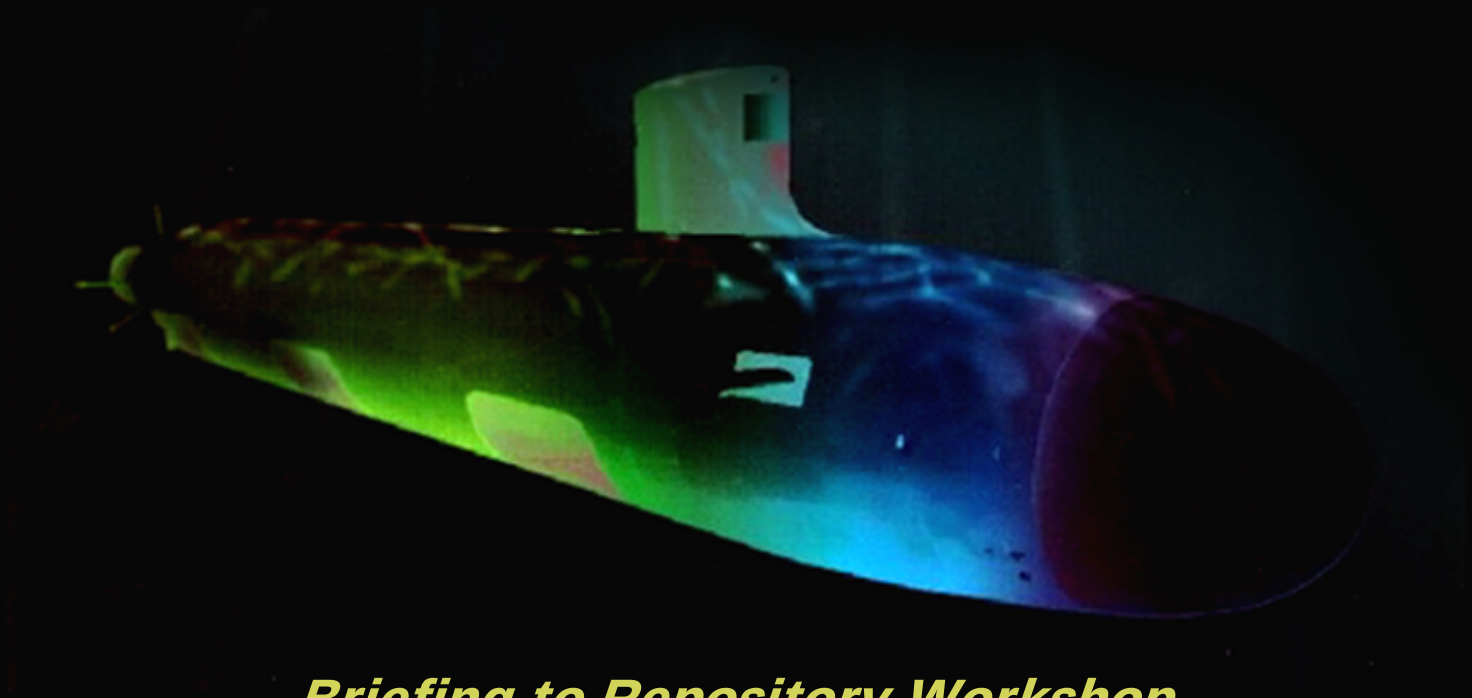
ASW ENTERPRISE OPEN ARCHITECTURE



Briefing to Repository Workshop

FEBRUARY 21, 2006

Presented by:
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PEO IWS 5A, Advanced Undersea Systems Development
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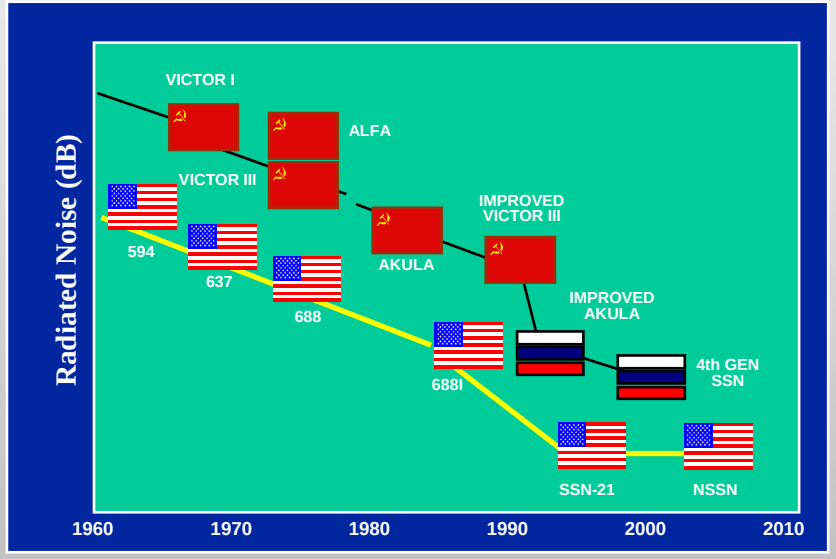
Purpose of This Brief

- Describe how Advanced Processing Build (APB)/Acoustic-Rapid COTS Insertion (A–RCI)/Tactical Control System (TCS) leverage open architecture concepts to affordably bring new operational capability into the submarine force
- Discuss the innovative processes that the APB/A-RCI /TCS Programs have used
- Discuss Open Architecture lessons learned
- Open Architecture as a means to an end

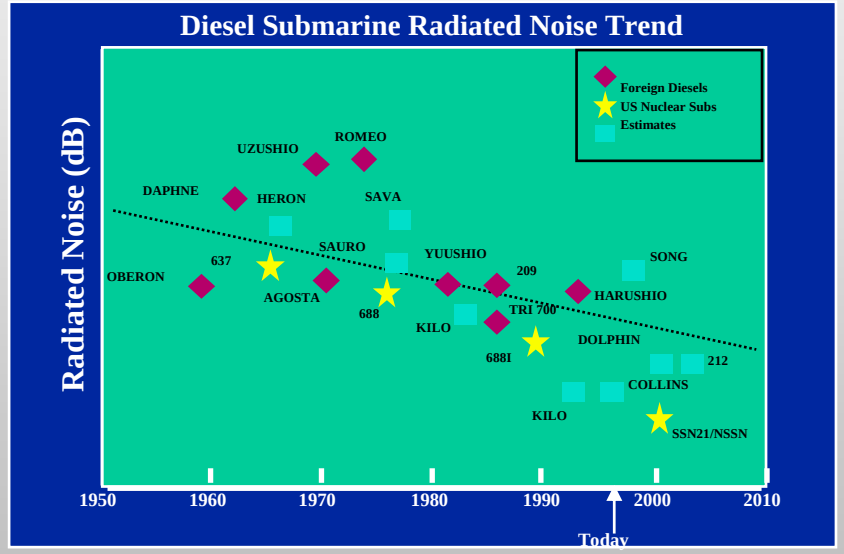
The Genesis of APB/A-RCI

Worldwide Submarine Challenges -

FSU/US Nuclear Stealth



Rest of the World Diesels



Rapid Reduction in
Russian Submarine Noise Levels and expanded
proliferation of Rest of World Submarines

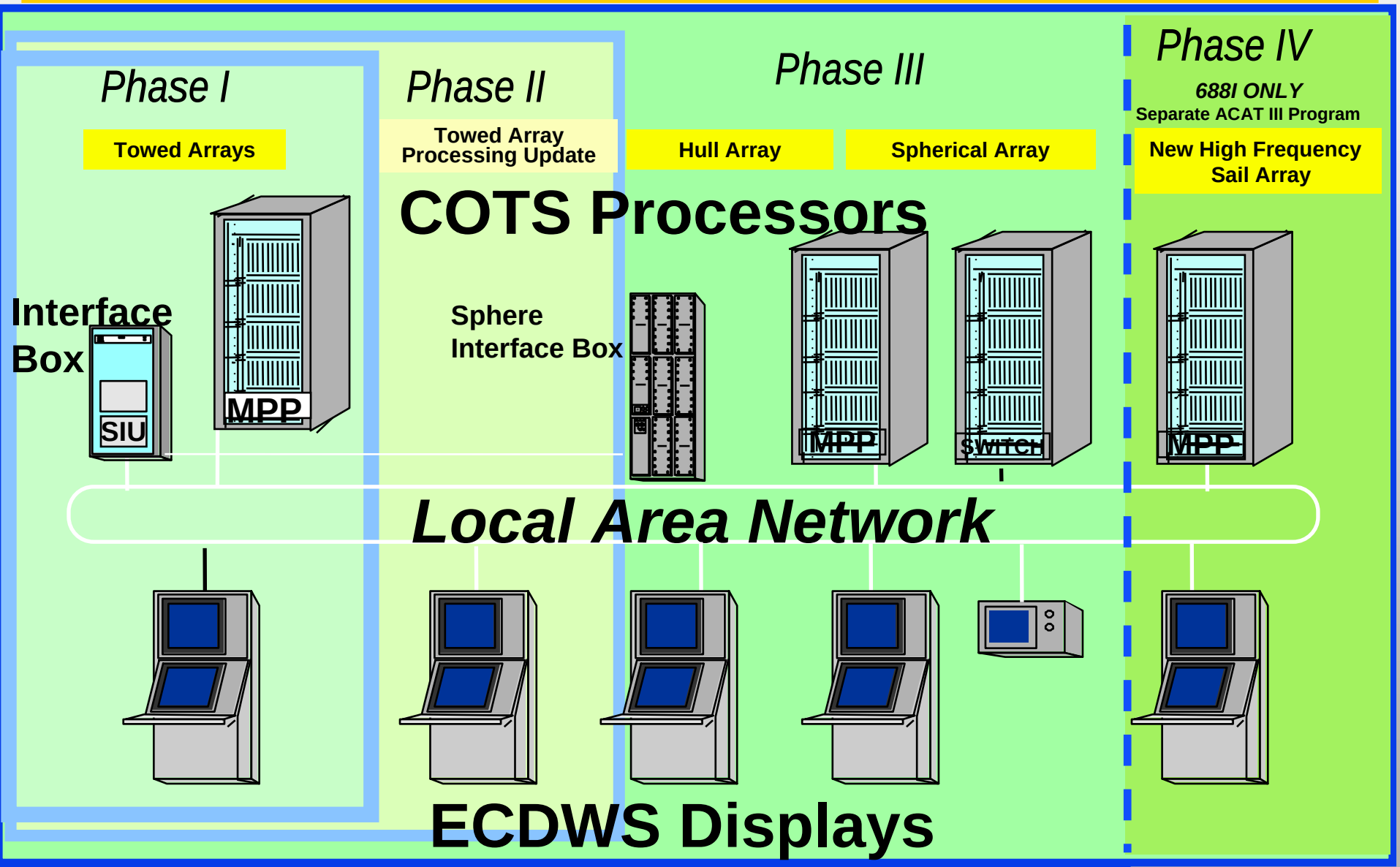
Economical and Effective Combat Capability Needed <u>Now!</u>

Submarine Systems Transformational Strategy

- De-invest in legacy system support
  - Replace rather than upgrade
  - Reinvest savings into COTS based systems
- Create systems commonality across platforms
  - Make effective use of the people and funds
  - Reduce burden on the fleet
  - Reduce DT/OT time
- Eliminate the need for augmentation systems
  - Originally required due to lagging performance of legacy systems
  - No more expensive cross-decking
  - Rapid update cycles via Technology Insertion with Advanced Development Processing Builds
- Migrate to COTS open systems / Open business model
  - Fosters continuous competition
  - Leverage existing infrastructure
  - Maximum growth capability
- Control Costs and Schedules

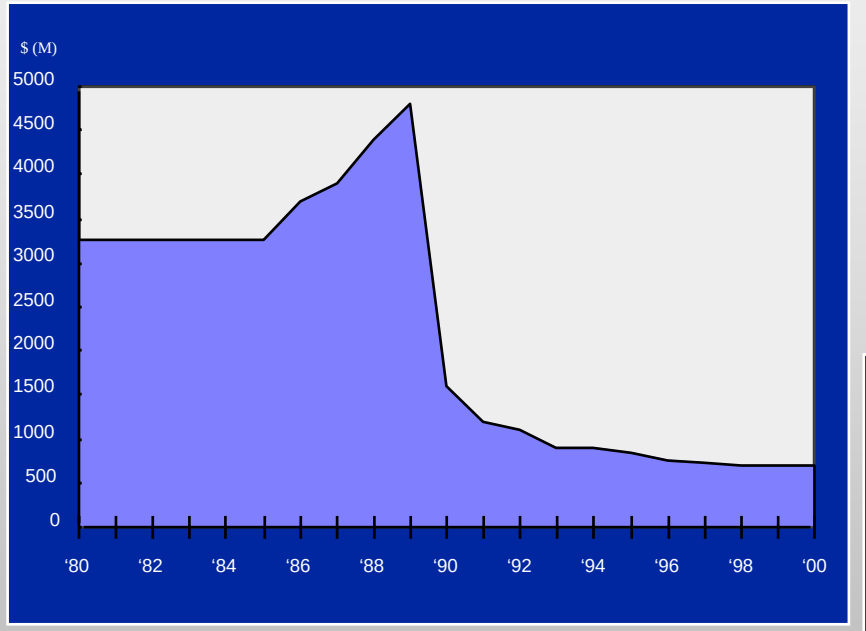
Open System/Open Source + COTS is the Enabling Force!

