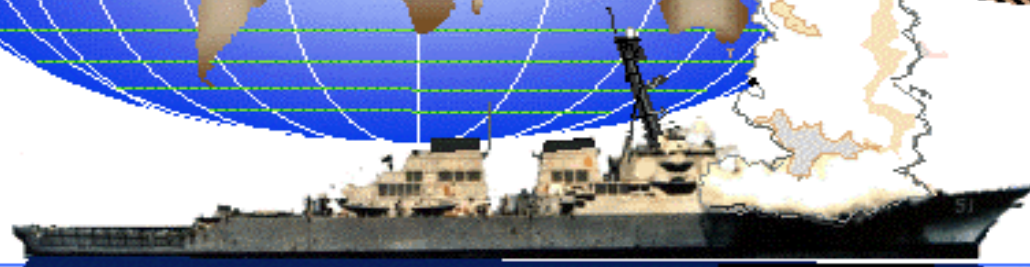




HiPer-D



Demonstration 2000

Michael W. Masters NSWCDD Code B35
540-653-1611 mastersmw@nswc.navy.mil

AEGIS ARCHITECTURE (PROBLEM STATEMENT)

	Ships	Warfighting Upgrades (CC&D, NTW...)	COTS Refresh	Computer Program Maintenance
B/L 6 Ph III	CG 59 – 73 DDG 51 – 84 DDG 85 –90	R	Y/R	Y/R
B/L 7 Ph I	CG 52 – 58 DDG 91 -107	Y	Y/R	Y/R
Open Architecture	TBD	G	G	G

- **Warfighting Performance Needs**
 - NTW/NMD requirements
 - Emergent AAW threat requirements
 - Land Attack (4D deconfliction)
 - Simultaneous multi-mission warfighting
 - Fault tolerance/survivability
 - Dynamic resource management
- **Development Cycle Time Reduction Needs**

- **Cost Needs**
 - Reduced Maintenance Cost
 - Reduce Development Cost
 - Portability (COTS Refresh)
 - Leverage Commercial Technology
- **DoD 5000.2R Direction / ASN Mandate**



AEGIS OPEN ARCHITECTURE



“When I go buy new equipment, I can prove to you that I can’t run the same computer program. The solution that will mitigate costs is really going to the open architecture.”

**– Capt John Geary, Aegis Combat System Director
quote from *Defense News*, 18 September 2000, “U.S. Navy Looking for More Adaptable Aegis Radar,” by Robert Holzer**

The new software would save hundreds of millions of dollars in avoidable costs, as well as greatly easing the addition of new capabilities to the system if an open architecture solution can be engineered and funded.

– excerpt from *Defense News* article

“I am committed to funding that.”

**– Radm John Kelly, Head, Theater Air warfare Programs
quote from *Defense News* article**



HiPer-D OBJECTIVES



Supportability-driven objectives

- **Explore open architecture baseline for Aegis**
 - COTS technology refreshable
 - Phases: C&D and ADS, SPY and WCS
 - Support PMS-400 & LMC computing critical issues
- **Evaluate DARPA and COTS technologies and trends**
 - QoS reference architecture
 - Quorum technologies
 - COTS products
 - Emerging trends
 - Standards bodies

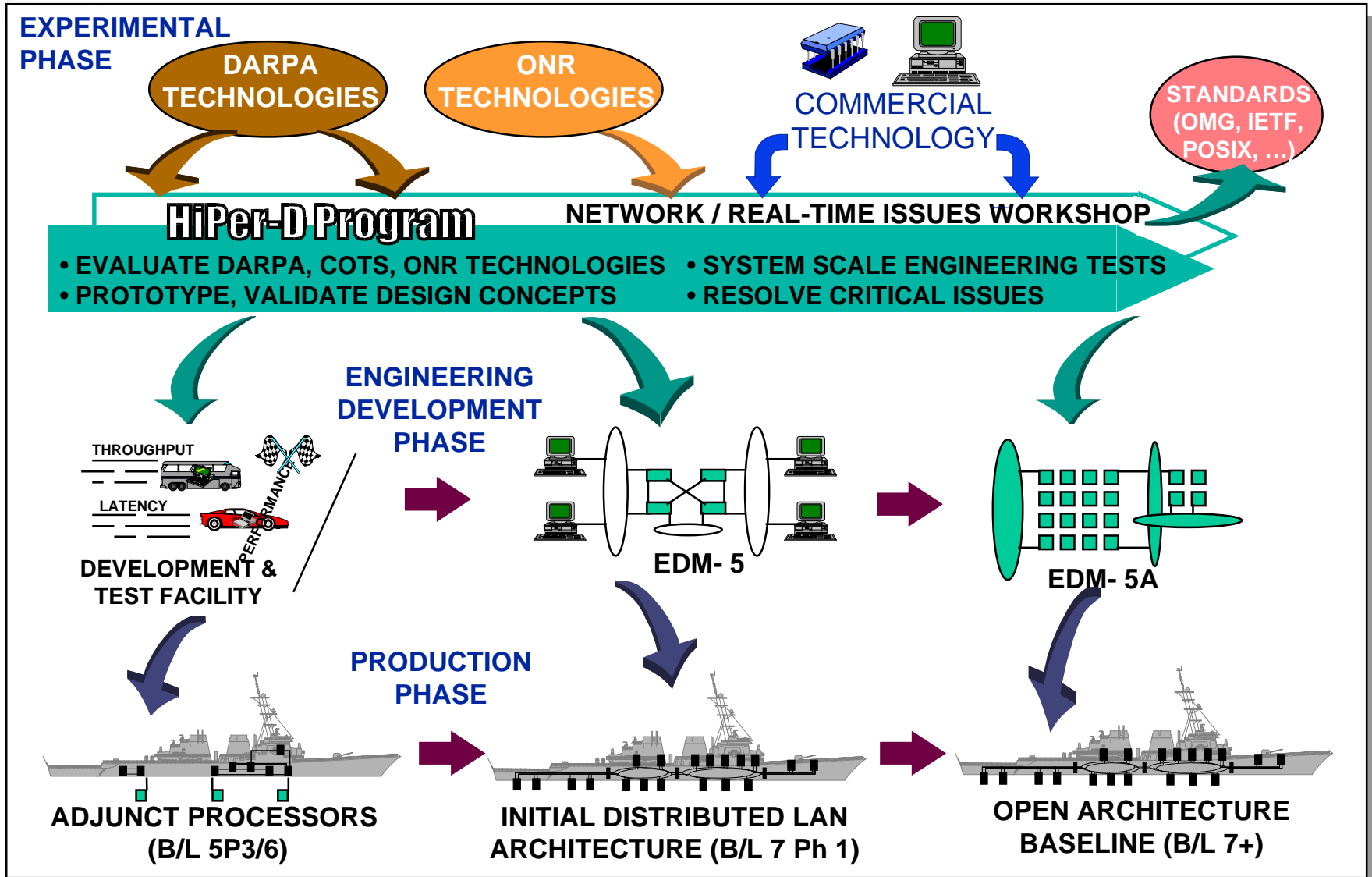
Requirements-driven objectives

- **Support AWS requirements**
 - AAW capability
 - TBMD/NTW capability
 - Radar computing capacity
- **Support ONR functionality enhancement initiatives**
 - Combat System Technology
 - Missile Defense FNC
 - Other FNCs as directed
- **Support other initiatives as directed, e.g.**
 - Land Attack mission
 - Common C&D

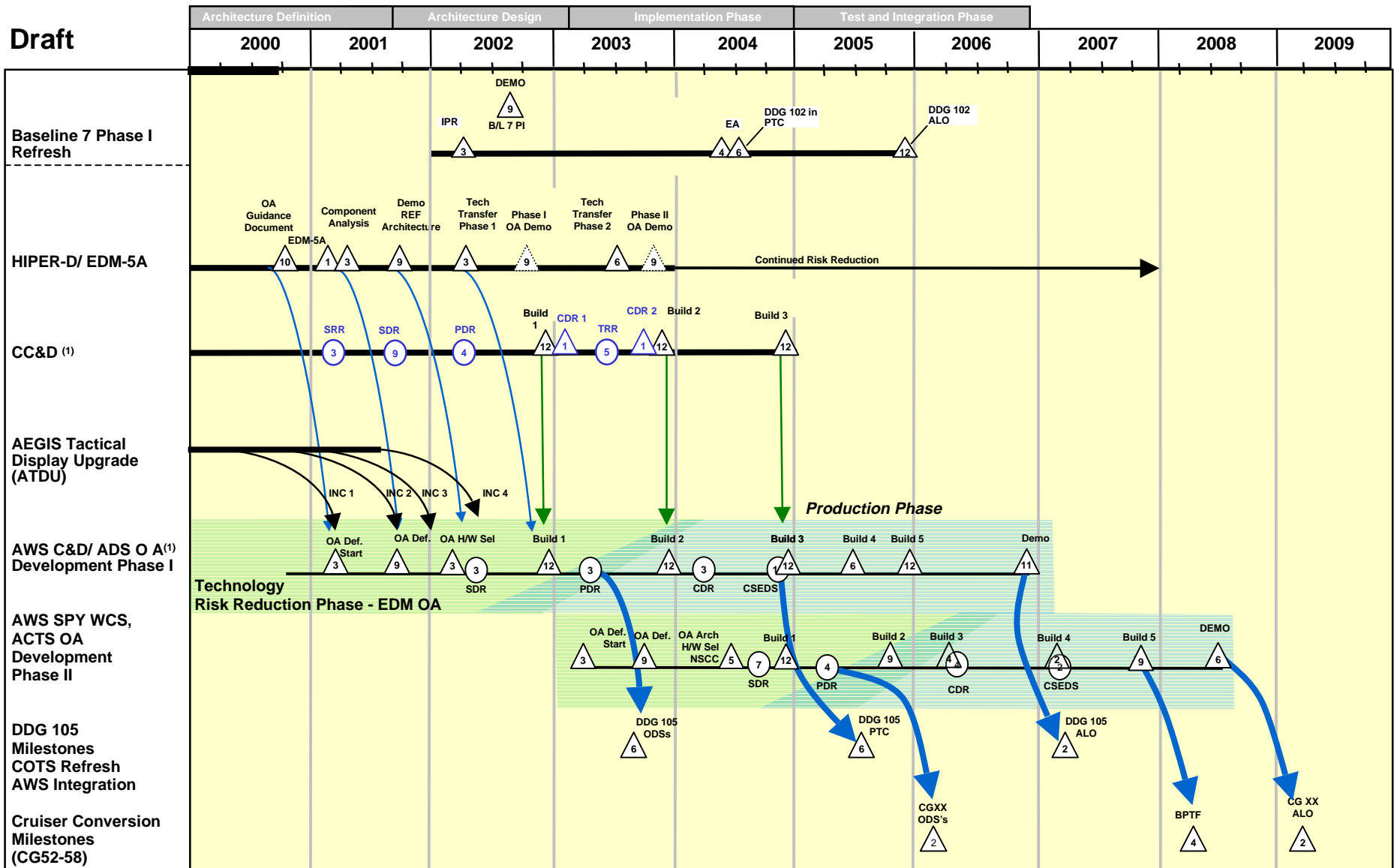
Supportable solutions that deliver required tactical performance



