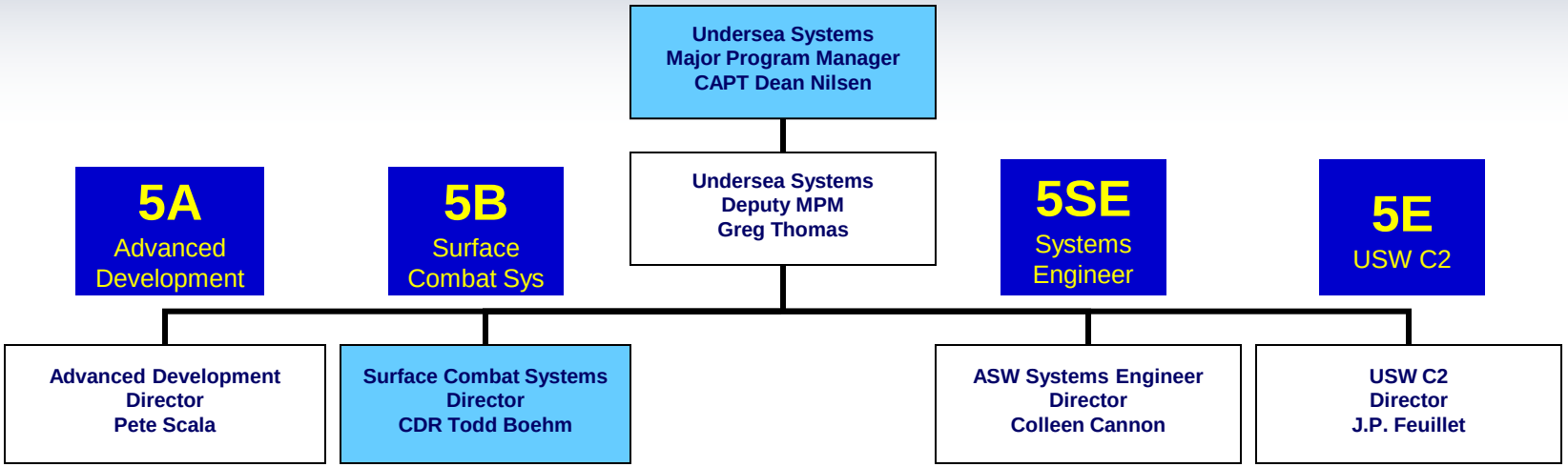
2011 Integrated Warfare Systems Conference

Undersea Systems (IWS 5.0)

Captain Dean Nilsen

dean.nilsen@navy.mil

IWS 5.0 Organization



- Submarine APB
- Submarine sensors
- Surface Ship ACB
- Distributed Netted Sensors

- Combat System Production & Installation
- Training
- Integrated Logistics Support
- Multi-Function Towed Array

- ASW Community of Interest Data Model (ACDM)
- Open Architecture

- Common ASW Tactical Picture Development
- USW-DSS
- CV-TSC

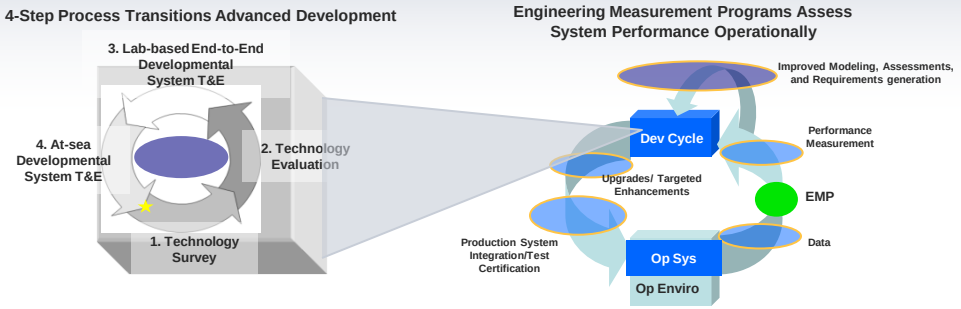
PEO IWS Stand-up – IWS 5.0 ASW Lead

ASN RDA Oct 2002 message created a new PEO for Integrated Warfare Systems (PEO IWS):

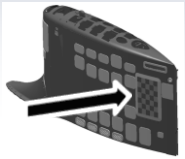
- **…Responsible for all Surface Ship and Submarine combat systems**
- **…Responsible for coordinating all ASW warfare area programs across PEOs**
- **ASW software development, including the annual submarine combat systems software update, will migrate to PEO IWS, facilitating optimal development of ASW software across platforms**
- **As the Navy moves to Open Systems Architectures and highly integrated Systems of Systems, it is critical that those efforts have a strong, consistent focus**

PEO IWS 5.0 Undersea Systems

Submarine APB

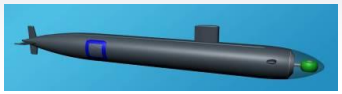


Submarine Sensors



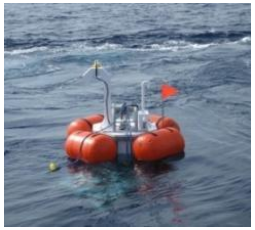
LWLCCA

CTA

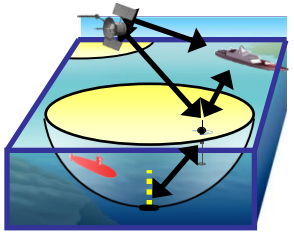


CAVES LVA

Distributed Netted Sensors

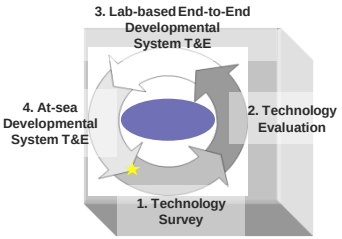


DWADS

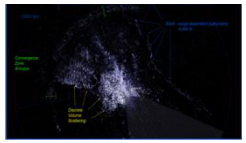


RAP VLA

Surface Ship Advanced Development

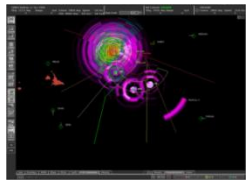


ACB



- Surface ASW Synthetic Trainer
- Continuous Active Sonar
- Active Clutter Reduction

Common ASW Tactical Picture



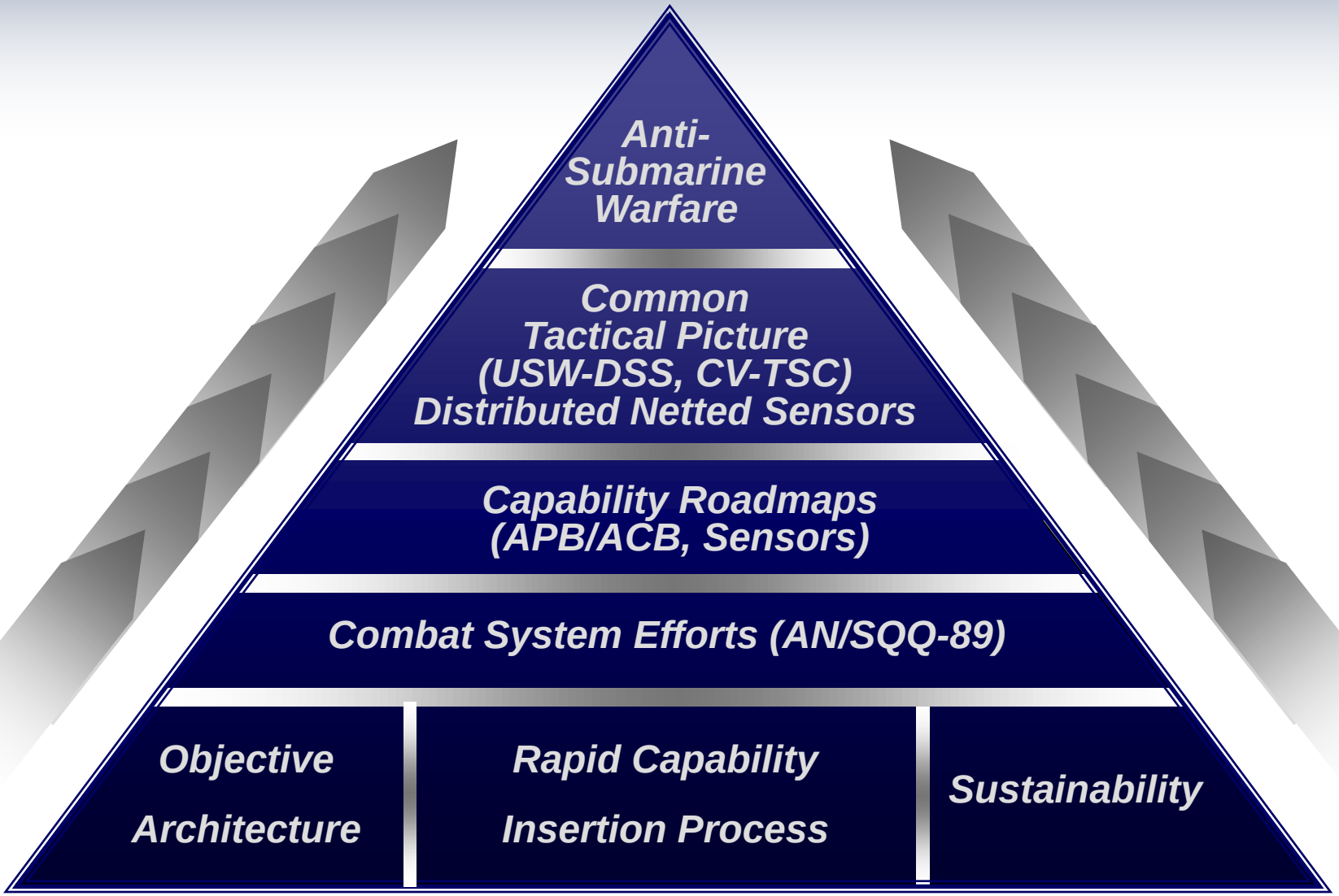
USW-DSS

CV-TSC

Mission: Develop, field, and support robust ASW systems and transform capabilities for tomorrow's forces

