



The Modernization of the Aegis Fleet with Open Architecture

Jamie.Durbin@lmco.com

Richard.W.Scharadin@lmco.com

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Report Documentation Page

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Topics

Things to talk about...



- **Background**

- Aegis Overview
- Capability Upgrade Evolution
- Modernization Concept/Approach

- **Aegis Open Architecture**

- Evolution to COTS Technologies and Products
- Incremental/Spiral Development Approach

- **Aegis Modernization**

- Overall Scope/Impact
- Product Line Architecture
- Integration of Common STM / TS Components

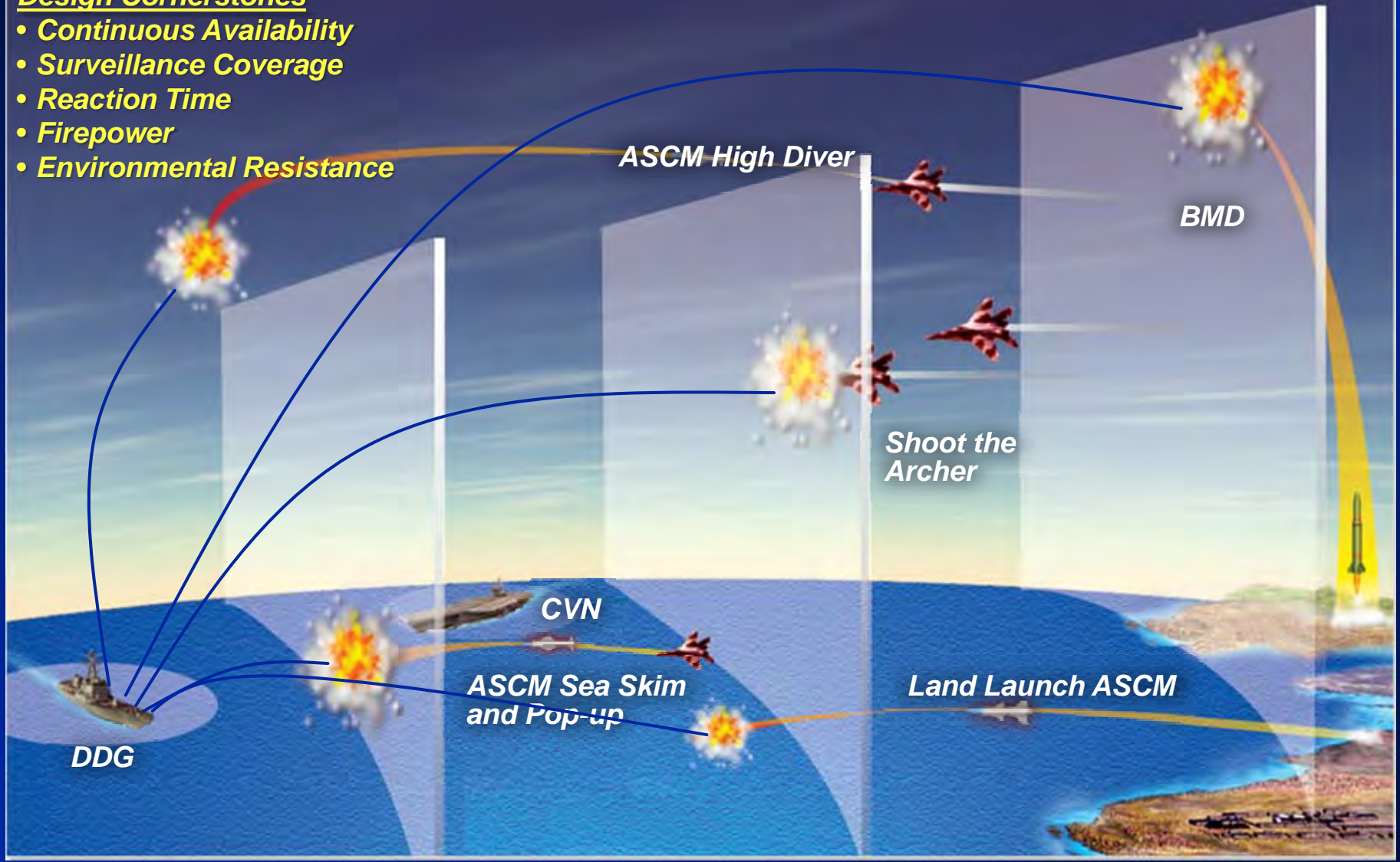
- **Summary**

Aegis – The Shield of the Fleet



Design Cornerstones

- Continuous Availability
- Surveillance Coverage
- Reaction Time
- Firepower
- Environmental Resistance