HiPer-D TECHNOLOGY TRANSITION



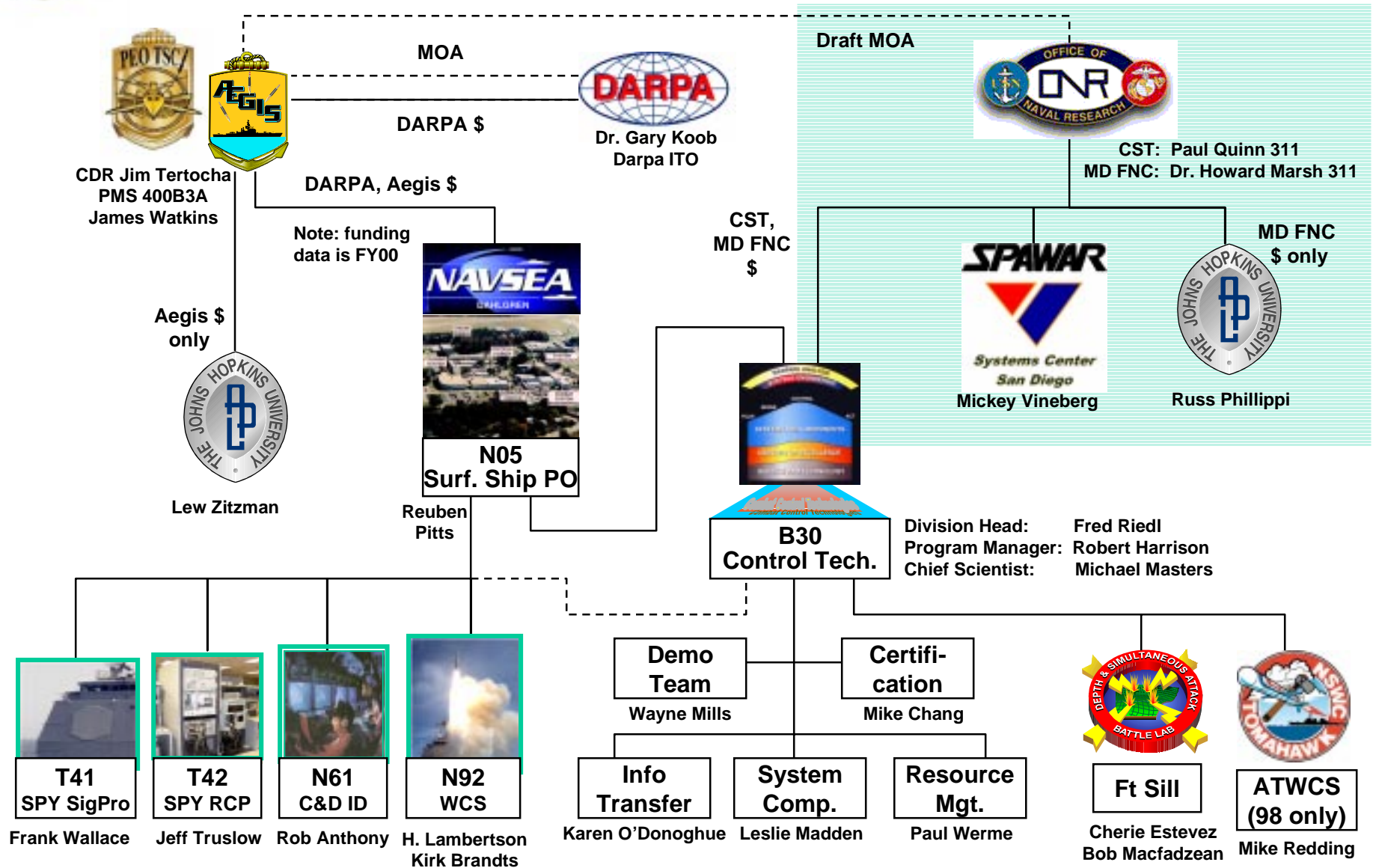
AWS OPEN ARCHITECTURE PROGRAM PLAN (INCREMENTAL OA with CC&D)



△ = Not funded (1) If CC&D is not funded, AWS C&D/ADS Scope increases but timeline remains the same



HiPer-D TEAM





HiPer-D PROGRAM



DARPA GOAL:

Transition Computing Technology to Military



HiPer-D Premise:

New Computer Program & System Architecture Required to Fully Exploit COTS Technology



AEGIS GOAL:

Eliminate Capacity & Scalability Bottlenecks



DARPA Technologies

- Advanced computers
- Operating systems
- Advanced networks
- Low latency protocols
- Quality-of-service middleware
- Resource management

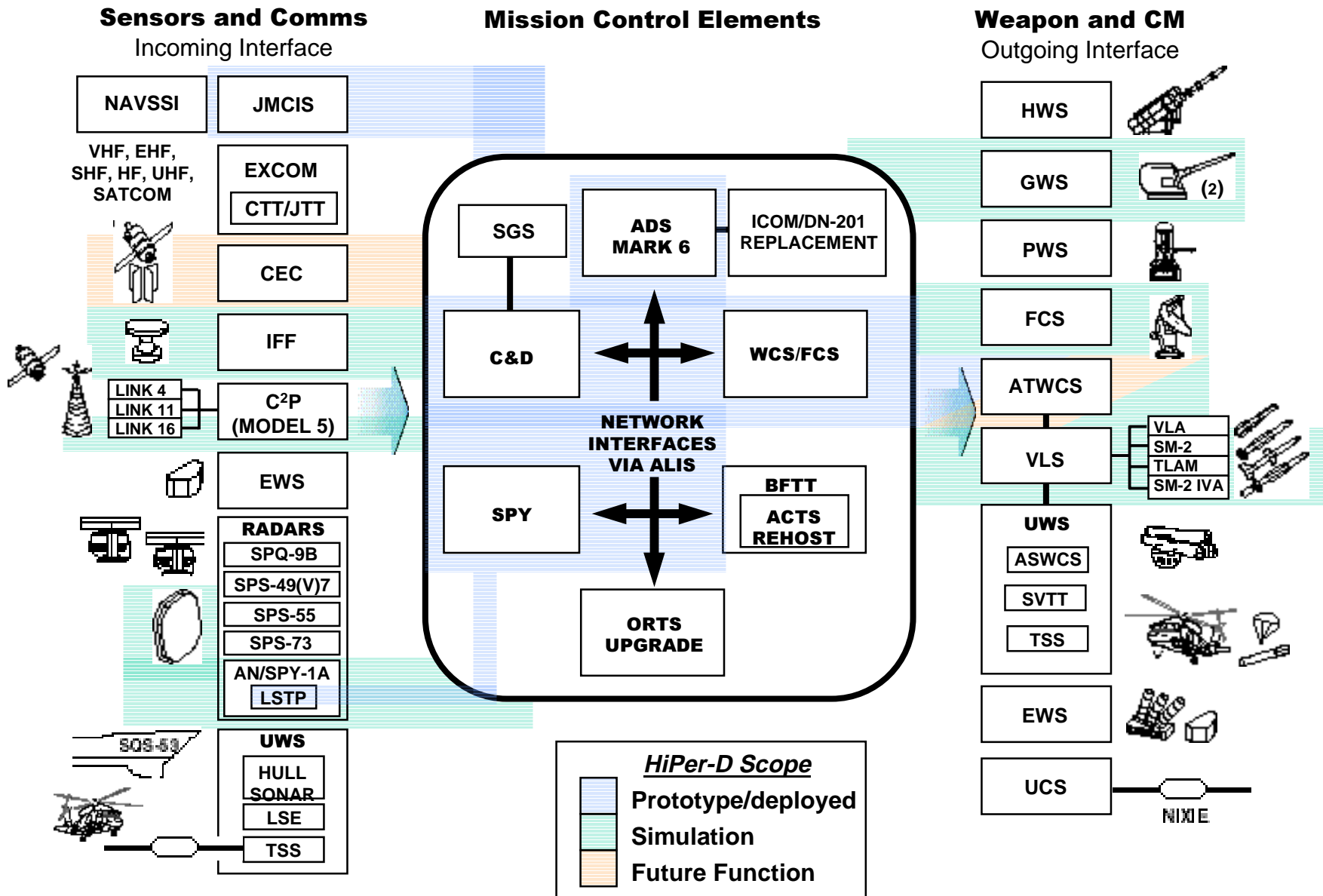
Architecture Concepts

- Distributed processing
- Open systems
- Portability
- Scalability
- Fault tolerance
- Shared resource mgt.
- Self-instrumented