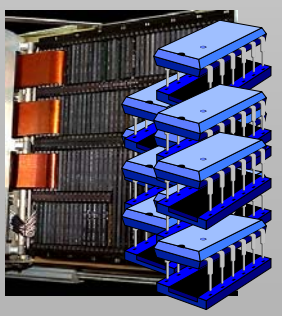
What is ARCI


Phase I
Towed Arrays
Phase II
Towed Array Processing Update
Phase III
Hull Array
Spherical Array
Phase IV
688I ONLY
Separate ACAT III Program
New High Frequency Sail Array
COTS Processors
Interface Box
SIU
MPP
Sphere Interface Box
MPP
SWITCH
MPP
Local Area Network
ECDWS Displays

Why COTS

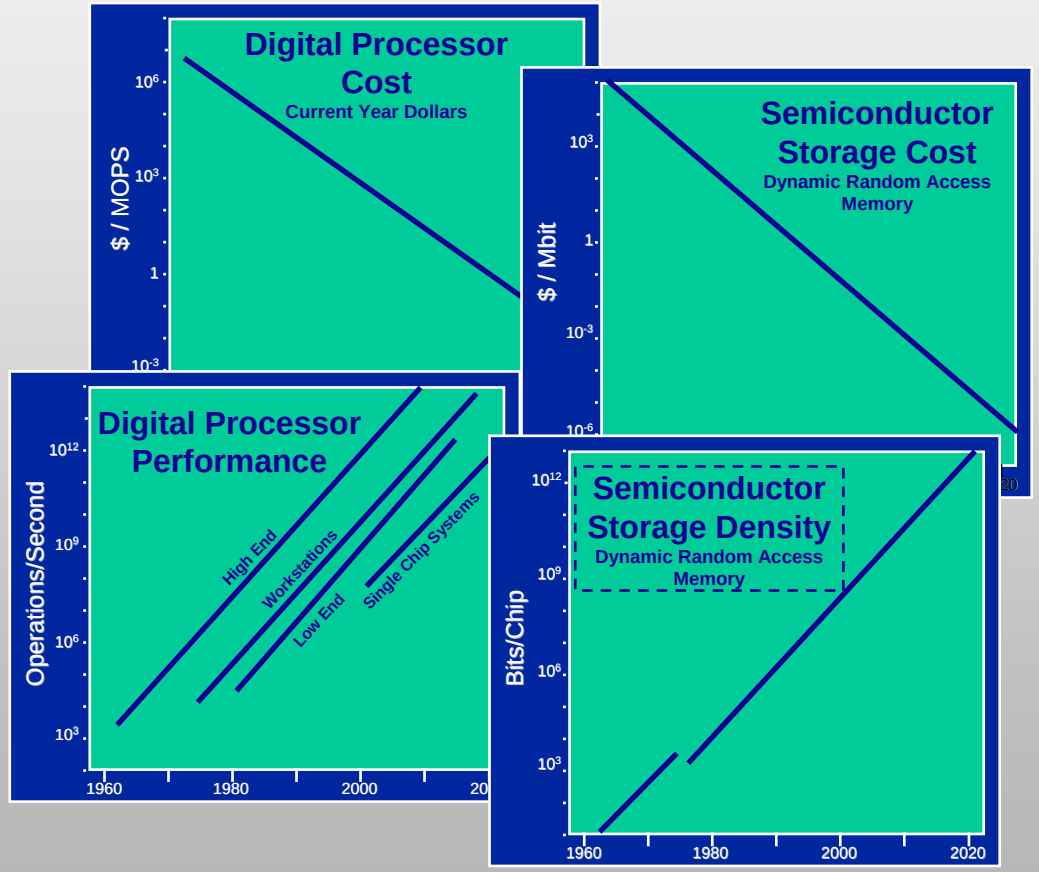
Submarine R&D Funding





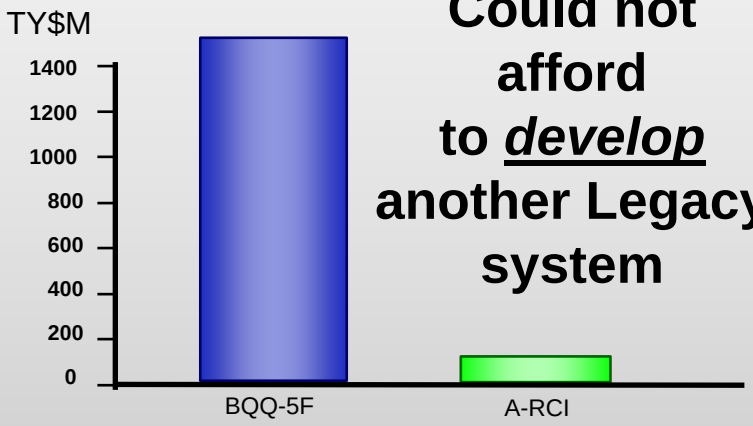
Time

Industry Trends



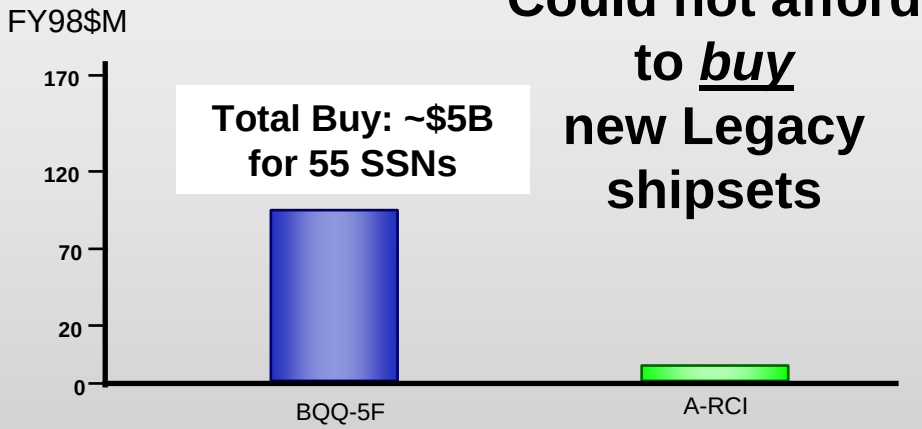
Leverage US Industry to Provide Affordable Solution

COTS / OA vs. Legacy Cost Efficiencies



Could not afford to *develop* another Legacy system

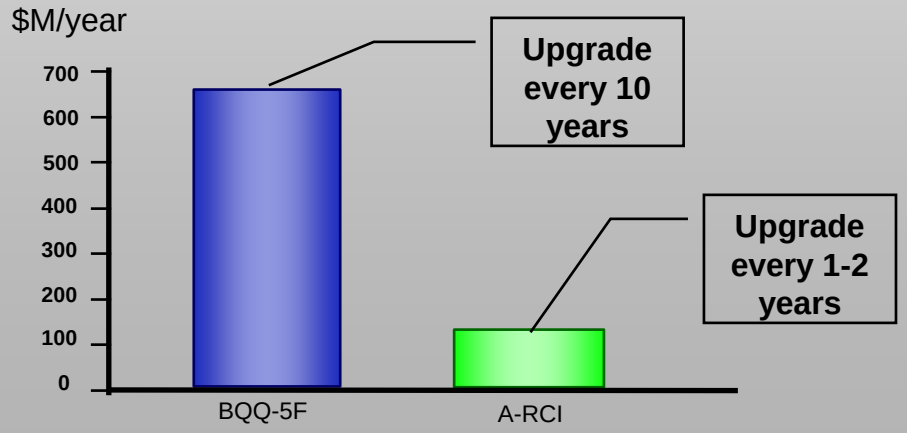
Development Cost



Could not afford to *buy* new Legacy shipsets

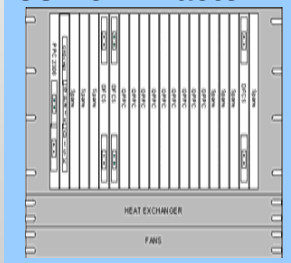
Shipset Cost

Ten Year Comparison Development, Installation & Support Cost



Some Hardware Specifics

TI98 : VME Technology
300 MHz Power PC Based
8U Form Factor



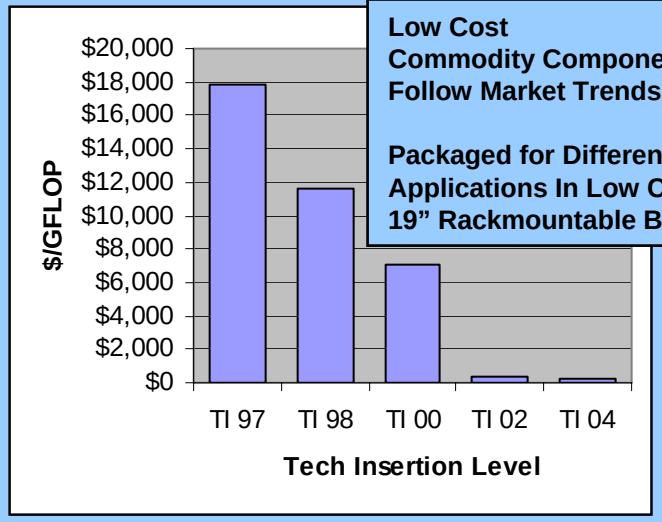
TI00 : Server Technology
Intel 700 MHz XEON III 8-Way
Repackaged 8U Form Factor

TI02 : Server Technology
Dual 2.2GHz Intel XEON
2-Way
2 x 2U Form Factor

TI04 : Server Technology
Dual 3.06GHz Intel XEON
2-Way
2 x 1U Form Factor

Each ship will deploy with the latest APB

- APBs delivered annually
- Each tech insert supports three (3) APBs
  - Year of insert + next two (2) APBs
  - Provides growth room for APB processing
- Hardware tech inserts developed every two (2) years
  - Start in production
- Platform hardware updates every four (4) years
  - Approximately 12-15 installs per year
- All tech insertions can be done in less than 35 days



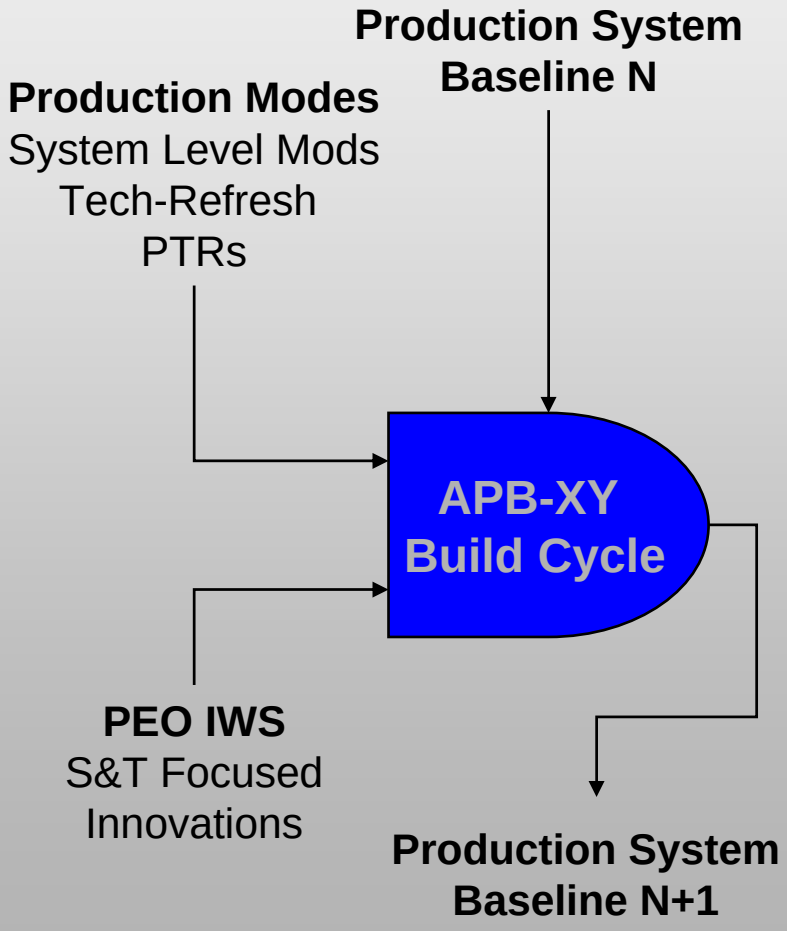
Low Cost
Commodity Components
Follow Market Trends

Packaged for Different
Applications In Low Cost
19" Rackmountable Box

Technology Insertion = H/W + S/W to Get More Capability

What is an APB?

- **An APB is a software product that contains new or enhanced capabilities**
  - **The thrust is to deliver new/improved Combat System Capability via Software**
- **APB's are applied as upgrades to existing baselines**
  - **An APB Build Cycle is a *Transform* that outputs a new production baseline**
  - **Production software systems are made resilient over hardware technology with Middleware and over APB Build cycles by solid software engineering practices**



The 4-STEP Process At A Glance

Creatively pushing Tactical Possibilities

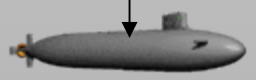
1 Algorithm Conceptual Designs → Algorithm Assessments

2 Algorithm Lab Implementations → Algorithm Lab Evaluations

Rigorously Ensuring Operational Utility

3 Embedded Implementations → String Lab Evaluation

4 At-Sea Demonstration → **Production**



Fleet Feedback

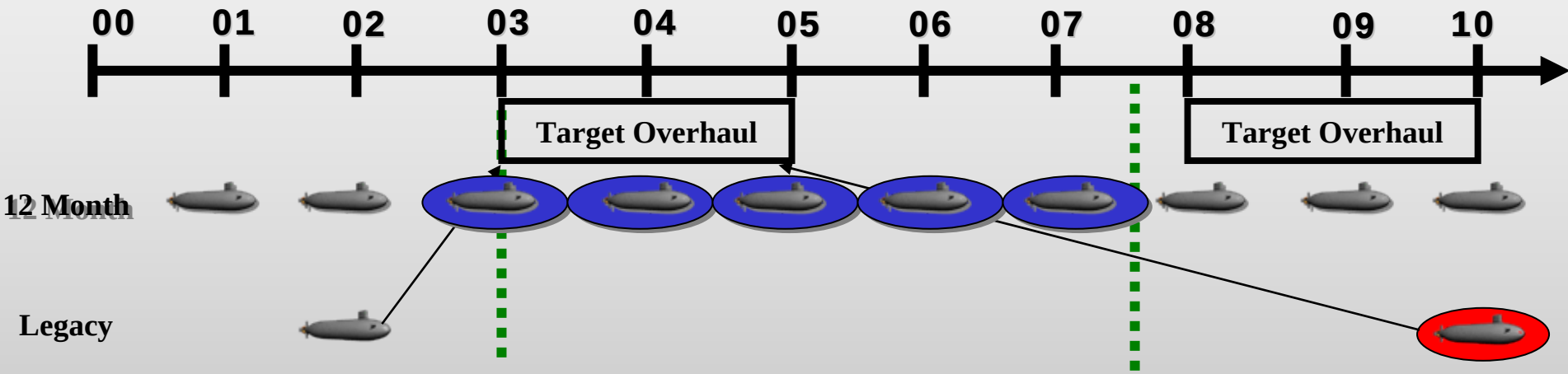
Qualitative Refinements

Quantify and Improve Effectiveness

Engineering Measurement Programs

Rapid Operational Capability Delivery Through Focused Innovation Employing Fleet Data

APB Cycle-Time



Legacy Approaches Miss Threats and Operating Environments by a Factor of 2!