Self Defense

Area Air Defense

**Long Range Air Defense
And BMD**

Aegis Combat Systems Architecture



Aegis Display System



**Radar System
AN/SPY-1**



**Command and
Decision System**



**Fire Control System
Mark 99**



**Vertical Launching
System Mark 41**



**Weapon Control
System**



**Aegis Combat
Training System
Mark 50**

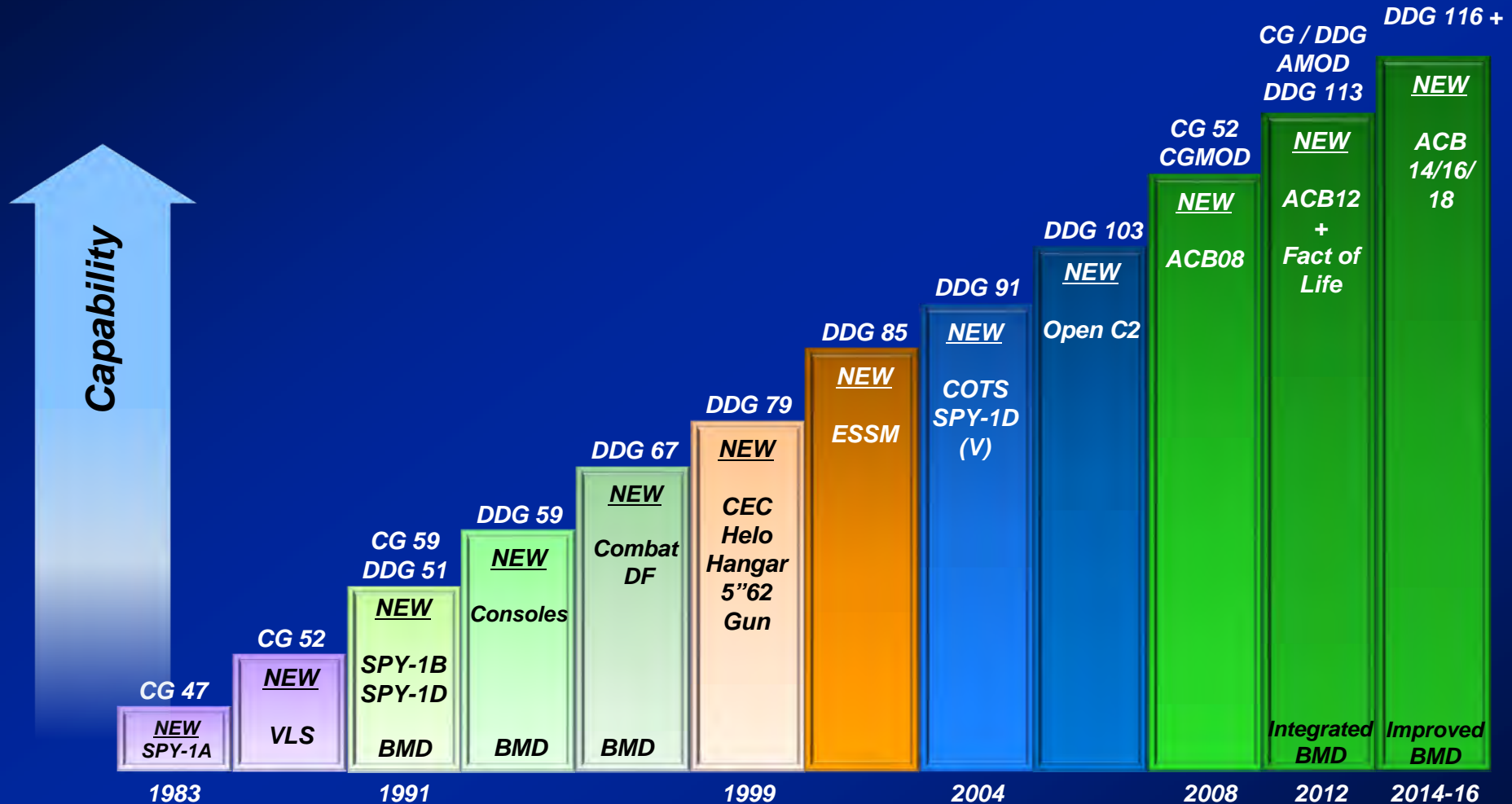


**Operational
Readiness
Test System**



**Standard Missile-2
SM-3
VLA
TLAM
ESSM**

Aegis Capability Overview



12 Generations and Over 27 Years of Proven Success

Aegis Modernization Concept



I. Decouple Hardware and Software Upgrades Using COTS

- Software Upgrades Every Two Years
- Hardware Refresh Every Four Years

II. Build on Fielded Baselines

III. Integrate Navy Enterprise HW and SW Solutions

IV. Transition Aegis to Navy Objective Architecture

Benefits of Aegis Modernization Concept

- More Capability to the Fleet Sooner
- Foster Collaboration and Competition
- Cost Savings from Commonality & Reuse
- Minimal Lifetime Spares
- Upgrades Backward Compatible

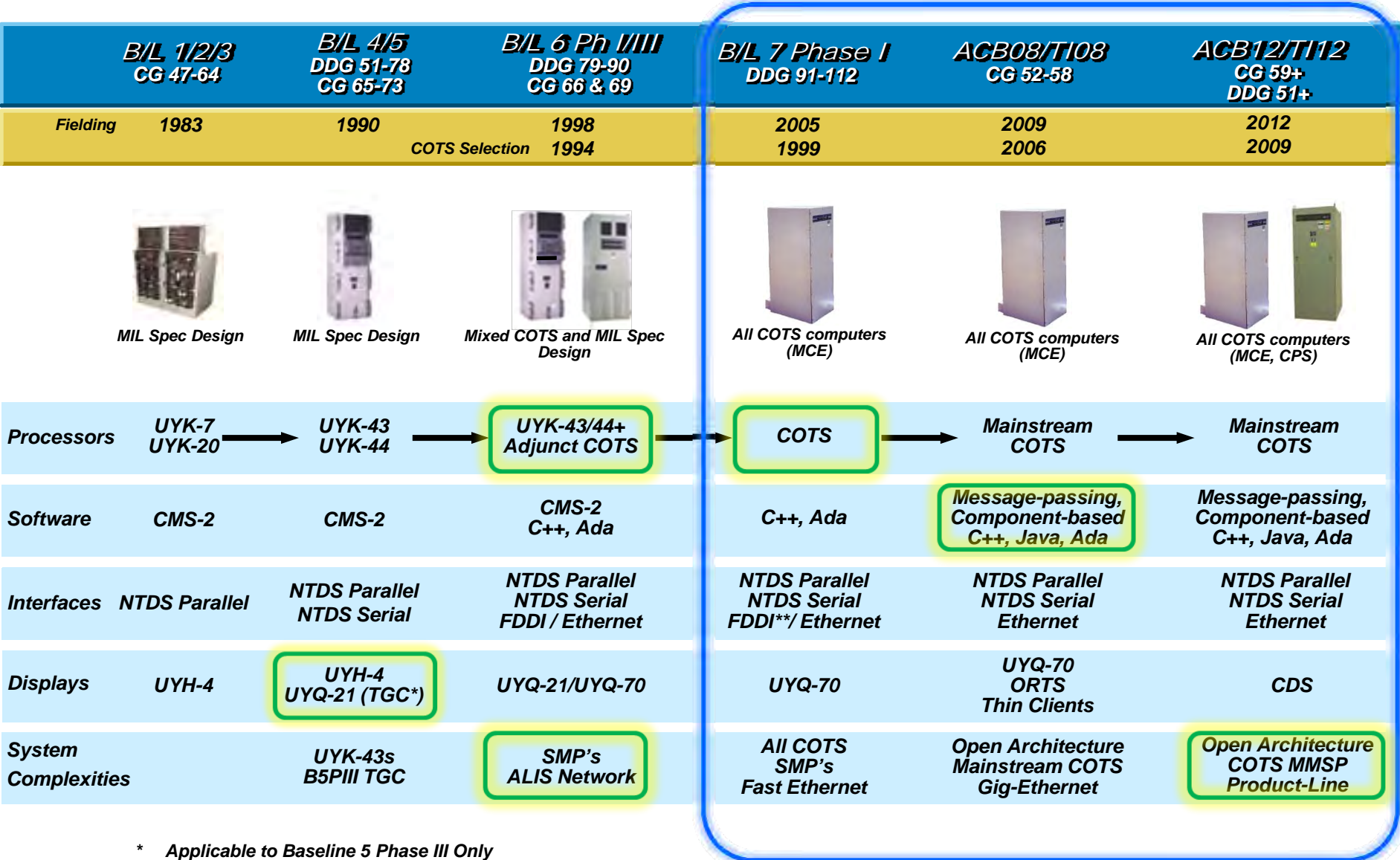
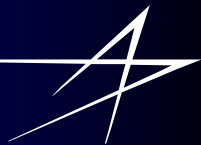


***COTS & Open Architecture -
While Maintaining Engineering Discipline***



Aegis Open Architecture

AWS Computer Architecture Evolution



* Applicable to Baseline 5 Phase III Only

** Eliminated in Baseline 7 Phase IR

COTS Technology and Products



Tech Insertion 00 2000

B7PhI



DDG 91-102

Tech Insertion 04 2004

B7PhIR



DDG 103-112

LCS / NCS - Derivative

Tech Insertion 08 2008

ACB 08



CG 52-59

Non-LM Hardware



- Computing Platform
- VME Single Board Computer
- Network Switching
- SAN Storage
- Network File System
- Thin Client LCD Display
- Analog Hardware/Devices