Navy Benefits

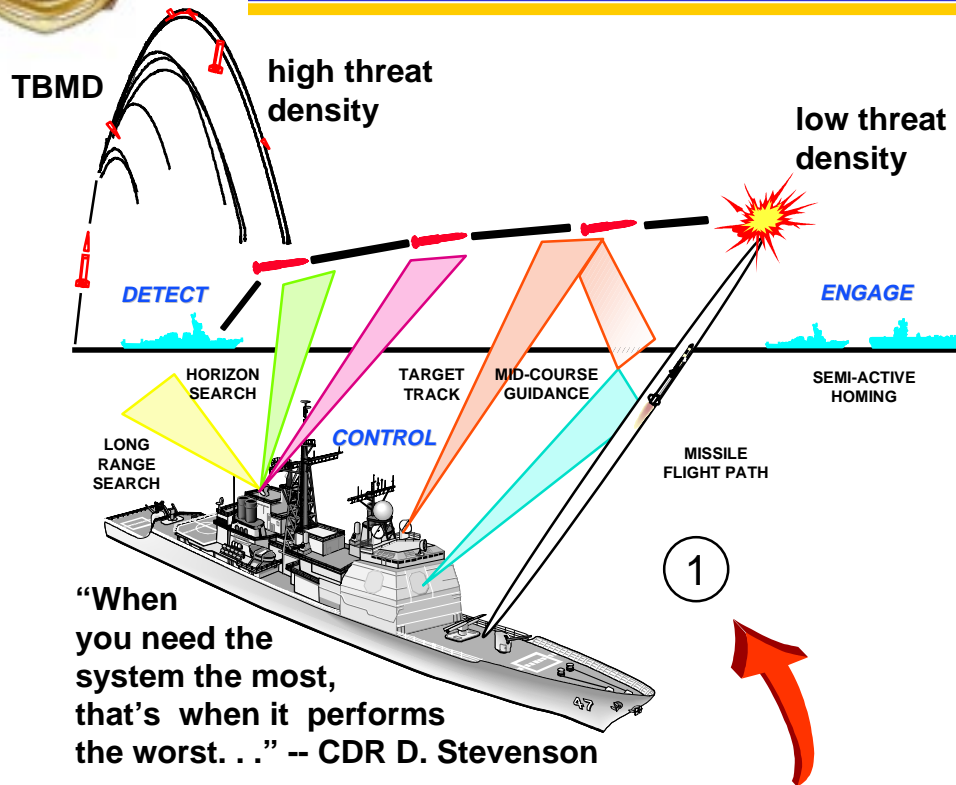
- Load-invariant tactical performance
- Information access
- Mission flexibility
- Continuous availability
- Rapid upgrades
- Low ownership cost

AEGIS Combat System Baseline 7 Phase IC





SCALABLE PERFORMANCE

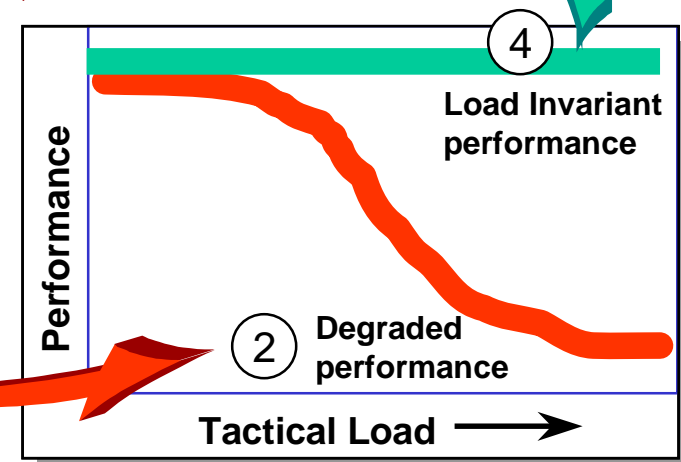


Scalable Computing Architecture

- Networked computers
- Distributed system middleware
- Scalable computer programs
- Load sharing management

3

- 1 Today’s systems often exhibit degraded performance as tactical load increases
- 2 Scalable, resource sharing design is an alternative to over-designing for worst case
- 3 Scalability thru load sharing provides constant performance despite load

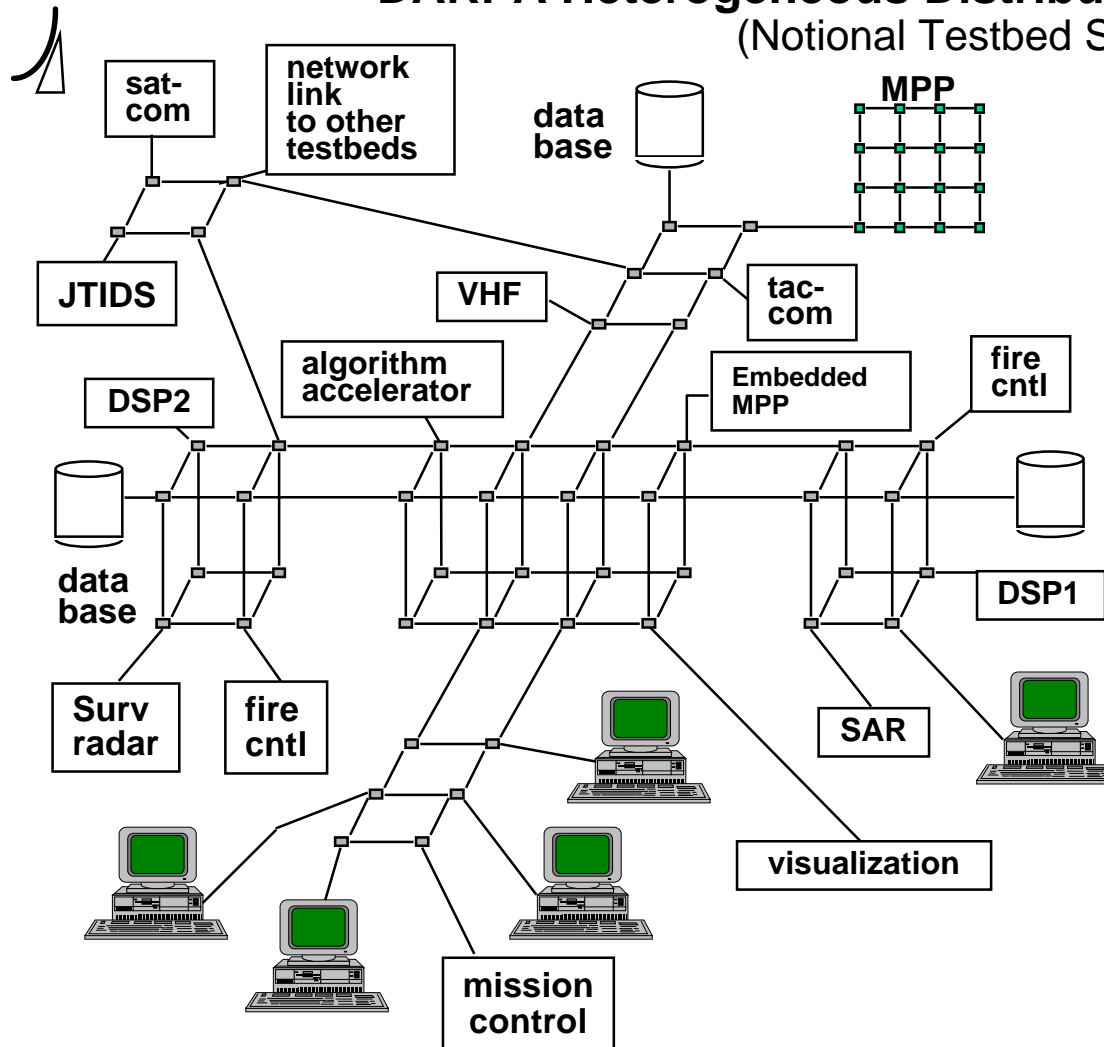




DARPA VISION



DARPA Heterogeneous Distributed Computing Vision (Notional Testbed System)

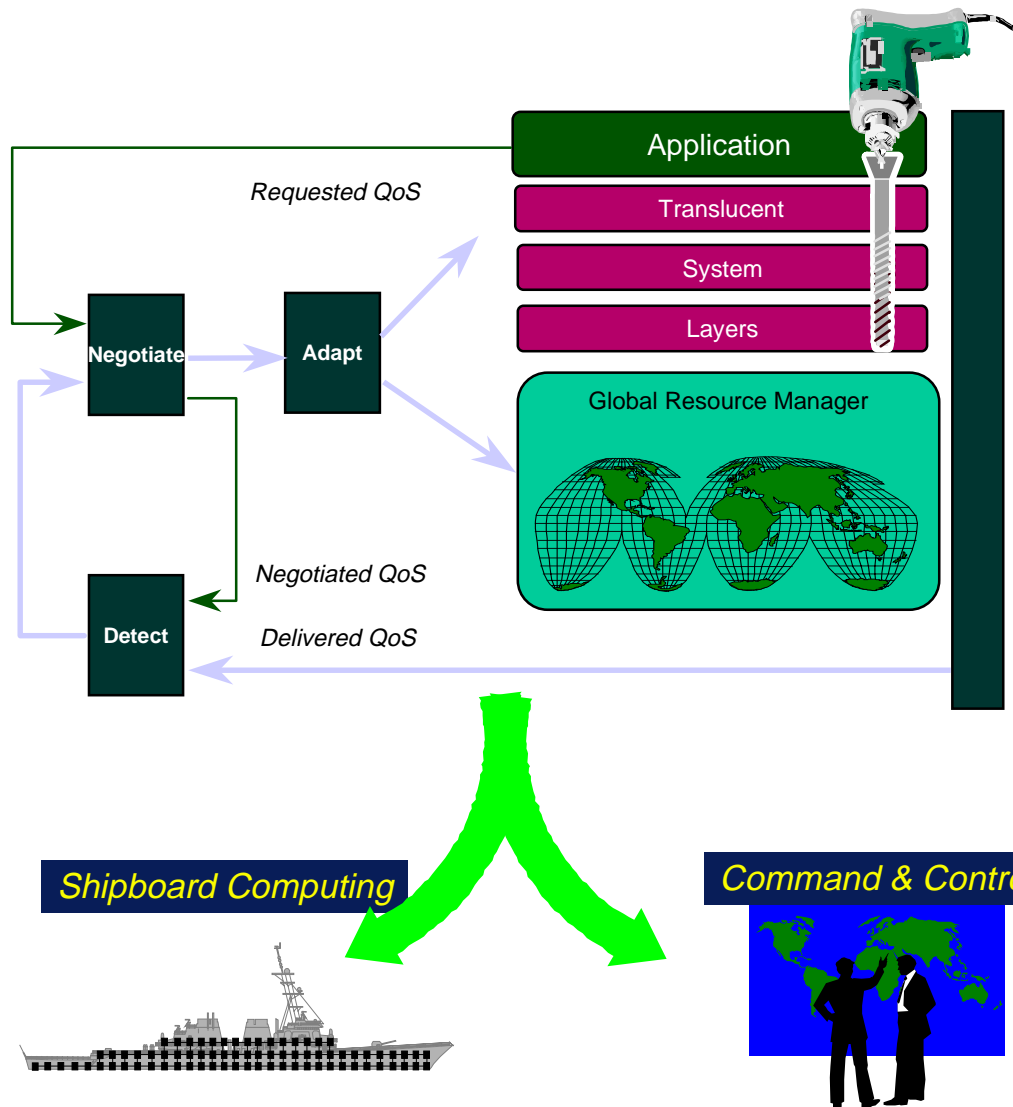


Desirable Communications Characteristics

- High data rate (>1Gb/s/link)
- Low latency (<1us)
- Low BER (<10⁻¹⁵)
- Fault tolerance
- Redundancy
- Auto-configuration
- Self-healing
- Uniform communication
- Locally scalable bandwidth
- Open COTS interfaces
- Performance at minimum cost
- Vendor neutral
- Interoperable with other testbeds sharing vision