12 month cycle-time gives 3-to-5 opportunities to adapt to threat changes;

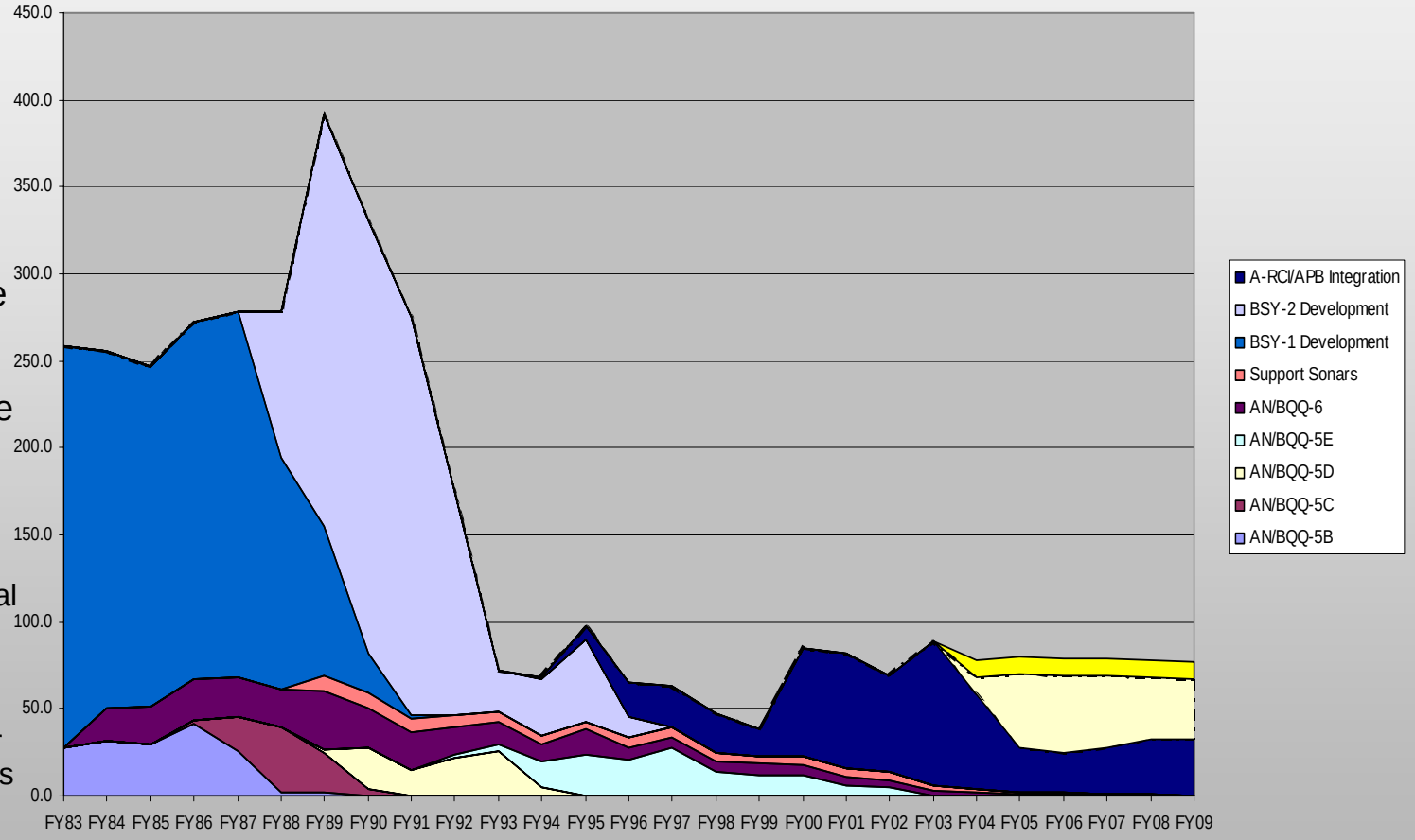
At a 12 month cycle and 2 APB's per TI, Target Acoustic Signature/Operating Environments don't out-pace our ability to respond

APB/ARCI Cost and Value

Arguments have been made that APB and ARCI are too Expensive

This is a Value Judgement - To date the APB/ARCI processes and business model have provided

- More Functionality
- Significantly Improved and Verified Operational Performance
- Shorter Time to Market
- Significantly Lower Development Costs



AEMP Cases validate our success and our need to do more.
CCEMP is just beginning to validate the tremendous potential for Tactical Improvements.

One Ship's Perspective

CY2001	2002	2003	2004	2005	2006

APB-00 Ready for Install

Sea Test

Ready for Install

APB-01

TA/SA/HF Improvements

Sea Test

Ready for Install

APB-02

Bell Ringers / STDA Improvements

Ready for Install

APB-03

TA / Contact Avoidance

Sea Test

Sea Test

Ready for Install

APB-04

SA / HF / Contact Avoidance

Installed

Installed

Installed

POM | Deployed | *Inter-Deployment* | POM | Deployed | *Inter-Deployment* | POM | Deployed | *Inter-Deployment* | POM

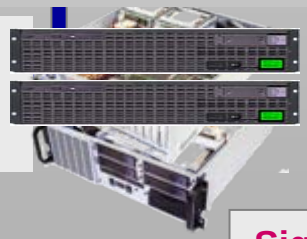
TI-00

- SMP LRU
- HP J5600 / 6000

Available but not installed on this ship

TI-02

- Dual Intel
- 2U XEON
- 3U XEON



TI-04

- Dual Intel
- 1U XEON
- 2U XEON

**Exact Config TBD

Signal Processing Technology

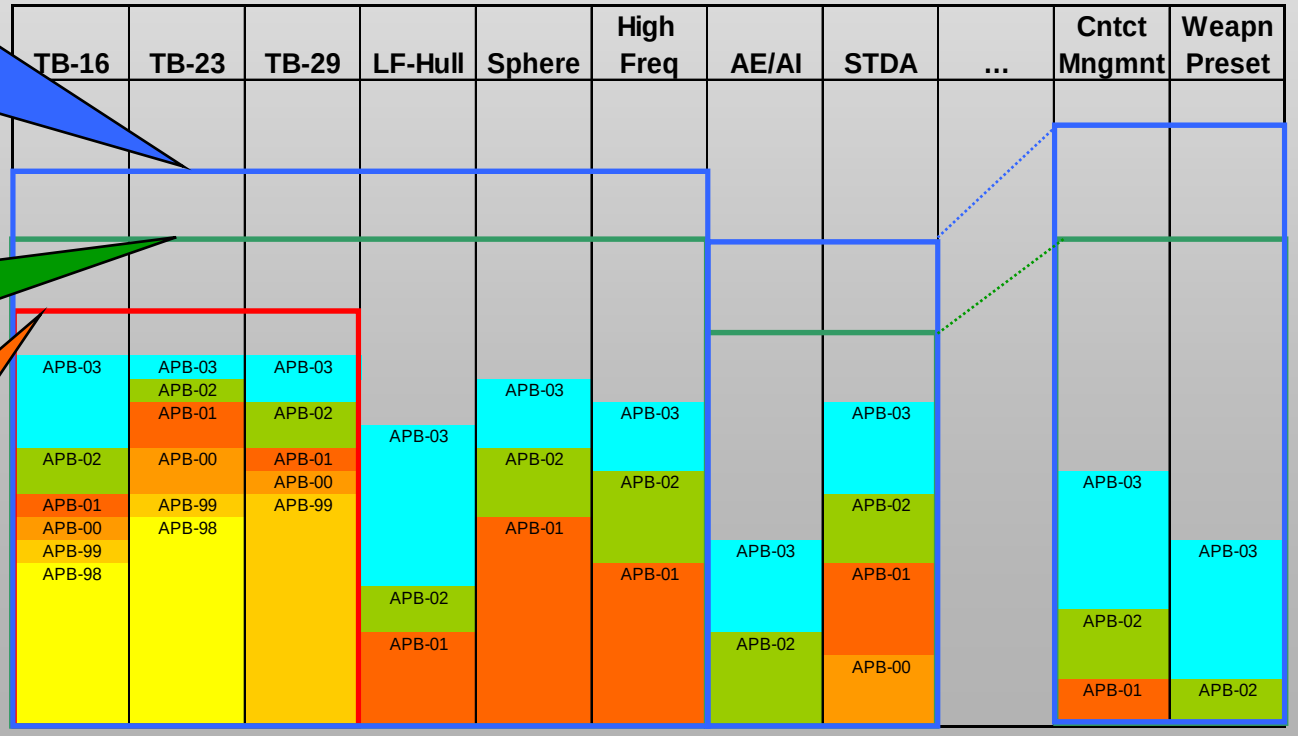
ECDWS Display Technology

Innovation vs. Fleet Pull

New Updates Based on STRG Direction, DT/OT/IS Corrections, and EMP Findings

STRG Consolidated Requirements of November 01

Original SSTP Recommendations Ratified by the SSMC



Technology Insertion
Lessons Learned

- **Use the rapid cycle time of COTS to your advantage**
  - **Upgrade hardware to:**
    - **Provide processing power for more advanced applications**
    - **Replace components before they become obsolete**
    - **Reduce system and spares procurement cost**

- **Involve all stakeholders in the decision process**
  - **Joint Navy / industry team to research and select best path for technology insertion**
  - **Incentivize industry to reduce system cost by using latest technology**
    - **Intra-program Competition**
  - **Develop equipment infrastructure to handle future upgrades**

Change is Implicit with COTS and Must be Planned For

Technology Insertion Across Subsystems

- Rather than mandating standards and components from outside, the Submarin community has developed an IPT approach
  - Sponsor and Top-Level Support Required
- Subsystem PARMs and contractors meet to discuss technology initiatives and to develop consensus approach to implementation
  - Aided by fact that the different subsystems share prime contractors - incentive for commonality
- Pursuing Similar Approach for ASW COI

Large Infrastructure and Mandates not Necessary to Exploit COTS/OA

APB / ARCI Business Process

OLD

- *Large Corporations dominate the Market*
- *Deficient GFE*
- *Yesterday's Technology*
- *Competing Cost Centers*
- *Builds Computers*
- *Structured*
- *6-8 Years Development*
- *To-The-Death Competition*
- *Re-Invent Wheel*
- *Years of Experience*
- *"Stove-Piped" Development*

NEW

- *Large Institutions Raise the playing field for everyone and Small Business plays Big*
- *System Ownership & As is FYI*
- *Today's/Tomorrow's Technology*
- *Teaming Cost Centers*
- *Packages/Integrates COTS Computers*
- *Flexible*
- *1-2 Years Development*
- *Team w/Competition Day-to-Day*
- *Improve Wheel*
- *New Ideas*
- *Closely Coupled Development and Production Efforts*

This shift is equally applicable to the Navy, Research Centers, Large and Small Industry

"Old School" → **What's Best for Navy**

NAVY OPEN ARCHITECTURE
Strategy & Way Ahead

- **Strategy**
  - **Create a Naval Enterprise OA Organization**
    - **OA Enterprise Team (OAET)**
  - **Prepare and promulgate Navy-wide business strategy to support OA goals**
  - **Increase involvement of industry and academia**
    - **Industry participation required by ASN RD&A**
      - **Industry Advisory Team (IAT) – IWS7 lead**
      - **NDIA OA-Fn study**
  - **Investigate alternative strategies for budgeting and contracting for platforms and their combat systems to maximize OA benefits**
- **Way Ahead**
  - **Assess ACAT I & II programs against the OA Assessment Model**
  - **Select ACAT I (and selected II, III, & IV) programs to conduct BCA to analyze cost and benefit of moving to coordinate selected OA Target Level**
  - **Prepare a business case to meet the OA goal**
  - **Decide how to change course to meet OA**

ASW SOFTWARE COMMONALITY

Initiatives

	Submarine	Surface	Surface	Surface	Surface	Surveillance	Air
Function	A-RCI/APB	DDX	LCS	CRUDES (A(V)15 and IPS)	Large Deck	SURTASS/LFA	P3/LIII
Acoustic Intercept							
ACI (Hull Array)	SPVA						
ACI (Towed Array)							
Torpedo Defense				NIXIE			
Mine Avoidance	AMDS			KINGFISHER			
Active Processing			OFFBOARD	ETC			
LFA Bistatics						X	
Passive Processing	APB						
ASW Sensors							
Sail Array Sensor	X						
Towed Array Telemetry	X						
Sonobuoys							
DIFAR							X
DICASS							X
ADAR							X
Performance Prediction							
Passive	STDA						

≥ $500 M Cost Avoidance

Approved – 2.47 M SLOC reused saving development of 4.5 M SLOC

Under Consideration – 1.5 M SLOC potentially saving development of 3.8 M SLOC

AMDS – Advanced Mine Detection System
APB – Advanced Processing Build
STDA – Submarine Tactical Decision Aid
WG – Working Group
TRAFS – Torpedo Recog/Alert Functional Seg
ETC – Echo Tracker Classifier
SPPFS – Sensor Perf Prediction System