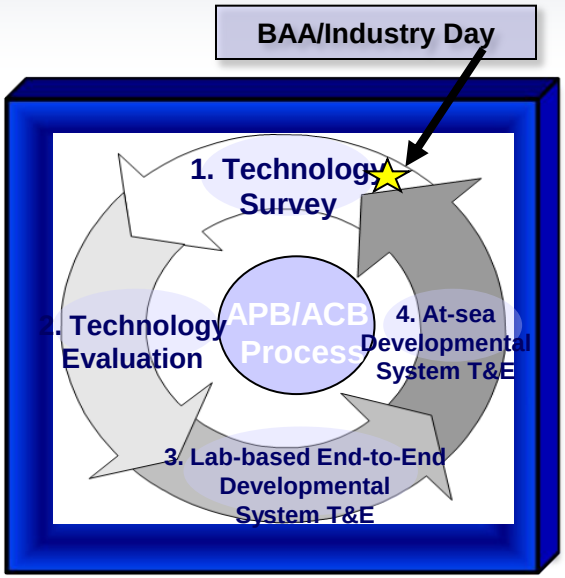
Vision: We are an investment made by the U.S. Navy in support of its mission. As trusted stewards, we will ensure this will lead to immediate and long-term value by providing: - Warfighting capabilities for today's Fleet - Expanded capabilities for tomorrow - Broader contributions to the science of ASW

PEO IWS 5.0



IWS 5.0 business model is dependent on successful transition of new technologies

APB/ACB Overview



- **Proven Cost Effective Build Test Build ARCI Model**
  - Fleet Driven Processes
- **Targets Affordability and Control Cost Growth, With LOE Funding**
  - Maintains SMEs and stable industry base
  - Targets obsolescence, maintenance and improvements
  - APB/ACB is an effective COTS supportability strategy
    - Rapid capability insertion strategy
- **Promote Real Competition, Multiple Awards vs. Single Developer**
  - Companies and Labs are Part of Larger Team
    - Harvests “best of breed” solutions from all possible sources
  - Industry is a partner in productivity and innovation
  - Small Businesses courted for new technology (SBIRs)
  - Utilize BAAs and SBIRs for rapid, efficient technology acquisition
- **Reduce Non-Productive Processes and Bureaucracy**
  - Sub and Surface Use Same Core Team Member
    - Maximize OMI, HW, ILS and Training Commonality
    - Eliminates Duplicative Infrastructure for Each System

Open Process, Open Product, Data Driven Collaborative Development

APB/ACB Process Efficiencies

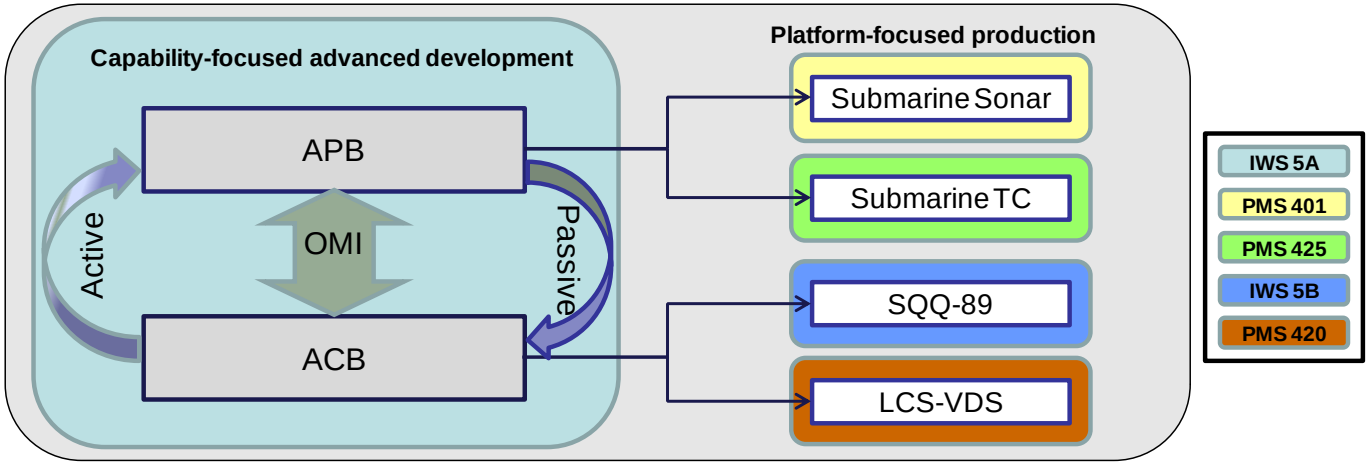
Active WG	SPWG	Algorithms/Automation	OMI-WG
Tech Insert IPT	Architecture IPT	Data Support	
Systems Safety	Security (IA) WG	TDWG	

Common or coordinated across all 3 communities

Common across surface and submarine

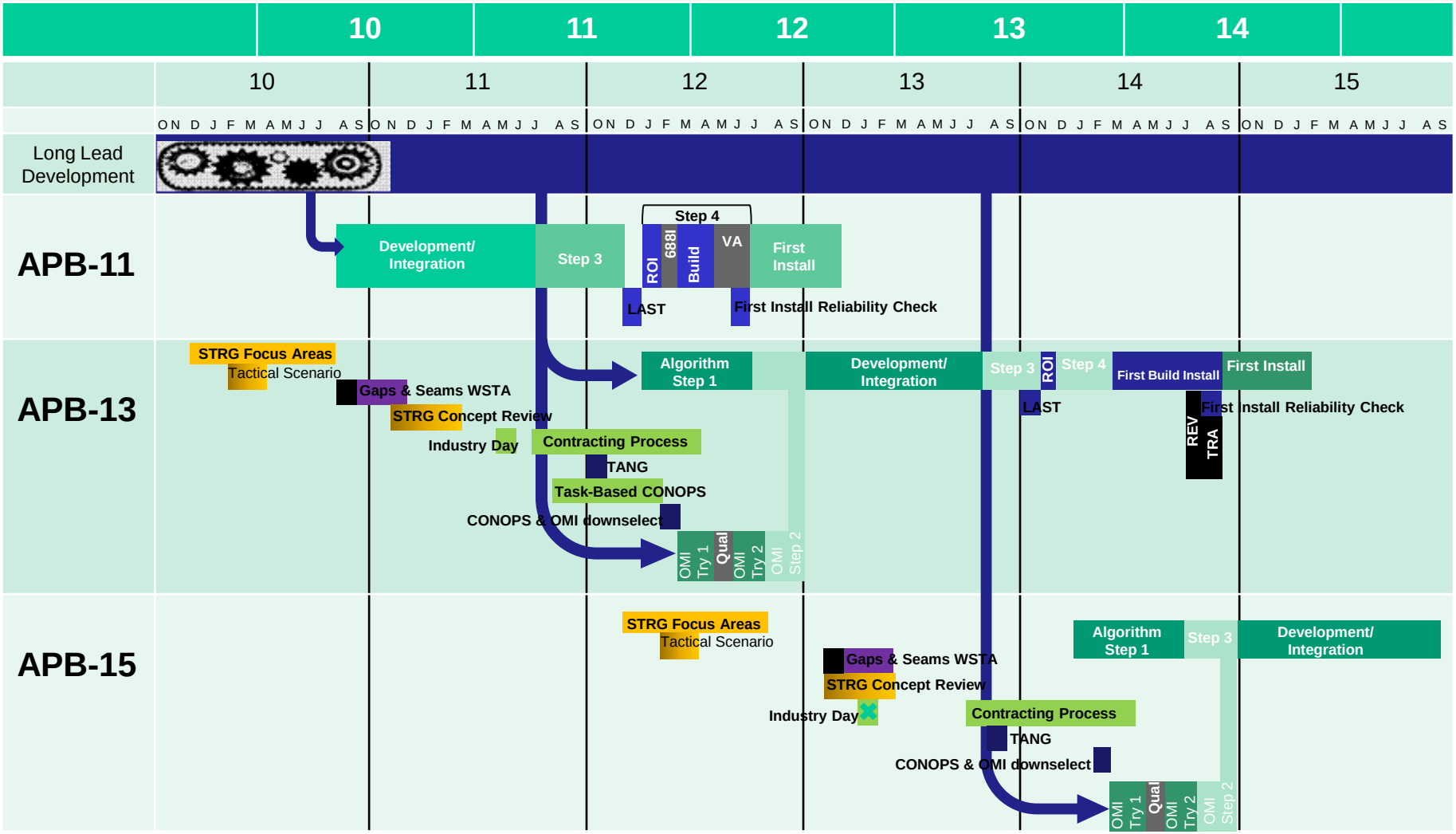
Commonality increasing

Unique



Driving Organizations, processes and content to maximize efficiency

APB Schedule



DRAFT APB Roadmap

Increasingly Capable Multi-Mission Submarines

End to end emphasis improves the submarine's multi-mission capability

Fast follow commercial *design*: key information, system simplification, increasingly intuitive OMI