Non-LM Software

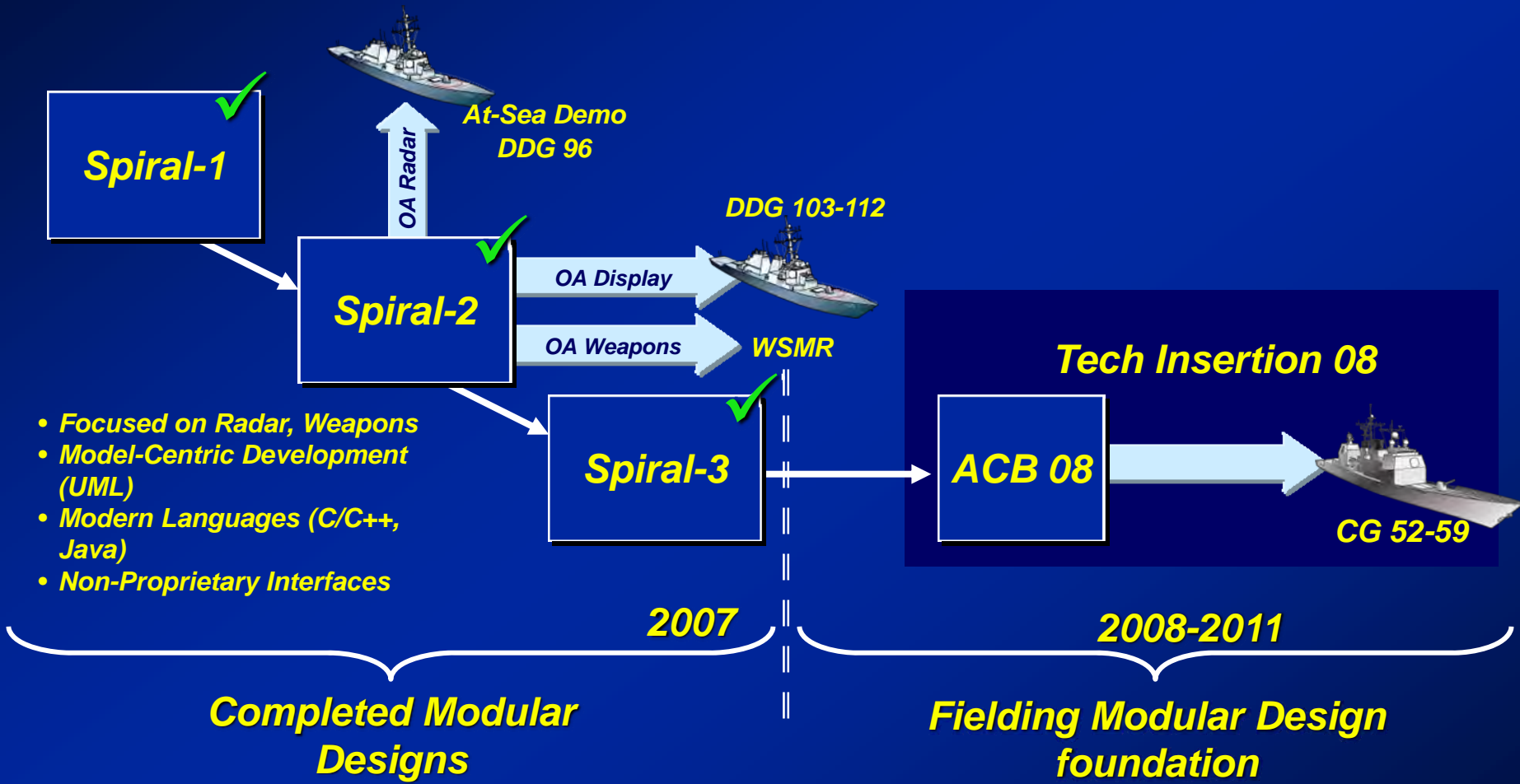
- Real Time Operating System
 - Pub-Sub Communications
- High Availability Middleware
- Enterprise System Management
- Human-Systems Software
- Network Management Tools



Smaller Footprint and Reduced Processor Costs

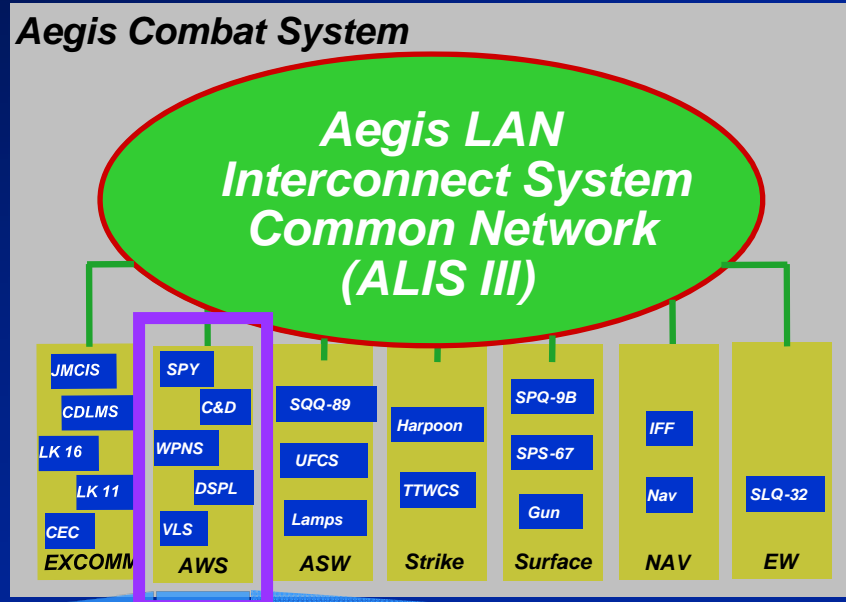
Incremental Development

"Build a little ... test a lot"



Open Architecture Foundation for Baseline 9 Developments

Where We are Today



	Technical Assessment	SPY		Open C2		Weapons/ Fire Control	VLS
		Signal Processing	Radar Control	Display	C&D		
DDG-91 2004	Hardware	Custom	SMP	Mainstream	Mainstream	SMP	Mainstream
	Software	Closed	Closed	Open	Open	Closed	Closed
CG-52 2008	Hardware	Custom	Mainstream	Mainstream	Mainstream	Mainstream	Mainstream
	Software	Closed	Open	Open	Open	Open	Closed
CG-62/ DDG-51 2012	Hardware	Mainstream	Mainstream	Mainstream	Mainstream	Mainstream	Mainstream
	Software	Open	Open	Open	Open	Open	Open

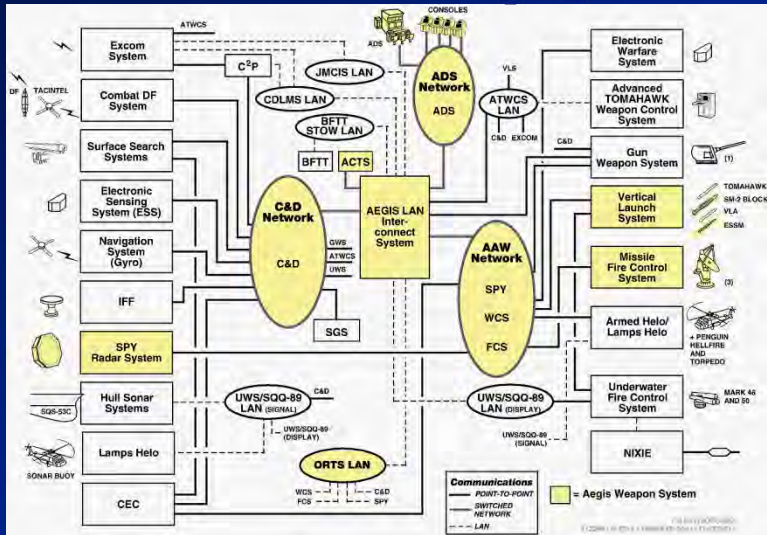
Continuously Advancing the Aegis Combat System Forward