ABC

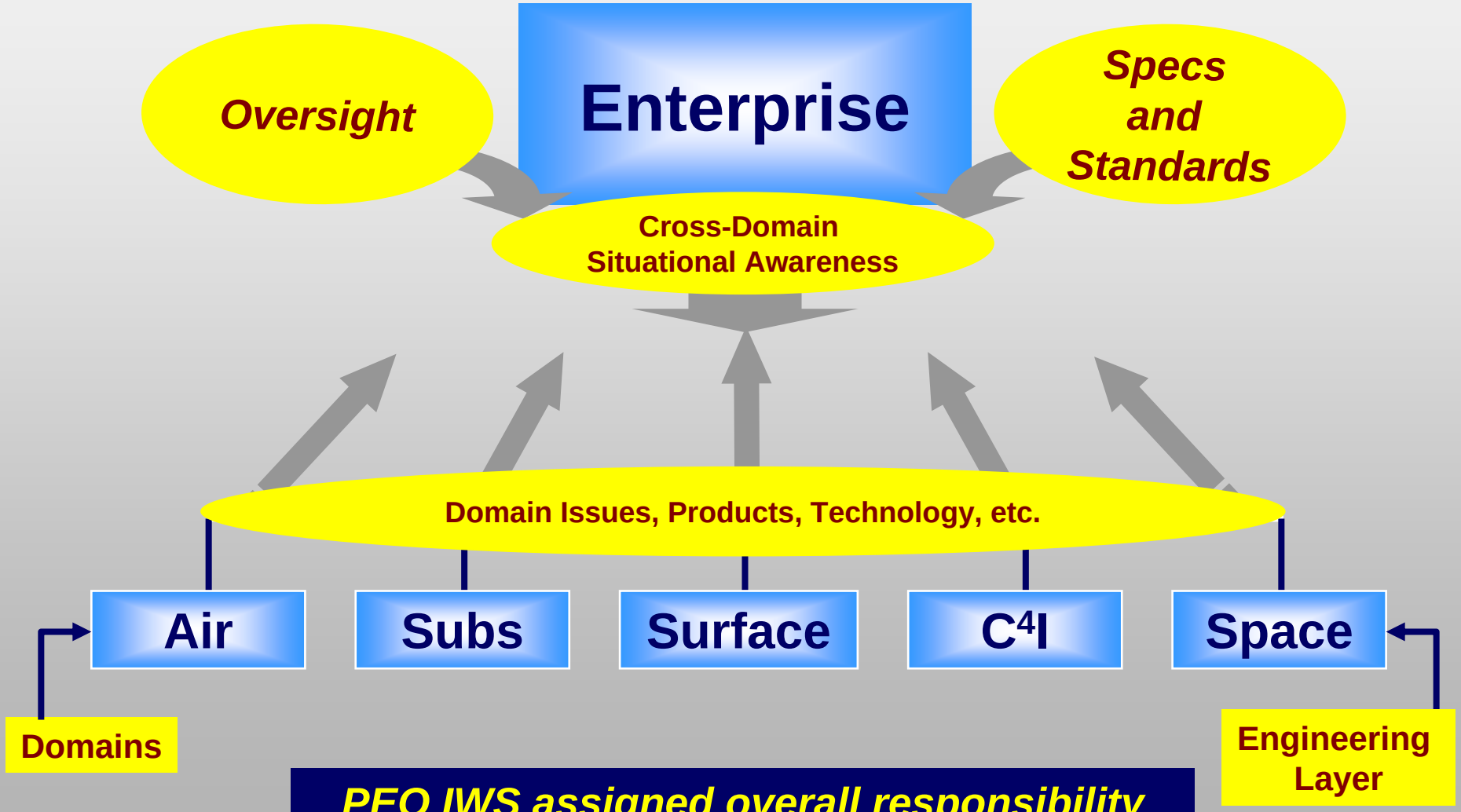
Initial Use Reuse

DEMONSTRATED ASW OA BENEFITS

- **Performance**
  - **Continuous competition yields best of breed applications**
  - **Focus on warfighter priorities**
- **Schedule**
  - **System integration of OA compliant software happens quickly**
  - **Rapid update deliveries driven by user operational cycles**
- **Cost avoidance mechanisms - ~$500M for ASW programs**
  - **Software – develop once, use often, upgrade as required**
  - **Hardware – use high volume COTS products at optimum price points**
  - **Training systems use same tactical applications and COTS hardware**
  - **Design for Maintenance Free Operating Periods (MFOP)**
    - **Install adequate processing power to support “fail-over” w/o maintenance**
    - **Schedule replacement with improved COTS vice maintaining old hardware**
    - **Reduced maintenance training required**
  - **Consolidate Development and Operational Testing for reused applications**
- **Risk reduction**
  - **Field new applications only when mature**
  - **Don’t force the last ounce of performance**
    - **Deploy less (but still better than existing) performance or wait until next update**

NAVY OPEN ARCHITECTURE

Enterprise Organization



PEO IWS assigned overall responsibility and authority for directing OA Enterprise

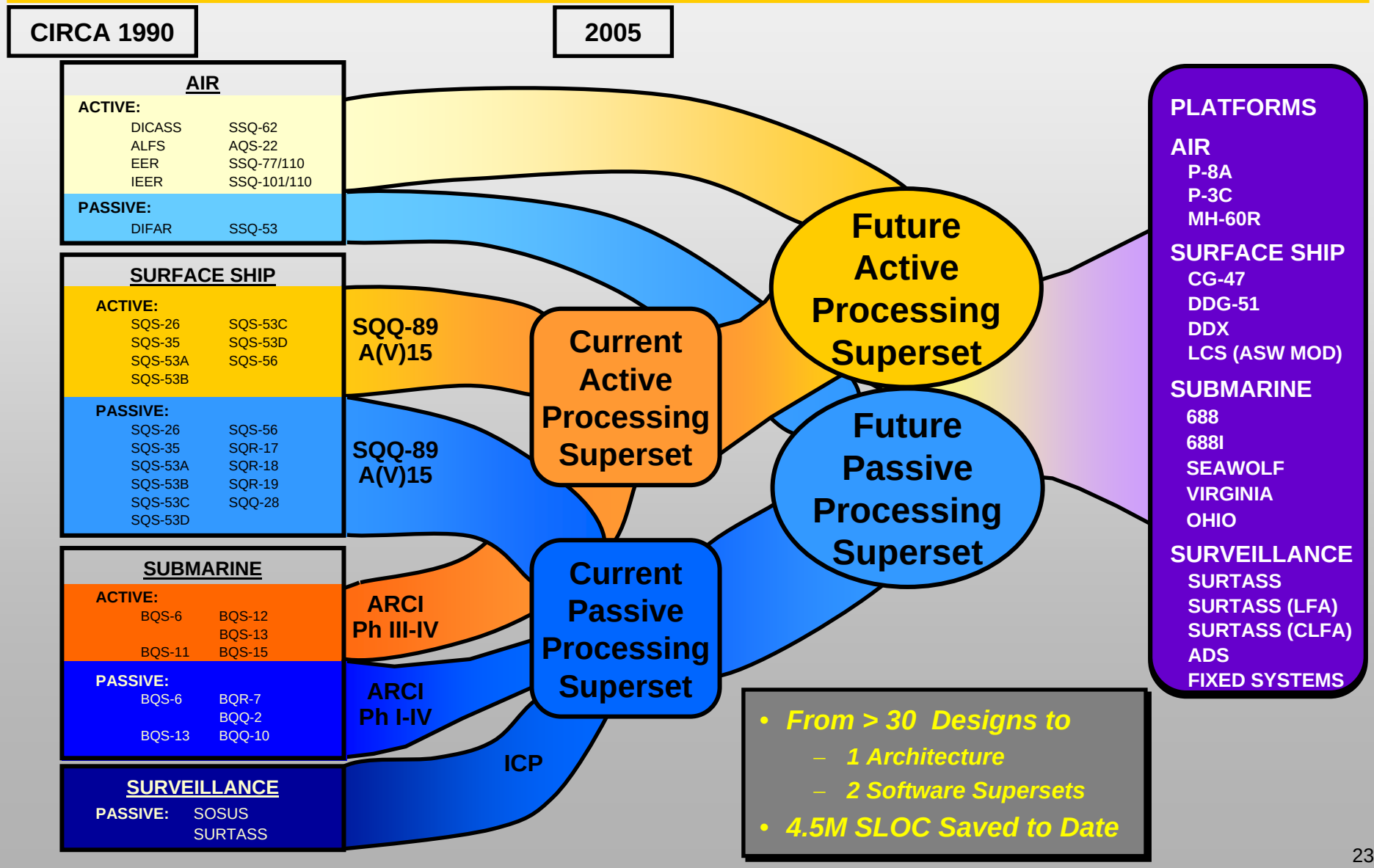
ASW OPEN ARCHITECTURE

Current initiatives - Status

- **ASW Community of Interest**
  - **USW XML Working Group established as a formal COI**
    - **DoN XML Working Group participating**
  - **Currently focused on ASW track management definitions**
- **ASW Common Interface Definition Initiative**
  - **All platforms identifying current and future off-board messaging requirements**
  - **Web services based syntax & semantics development begun**
  - **Metadata development is part of the task**
- **ASW Software Commonality meetings**
  - **Initially focused on greater ASW software commonality with the air community**
- **ASW C2 FIBL assessment**
  - **Initial assessment completed**

ASW designated an OA pilot by ASN RD&A

ASW OPEN ARCHITECTURE
Common Software & Architecture – ASW Sensors



ASW OA PILOT PROGRAM

Background

- **Focus – Getting to ASW Enterprise level execution**
- **Action assigned at OA EXCOMM #3 (Feb 05)**
  - **Including surface, submarine and MMA**
  - **“to prove out definitions, capabilities, and concepts”**
- **Multi-faceted program**
  - **OA assessment of key ASW programs using OA Assessment Tool**
  - **ASW Enterprise Community of Interest stand-up**
  - **Industry involvement**
  - **Measure and report on ASW OA metrics**

ASW OA PILOT PROGRAM

Next steps

- **Complete OA Assessment analysis of key ASW programs**
  - **P-8A, P-3C, MH-60R, A-RCI, IPS, ADS, LCS ASW Module, USW DSS**
  - **Qualitative Assessment**
  - **Use Business Case Analysis to determine OA priorities**
- **Extend Community of Interest (COI) to entire ASW Enterprise**
  - **ASW COI Charter in review**
  - **Develop ASW Enterprise Data Strategy IAW OSD NII guidance**
    - **Coordinate existing Working Group efforts**
      - **ASW Common Interface WG, usw-xml WG, Common Acoustic Processing WG, Sensor Optimization WG, ASW Modeling & Simulation WG**
    - **Determine best data handling technologies**
    - **Publish ASW interface, data and metadata standards**

ASW OA PILOT PROGRAM

Next steps

- **Extend Community of Interest (COI) to entire ASW Enterprise (cont)**
  - **Institute ASW Software Product Line (SPL)**
    - **Develop governance process for ASW enterprise software development**
      - **Use IPCL for priorities**
      - **POM-08 ASW Enterprise review for dupes & gaps using Comparative Modes Chart**
    - **Plan for enterprise-wide reuse of government owned software**
    - **Consolidate sonobuoy processing and ASW C2 programs for enterprise**
    - **Establish enterprise level software support & libraries**
    - **Have CMU SEI document the ASW Enterprise SPL process**

ASW OA PILOT PROGRAM

Next steps

- **Industry involvement via NDIA UWD**
  - **Briefings on ASW OA status at every NDIA UWD Conference**
  - **NDIA UWD ASW C2 OA-Fn Study**
    - **Purpose – educate industry and get technical feedback**
    - **Tasking and Terms of Reference (TOR) in OPNAV chop**
    - **Common picture focus**
    - **July 06 completion**
- **Measure and report on metrics for ASW OA progress**
  - **Cost avoidance, time-to-market, reduction of duplicative software builds, software debug & integration costs, T&E costs, etc.**
  - **Quantitative assessment**
- **Brief status at next OA EXCOMM (May 06?)**

DEMONSTRATED ASW OA BENEFITS

- **Performance**
  - **Continuous competition yields best of breed applications**
  - **Focus on warfighter priorities**
- **Schedule**
  - **System integration of OA compliant software happens quickly**
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  - **Field new applications only when mature**
  - **Don’t force the last ounce of performance**
    - **Deploy less (but still better than existing) performance or wait until next update**

Conclusions
OA is an Acquisition Philosophy!

- **Mandates alone will not achieve OA and the Promise of Better-Faster-Cheaper**
- **A-RCI has proven that OA can be successfully implemented in a Fleet system with substantial savings**

Since 1997
- **Seven generations of software improvements**
- **Five generations of hardware technology insertions**
- **3 Partner Platforms with common mission components**
- **Surface and IUSS Partners Making Similar Headway**

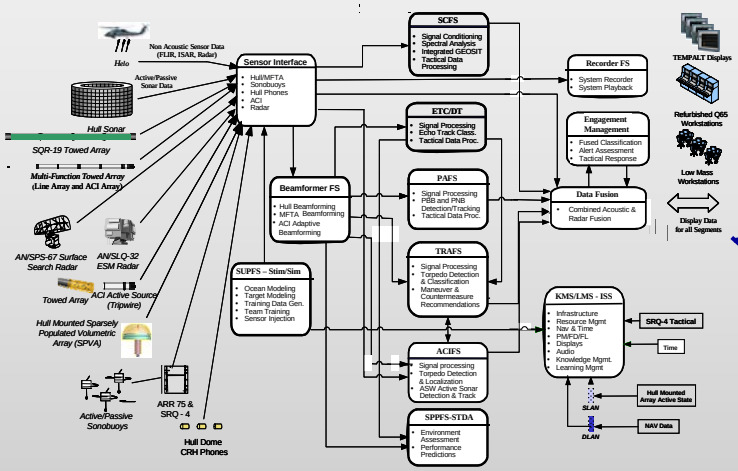
- **Flexible software architecture using adaptive middlewares and standardized system interfaces essential for mission innovation**
- **Its all about Team Work - Process is necessary, *People make it sufficient***
- **Innovative and flexible contracting processes absolutely required**

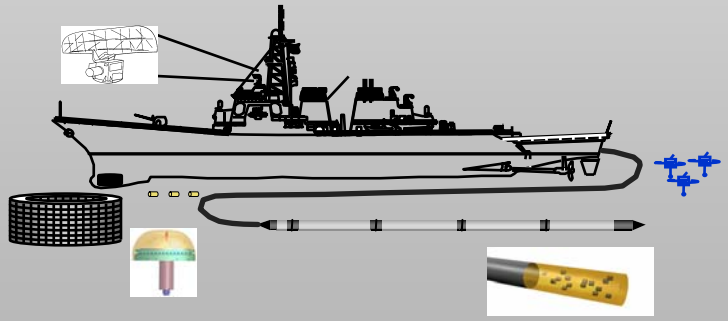
ASW Open Architecture Community of Interest

Rapid, Affordable Operational Capability Improvements

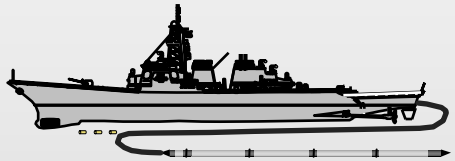
Back-up

IPS / SIPS
Applicability





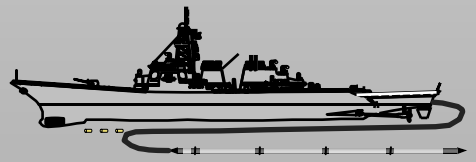
Scaled Improved Performance Sonar (SIPS) → Surface Combatant Modernization



Virtual LCS Demo →

Virtual DD(X) Demo →

AN/SQQ-89A(V)15 Build 1 Update → Surface Combatant Modernization



Common IPS technologies provides multi-community USW solutions
the test bed for multi-community technology transition paths