2011 2012 2013 2014 2015 2016

APB-11
ASW Hold at Risk

- Range triage display (RAZ)
- Integrated WAA, TB-34, LCCA
- 360^0 stitched sonar
- Image contrast
- Consolidated ranges
- Track monitor
- STDA redesign

APB-13
ASW Multi-mission, Intermittent Track

- Intuitive interfaces for passive narrowband
- Layered commercial geo for contact centric intermittent track
- RAZ extension to TB-34, further range estimation consolidation
- 360^0 image stitching, auto-tracking, auto-focus
- Hands free TMA
- Standardized colors and symbols across the federated systems
- Mission planning

STRG scenario/requirements

APB-15
Multi-Mission ASW/ISR

- Extend leveraged commercial designs → "One System"
- Commercial based information management techniques
- Information mobility
- Collaborative workspaces
- Workload reduction, automation improvements
- Extension of pipelined signal processing techniques enabled by COTS

APB-17
Steady state fast follow:

- COTS hardware
- Commercial design
- Advanced signal processing enabled by the COTS

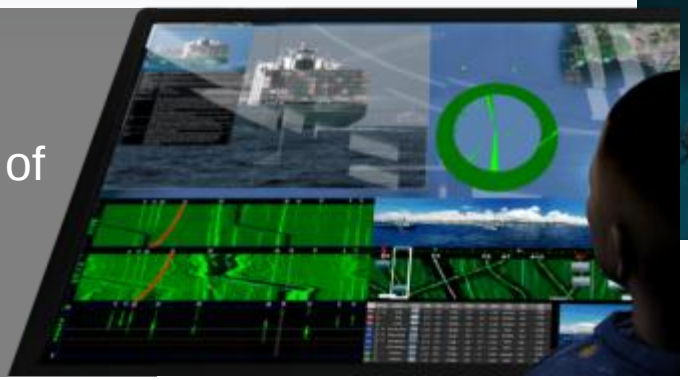
DRAFT

Continuous innovation: brainstorming, prototyping, data collection and advanced development

Combined Approach to Managing Information Effectively

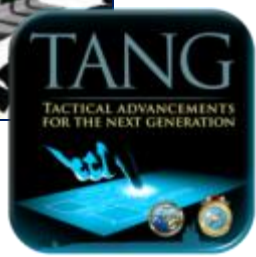
Continue to lead in high performance algorithms

- Continue to exploit advantages of Moore's law and new TIs
- Consolidate hands-free ranging
- Integrate imaging



Add Fast Following in Design

- Sailors come "trained" by commercial information management products
- Add flexibility for multi-touch composite glass workspaces
- Add Industrial Design methods, including the TANG Workshop



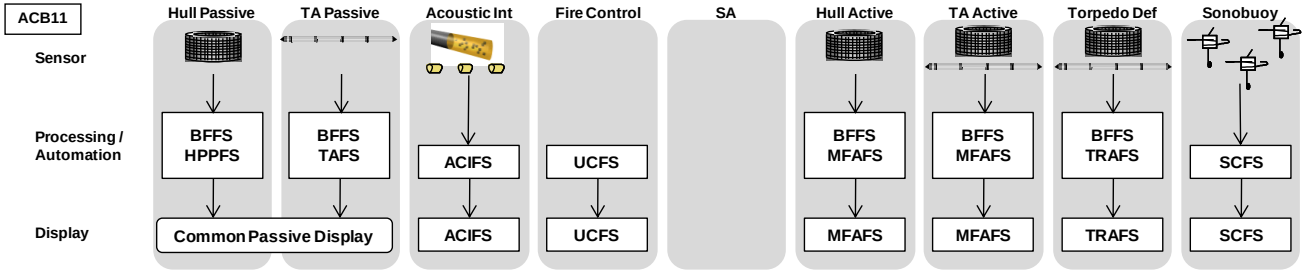
Disciplined Engineering

The APB process and its peer groups/test program will bring commercial innovations to the submarine environment : Rapidly, Efficiently, and Safely.

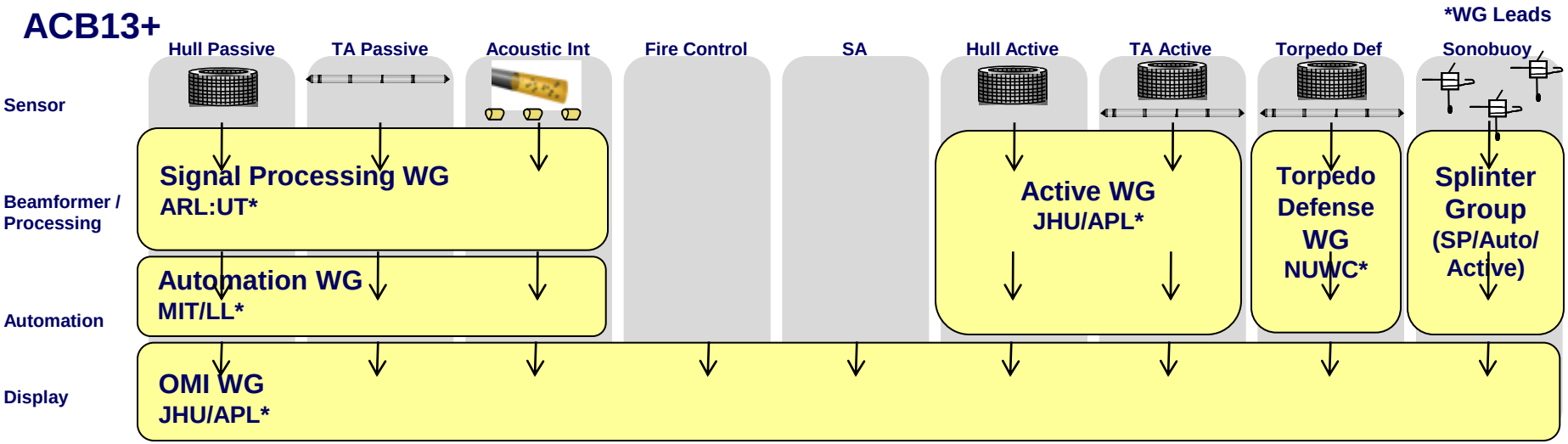
Movement to ACB Process

- **ACB09**
  - Significant capability gains
  - Stove-piped sensor to display
  - Not a four-step ACB build
  - TI to enable ACB11+

- **ACB11**
  - First ACB Working Group build – one prime integrator, multiple small business teams
  - Began breakdown of stove-piped development with common passive



ACB13+



- Increase in commonality with reduced cost development and support
- Corporate knowledge transitions from labs/companies to Working Groups

Infrastructure IPTs

Advanced Capability Builds (ACB) Roadmap

Legacy green screens

Proposed

ACB15

Build – Test – Build Evolution

- Passive: APB improvements
- Torpedo: Active TDCL waveforms w/ fusion
- MH-60R integration*

* concurrent with AEGIS Implementation

ACB13

Multi-sensor / Workload

- Active: Common displays
- Torpedo: Radar fusion
- Weapons separation
- Additional sensors simulated in SAST
- Situational awareness OMI / CADRT Geo
- Integrated PM/FL

ACB11

Detection / Tracking

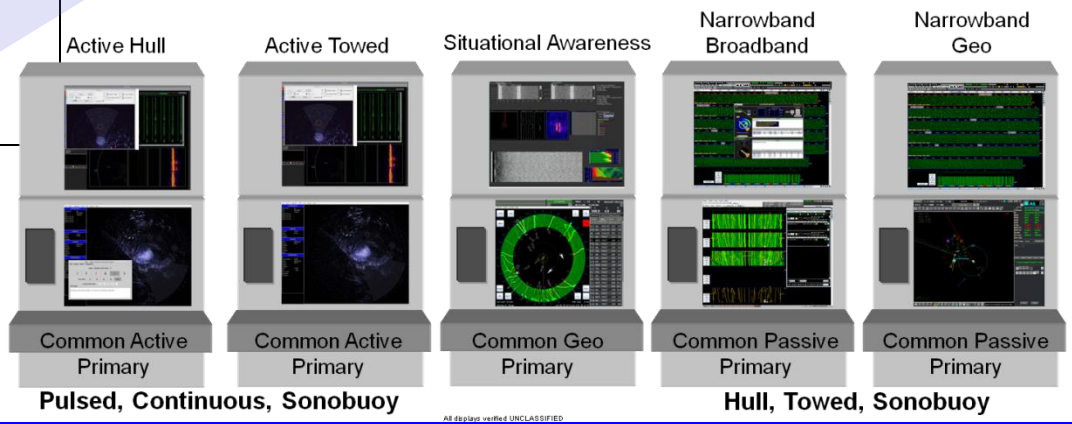
- Passive: APB09 Automation & OMI
- Active: Clutter reduction
- Improved integrated training (SAST)
- Initial PM/FL