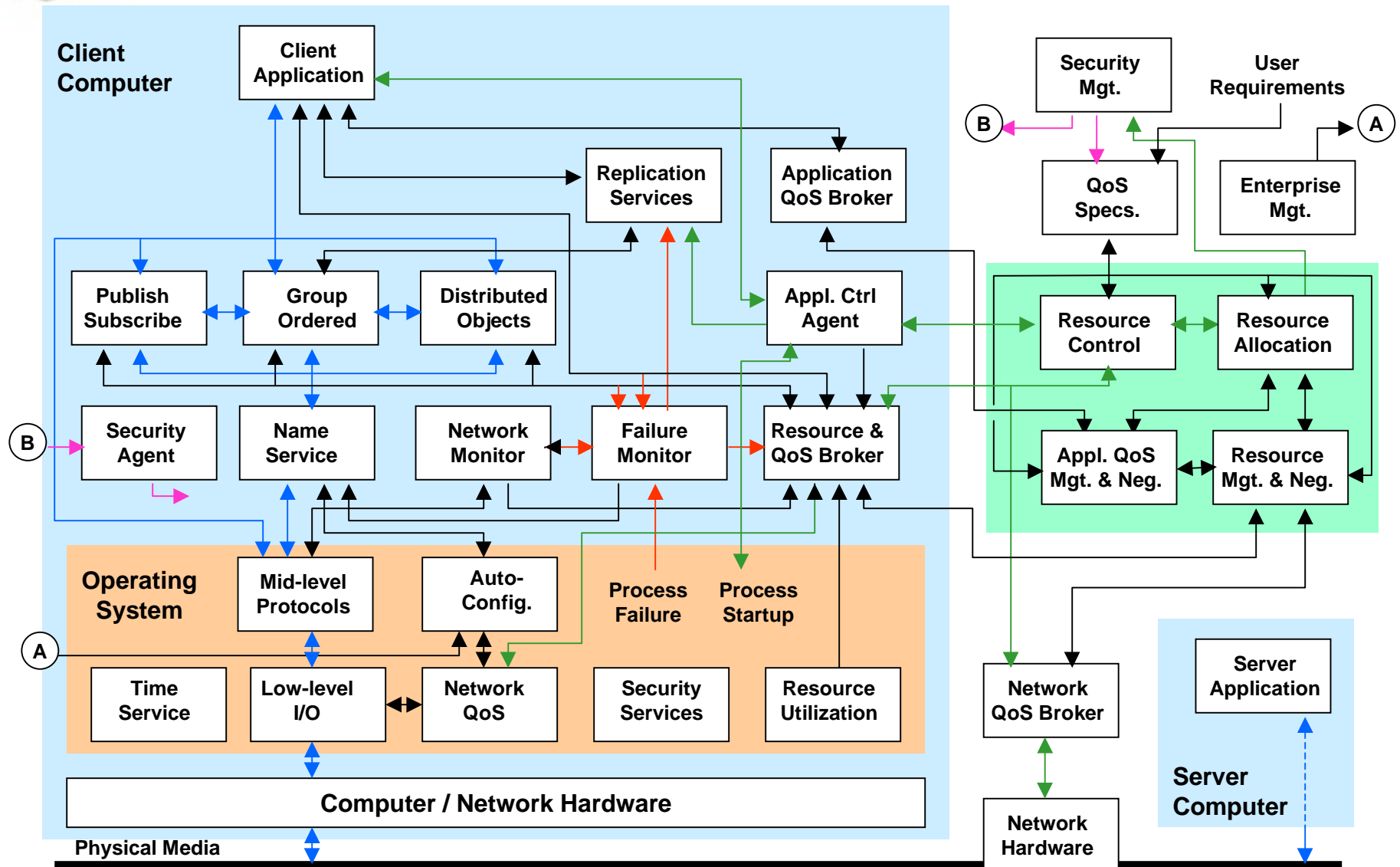
Quorum Program Organization



- **Quality-of-Service Arch**
 - Negotiated QoS “contracts”
 - Feedback control system
- **Drill-Down Technologies**
 - Adaptation mechanisms
- **Translucent Layers**
 - Propagate QoS constraints
 - Cross-layer adaptation
- **Adaptive Global Resource Manager**
 - Dynamic discovery
 - QoS-driven allocation
 - Adaptive reconfiguration
- **Integration/Demonstration**



QoS REFERENCE ARCHITECTURE

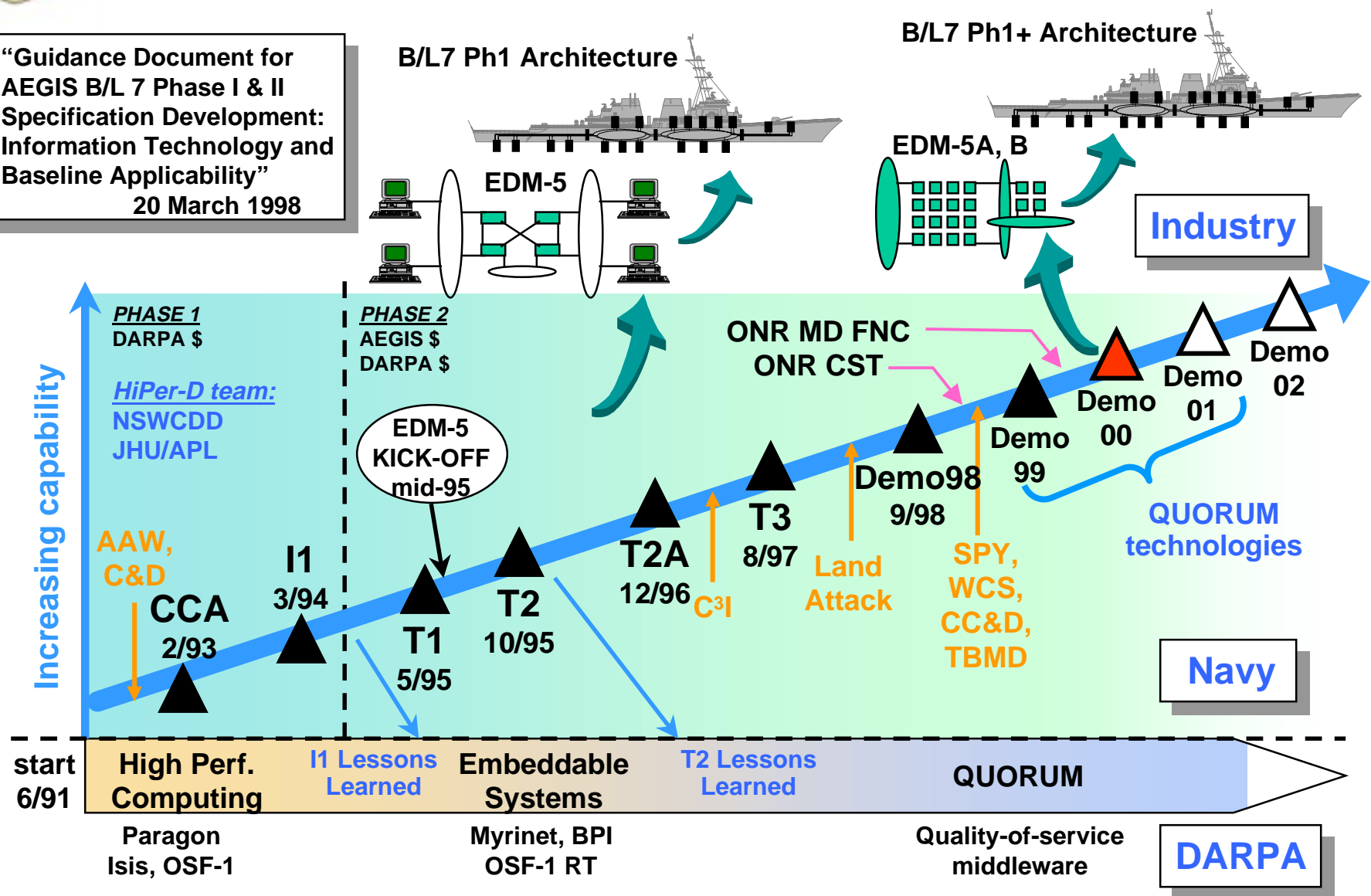




HIPER-D HISTORY



“Guidance Document for AEGIS B/L 7 Phase I & II Specification Development: Information Technology and Baseline Applicability”
20 March 1998