ASW COMBAT C2

Functional consolidation

NITES II
- Visualization tools
- METOC tools

CADRT / ITC3
- TDAs
- Navigation, AEGIS & Q89 interfaces

CV-TSC
- TDAs
- Enviro prediction tools
- ACDS / SSDS interfaces

USW-DSS
- Mission planner suite
- TDAs
- Enviro prediction tools

SBIRs (ONR)
- 4D Visualization tools
- Uncertainty mgmt tools
- Intelligent agent technologies
- AT-FP (SentinelNet)
- Reconstruction tools

TUSWI (ONR/CTF12)
- TDAs
- Reconstruction tools

Common Software Architectural Framework (Java, OA, web services)

All platforms

Functional consolidation

Modular, Scalable Construction

Universal Components
- Basic Architecture / C2 Core
- Combat System Interfaces
- GCCS-M/JC2 Interfaces
- Navigation Interfaces
- Visualization Environment
- Metadata Sharing
- Intelligent Agents

Mission Modules
- Combined, Uniform TDAs in Mission Sets
- SCC Planning Environment
- Environmental Prediction Tools
- Uncertainty Management Tools
- Reconstruction / Analysis Tools
- Operator Consoles (ITC3, MMWS)

CURRENT INITIATIVES

Status

- **ASW Community of Interest**
  - **USW XML Working Group established as a formal COI**
    - **DoN XML Working Group participating**
  - **Currently focused on ASW track management definitions**
- **ASW Common Interface Definition Initiative**
  - **All platforms are identifying current and future off-board messaging requirements**
  - **Web services based syntax & semantics development begun**
  - **Metadata development is part of the task**
- **ASW Software Commonality meetings**
  - **Initially focused on greater ASW software commonality with the air community**
    - **MMA and P-3C insertion opportunities**

      Goal – single air ASW acoustic processing solution by P-8A Spiral One
- **ASW C2 FIBL assessment**
  - **FORCEnet EXCOMM Action Item**
  - **Initial assessment completed**

LESSONS LEARNED

Acquisition

- **Yearly incremental production reviews with MDA**
- **No LRIP phase – all production buys are limited quantities**
- **Phased approach allows starting small and growing into complete system**
- **Provide level playing field for small business**
- **Conduct delivery readiness reviews for every hardware and software delivery**

LESSONS LEARNED

Budget

- **Traditional funding profiles don't support COTS technology insertion**
  - **Need stable funding levels**
- **Long term stable budget required to support the Tech Insertion Process**
  - **Need to be able to plan on periodic updates matched to the ships' schedules**
  - **Budget shortfall in one year impacts all following years**
- **Fiscal year funding realities impact ability to execute technology insertion plan**
  - **Early funding / multi-year funding would provide more time to develop and execute technology insertion prior to scheduled installation date**

Budget Stability is Key to Program Execution

LESSONS LEARNED

Contracting

- **IPT Pricing**
  - **Parallel activities reduce time to contract award**
  - **Work as a team with a common goal**
- **Flexible contract vehicles**
  - **Incentivizes risk taking**
  - **Maximize contractor flexibility**
  - **Balances risk and cost savings**
- **Dual Prime Contractors**
  - **Segregate system into subsystems**
  - **Creates competitive environment**
- **Use of small businesses**
  - **Breeds innovation**
  - **Reduces cost**

LESSONS LEARNED

Technology Insertion

- **Use the rapid cycle time of COTS to your advantage**
  - **Upgrade hardware to:**
    - **Provide processing power for more advanced applications**
    - **Replace components before they become obsolete**
    - **Reduce system and spares procurement cost**
- **Involve all stakeholders in the decision process**
  - **Joint Navy / industry team to research and select best path for technology insertion**
  - **Incentivize industry to reduce system cost by using latest technology**
  - **Develop equipment infrastructure to handle future upgrades**

Change is inherent in using COTS and must be planned for

LESSONS LEARNED

Procurement

- **Evolutionary development with annual MDA reviews and production decisions**
- **Fixed price procurements do not work in time of rapid technology change**
  - **All of the savings go to contractor**
  - **Less government involvement**
- **Cost plus incentive fee / award fee is effective**
  - **Contractor and government share procurement savings due to technology insertion**
  - **Allows ordering hardware with one configuration and funding the upgrade to the next technology insertion with the OPN savings**
  - **Award fee to reward schedule, system performance**

This is counter-intuitive but we've reduced cost every cycle!

Partnership with Contractor

LESSONS LEARNED

Hardware

- **Use Open Architecture COTS components**
  - **As a matter of Contract & Industry Standards, not as a separate entity**
- **Migrate to mainstream COTS as soon as possible**
  - **Cheaper components**
  - **Better component selection**
  - **Better software support**
- **Use more than one contractor for hardware procurements**
  - **Multiple sources with one integration agent**
  - **Instills both technology and price competition**
  - **Allows bringing small business into the program**
  - **Provides for sharing of good ideas**

LESSONS LEARNED

Hardware

- **Structure procurement contracts to provide maximum flexibility**
  - **Take advantage of technology improvements**
  - **Incentivize contractor to reduce cost and implement new technology**
  - **Government shares in cost savings from new technology**
  - **Use IPT pricing to reduce time to contract award**
- **Be sensitive to commercial product lifecycles**
  - **Products going End-of-Life can drive configurations**

LESSONS LEARNED

Software

- **Rapidly respond to user requirements - Advanced Processing Build (APB) process**
  - **Fixes problems when needed instead of too late**
  - **Keeps Fleet support behind the program**
- **Use standard operating systems and software languages**
  - **Takes advantage of many other users' lessons learned**
  - **Easier to get qualified software developers**
- **Use middleware to isolate application code from hardware baseline**
  - **Allows rapid upgrades to take advantage of technology**
  - **Minimizes code rework from hardware changes**

LESSONS LEARNED

Software

- **Use open source software development process**
  - **Eliminates problems with proprietary software**
  - **Allows all participants to share successful ideas**
  - **Makes transition to other programs easier**
- **Open the software development process up to any company with a good idea (APB process)**
  - **Leverages developments from other Navy programs**
  - **Company develops the new software application**
  - **System prime contractor integrates application into overall system and certifies operation**
  - **Builds environment of friendly competition leading to more innovation**

LESSONS LEARNED

T & E

- **Early Operational Test Organization involvement is critical**
  - **Assist evaluations on every Phase and configuration to date**
  - **Participate in APB sea testing**
- **Evaluation hardware configuration is a moving target**
  - **Technology Insertion / APB updates require development team attention**
  - **Use evolutionary testing vs. one-time OPEVAL**
  - **Take credit for Developmental Testing & AEMP results**
- **MOA's established for FOT&E of future APBs**
  - **Test one of several hardware configurations**
- **ORD / TEMP update process too cumbersome to support evolutionary acquisition programs**
  - **Use CPD/CDD process to streamline**
  - **Annual MDA review serves as Milestone Review**

Test program must be closely managed

SUMMARY

- **A-RCI is an alternative acquisition approach**
  - **Requires good, close relationship with system integrator and all those provide innovations**
- **New software upgrade fielded every year**
  - **Increased capability**
  - **Driven by emerging customer requirements**
- **New Hardware baseline delivered every two years**
  - **Stays ahead of obsolescence**
  - **Leverages the small, agile, innovative companies**

A-RCI / APB is a process that delivers capability rapidly

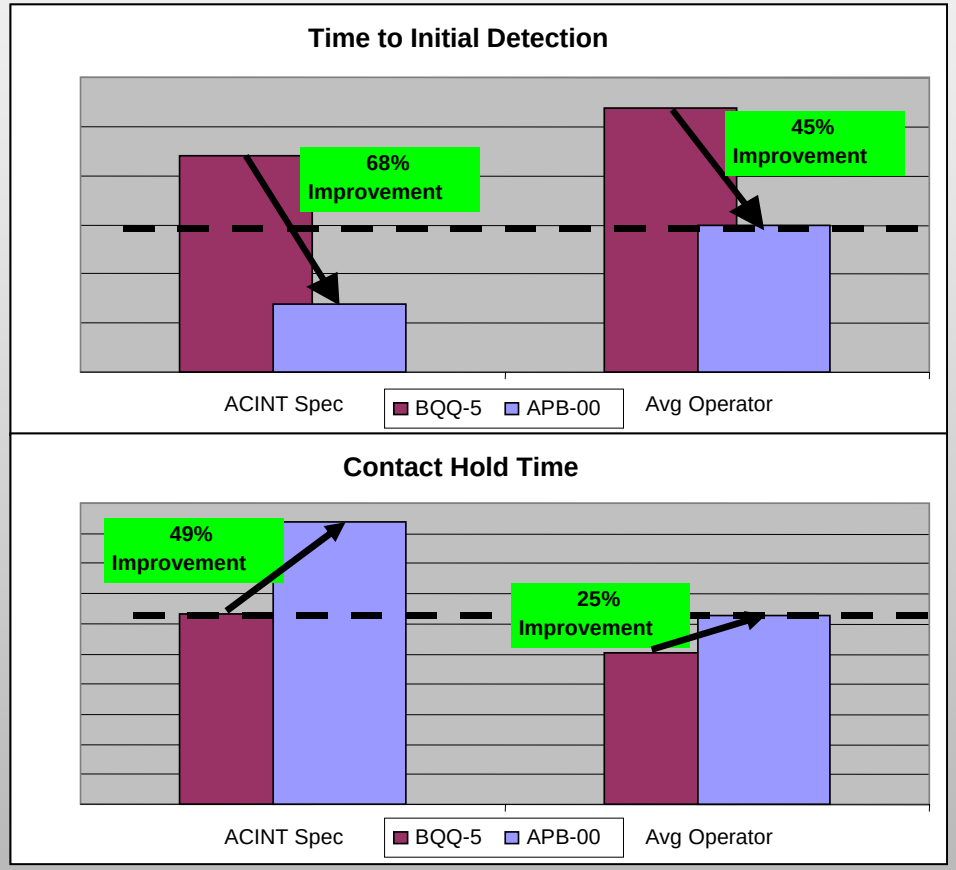
DISCIPLINE AT SPEED

- **Relationships, Relationships, Relationships**
- **Communications, Communications, Communications**
- **Analysis, Analysis, Analysis**
- **Process Improvement**
  - Knowing the development and production process details
    - Including internal and External Dependencies
    - Work Breakdown Structures
  - Critically looking at where Value is not added or needs to be added
    - Make the processes leaner and more agile
    - The Integrator is doing it now….
  - Revamp processes without interrupting product flow…

And analyze whether or not we got better, faster….

Early Acoustic Performance Gains

- **Recent AEMP Level 4 analysis compared the performance of AN/BQQ-5E and ARCI APB-00 against select real world targets using both ACINT specialists and fleet sonar operators**
- ACINT Specialists demonstrated significant performance improvement **with ARCI APB-00 over BQQ-5E**
- ARCI APB-00 enabled average operators to meet or exceed performance achieved by ACINT specialists on BQQ-5E **in 1999 study**
- **Further analysis comparing APB-00 to APB-02 is planned for Spring 2004.**



Substantial performance improvements using ARCI were seen for all operators

Average Operator with ARCI matches or bests the Expert Operator with BQQ-5

Automated Alerts

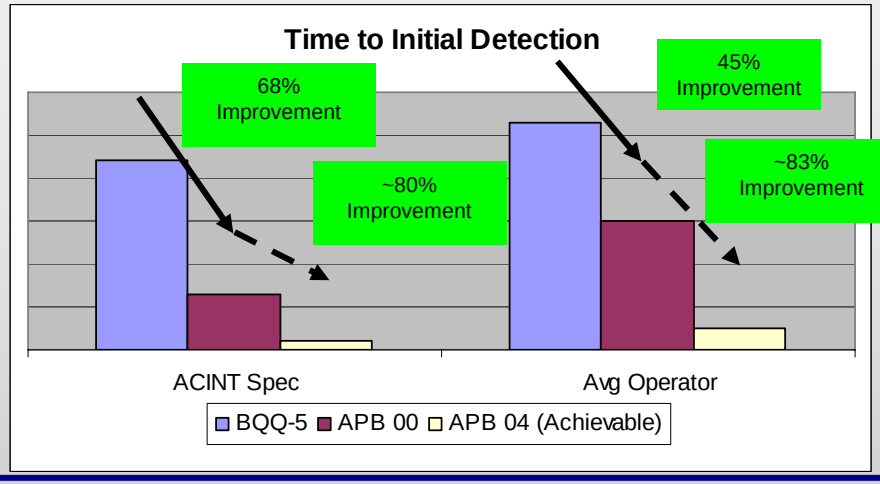
Steady Measured Progress

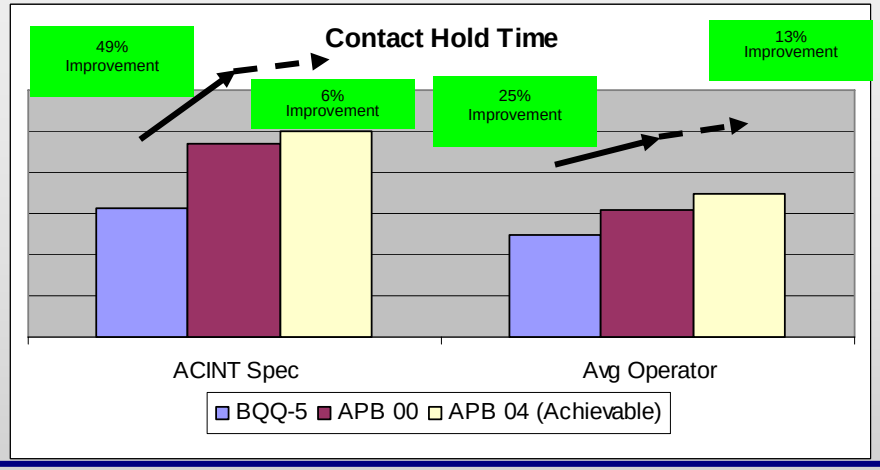
Feature	SSN	SSK	SA	HA	TB-16	TB-23	TB-29
VLF T1	A,B	G				APB-00	
VLF Int	A,B	D,E,F,G				APB-00	APB-01
MCSD	A,B					APB-00	APB-01
Band Ratio	A,B					APB-00	APB-01
DLT						APB-00	APB-01
LF/MF T1	A,B	D,E,F,G	APB-06				
DSTD		D,E,G		APB-06	APB-02	APB-02	
HP		D,E,G		APB-06	APB-02	APB-02	
A-Line		D,E,F		APB-06	APB-02	APB-02	
CP		D,E		APB-06			
C1		D,E,F	APB-06				
Aux		D,E,F		APB-06	APB-02	APB-02	
HST		D,E,F,G		APB-06	APB-02	APB-02	
HD		D,E		APB-06	APB-02	APB-02	
CSR		D,E		APB-06	APB-02	APB-02	
NTS			APB-02				
Fused Features	A,B					APB-00	APB-01
Fused Features		D,E			APB-02	APB-02	APB-05
Fused Features		D,E,F,G		APB-06			APB-05
Operator-Designated		D,E			APB-02		
Operator-Designated		D,E,F,G		APB-06			

Notes:

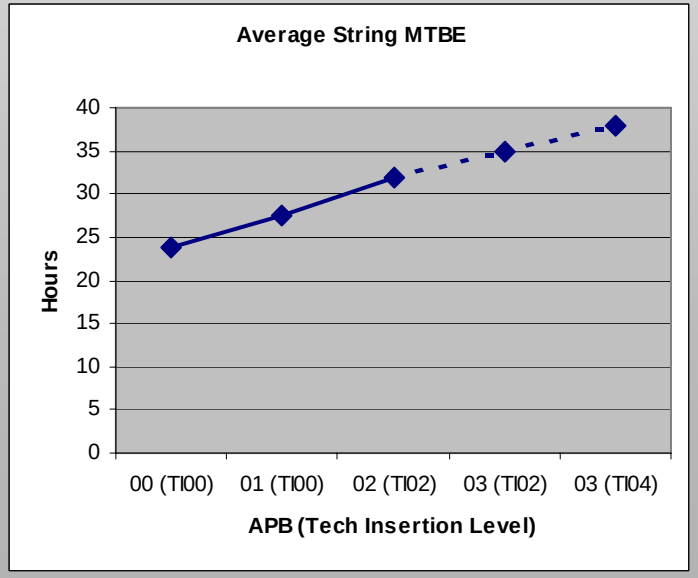
APB-00 and APB-01 provided alerts for Red SSN.
APB-02 introduced alerts for Red SSK.
Focus continues for APB-03 and beyond (additional classes/features, multisensor).
Many features appear to the operator only as a fused alert.