ACB09

Sensors/Integration

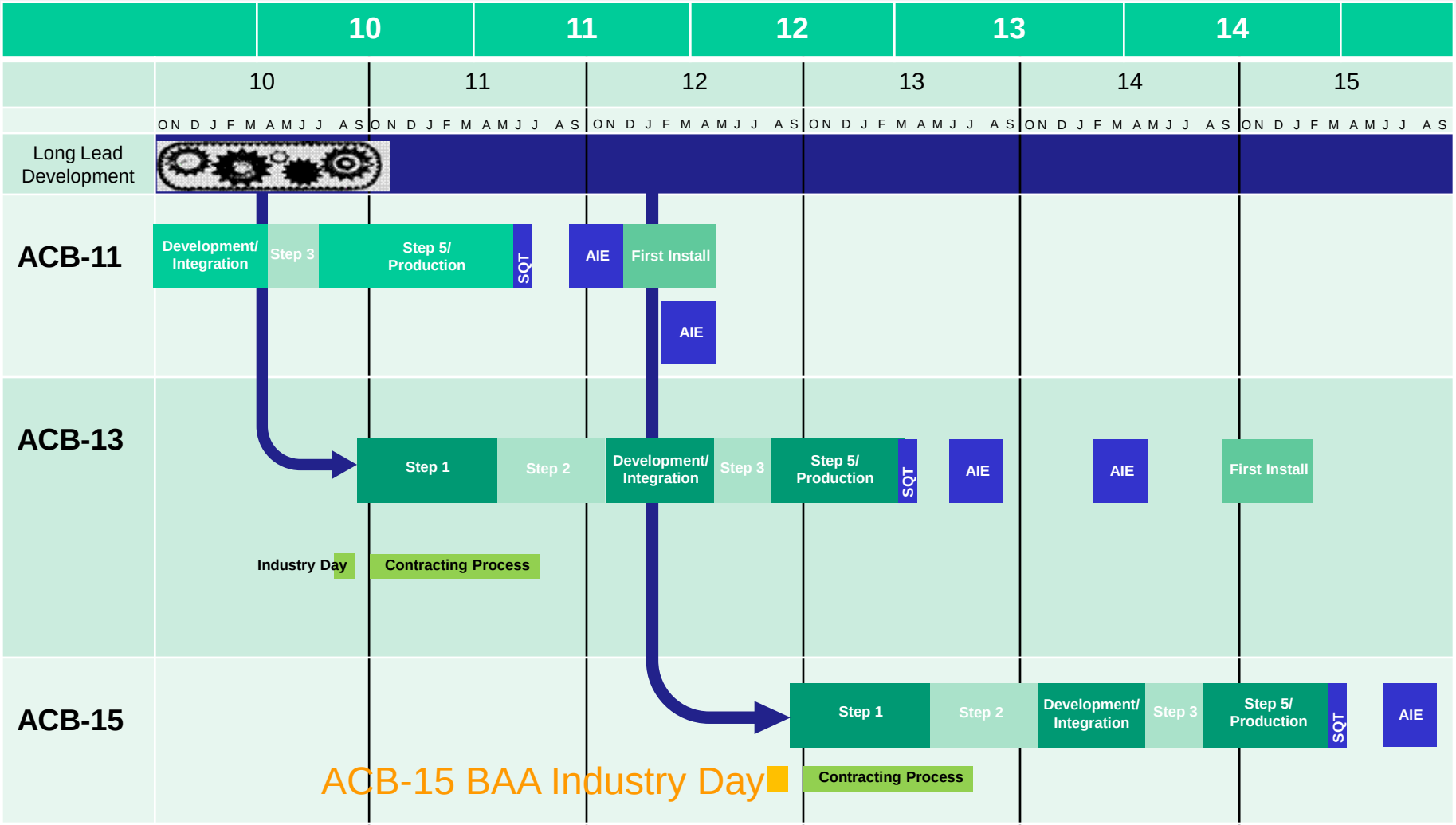
Multi-Function TA (MFTA)
Significant updates in:
Passive processing (APB00)
Active processing (MFAFS)
Torpedo Defense (TRAFS)

Planned ACB15 Sonar Layout



Significant improvements in capability with A(V)15 as the vehicle

ACB Schedule



Common OMI and Display Reduction

ACB09 to ACB11

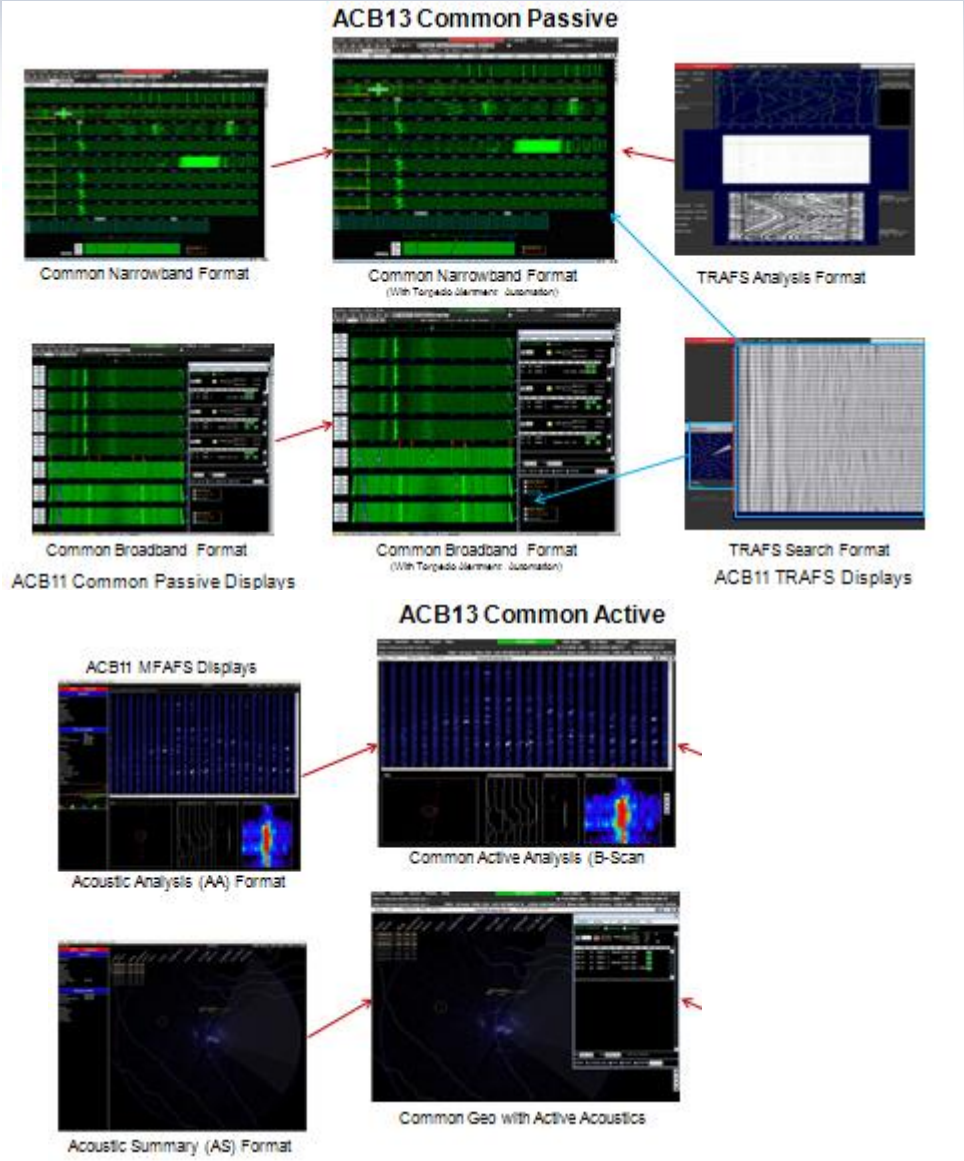
- Consolidated hull passive and towed array passive displays into APB09 Common Passive
  - ***Reduces by 6 total number of ACB09 passive display formats***

ACB11 to ACB13

- Common Passive incorporates TRAFS Display functionality
  - ***Reduces by 2 total number of ACB11 passive display formats***

ACB15+

- Consolidate Sonobuoy and Acoustic Intercept into common display formats
  - ***Reduces by 4 total number of ACB13 display formats***



ACB High Interest Items

ACB-13

- **Continue advancements in active**
  - Processing and display
  - Automation
  - Operator Interaction
- **LCS-VDS/MFA Processing Combination**
- **Display Consolidation / Commonality**
- **SAST advanced development items**
- **Further improvements in passive processing and automation in concert with APB capability improvements**

ACB-15

- **Passive APB improvements from APB11/13**
- **Active waveforms and processing for torpedo defense**
- **MH-60R integration**
  - Concurrent with Aegis implementation

Advanced Sensors Methodology

Promising Technology (6.3 – 6.4) + Clear Need + Concept

High level requirements

Studies

Develop array design

Build, test components

Integrate & lab/lake test

Environmental tests (shock, thermal, etc)

Drawings & Technical Package

Install on ship (OPALT)