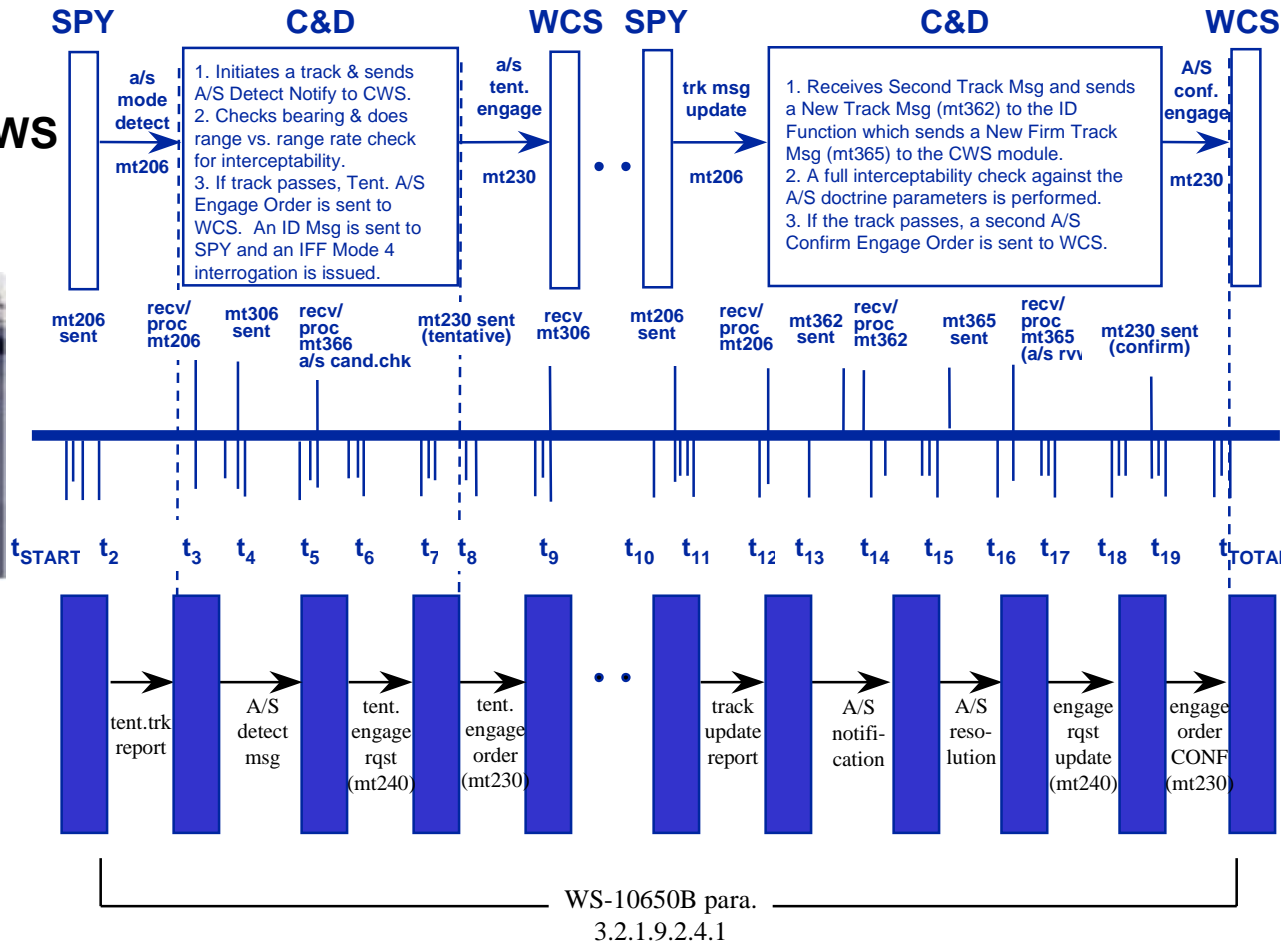




SPY AUTO-SPECIAL



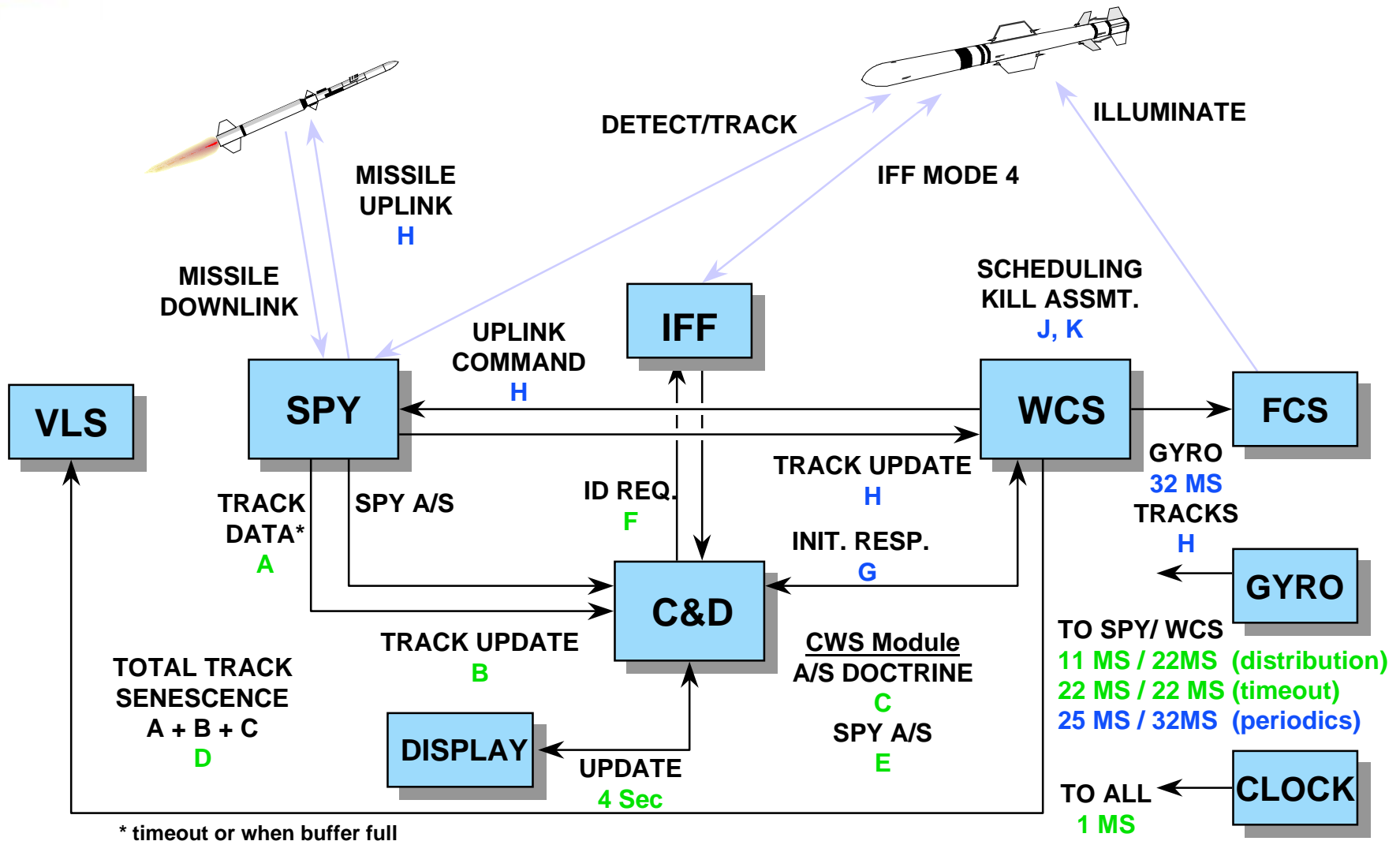
CURRENT AWS



HiPer-D prototype meets autospecial reaction time requirement while operating near 10x AEGIS track & doctrine review capacity & well below fault recovery time



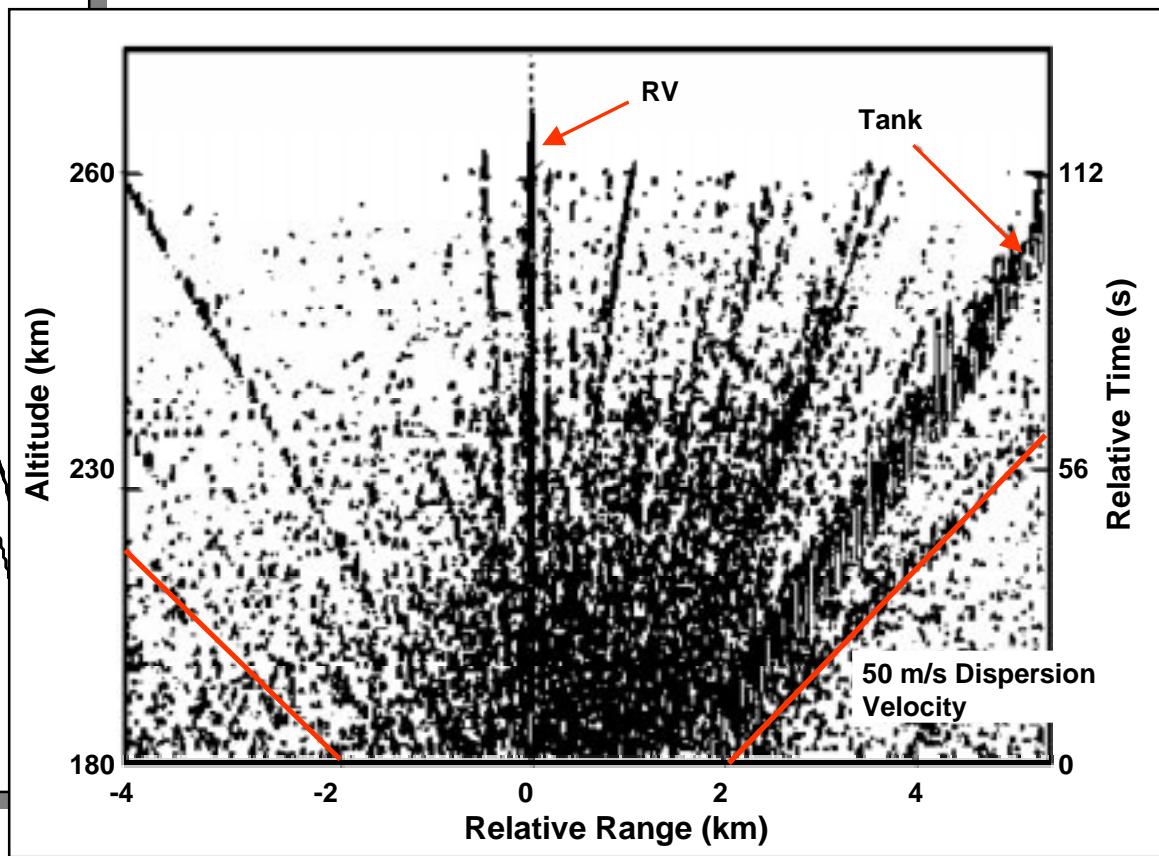
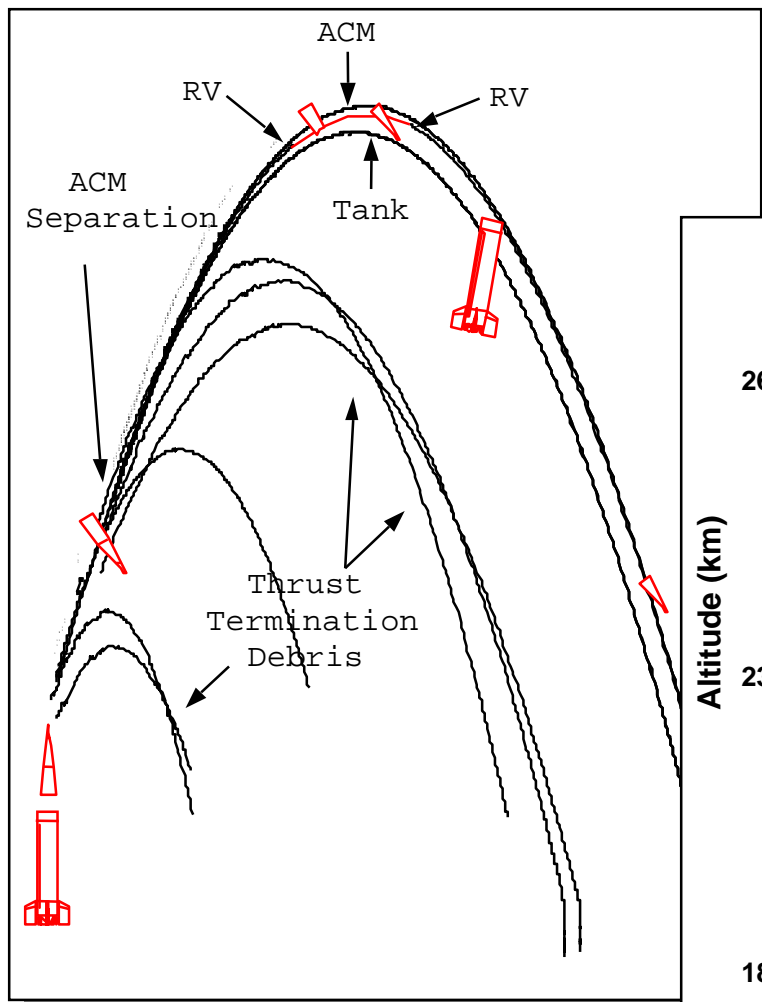
AEGIS SM-2 ENGAGEMENT





