ Resource Management
- Reconnaissance Theory
- Assumptions/ Uncertainty
- Search Theory
- Assessing Effort
What is PMA?

- Tactical & Environmental Sensor Data Analysis
  - Display imagery data from MIW tactical & environmental sensors via transferable mass memory devices shared with the sensor vehicle
  - Analyze tactical sensor data to detect & classify mine-like contacts
  - Analyze environmental sensor data to characterize the performance of tactical sensors, provide forecast modeling for MIW planning & enable change detection against historical route surveys
Identified Need for a PMA Strategy

There are currently multiple PMA Systems that are required to manage environmental and tactical data.

- MCM Class
- COBRA (BPAUV)
- MH-60S AMCM Systems
- RMS
- UUVs
- Bluefin (Sea Lion)
- USV Sweep
- Hydroid, Inc. (REMUS)
- Environmental PMA
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Network-Centric PMA Vision

Raw Data
- Tactical
- Environmental
- System Performance

Information Layers
- Geographically-Referenced

SENSORS
- Air-based
- Ship-based
- Unmanned vehicles
- Man-portable

Common Processing Architecture
- Data Processing Modules
  - Contact Correlation Module
  - Data Fusion Module
  - Training Scenario Generator
- Tactical Sensor Modules
  - Contact Detection/Classification
  - System Specific CAD/CAC
- Environmental Sensor Modules
  - Change Detection
  - Environmental Characterization

MEDAL
- Mission Evaluation Software

Master Historical Database

EDM in Development!
PMA Research Framework

- Computer Aided Detection/Classification
- Contact Correlation
- Algorithmic Environmental Adaptation
- Feature-based Pattern Recognition
- Data Fusion/Probability Assessment
- Display Technology/Knowledge Management/ HSI

Research Focus Areas
How Industry Can Assist Mine Warfare C2 Improvements

- New techniques for search that are beyond uniform tracks
- New techniques for reconnaissance
- Sampling techniques for environment data collection/ Applying sampling to estimate across the area
- $P(y)$ planning routing that optimally puts tracks where needed
- Exploratory objective planning routine
- Breakthrough objective planning routine
- Reconnaissance objective planning routine
- Non parallel planning versus parallel planning (?) Cross hatching
- Multi-sensor Planning for MCM
  - Asset scheduling
  - Asset allocation
  - Search area participation
  - Adaptive search planning
- Multi-objective/Pareto optimization
- Evaluation of current effectiveness
- Prediction of future effectiveness

- Probabilistic modeling of search event space/ Non-parametric mixture modeling
- (Variational) Bayesian inference
- Transformation of discrete observations to predictive (probabilistic) frameworks
- Tactics/ConOps for LCS using manned & unmanned assets
- Multi-sensor data fusion (e.g. multi-aspect, imaging sonars, broadband sonars, electro-optic, magnetic, etc.)
- Feature selection & optimization
- Detection & Classification (single & multi-sensor)
- Pattern recognition
- Machine learning/ information theory
- In-situ retraining of automatic target recognition
- Human-machine interface for MCM target classification
- Modeling conditional dependence between sensors
Systems Engineering Enablers

Programs of Record

System

Process (doctrine/tactics)

Fleet Driven

Functional

Enabling

Data

Business

Acquisition Strategy/Business Model

Documentation

Assessment

Supporting

Systems Engineering REQUIRED
Summary

- Processes should be developed to enable technology transition to software programs
- An Open Business Model has been adopted by the Mine Warfare C2 software programs to enable technology insertion
- Information to support MIW research is being compiled
  - Glossary
  - Tactical User Processes
  - Data Standards
  - Information Support Plan
- Access to the MIW COI Website is available for industry partners under contract to DoD