Sea tests and deployment

Characterize performance

Crew feedback

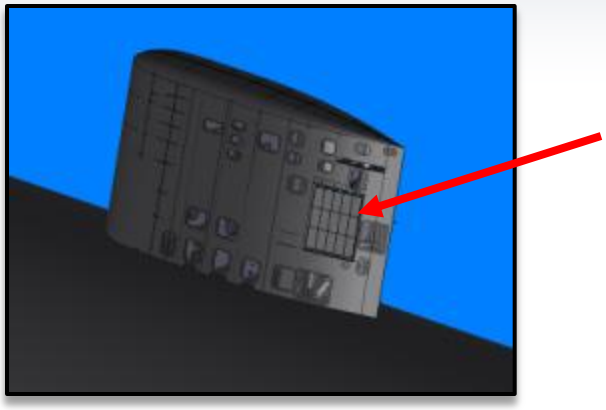
Develop operating procedures

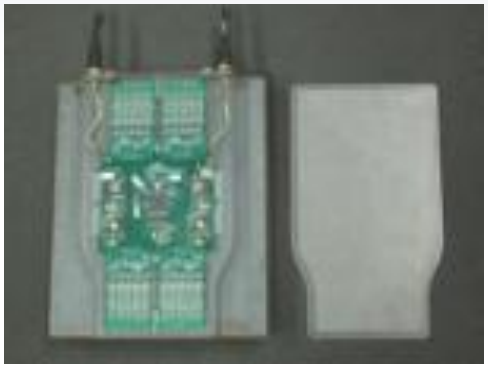
Refine requirements

Provide to program office:

- Draft CDD
- Cost estimate
- Drawing/technical package
- Lessons learned
- Assist with production/test

Lightweight Low Cost Conformal Array (LwLCCA)





Schedule

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
FY10	LW ADM Design and Development			
FY11	LW ADM Design and Development			
FY12	LW ADM Design and Development	LW ADM Lake Test		LW ADM Integration
FY13		LW ADM At-sea Test		

Concept:

- Upgrade LCCA design for lighter weight and simplified ship installation
- Design Objectives
  - Reduce sonar array costs
  - Lighter weight with performance refinements/upgrades

Concept of Employment:

- LwLCCA will be used to establish and maintain situational awareness

Deliverables:

- Initial plan is targeted for Virginia Class with an option to install on 688I Class
- Advanced development work key milestones:
  - ADM initial design complete - 1QFY11
  - ADM fabrication complete - 2QFY12
  - ADM in lake testing - 3QFY12
  - ADM shipboard installation – 4QFY12; at-sea test 1QFY13

Advanced Towed Array Technology (ATAT)

TB-29 FOLLOW - ON TOWED BODY

Schedule

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
FY12		TB-29(x) LPO	TB-29(x) R/V	TB-29(x) Sub Demo
Fy13	CTA MFTA R/V Test			CTA MFTA Sea Test

Concept:

- Develop capability to provide improved performance and reliability.
- Develop next generation TB-29 and MFTA ADM systems with twin-line technology, Compact Towed Array telemetry.
- Transition to PMS 401 for production

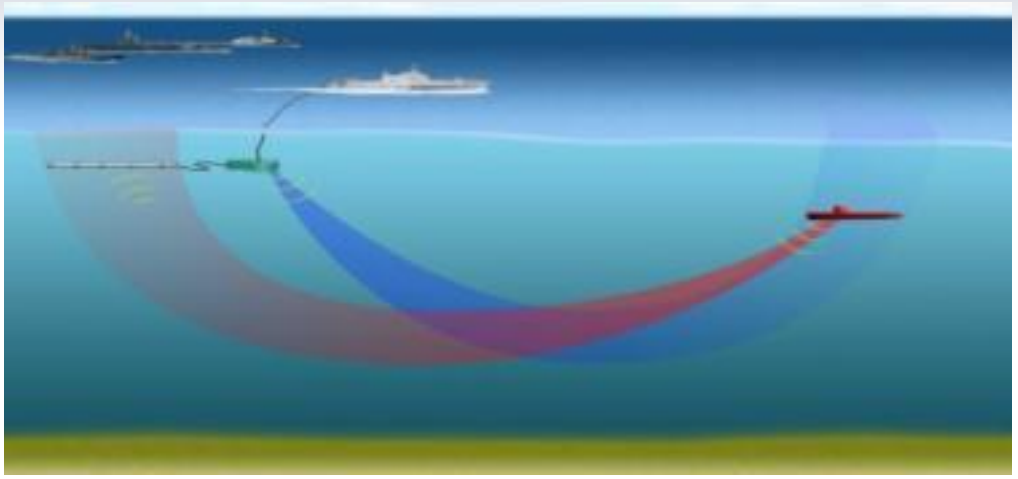
Concept of Employment:

- Backward compatible with TB-29A systems without ship impact
- Replace current MFTA receiver with the newly developed universal MFTA receiver to compatible with the existing MFTA and future towed array system

Deliverables:

- TB-29(X) ADM LPO (FY12)
- TB-29(X) ADM R/V (FY12)
- TB-29(X) Sub Demo (FY12)
- TB-29(X) ADM Sub Demo Reports (FY13)
- TB-29(X) Array transition documents (FY13)
- CTA MFTA ADM LPO test (FY13)
- CTA MFTA ADM sea test (FY13)
- CTA MFTA ADM sea test report (FY13)

Littoral Combat Ship (LCS) Variable Depth Sonar (VDS)



Schedule

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
FY10			ADM Dev	
FY11	ADM Dev			
FY12	ADM LBIT			

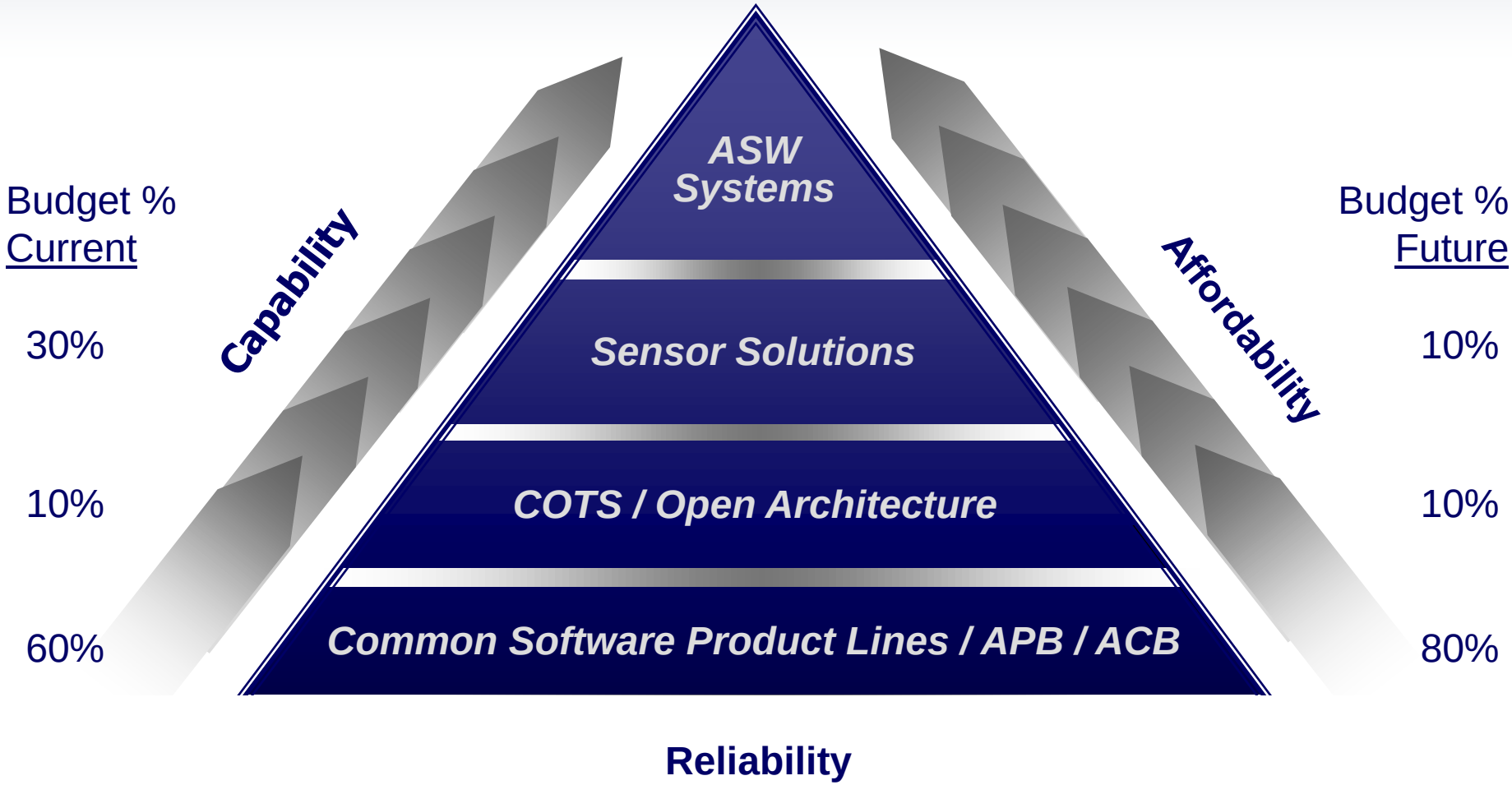
Concept: (from OPNAV letter of direction dated 31JUL09)

- Develop an effective and affordable, deep water, wide area active ASW search capability
- Modular Variable Depth Sonar (VDS) form factor for LCS
- Fulfill HVU escort mission requirements.