S-Band RCS Profile History Exoatmospheric Thrust Termination

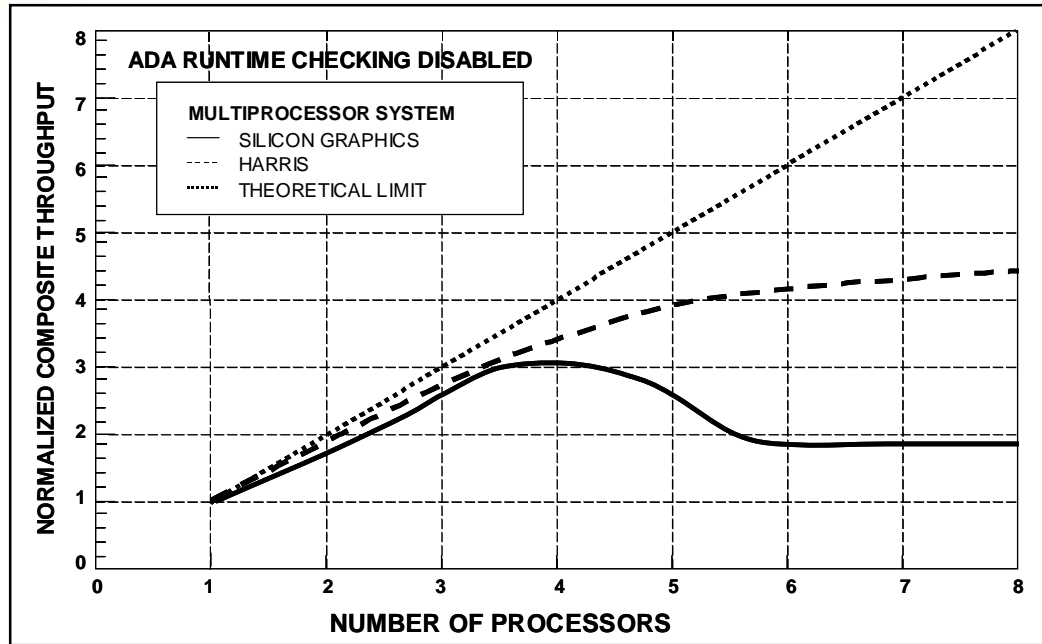
UNCLASSIFIED



UNCLASSIFIED

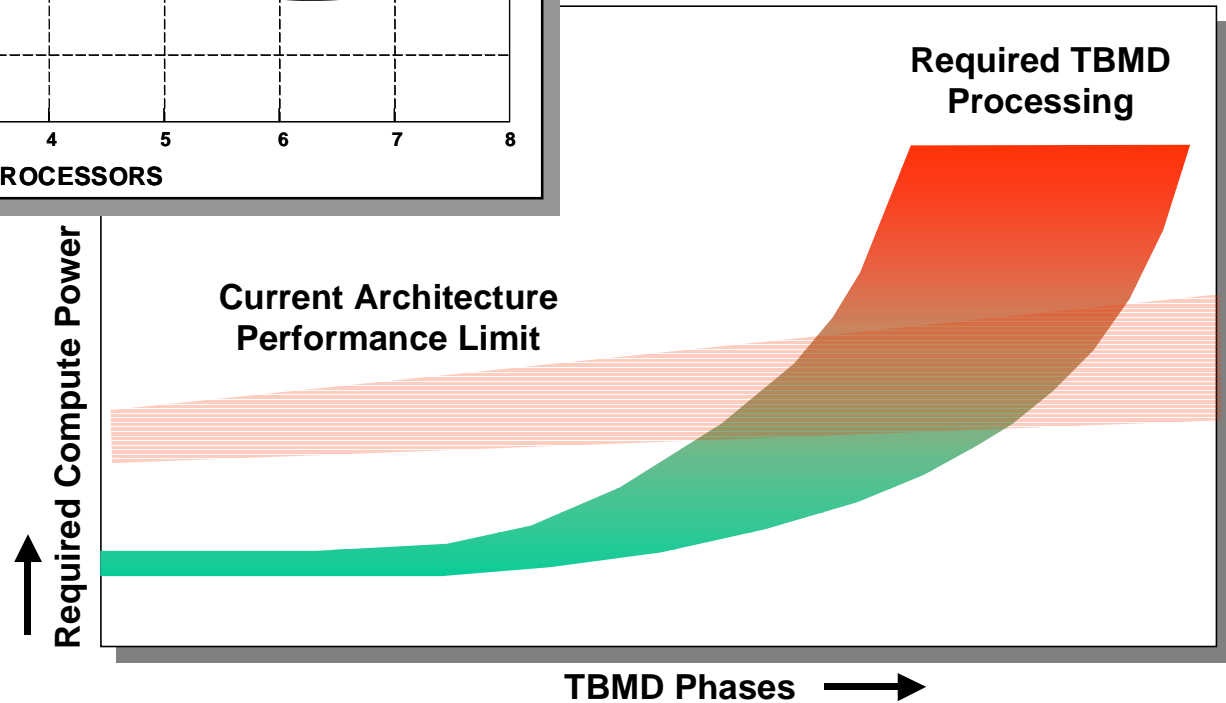


RADAR CONTROL PROGRAM SIZING ESTIMATES



TBMD Phases:
 AREA 6 Ph 3
 AREA 7 Ph 1
 NTW BLK 1A
 NTW BLK 1B
 NTW BLK 1C
 NTW BLK 2

Estimates are notional, based on 6 Ph 3 & 7 Ph 1 design and projections of NTW Block I and Block II requirements



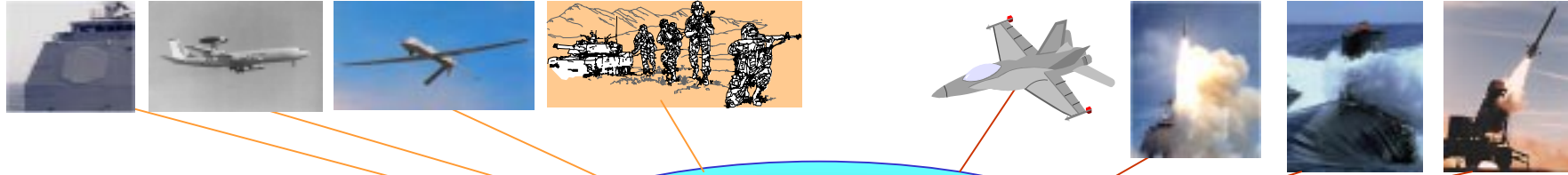


NETWORK-CENTRIC COMBAT SYSTEM



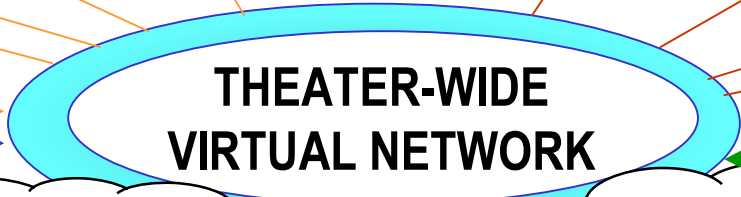
FORCE SENSOR NETTING

COORDINATED WEAPON EMPLOYMENT



DETECT

ENGAGE



“Centralized planning . . . decentralized execution”