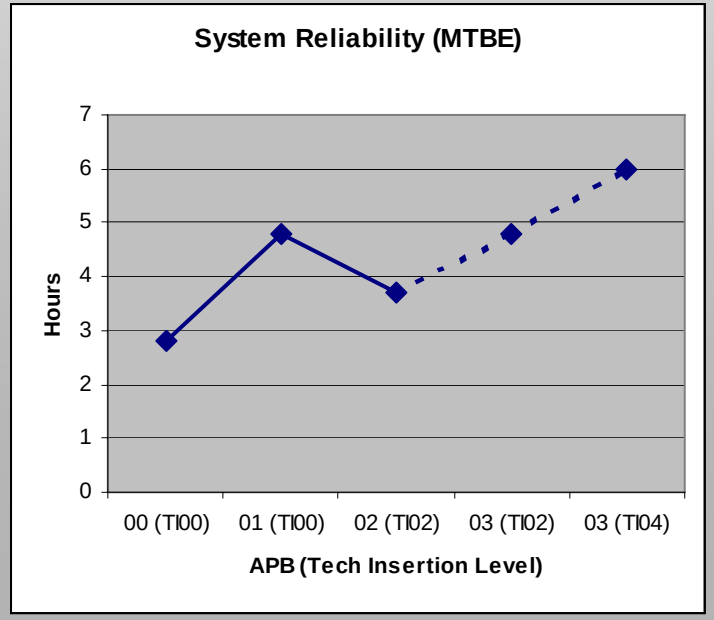
Projected Acoustic Performance Gains





A-RCI System Reliability





Hardware Lessons Learned

- Use Open Architecture COTS components
  - As a matter of Contract & Industry Standards, not as a separate entity
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  - Cheaper components
  - Better component selection
  - Better software support
- Use more than one contractor for hardware procurements
  - Multiple sources with one integration agent
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Hardware Lessons Learned (cont'd)

- **Structure procurement contracts to provide maximum flexibility**
  - **Take advantage of technology improvements**
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- **Be sensitive to commercial product lifecycles**
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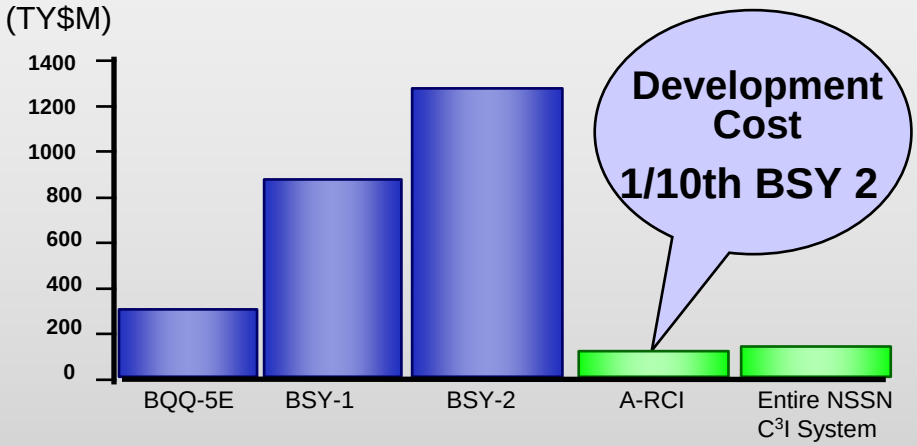
Software Lessons Learned

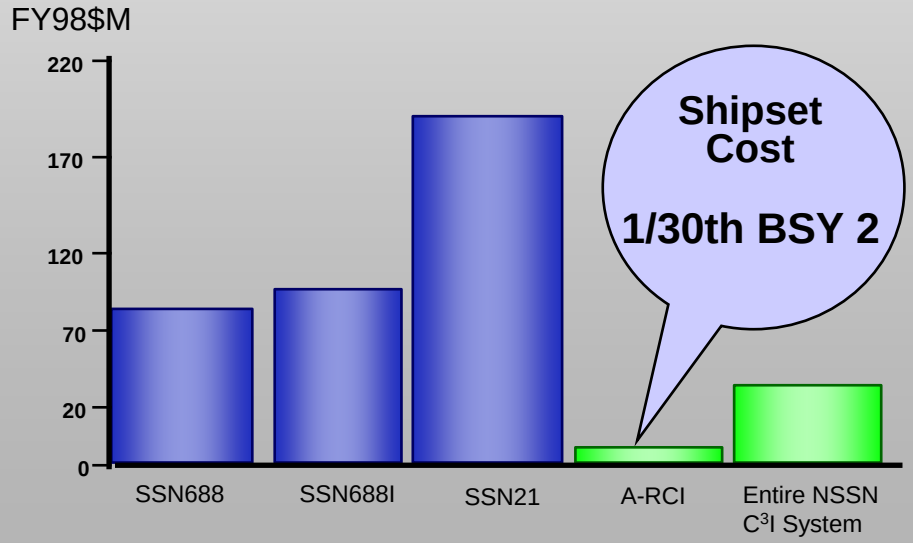
- Rapidly respond to user requirements - Advanced Processing Build (APB) process
  - Fixes problems when needed instead of too late
- Use standard operating systems and software languages
  - Takes advantage of many other users' lessons learned
  - Easier to get qualified software developers
- Use a middleware to isolate application code from hardware baseline
  - Allows rapid upgrades to take advantage of technology
- Cultivate an Area of Interest with Similar Mission Programs

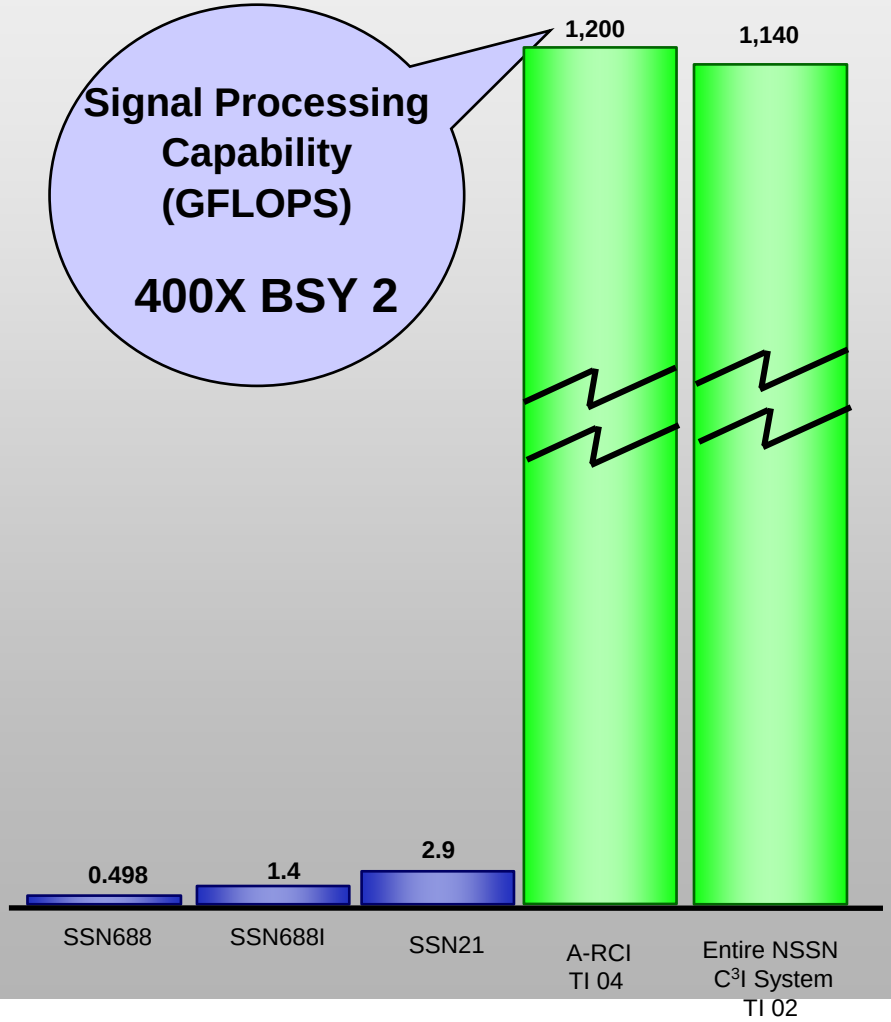
Software Lessons Learned (cont'd)

- Use open source software development process
  - Eliminates problems with proprietary software
  - Allows all participants to share successful ideas
  - Makes transition to other programs easier
- Open the software development process up to any company with a good idea (APB process)
  - Leverages developments from other Navy programs
  - Company develops the new software application
  - System prime contractor integrates application into overall system and certifies operation
  - Builds environment of friendly competition leading to more innovation

OA vs. Legacy Cost / Capability







Militarized Legacy Systems

COTS Based Systems

Conclusions

- A-RCI is an alternative acquisition approach
- Requirements - STRG provides yearly requirements for each APB
- Budget - Steady state funding needs to reflect periodic technology insertions
- Schedule - 18-24 month APB process from requirement to Fleet Introduction
- T&E - Evolutionary testing vs. one-time OPEVAL
- Business Process - Multiple developers breed competition and innovation
- ILS - Traditional logistic product development timeline needs to be synchronized to system development
- Innovative and flexible contracting processes required

A-RCI / APB is a Process That Delivers Capability Rapidly

Final Thoughts

- OA is an acquisition concept not a technical matter
- You do not need a large infrastructure to enforce and certify the use of OA
  - No Architecture for Architecture's sake
- A-RCI has proven our ability to use OA
  - Four H/W vendors using common components selected 5 months in advance of delivery
  - Twenty S/W developers
    - Updates every year
    - Proven interoperability and transportability across H/W
  - Software shared with other ASW systems
- Standardization vs. open systems
  - Total Ship Computing
- We don't know all the answers
  - IVV
  - Use of libraries
  - Baseline integrity
- Even at our update rate, we can't keep up with the commercial H/W half life

Development vs. Integration

System Integration and Test
Lockheed Martin

Towed Array / STDA / TSMS *GD-AIS*	High Freq Active *ARL/UT*	Acoustic Intercept / Recording *Progeny*	Sphere Array / Med Freq Active *LM*

Multiple Developers Provide Options

A-RCI / APB Process Leverages Advanced Development

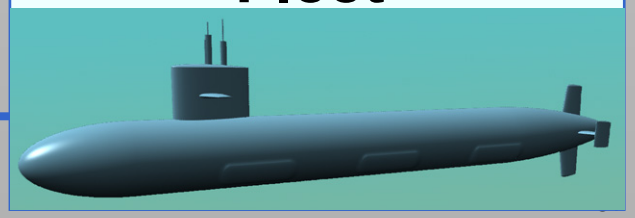
Research
ONR
DARPA
IR&D
Industry
Academia
Navy Labs