Concept of Employment:

- Active Sonar
- High Dynamic Range, Bistatic Receiver (MFTA)
- High Reliability, Wideband source array in VDS form factor

Investment


Budget %
Current
30%
10%
60%
Capability
ASW Systems
Sensor Solutions
COTS / Open Architecture
Common Software Product Lines / APB / ACB
Affordability
Budget %
Future
10%
10%
80%
Reliability

Current IWS5A SBIR Topics

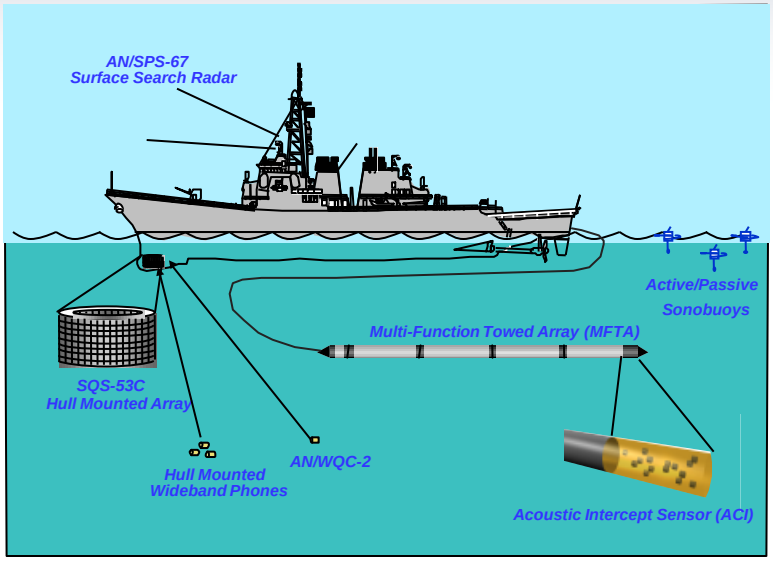
- **N02-207** - Anti-terrorism Technologies for Asymmetric Naval Warfare
- **N04-071** - Surface Ship, Hull Mounted, Mine Avoidance Sonar
- **N04-166** - Fiber Optic/Electrical Lightweight Tow Cable for Optical Towed Arrays
- **N05-059** - Hi-Fidelity Simulator for Physics Based Unit Level Training Surface ASW
- **N05-077** - Station Keeping Buoy
- **N05-125** - Compact Towed Array
- **N06-051** - Marine Mammal Mitigation Domain Awareness
- **N07-144** - Wave Energy Harvesting Buoy
- **N07-215** - Fiber Optic Vector Sensor
- **N08-054** - Marine Assessment, Decision, and Planning Tool for Protected Species
- **N08-056** - Active Sonar Clutter Mitigation through Enhanced Training and Automated Contact Detection and Tracking
- **N08-057** - Torpedo Detection, Localization, and Classification
- **N08-171** - Distributed Sensor Communications
- **N08-208** - Ultra Low-Cost Low-Noise Hybrid Integrated Laser
- **N08-213** - Affordable Small Diameter Heading Sensor
- **N08-216** - Fatline Towed Array Vector Sensor
- **N08-219** - Advanced Communications at Speed and Depth
- **N09-068** - Mid Frequency Active Distributed Fusion and Tracking
- **N09-132** - Advanced Hybrid Energy System for Wet and Dry Submersibles
- **N09-137** - Array Shape Estimation Using Fiber Optics Shape Sensing
- **N09-188** - Image Fusion for Submarine Imaging Systems
- **N09-204** - High Data Rate Storage
- **N111-037** - Modeling and Simulation Technologies Development for Combat System Integration and Certification
- **N111-041** - Strike Group Active Sonar Exploitation
- **N111-050** - A Lightweight, Flexible, Scalable Approach to Trainer Systems
- **N111-051** - Improved Towed Array Localization for Active Systems
- **N111-055** - Low Cost Hydrophones for Thin Line Towed Arrays
- **N111-061** - Serious Games for Sailor Proficiency
- **N121-374** - Embedded Sensors with Low Power Telemetry
- **N121-374** - IA compliant remote application administration for reliability, maintainability, and availability (RM&A)

A great opportunity for Small Business to participate

Future Technology Needs

- Automation techniques to assist (but not replace) operators
- Hull URO Solutions – hull corrosion and flaw inspections
- High Density through-hull telemetry
- Towed array vertical discrimination
- Improved acoustic sensors (lower cost, better coupled, wider bandwidth, vector sensors, etc.)
- Long range organic non-acoustic sensor technology
- Improved CAVES installation techniques
- Improving Single Crystal yields
- DNS data exfiltration in satellite-denied environment and long endurance power sources.

AN/SQQ-89A(V)15



What it Does: Greatly *expands sensor performance* using OA COTS processing.

- Developed using an "ARCI-like" best of breed build-test-build process
- Achieves *cost effectiveness* through the use of *common software components* (CAUSS, PNB, MF Active, and torpedo defense are common across Surface ASW programs)
- Will become the maintenance and modernization process for the Surface Fleet USW Combat System

What it brings

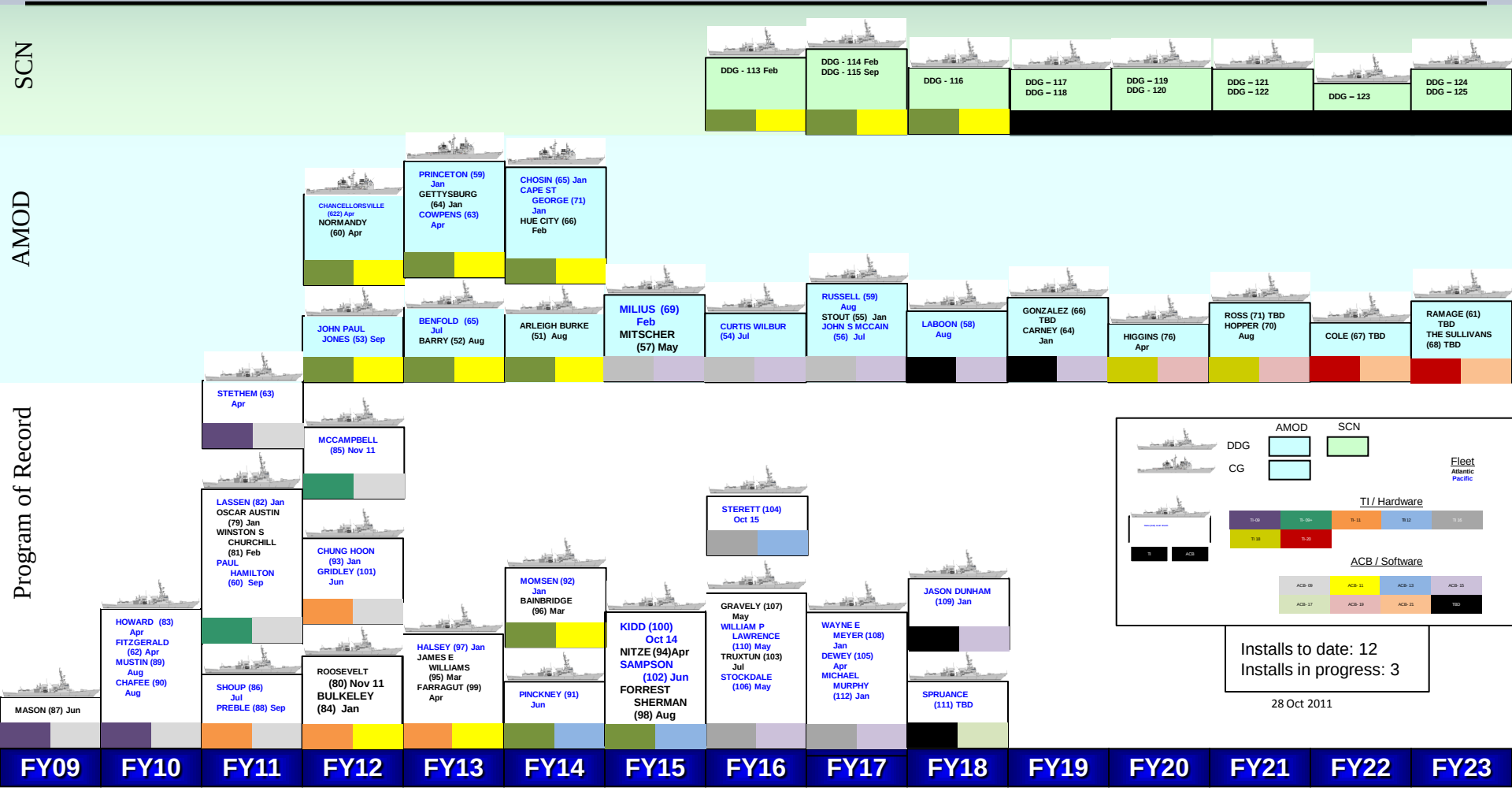
- New Sensors
  - Towed Array (MFTA) and Calibrated Reference Hydrophone (CRH)
- COTS Software
- State of the Practice Signal and Data Processing Hardware
- Improved PM/FL
- Improved Warfighting Capability

AN/SQQ-89A(V)15 …significant advancement in Surface ASW

ACB/TI Relationship

- ACB process to provide software updates with improved capabilities every two years.
- Hardware upgrades known as Technology Insertions (TI) will also begin a two year update cycle. Hardware is planned to support two ACB software cycles.
- Provides a formal method for the transformation of Fleet operational requirements into new capabilities while maintaining the fewest number of system baselines in the Fleet.