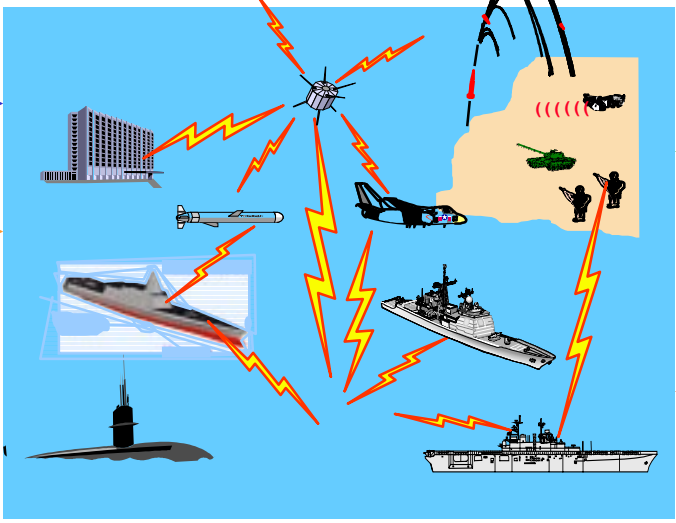
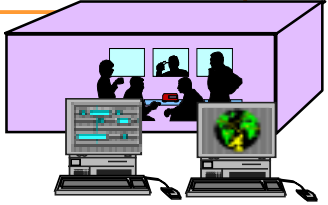
“Exploit force sensor netting to achieve coordinated weapons employment”

CONTROL



Common Plans & Objectives

Common Pictures



Battle Management Coordination



Real-time Weapons Control



TECHNICAL APPROACH



Collaborative Planning Tools:

- Web-based
- Distributed object computing

Heuristics:

- Goal selection
- Conflict resolution
- Autonomous ops

Algorithms:

- Weapon selection
- Scheduling
- Deconfliction

Network-centric combat system:

- Tactical Picture
- Sensor-to-shooter
- Shooter-to-shooter

Network-centric combat system:

- Goals, plans
- Policies, constraints
- Commands

- Status
- Conflicts
- Queries

Combat system 1

Combat system 2

Combat system 3

Combat system n

Coordinated Battle Management

- Doctrine
- Decisions
- Status
- Conflicts

Distributed Weapons Control

Leverage Other work:

- HiPer-D
- Quorum
- Sensible agents
- SSA CCE
- ASDCS RAIDS
- ...

Network-centric combat system



PMS-400B DIRECTION*



- **Support major ongoing PMS-400B computing efforts for Baseline 7 and follow-on**
 - Technology refreshable architecture
- **Integrate and evaluate ongoing TBMD computing efforts in HiPer-D testbed**
 - MIT/LL debris model, characterization processing
 - COTS Signal Processing initiative
 - SPY Radar Control Program re-architecture effort
 - WCS computer program re-architecture effort
 - LMC TBMD algorithms
- **Objectives of evaluation**
 - Are all computing components of a TBMD solution present?
 - Does the observed performance meet the requirement?

* CAPT John Geary, PMS-400B, B-Day review, 26 October 1999, following Jeff Truslow SPY RCP brief



PMS-400B3A DIRECTION



- **Investigate fault tolerance, including hardware**
- **Hot swap components during system operation**
- **Investigate emerging COTS issues**
- **Investigate 10 GB Ethernet**
- **Investigate Operating systems**
- **Investigate Middleware**
- **Investigate Dynamic reallocation**
- **Investigate Security**
 - **Intrusion detection, authentication**
- **Update Baseline 7 Guidance Document**
- **Certification of dynamically allocated systems**



DEMO 2000 OBJECTIVES



- **Support Baseline 7 & Open Architecture computing issues**
 - COTS refreshable architecture and technology base
 - SPY & WCS re-architecture, scalability, fault tolerance
 - Emerging technology issues, LMC critical technology issues
- **Support computing issues for AAW and TBMD capability**
 - SPY & WCS AAW fire control loop closure
 - Radar characterization, discrimination, signal processing
 - SPY RCCP & Signal Proc. shared equipment resource mgt.
- **Evaluate Quorum & COTS computing technologies**
 - Quorum technologies, COTS products as appropriate
 - Quality-of-Service reference architecture serves as standard
 - Standalone benchmarking, demo integration
- **Support ONR technology initiatives**
 - CST 4D airspace deconfliction for Call-for-Fire, AAW
 - CST battle management coordination, SSC/SC collaboration
 - Missile Defense FNC distributed weapons coordination support
- **Support other missions and initiatives, e.g. Common C&D architecture and technology base**



WARFIGHTING COMPONENTS



Weapon System Components

- **AWS AAW, TBMD**
 - SPY radar control program
 - LSTP signal proc. functions
 - HiPer-D Correlator-Tracker
 - Automated Eng. Controller
 - IDsys identification function
 - WCS engagability, scheduling
 - SPY/WCS fire control loop
 - TBMD engagements
 - **AAW/TBMD deconfliction ***
- **Land Attack**
 - NSFS Call-for-fire
 - **4D airspace deconfliction ***

Not in today's demonstration

Other Components

- **Lightweight shooters ***
- **ABMX 3D deconfliction visualization ***
- **Battle management coordination agents ***
- **Navigation, gyro data**
- **UAV Video**
- **GCCS-M**
 - OTH path
 - Mission changes
- **AACT (OTH data correlation)**

* **ONR supported components**



TECHNOLOGY COMPONENTS



DARPA/Quorum Technologies

- TAO
 - ORB, Event Channel
 - Common Name Service
- Ensemble group comms
- Resource Management
 - DeSiDeRaTa-based
- Globus
- REMOS network instr.
- QuO
- Quasar/Resource Kernel
- RT Cast ¹
- AQuA replication services¹
- NetCamo ²

Not in today's demonstration

COTS Technologies

- ORB Express
- VisiBroker
- NDDS
- SPREAD ³
- Isis ⁴
- Windows NT, HP-UX, IRIX, Solaris, Linux, Lynx OS, VxWorks
- ATM, Fast & Gigabit Ethernet
- Alteon load balancing switch
- Information Security
 - IPSEC/NT 5.0 Beta
 - INBounds ⁵

¹ Available as standalone demo/benchmark

² DARPA supported but not a Quorum technology

³ Johns Hopkins University protocol

⁴ No longer available

⁵ Ohio University intrusion detection project



SUPPORT COMPONENTS



- **Simulations**
 - HiPer-D Environment Sim
 - Kined track load sim
 - DS3 radar simulation w/ MIT/LL debris model & IQ generator
 - Army/Ft. Sill Firesim-XXI
 - Multots Link 16 sim
- **Multiwarfare scenario**
 - AAW
 - TBMD
 - NSFS
 - C3I
- **Benchmarks, test tools**
 - CAST, MCAST network benchmarks
 - Load Simulator
 - CORBA benchmark
 - Group comms benchmark
 - Publish-subscribe benchmark
- **Instrumentation**
 - Jewel
 - Jewel extensions
 - JEDSI
- **Facilities & tools**
 - “Computing plant” clusters: SUN, SGI, PCs
 - ATM, Fast & Gigabit Ethernet
 - Alteon switch
 - Physical media capabilities
 - Configuration mgt. tools
 - Classified integration & demo

Not in today's demonstration

INTERFACE MATRIX	AACT	Decon Svr AAW	Decon Svr LA	Display	Display Server	Doctrine	Eng Svr AAW	Eng Server LA	GCCS-M	Globus	ID System	ID Broker	InBounds	Instrumentation	LA Broker	LW Shooter	Man Eng Ctl	NetCamo	OTH Data Server	Plan Server	Quasar	Quo	Remos	Resource Mgmt	RTDS	SPY RCP	SPY Sig Pro	TCF	TNS	WCS
	Adv Aegis Correlation Tracker	X																												
Deconfliction Server, AAW		X																												
Deconfliction Server, Land Att			X																											
Display		X	X	X																										
Display State Data Server				X	X																									
Doctrine				X	X	X																								
Engagement Server, AAW		X			X	X	X																							
Engagement Server, Land Att			X			X		X																						
Global C&C System - Maritime	X								X																					
Globus										X																				
Identification System											X																			
Identification Broker				X		X	X				X	X																		
InBounds													X																	
Instrumentation		X	X			X	X						X	X																
Land Attack Broker								X							X															
Light Weight Shooter																X														
Manual Engagement Control				X	X	X	X	X									X													
NetCamo									X									X												
OTH Data Server	X	X	X																X											
Plan Server				X	X	X														X										
Quasar																					X									
Quo														X								X								
Remos																							X							
Resource Management										X			X	X								X	X	X						
Radar Track Data Server		X	X	X		X	X					X					X								X					
SPY Radar Control Program											X															X				
SPY Signal Processor																										X	X			
Track Correlation Filter	X					X								X						X					X	X		X		
Track Number Server							X							X														X	X	
WCS		X					X							X												X				X