Four Step APB Process

1. R&D Test
2. Stress Test
3. Lab Test
4. Sea Test

Production System Integration & Test

Fleet

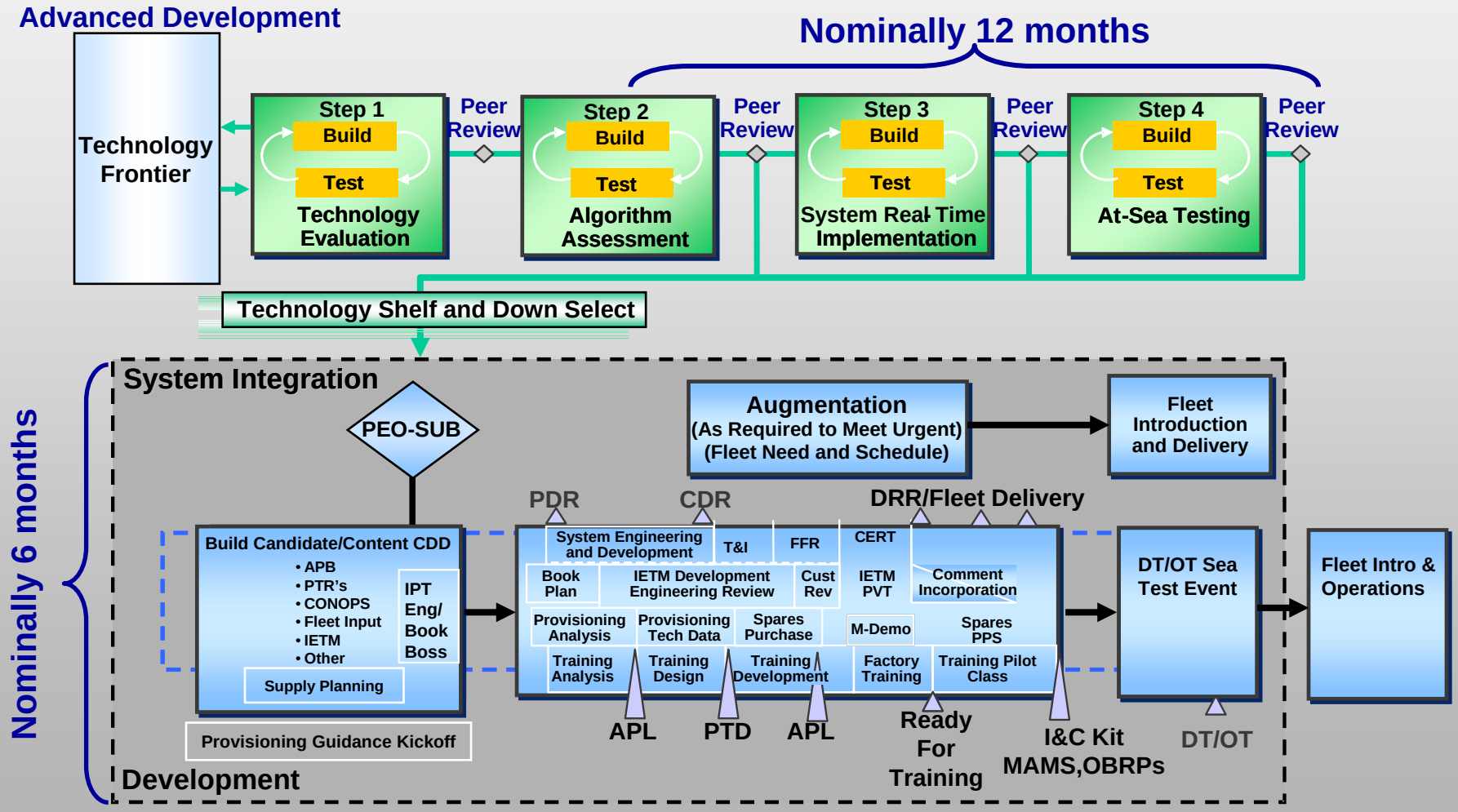


Assess Current Performance and Recommend Improvements

Build-Test-Build

- **Faster Introduction**
- **Earlier testing**
- **Reduced risk**

A-RCI / APB Development Process



Disciplined System Integration is the Key to Success

Future APB Focus Areas

04	05	06	07	08
High Frequency Tactical Control System (HFTCS) - HF Active/PBB - HFSTDA - ASW Fast Ping Acoustic Intercept & Ranging (AI&R) - SPVA Sensor & Processing Real Time Reach Back Spectral Trackers TA/HA Bell Updates TC Like GEO in Sonar RDTE STDA Updates	HFTCS - HF Active - SPVA PBB Ranging AI&R - SPVA Ranging Diesel - Bell Ringers - Towed Array Ambiguity Resolution SURTASS Cues Low Frequency Active Multi-static's Common Undersea Picture (CUP) Improved Environmental Databases Intelligent Ranging Toolbox (IRT) v 0.1	Low Cost Conformal Array (LCCA) Bottom Mine Detection AI&R 36" SPVA IRT v1.0 Diesel - Bell Ringer - TB-29 Beam Form Thru turns DARPA RPS TB-16 Medium Freq - Correlation Sphere/TA/HA TB-16 High Freq - Correlation SPVA/TA/HF Distributed arrays	Covert InSitu Environmental Data Estimates Diesel - Bell Ringer - TB-29 Track thru turns Ranging DARPA RPS IRT v 2.0 TB-16 High Freq - Correlation 36" SPVA Medium Freq Active Remote Vehicles	CAVES, LVA Bell Ringer Thin/Fat dual line coherent processing IRT v 3.0

TB-29 Imp

Rearchitect the People

- Focus on the delivered product, not stove piped concerns
  - Peer Review Groups vs. prime contractor and TDA
- Many ARCI IPT's with diverse membership
  - APB Peer Groups
  - Test and Evaluation Support Group
  - String Development Groups
  - Tech Insertion/Refresh
  - Middleware
  - Installation
  - ILS
  - Production
  - ICB
  - Joint Test Groups
  - Fleet Readiness Groups
  - AEMP
- Data Driven Decisions

No One Organization Has the Answer

ARCI - Business Areas

- SENSOR & APB Development
- Component Integration
- System Integration
- Middleware Management

6.4 R&D (SO223)

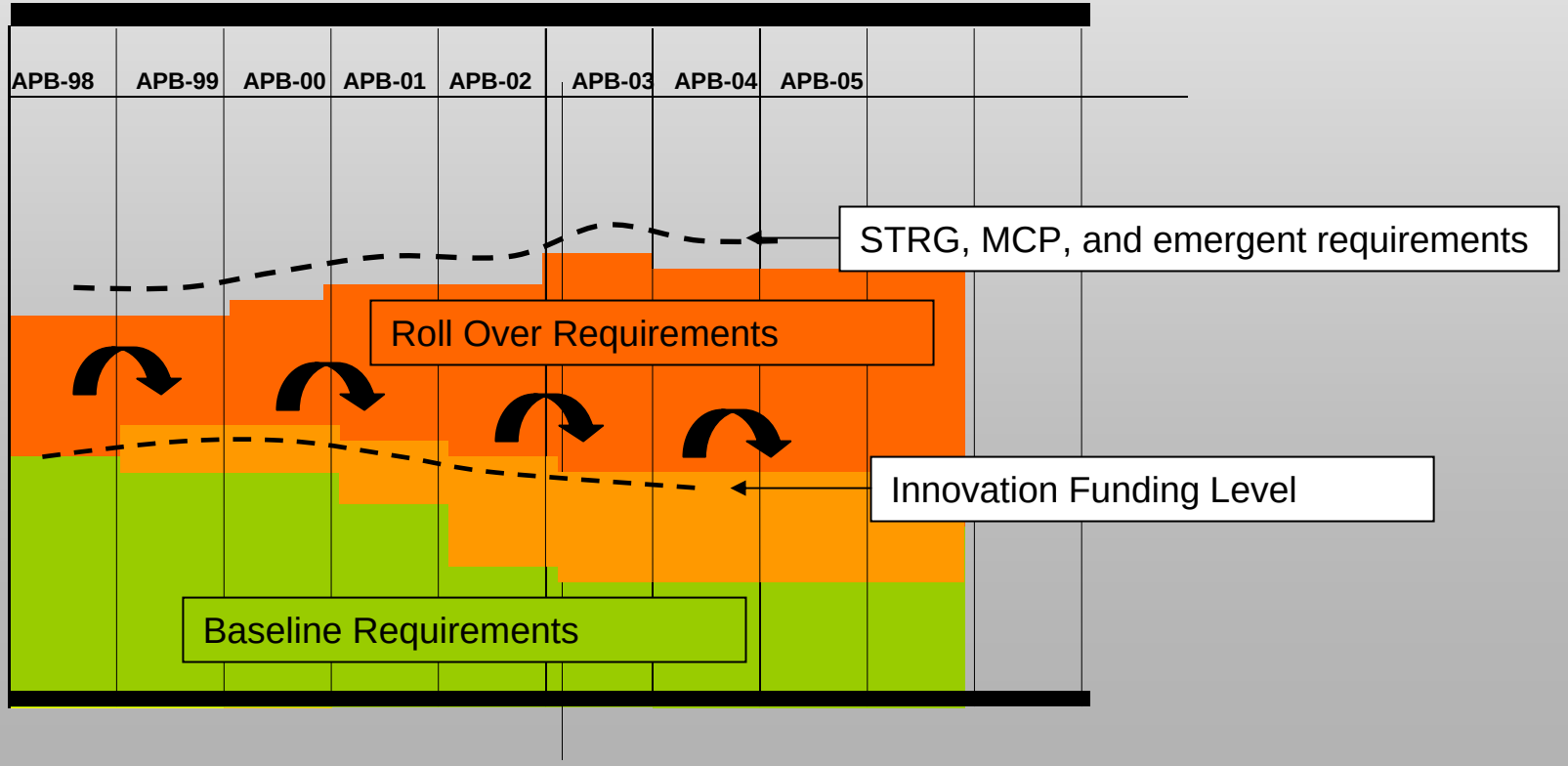
6.5 R&D (FO219)

- Procurement
  - Processors
  - Sensors
- Installation
- TECH Insertion

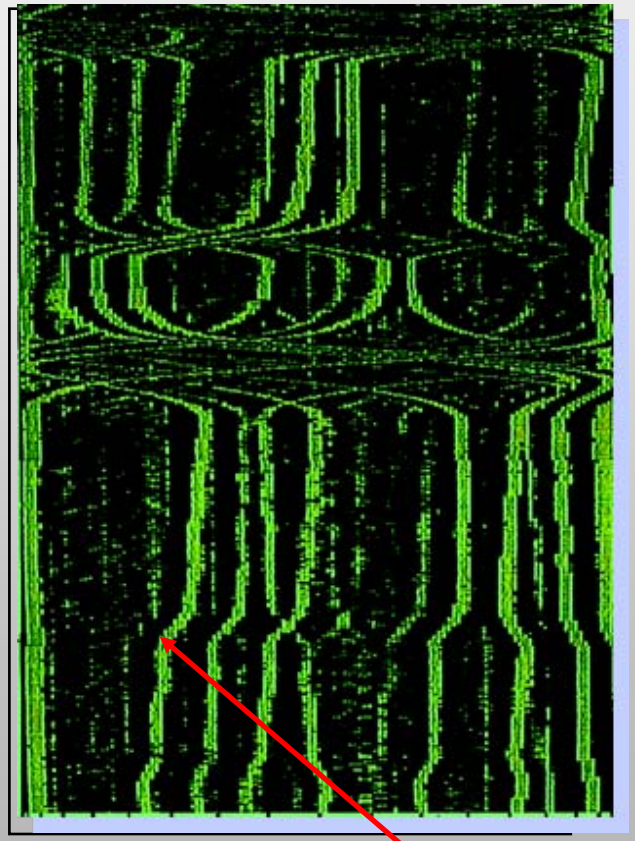
OP-N (P, I)

Innovation Rate VS. Fleet Pull

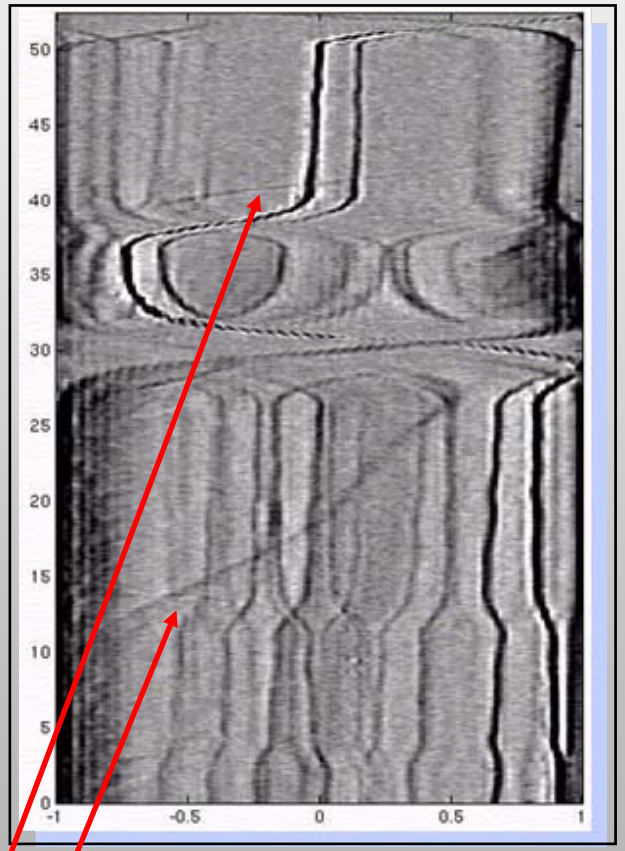
- Innovation rate is marginally effective at meeting requirements for 2012
- Can't satisfy the MCP sub ASW requirements allocation for hold at risk
- Strong requirements pull from STRG at current levels still go unmet
- Each year a large % of requirements are bow waved



APB-98/ARCI Phase 2: Signal Processing and OMI Gains



Legacy Display



A-RCI - 2

Contact
Vs.
No Contact

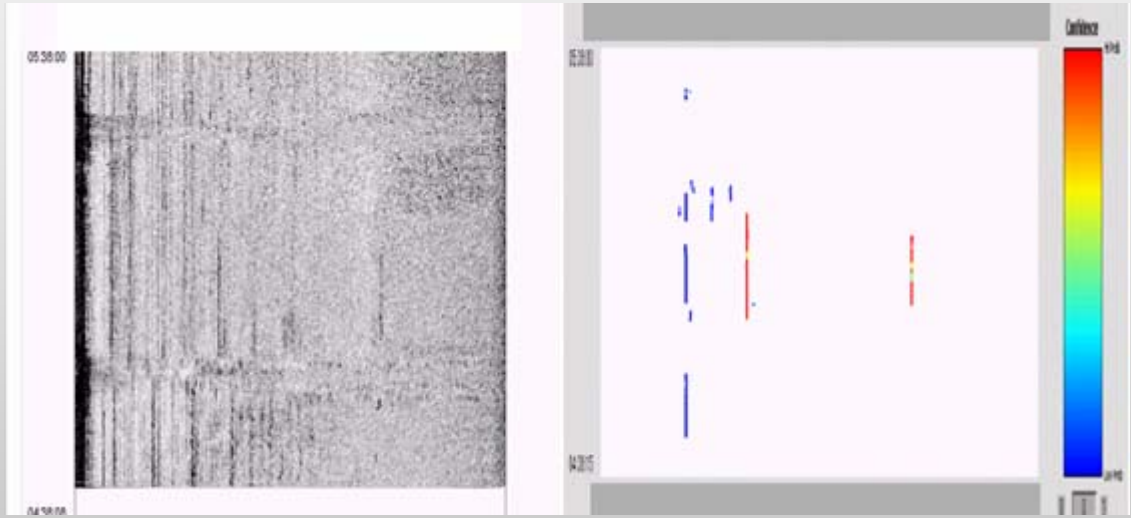
- ARCI-2 Leveraged Advanced BB Algorithms:
  - VLF Emphasis
  - Sub Band Peak Energy Detect & SCOT (Adaptive Equalize)
  - Cross-Correlation for Improved Bearing Resolution & Detection
- BQQ-5 + AFTAS Uses Legacy LR & CC with Fixed Spectral Shaping