AN/SQQ-89(V) Fielding Plan



ACB 09
- MFTA
- Improved Active
- Passive
- MK54 DFCI/OTS
- Bi-Static

ACB 11 Candidate
- ASW Trainer Upgrade Ph I
- Continuous Active Sonar
- Active Clutter Reduction
- Bellringers

ACB 13 Candidate
- ASW Trainer Upgrade Ph II
- Netted Systems/Sensors
- COTS Hardware Tech Refresh

ACB 15 Candidate
- Architecture
- Automation
- Displays
- Multi-Static Active
- MK-60R A(V)15 Integration

ACB 17 Candidate
- Architecture
- Automation
- Displays
- Multi-Static Active

ACB 19 Candidate

ACB 21 Candidate

ACB 23 Candidate

MAJOR SURFACE ASW CAPACITY AND CANDIDATE CAPABILITY UPGRADES

AN/SQQ-89A(V)15 Contract Highlights

Goals

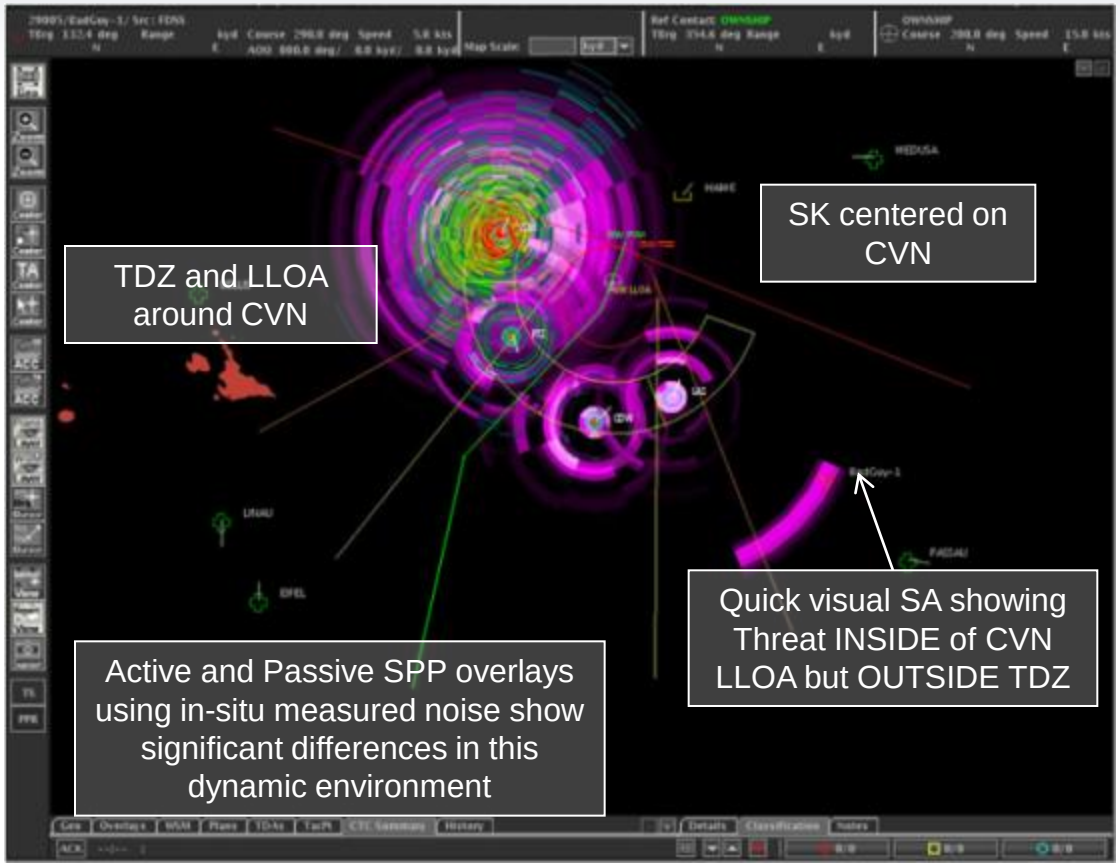
- Procure a fully integrated, fully supportable, certifiable A(V)15 system that meets the Navy's requirements
- Competitive Award
- Open systems architecture, collaborative development environment
  - Incorporate ARCI-like processes into procurement
- Incorporate options (flexible) to meet new FMS requirements

Major Areas

- Integrated Program Management
- Engineering
- Test & Evaluation
- Integrated Logistics Support
- Configuration Management
- Training
- Checkout, Field, and Installation Support

Common ASW Tactical Picture
Undersea Warfare Decision Support System (USW-DSS)

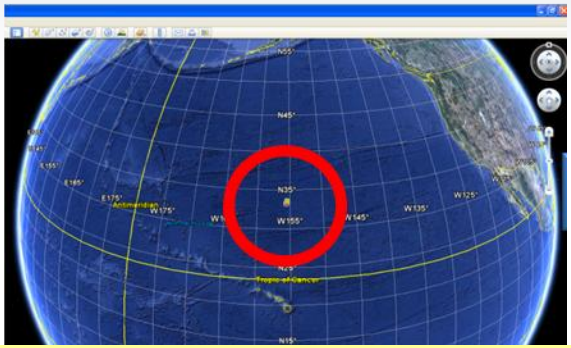
Carrier Strike Group Screen Kilo

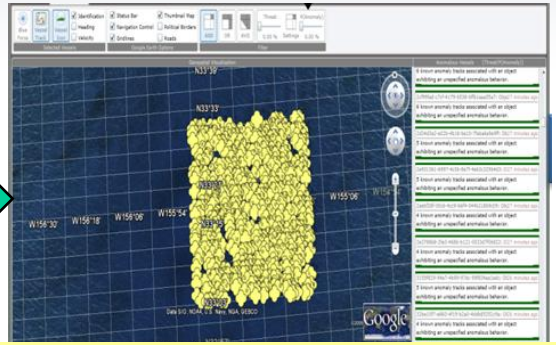


- Cross Platform Sensor/Data
- Dynamic Situational Awareness
- Automated Sensor Inputs
  - Acoustic Reverb Data
  - Passive Beam Data
  - Sound Velocity Profiles
- Sensor Measured Environmental Data Modeling
- Tactical Decision Aids
- Shared Across CSG
- Plotting Errors Eliminated
- Near Real-time

Near Real-time SCC CASWTP and Shared Across CSG with In-Situ Environmental Updates

Level 2-3 Information Fusion



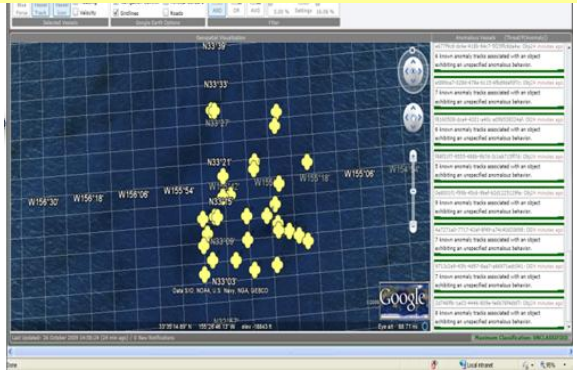


Current Shortcomings

- False alerts and alert redundancy
- Screen clutter
- Cognitive overload for the analyst
- Minimal reach back and pedigree information
- Inadequate anomaly detection models

Level 2-3 Fusion benefit to the sailor:

- What vessels are important?
- Where should I focus my attention?
- What threat do these vessels pose to me and my assets of interest?