DEMO 00 SCENARIO



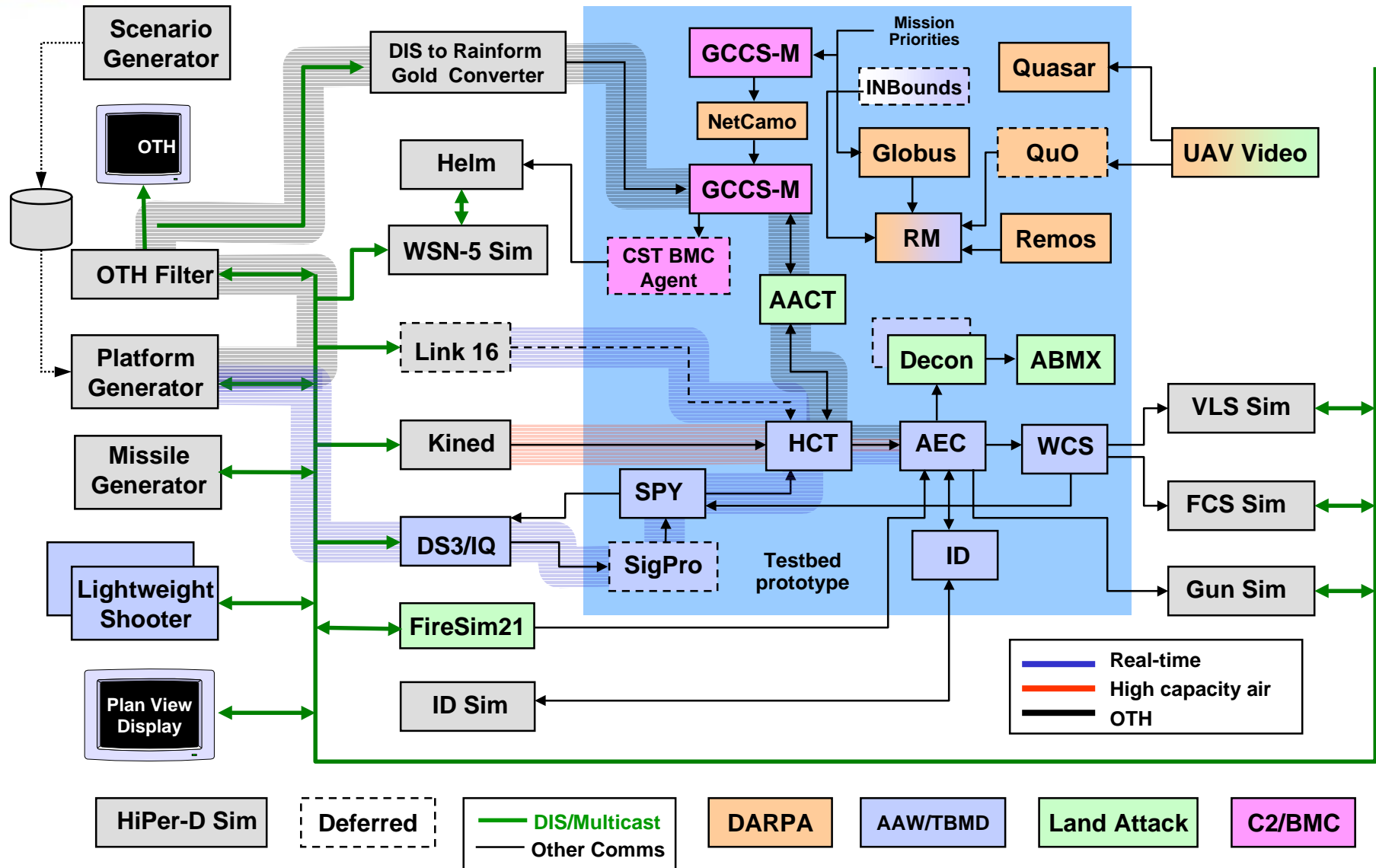
Korean Peninsula



- **Scenario pedigree**
 - North Korean invasion scenario
 - Developed by MCCDC, J-8 approved
 - Used in previous analyses:
 - Medium Lift Replacement (V-22) COEA
 - AAV COEA
 - 155mm Light Weight Howitzer COEA
- **Scenario overview**
 - North Korea (Orange) invades South, at day 60 Orange is 60-90 km into South Korea, preparing to renew offensive
 - Blue plans an amphibious operation to:
 - Preempt attack, cut off attackers
 - Isolate, destroy enemy maneuver force
 - Recapture lost territory
 - **HiPer-D-capable ship supports amphibious ready group**

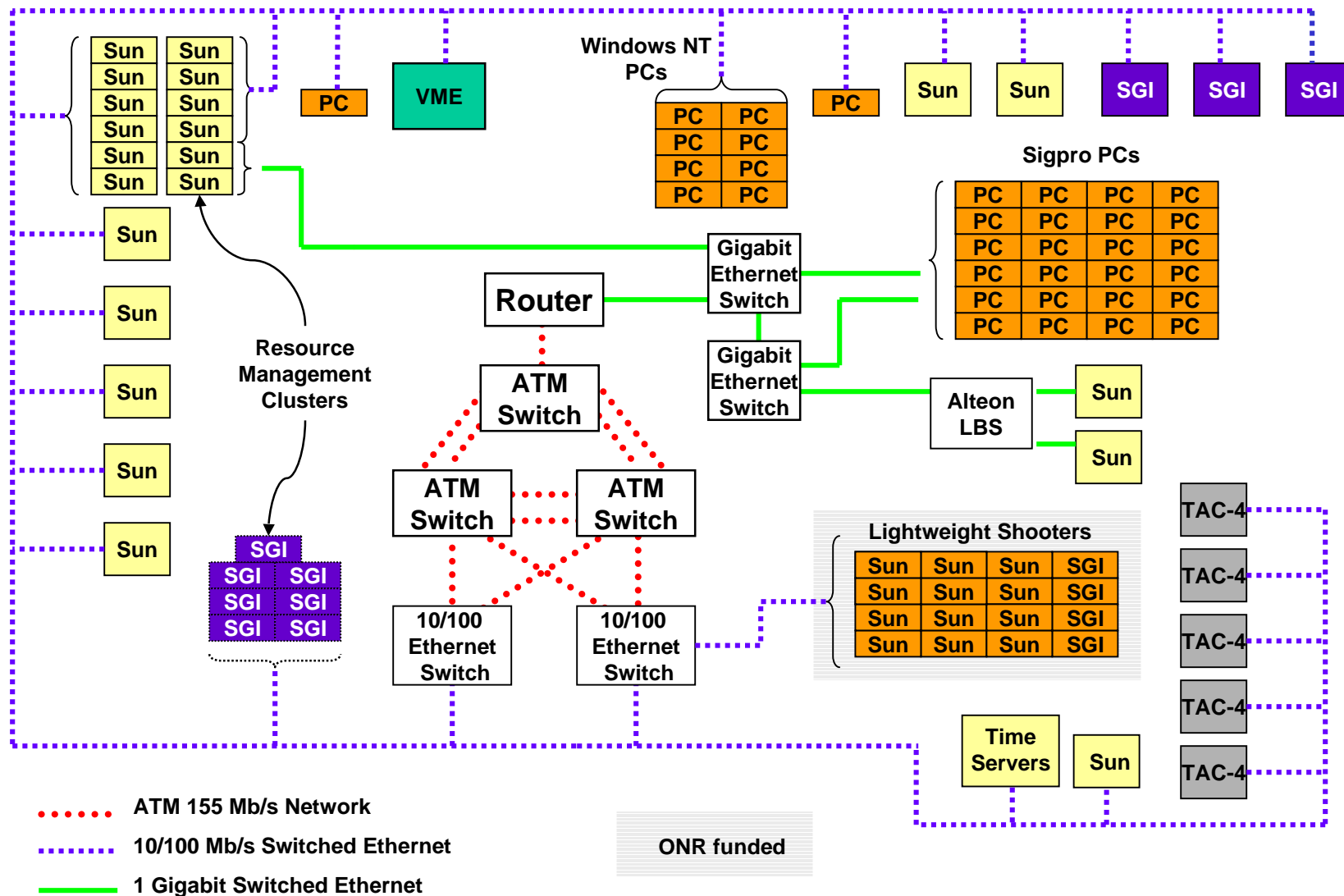


DEMO 2000 OVERVIEW



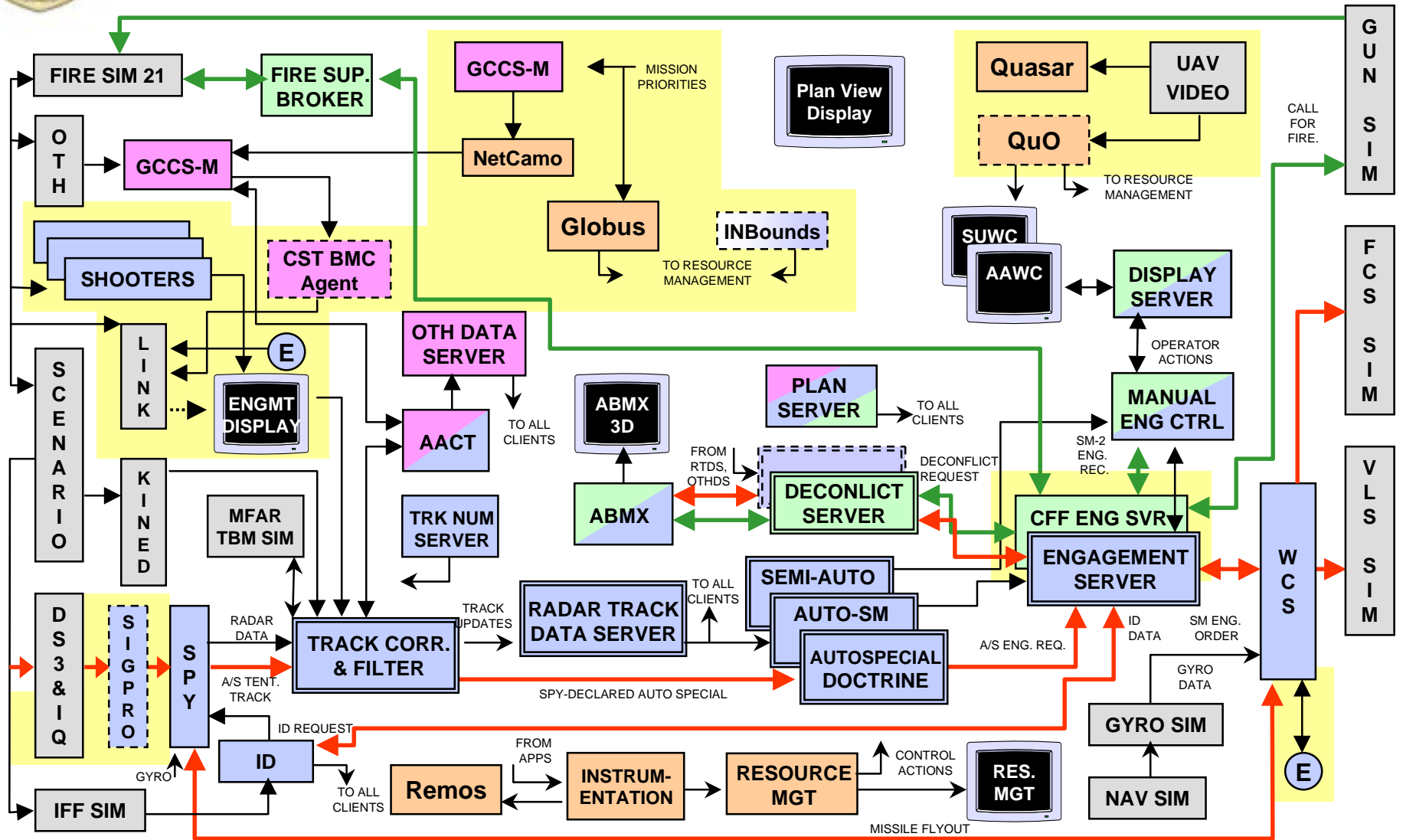


DEMO 2000 EQUIPMENT CONFIGURATION





DEMO 2000 BLOCK DIAGRAM



AAW, TBMD CALL FOR FIRE → Simulation AAW/TBMD Fault tolerant and/or Scalable Land Attack C2/BMC DARPA New in 00