Today's Aegis Combat System

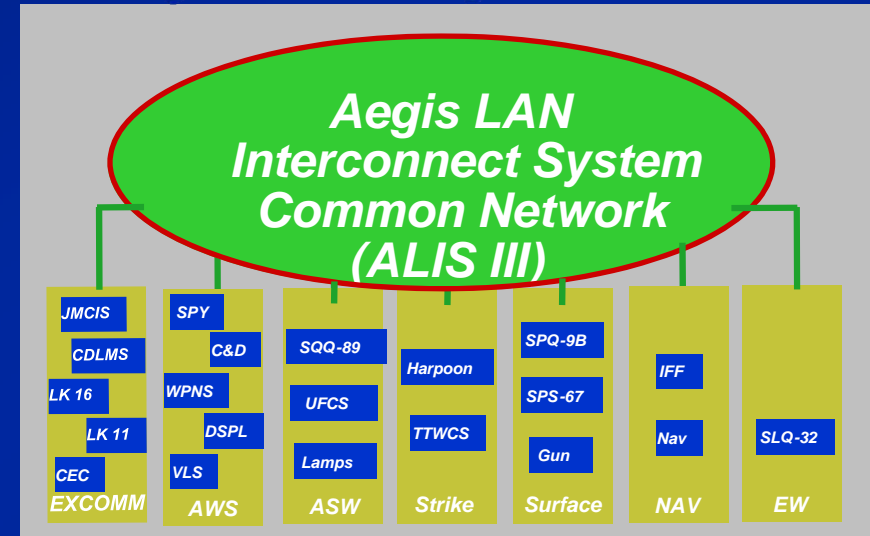
Surface Warfighting Electronics Architecture



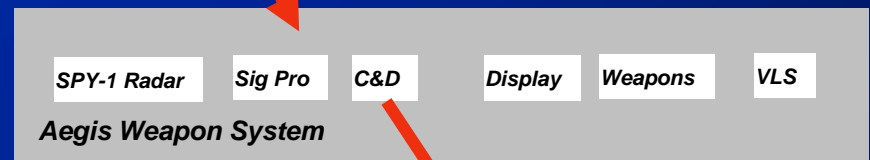
Detect/Control/Engage View



System/Subsystem View



- ✓ Federated, Tiered Architecture
- ✓ Efficient ACS Capability changes
- ✓ Well-Define Components and API's

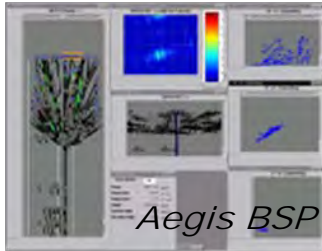


Supports Operational and Navy Business Model Objectives



Aegis Modernization

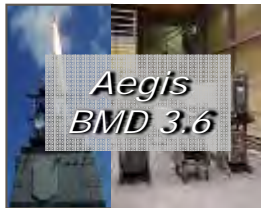
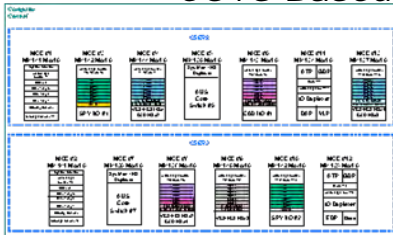
Roadmap to Aegis Modernization (AMOD)



Increased Battlespace and Multi-Mission Interoperability



COTS Based Infrastructure



Aegis BMD Block 06/08

✓ Aegis BMD 3.6
 LRS&T, Engagement and LoT
 Multi-Mission
 Integrated Mission Planning
 SM-3 Blk I and IA

Aegis BMD Block 04

AMOD Advanced Capability Build 12
 (DDG configuration)

Tech Insertion (TI) 12 Aegis BMD 5.0
 ACS Element Upgrades NIFC-CA
 JTM Alignment MMSP
 SM-6

AMOD Advanced Capability Build 12
 (CG configuration)

TI12 NIFC-CA
 ACS Element Upgrades
 JTM Alignment
 SM-6

AMOD ACB12 (TI12)

Aegis BMD 4.0.1
 Improved Discrimination
 Improved Track Handover
 Enhanced LoT
 Integrated IR/RF KA
 SM-3 Blk IA and IB

ACB08
 OA Spiral 3
 ACS Element Upgrades
 TI 08

CG MOD ACB08 (TI08)

B/L 7 Phase IR
 OA Display Improvements
 CIWS Block 1B Fratricide Avoidance
 CEC 2.1 (Mode 5)
 COTS Refresh 1

✓ B/L 7 Phase I
 COTS architecture

CR0/CR1

AMOD Technical Scope



HM&E Upgrades



BMD 4.0.1 Functionality and SM-3



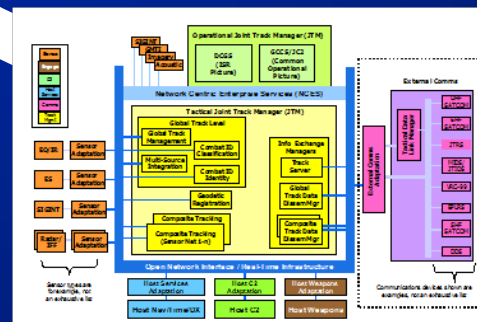
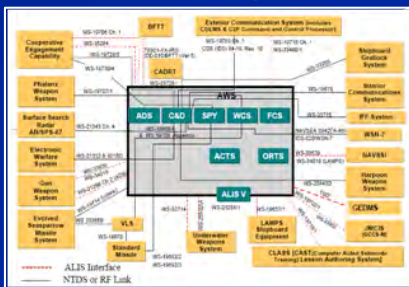
Aegis Weapon System COTS Refresh 3