Proposed ASW C2 Level IV Implementation

SS 1
SS 2
SS N

FUSION
NLP
Rule Engine
Uncertainty Calculations

SS Est 1
SS Est A

HS 1
HS 2
HS M

FUSION
Error Value Extraction

HS Est 1
HS Est B

Situational Understanding (Level II)
Situational Awareness
Impact Assessment (Level III)

COA Decision-Maker

Feature List

Pairwise Comparison

Calculate Weights of each Feature

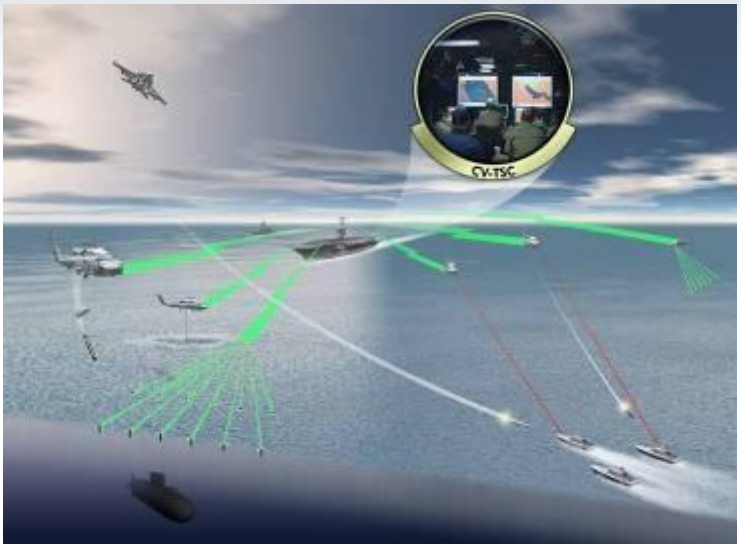
Refined Estimate List

List of possible Estimate Refinements

Reliability, Credibility, and Weight Values

Optimization Model (Level IV)

Aircraft Carrier Tactical Support Center (CV-TSC)



Concept:

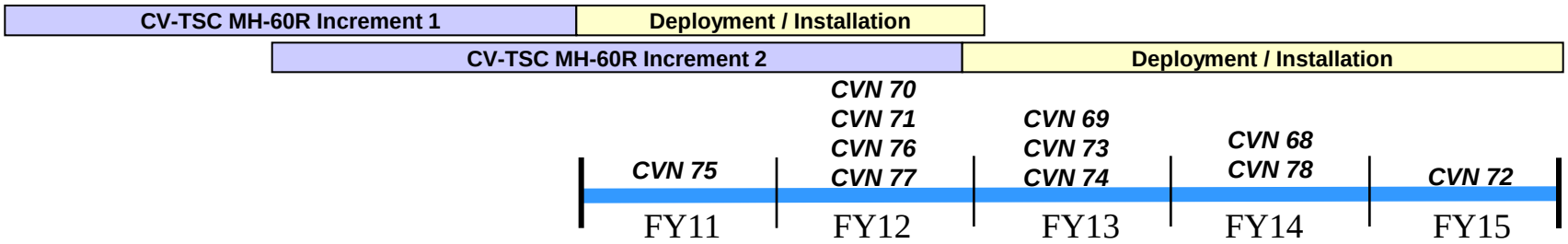
- Integrates multi-mission aircraft with CVN shipboard systems (ASW,SUW,MIO,SAR, etc…) S-3, SH-60F ⟹ MH-60R
- Integrates off-board sensors/systems with shipboard systems to detect, classify, and localize threats
  - Process, Exploit, and Distributes Sensor Data
  - Exchanges tactical data with embarked aircraft
  - Exercises sensor control of off-board sensors
  - Reduces aircrew operator workload
- Provides Local Platform C2 for ASW Operations

Highlights:

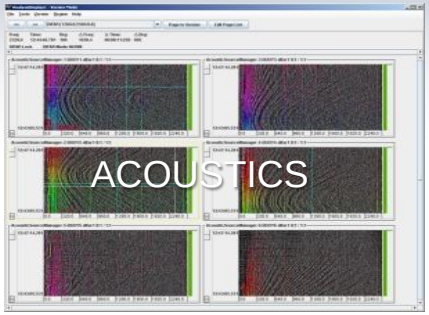
- First Installation Supporting MH-60R Integration on CVN-75 (TRUMAN) complete in Jan 2012
- FY13 software upgrade to begin formal testing in Jan 2012

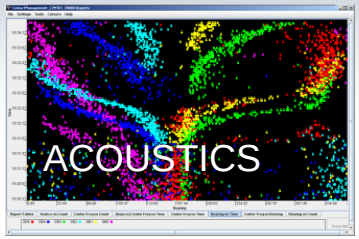
Deliverables:

- Field Integrated CV-TSC on all CVNs
- Provide updated software builds on 2-year cycles to address fleet priority upgrades
- Aligned with Major Acquisition initiatives of MH-60R and future air platforms (P-8/BAMS)



CV-TSC Variant Summary





Existing Systems, AN/SQQ-34A/B/C(V)1 (Fielded)

- Support SH-60F
- DICASS/DIFAR/VLAD/BT Sonobuoy Processing
- Primarily Post-Mission Analysis

AN/SQQ-34C(V)2, Increment 1 (Field in FY 11)

- MH-60R Integration Baseline
- Link with helo through Ku-Band Common Data Link (CDL)
- Partial Implementation of MH-60R Air-Ship Message Interface - Downlink Focus
- Transition to Common Display System and Common Processing System (CDS/CPS)

AN/SQQ-34C(V)2, Increment 2 (Field in FY 13)

- Uplink Messaging Capability to the MH-60R
- Remote Control of Common Data Link System (CDLS)
- User Interface Improvements
- Ability to Participate in Fleet Synthetic Training (FST) Scenarios with SSDS
  - Update To SSDS Interface
- Expansion of System to Support up-to 4 MH-60R Simultaneously (Requires Future Upgrade to CDL)
- Initial Increment of Automated Acoustic Fusion Capability
- Obsolescence Issue – Removing Dependency on GCCS Common Operating Environment (COE)

AN/SQQ-34C(V)2, Future Upgrades

- PEO IWS Product Line Architecture (PLA) Transition, MH-60R Upgrades (ARRPD), P-8 Integration, ADAR Sonobuoy Processing, Surface Ship Torpedo Defense (SSTD) Integration, Periscope Detection Radar Integration, Simulation/Training, Future Aircraft Integration (BAMS)

Prioritized CV-TSC S&T Needs

Higher Priority

- Automated Classification Aids for EO/IR, ISAR, and Acoustic Sensors
- High Fidelity Embedded Training Capabilities
- Analysis of Multi-Statics Using ALFS and DIFAR Bouys
- Multiple Levels of Data Fusion
- Improved Search Optimization Algorithms to Include Multiple Acoustic and Non-Acoustic Sensors
- Faster than Real-Time Automated Screening Techniques for Operator Workload Reduction

Lower Priority

- Information Assurance Compliant Remote Application Administration
- 3-Dimensional Visualization Tools
- Optimized Naval Search and Rescue Routing Algorithms

Opportunities for SBIRs / RTTs

Science and Technology Activities for USW-DSS and CV-TSC

Activities that will enable vision for Information Dominance:

- Global Net-Centric Interoperability
  - ONR FNT 09-04 (Level B): Dynamic Command and Control for Tactical Forces and Maritime Operations
- Data Processing, Exploitation, Fusion, and Analysis
  - ONR RTT: Theater Undersea Warfare Initiative (TUSWI)
  - SBIR N05-046 (CPP): Multi-Sensor Data Fusion System
  - SBIR N06-050: (CPP): Undersea Warfare Intelligent Controller
  - SBIR N06-109 (Phase II): Data Fusion Handoff
  - SBIR N08-057 (Phase II): Distributed Multi-Layer Fusion
  - SBIR N08-173 (CPP): Intelligent Network Traffic Management
  - SBIR N10-145 (Phase I): Enabling Netted Sensor Fusion for ASW in Uncertain and Variable Environments
  - SBIR N10-152 (Phase I): Near Field Passive Tracking
  - SBIR N10-158 (Phase I): Intelligent Agents for ASW Threat Prosecution
  - SBIR N10-154 (Phase I): Collaborative ASW Threat Assessment
  - SBIR N04-175 (Phase II): Acoustic Surveillance Multi-Array Search Aid
  - SBIR OSD05-SP3 (Phase II): Software Test Engineering Analysis of Trace Semantics
- Alert Management
  - SBIR N09-037 (Phase II): Real-Time, BW Optimized Collaboration Mission Planning Infrastructure
- Situational Awareness / Visualization / Training
  - ONR SHD-FY10-02 (Level C): High Fidelity Active Sonar Training (HIFAST) ASW C2
  - ONR SHD-FY10-02 (Level C): Surface Active Synthetic Trainer (SAST)
  - SBIR N09-136 (Phase II): Training Cognitive situational Awareness for Multi-Platform Command and Control
  - SBIR N09-193 (Phase II): Shared Situational Awareness Measurement
  - SBIR N09-125 (Phase II): Context-Aware Visualization for Tactical Multi-Tasking
  - SBIR N04-119 (Phase II): USW SA Interface Design
- Mission Planning
  - SBIR N08-054: (Phase II Option 1): Marine Assessment Decision and Planning Tool (IWS 5A)
  - SBIR N10-048 (Phase II): Environmentally Constrained Naval Search Planning Algorithms

ASW COI Data Model (ACDM) Purpose

The ACDM is the common language for ASW data exchange between systems

Enablers for Plug and Play, Net-Centric Warfare of the Future

- Common Language
- Policies and Procedures
- Robust Communications
- Governance and Strategy
- Supporting Infrastructure

Common interfaces provide clarity and reduce system development and integration costs

Industry Involvement

NDIA USW Division C4I Committee Tasking

- **Participate in review of ACDM Data Model and associated documentation**

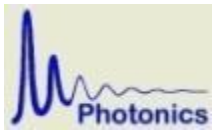
Review the ACDM for applicability

- **ACDMv3 and supporting material available December 2011**
- **Industry Conference mid-January 2012**

Get help from the ACDM developers

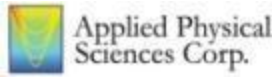
- **Align the ACDM with your system's information exchange needs and requirements**
- **Utilize documentation, tools, and assistance to develop a system specific profile and implementation**

IWS 5.0 Relationships



Pacific Sciences

General Magnetics



Sigtech Inc.