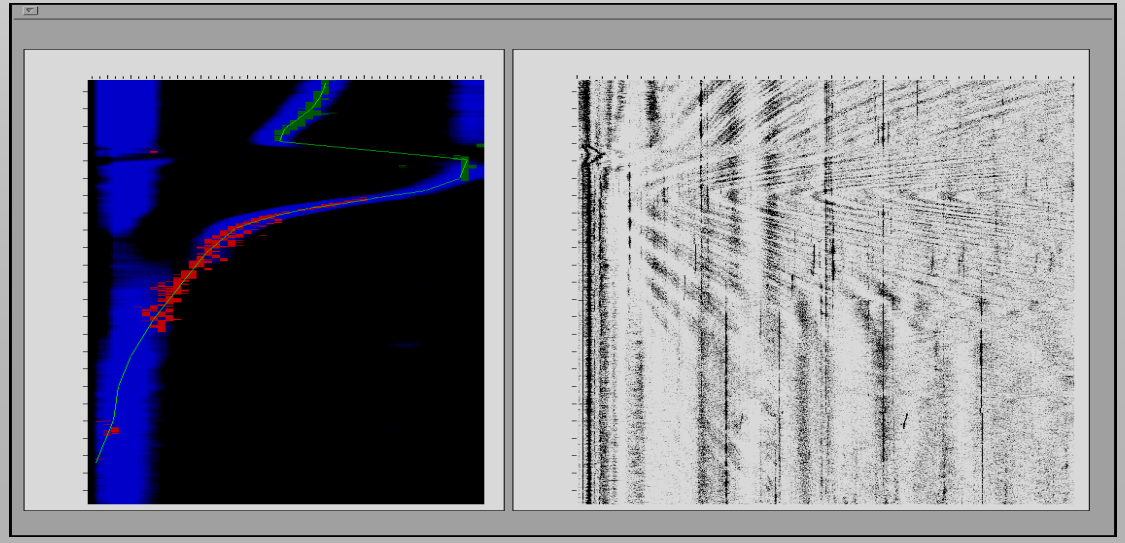
Gains in APB-00

Transitions from the Full Spectrum Program to NAVSEA

- **<u>Automated Signature Alerts</u>**

- **Prioritized Alerts Take the Junior Operator Through The Steps of the Senior Acoustic Intelligence (ACINT) Specialist**





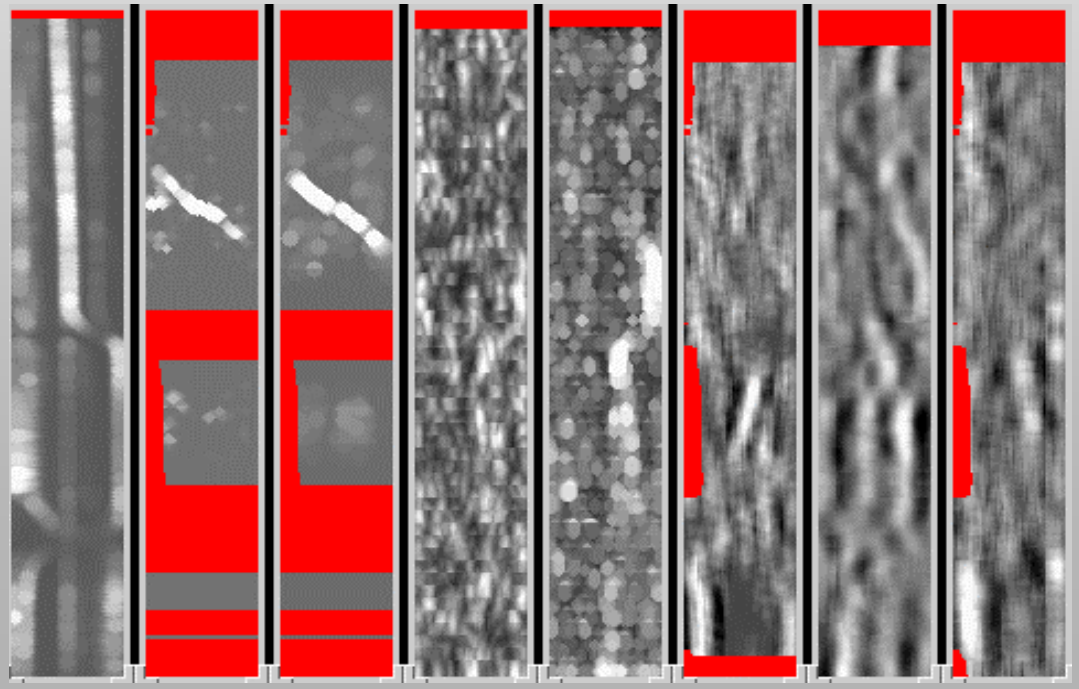
Gains in APB-00

Transitions from the Full Spectrum Program to NAVSEA

- **<u>Automated Fusion of Multiple Alerts</u>**

- **Fused Summary Reduces Operator Workload and Mitigates False Alarms**

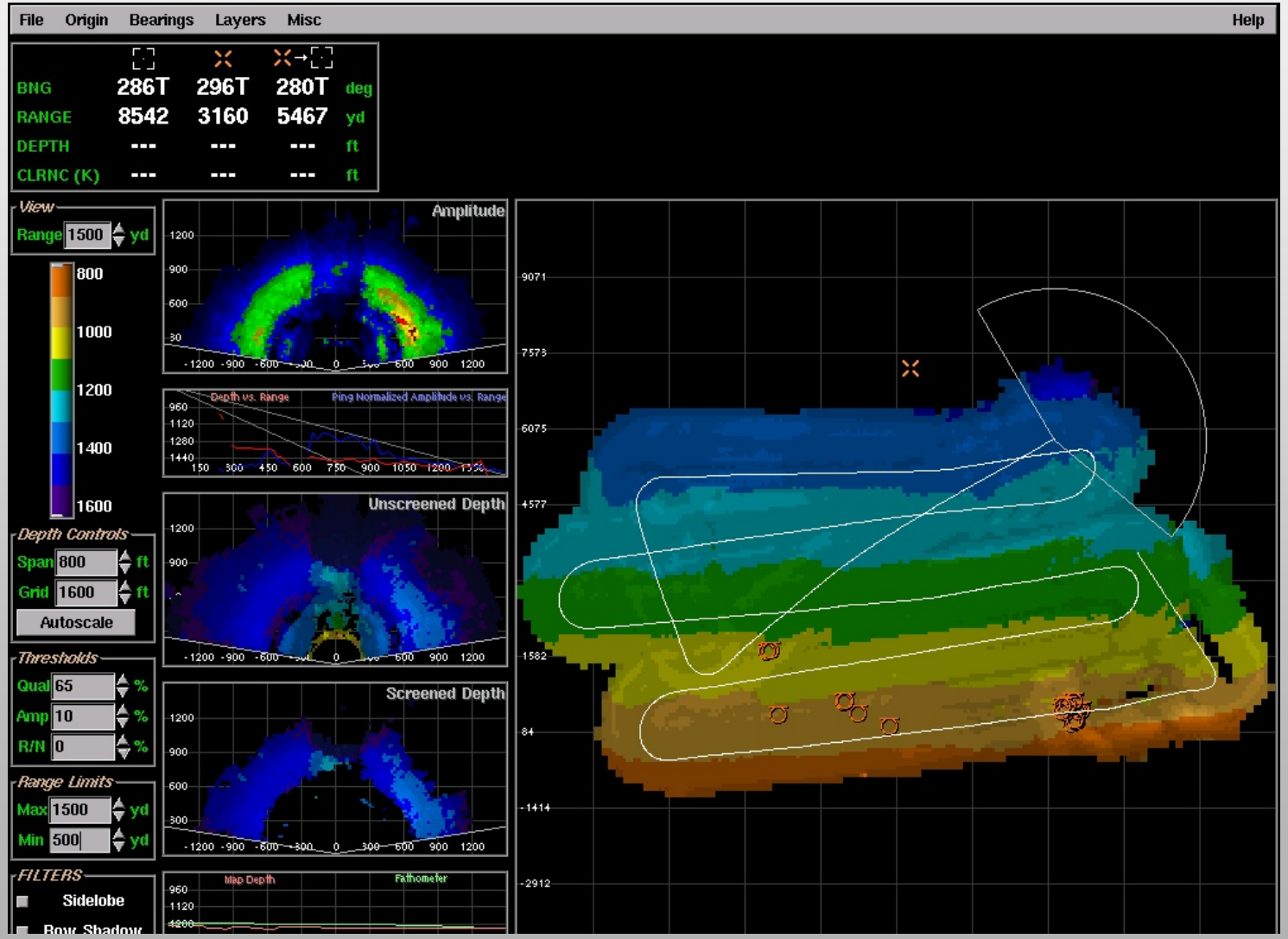
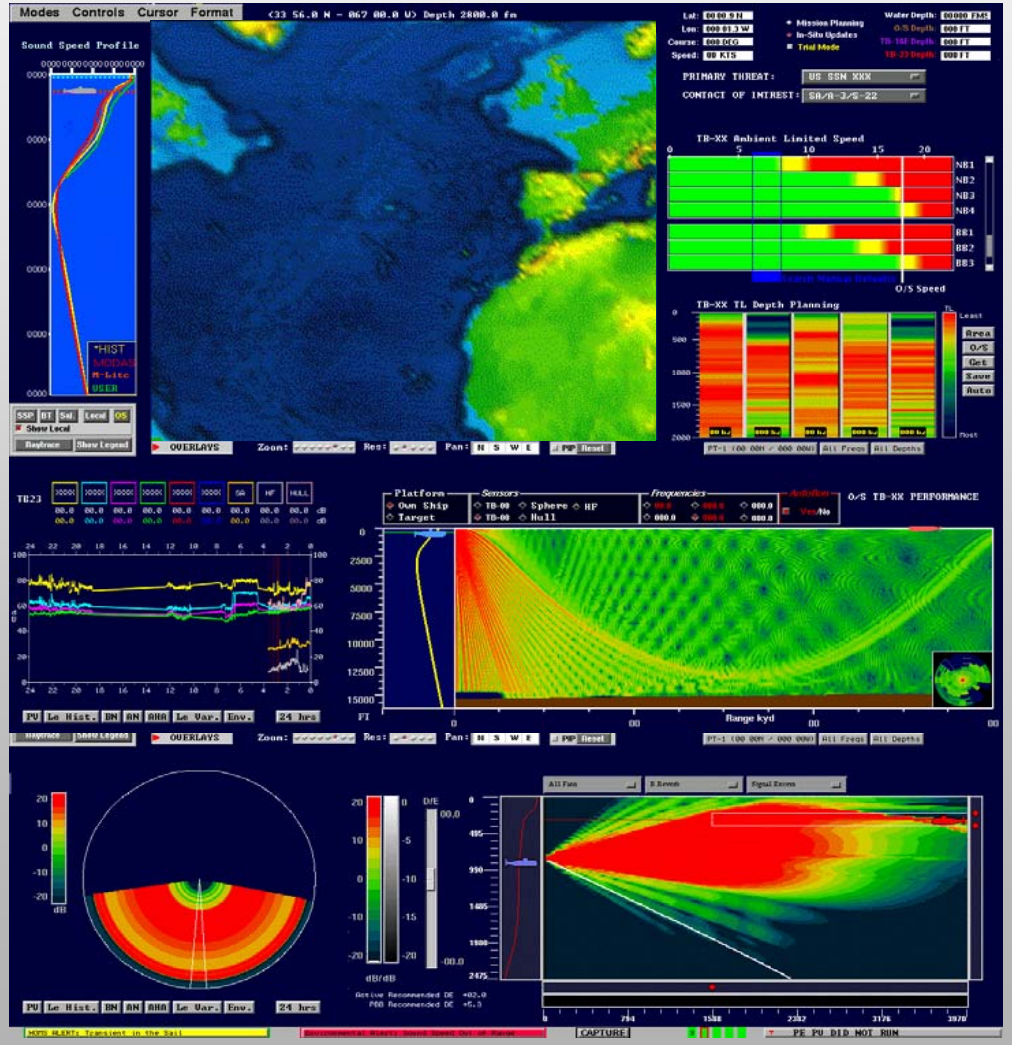
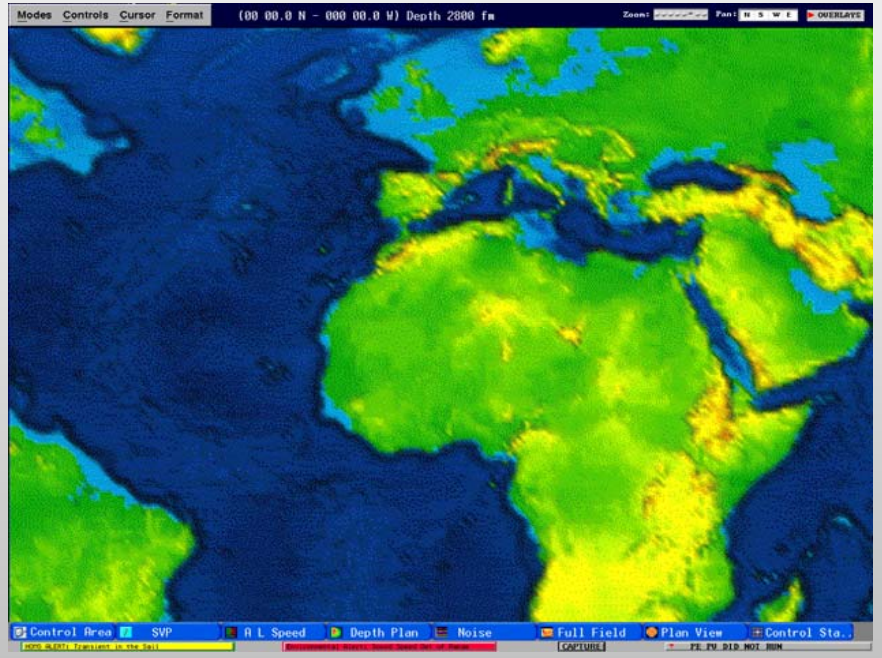
Signature Features of Interest



Fuse Before Threshold

Summary Display

Battle Space Preparation
PUMA Map - Berry Islands



APB03 Submarine STDA System