NIFC-CA and SM-6

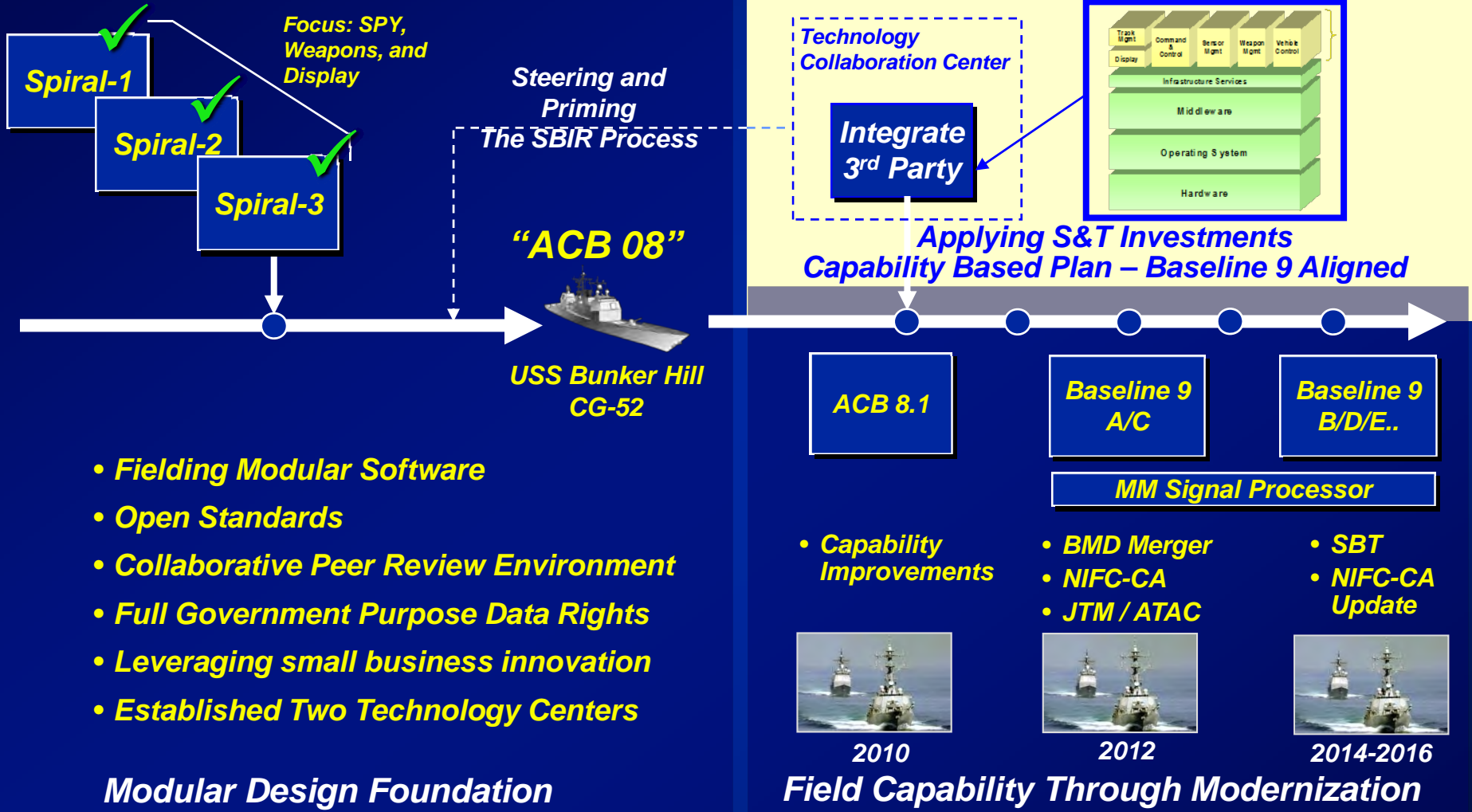


Aegis Combat System Upgrades



JTM Alignment

Way Ahead ... Baseline 9



Balancing Capabilities with Complex Combat System Integration Foundation Established for Transition to Objective Architecture

Implementing Open Architecture

Layered Architecture Foundation

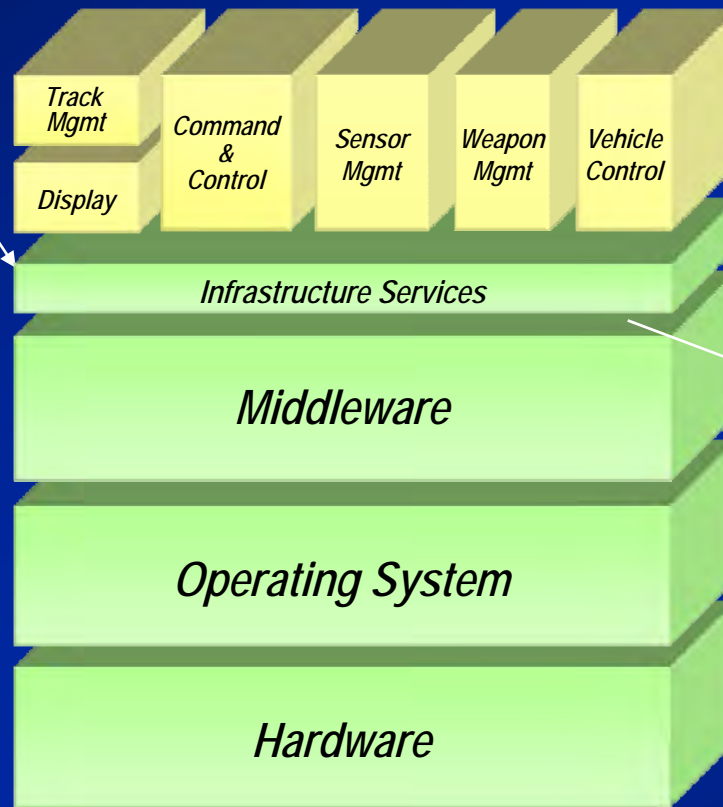


Infrastructure:

- Common Services and APIs
- Flexibility to Support Forward-Fit and Back-Fit

Common Computing Environment:

- Standards-based Interfaces to network
- Commercial Mainstream Products and Technologies



Componentized Objective Architecture:

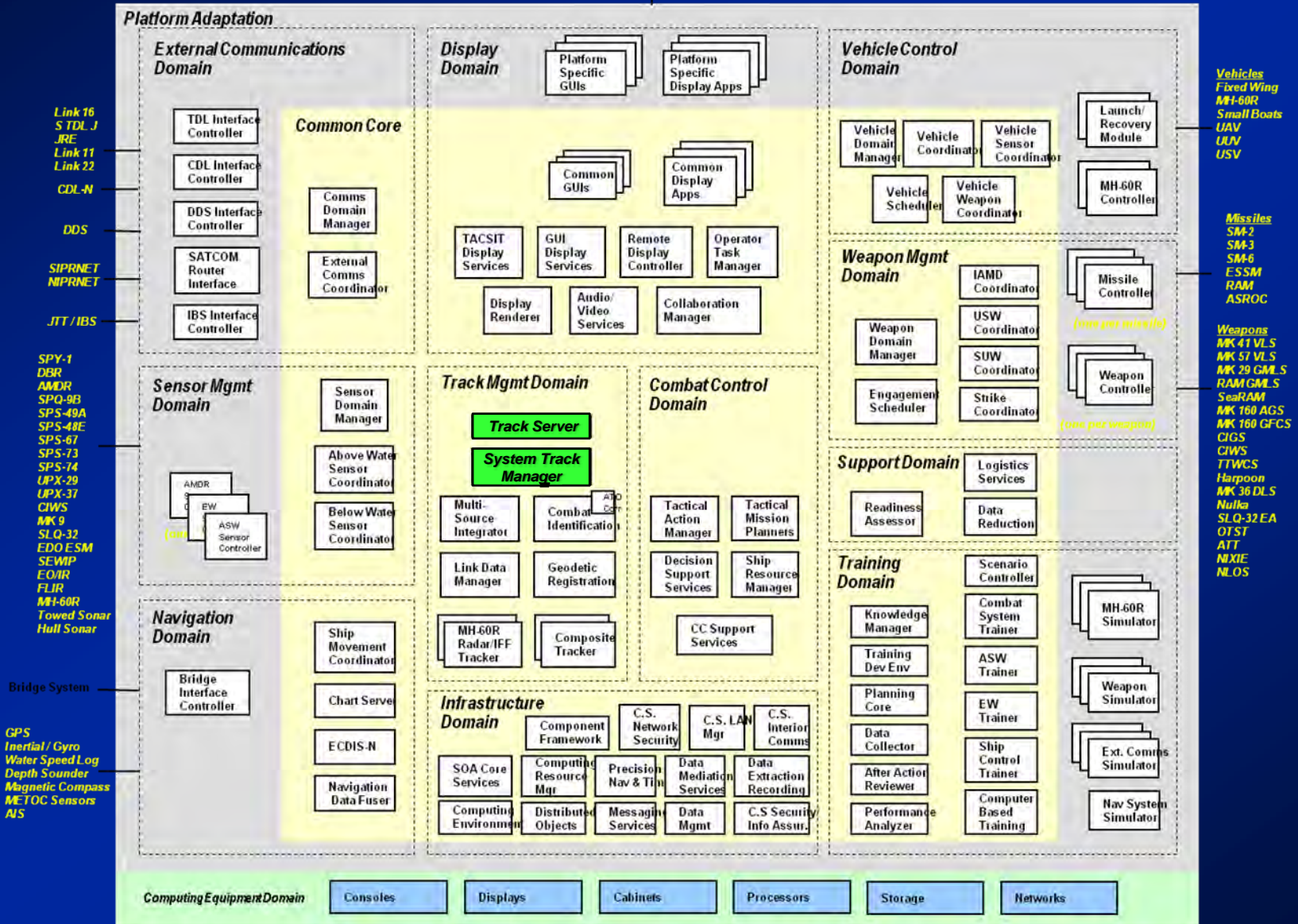
- Common Reusable Components
- Platform Specific Components
- Data Model
- Extensible to the Future

Decouple Hardware (H/W) from Software (S/W)

Upgrading Hardware and Software Independently

Top Level Objective Architecture

“Component View...”



Joint Track Management Alignment

Overview

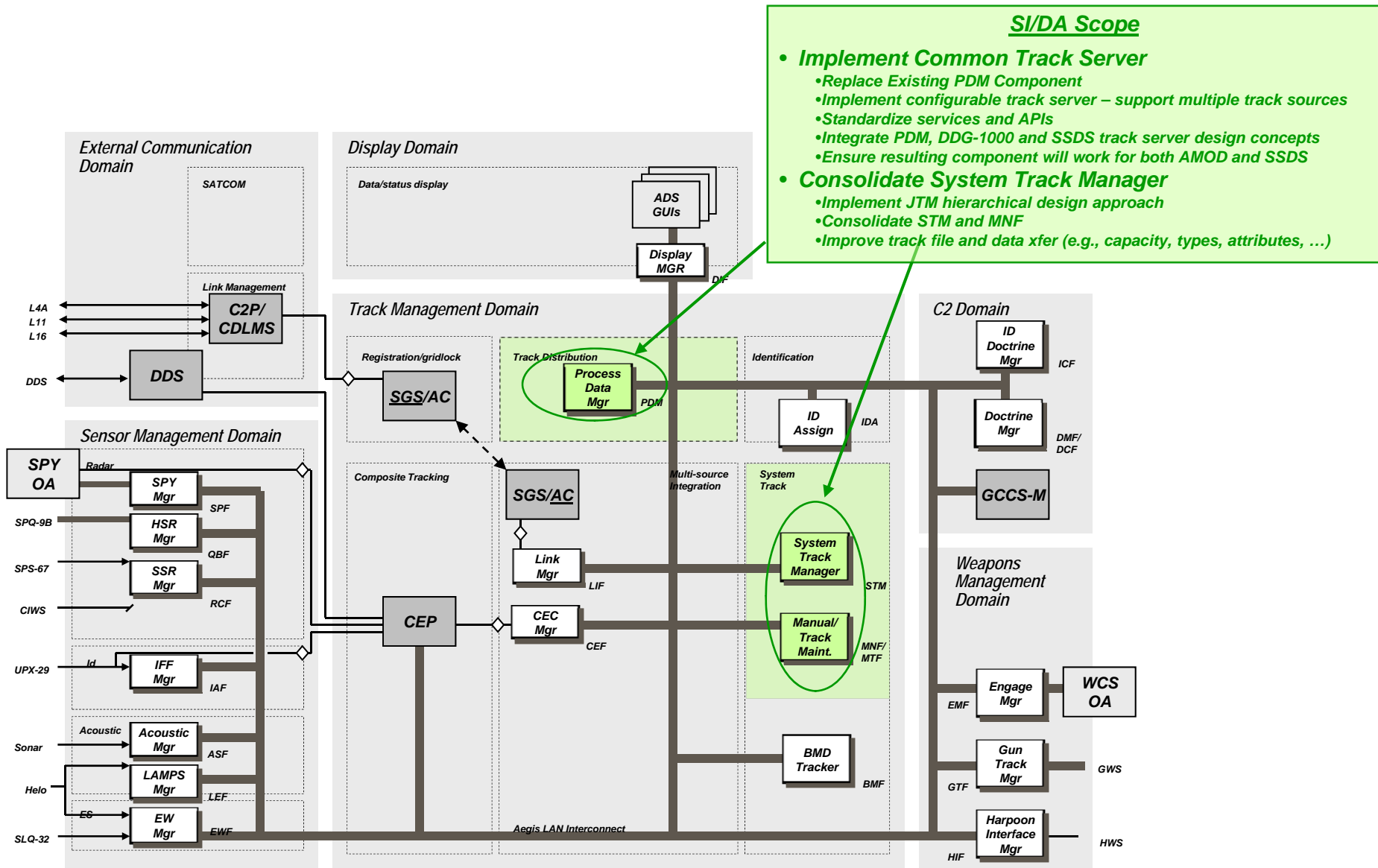


- **Align AMOD and SSDS Track Management to a Common Architecture**
 - Provide Consistent Functional Allocation, Data Representation and Attributes
 - Incorporate Reusable System Track Manager and Track Server Components
- **Provides Hierarchical Track File (System Level – Source Level)**
- **Provides Standard Interfaces**
 - Track Server Standard Access Interface for Client Applications
 - Track Manager Integrates Track Data Sources via Common Interface; Extensible for New Track Data Sources
- **Provides Two Complete Versions of Live Training Tracks:**
 - Allows Training Override of Multiple Attributes
 - Training Tracks Can be Physically Relocated From Live Location
- **Provides Dual Ownership – Tactical and Training:**
 - Allows Training View to be Repositioned with No Impact to Tactical View

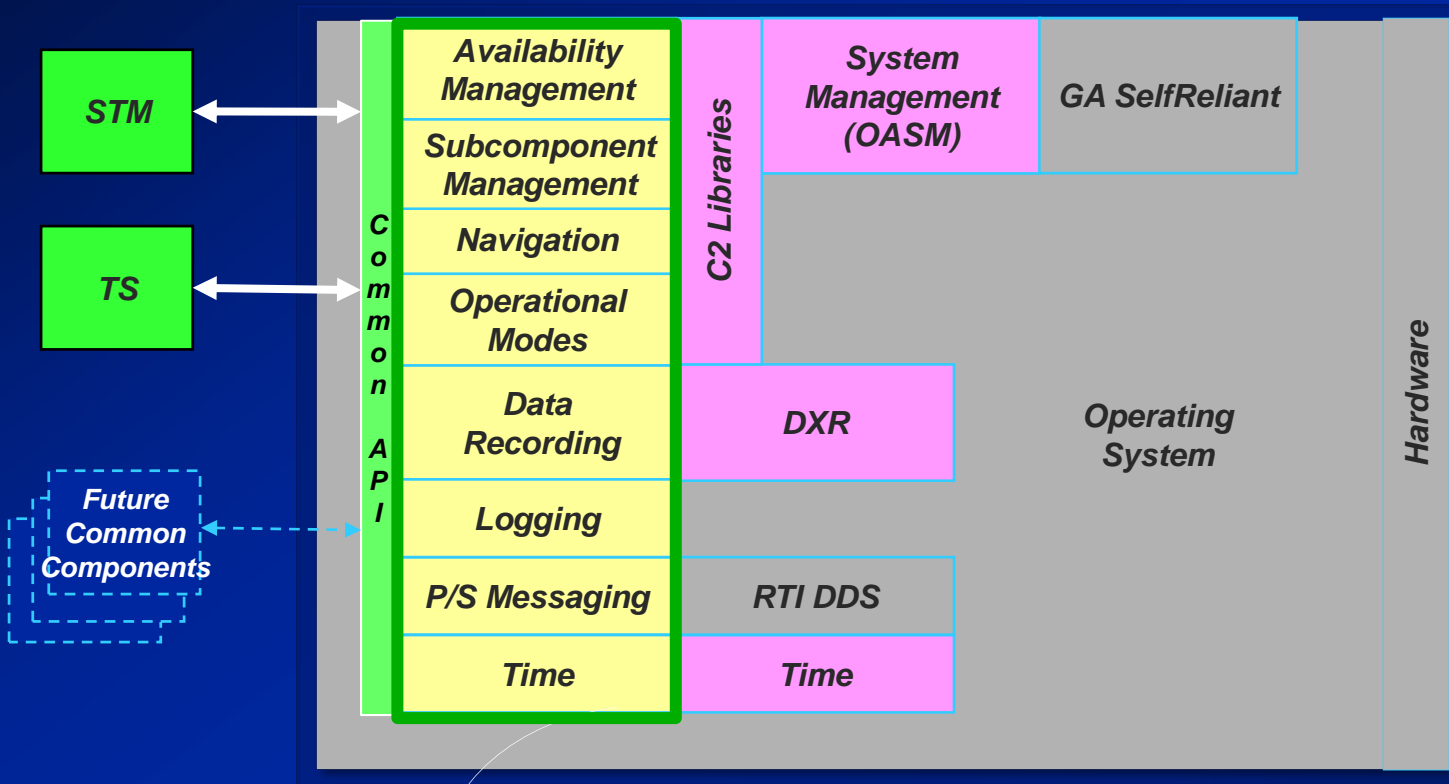
*Aligning the Architecture for Future:
Common Components Across Ship Classes*

JTM Alignment

Integration of Common STM and TS Components...



Component Framework Services



Component Framework Services



Common STM and TS Components

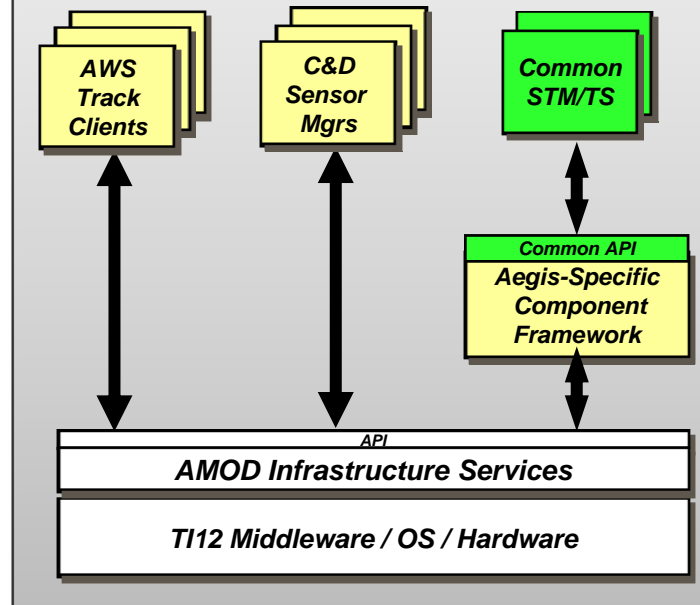
Task Allocation...



LM Tasks:

- Update AMOD System Specs (A-level, B1, B5)
- Provide Legacy Aegis Requirements (e.g., STM, PDM, MNF) to SI/DA
- Validate Aegis Requirements Covered by Enterprise SRS's
- Remove STM/TS Functionality from Existing Components
- Modify C&D Sensor Managers IAW Functional Allocation (Design, Code, and Test)
- Modify Aegis Track Server Clients (Design, Code and Test)
- Design, Code and Test Aegis-Specific Component Framework
- Integrate STM/TS into AMOD
- Provide TOR/CPCRs
- Verify System Performance

AMOD System



SI/DA Tasks:

- Develop Enterprise SRSs for STM and TS from Aegis and SSDS
- Develop UML Models
- Auto-generate IDD and Interface Code from UML Models
- Design, Code and Test STM and TS Components
- Provide Interim and Final STM/TS Components to LM
- Implement CM and Change Control of STM/TS
- Implement CPCr Fixes to STM/TS Components
- Support Integration of STM/TS into AMOD
- Support SQT of STM and TS

LM and Third party Joint Tasks:

- Establish linked classified development environment
- Establish and Track Progress and Dependencies via Joint IMS
- Participate in Navy-led Data Model and Component Framework Working Groups
- Support Functional Allocation
- Support Definition of Data Model, TS APIs, and Common Service APIs
- Support Definition of Enterprise-level Processes and Artifacts
- Support Enterprise ETRs and Enterprise SSR
- Support Enterprise CCB and Prioritization/Adjudication of TORs/CPCRs

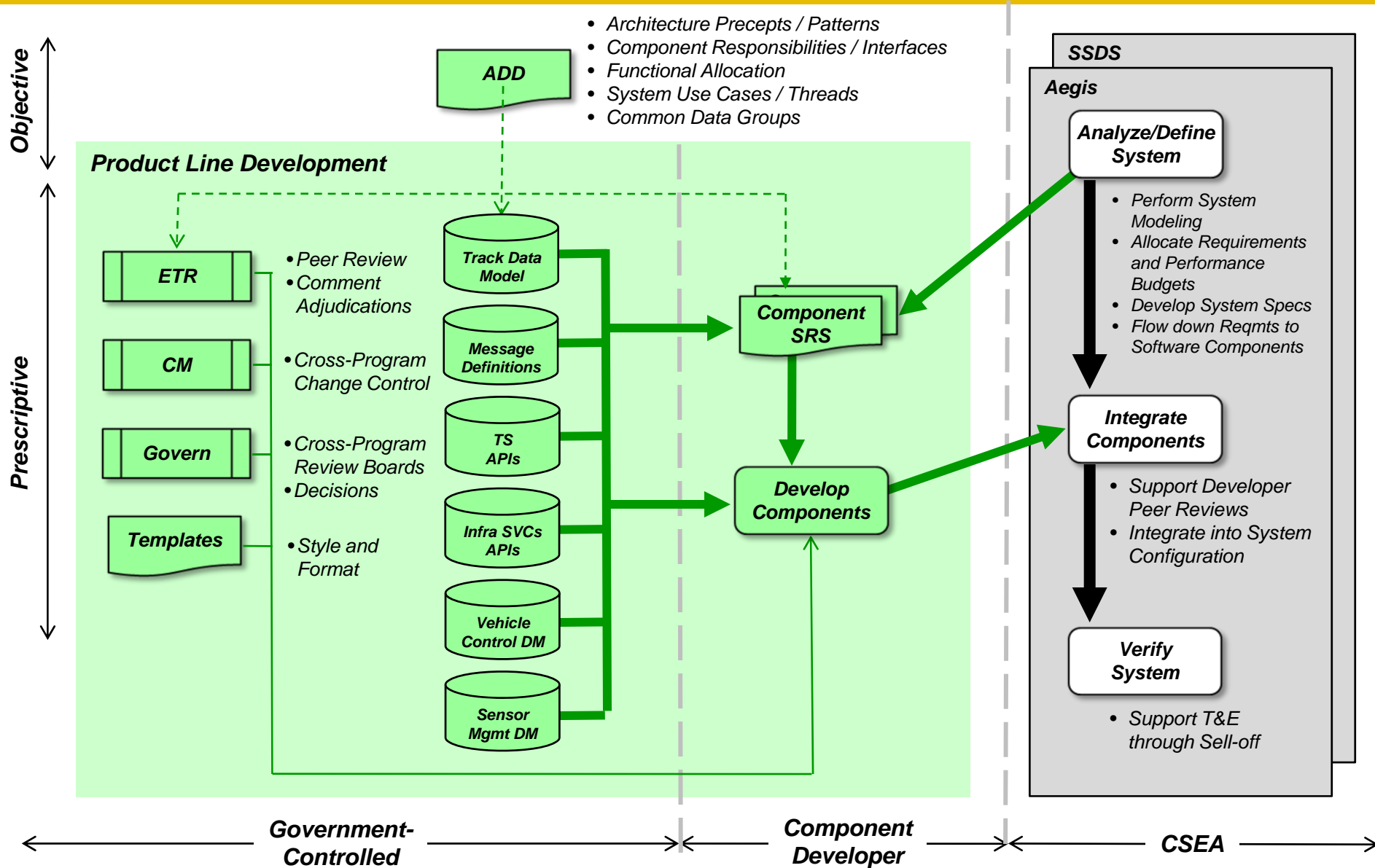
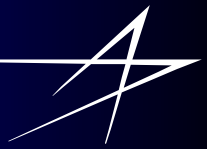
Legend

- New/Modified AWS
- New Common

Allocation and Governance Was Essential

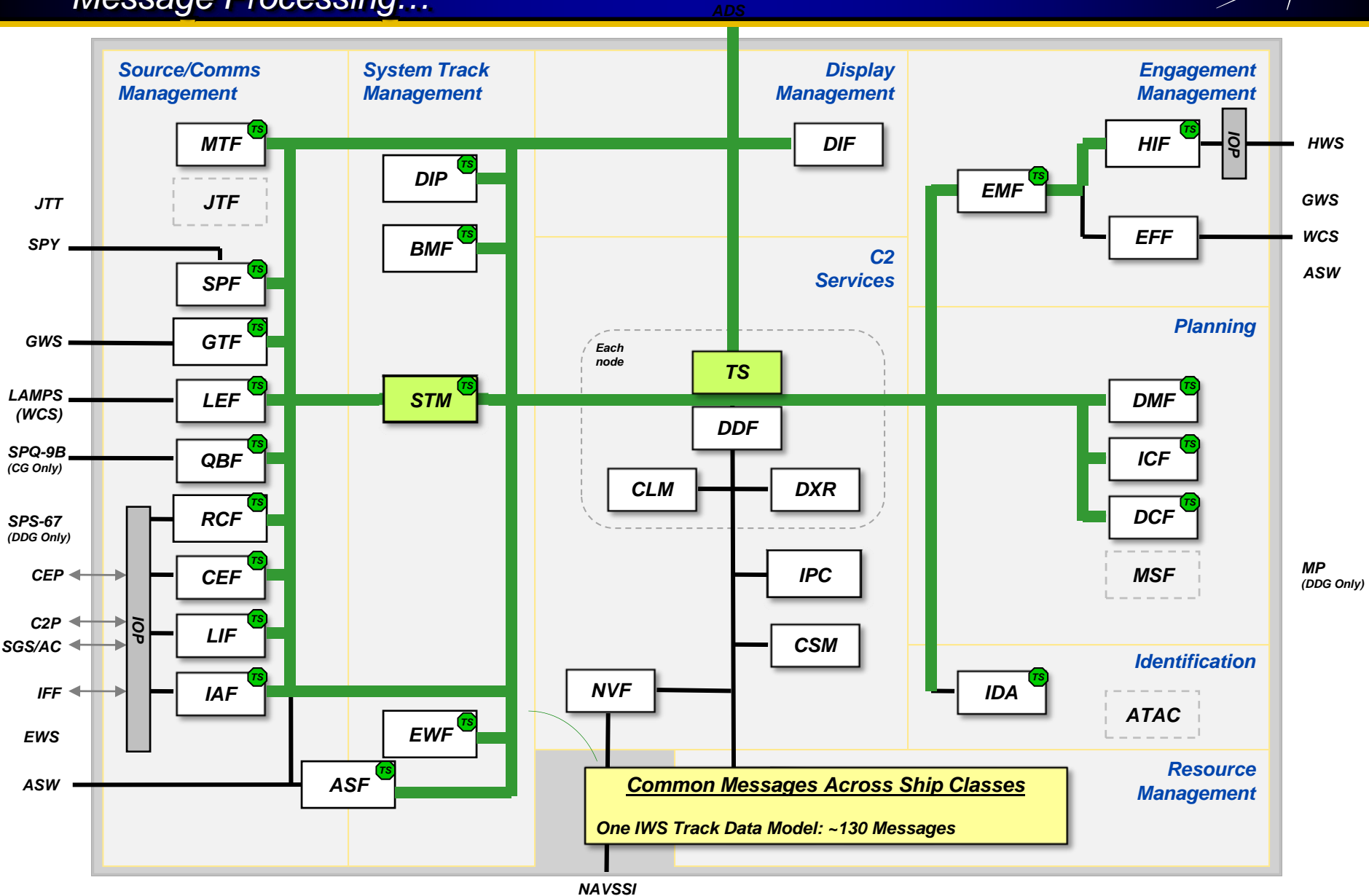
Objective Architecture

Roles and Responsibilities...



AMOD C&D Component Architecture

Message Processing...



NAVSSI

What We Learned



Lessons Learned Address Multiple Perspectives

Aegis Open Architecture

Summary



1994

2000

2006

2012-2016

COTS Infrastructure



B7PhI



DDG-91+

- Separation of Application/ Infrastructure
- Commercial Standards
- Commodity Products

Component-Based Software



- Component-Based Designs
- Layered Architecture
- Configurable Test Environments



CGM



CG-52+

Open Business/ Common Components

- Objective Architecture
- Open Business Practices
- Open Disclosure / Gov't Purpose Data Rights
- Increase Number of Players/ Opportunities



AMOD

DDG-51+ / DDG 113

CG-62-73

Increased Capabilities

- AAW/BMD
- JTM
- SM-6
- NIFC-CA
- SBT



Glossary



Acronym	Description	Acronym	Description
ACB08	Advanced Capability Baseline 2008	LAN	Local Area Network
ACB12	Advanced Capability Baseline 2012	LM	Lockheed Martin
ACS	Aegis Combat System	LOT	Launch on TADIL
ADD	Architecture Definition Document	MMSP	Multi-Mission Signal Processor
Aegis	(not an acronym) Greek Shield of Zeus	MS	MicroSoft
ALIS	Aegis LAN Interconnect System	NIFC-CA	Naval Integrated Fire Control - Counter Air
AMOD	Aegis MODernization	OA	Open Architecture
API	Application Programming Interface	OAET	Open Architecture Enterprise Team
ASCM	Anti-Ship Cruise Missile	OASM	Open Architecture System Management
ASROC	Anti-Submarine ROcket	P/S	Publish/Subscribe
BL	Baseline	PIDS	Prime Item Development Specification
BMD	Ballistic Missile Defense	PIM	Platform Independent Model
C2	Command and Control	PSEA	Platform System Engineering Agent
CCB	Configuration Control Board	PSM	Platform Specific Model
CEC	Cooperative Engagement Capability	Pub/Sub	Publish/Subscribe
CG	Guided Missile Cruisers	RF	Radio Frequency
CIWS	Close In Weapon System	SAD	System Architecture Document
CM	Configuration Management	SAN	Storage Area Network
COTS	Commercial Off-the-Shelf	SBT	Sea-Based Terminal
CPCR	Computer Program Change Request	SI/DA	System Integrator / Design Agent
CR	COTS Refresh	SM	Standard Missile
CSEA	Combat System Engineering Agent	SMP	Symmetric MultiProcessor
CVN	Carrier Vessel Nuclear	SQT	System Qualification Test
DDG	Guided Missile Destroyer	SRS	System Requirements Specification
DDS	Data Distribution Service	SSDD	System/Segment Design Document
DM	Data Model	SSDS	Ship Self Defense System
DOORS	Dynamic Object-Oriented Requirements System	SSR	Software Specification Review
ESSM	Evolved Sea Sparrow Missile	STM	System Track Manager
ETR	Engineering Technical Review	SVC	Service
GCC	GNU Compiler	SW	Software
GFE	Government Furnished Equipment	SysML	Systems Modeling Language
HM&E	Hull, Mechanical and Electrical	T&E	Test and Evaluation
HW	Hardware	TADIL	Tactical Digital Information Link
IAW	In Accordance With	TI	Technology Insertion
IDD	Interface Definition Document	TLAM	Tomahawk Land-Attack Missile
IDS	Interface Design Specification	TOR	Test Observation Report
IMS	Integrated Master Schedule	TS	Track Server
IPO	Input/Output/Process	UML	Unified Modeling Language
IR	Infrared	VLA	Vertical Launch ASROC
JTM	Joint Track Management	VLS	Vertical Launch System
KA	Kill Assessment	XML	eXtensible Markup Language