Applying CORBA in a Contemporary Embedded Military Combat System

(A Submarine Combat System Perspective)

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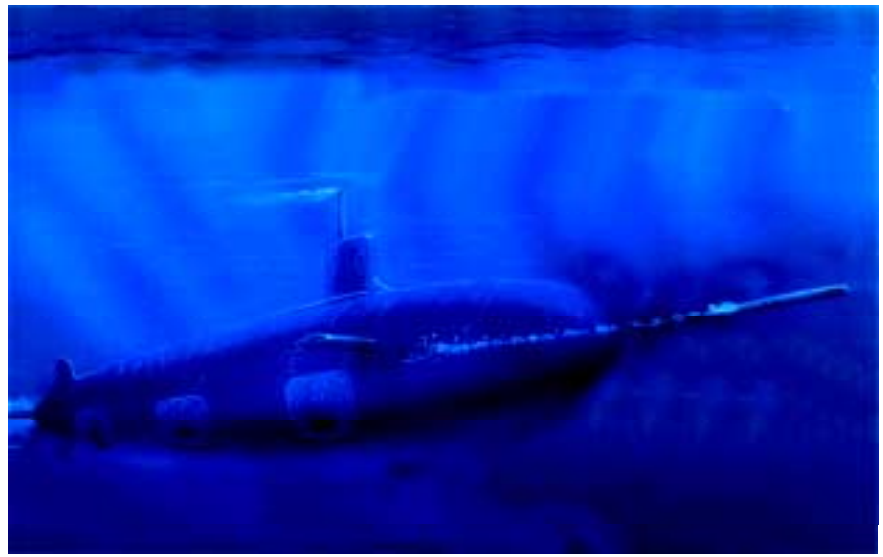
CORBA: Submarine Combat Control Systems

The US Navy has fully and openly embraced CORBA. CORBA has been endorsed throughout the entire US Navy Submarine fleet. This infusion of CORBA is not limited to future system upgrades, but also includes several potential backfit platforms.

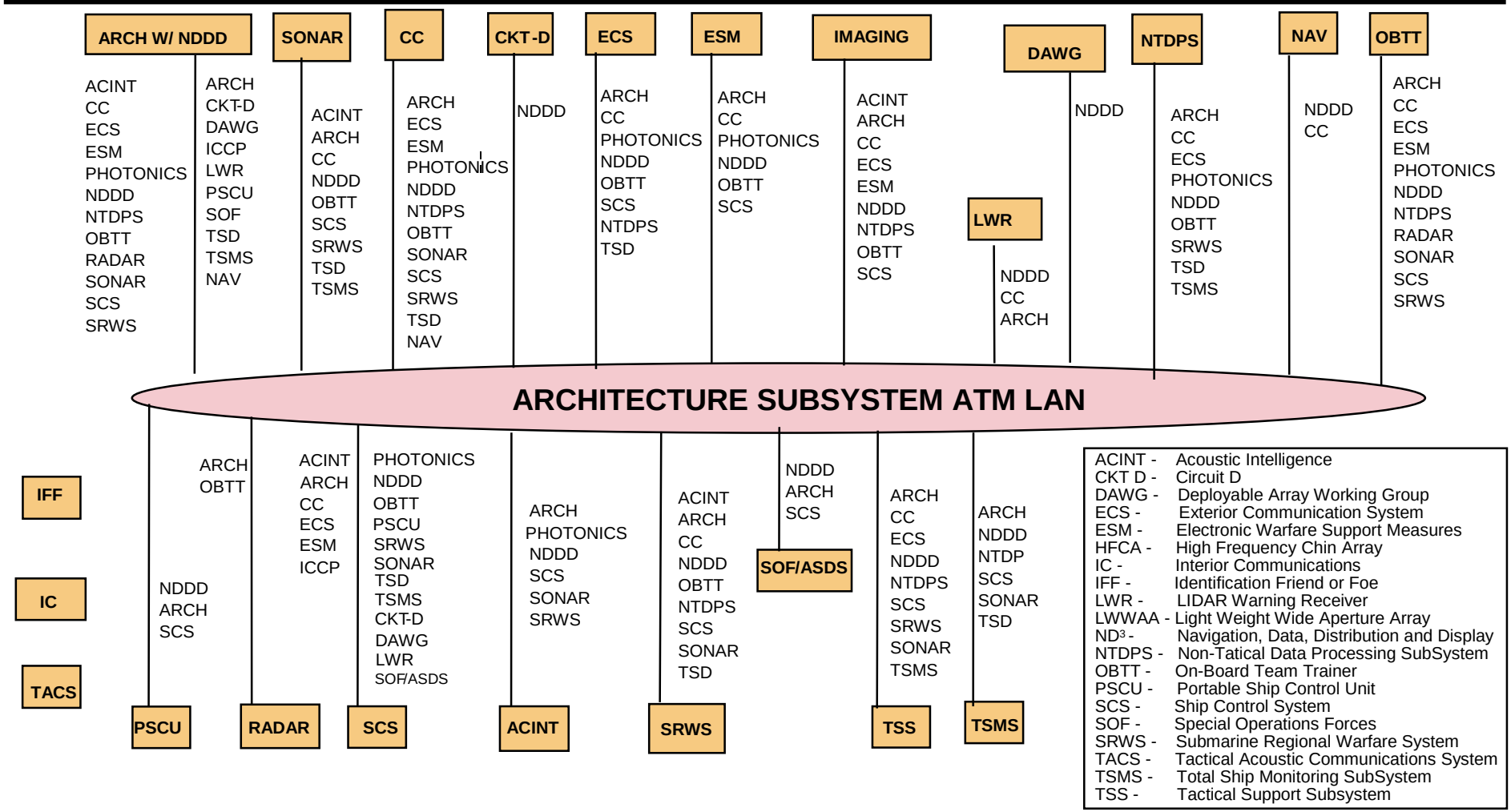


CORBA has been designated as the technology of choice for integrating the many subsystems onboard the submarine platform. CORBA is being employed on virtually all the inter-subsystem interfaces on the New Attack (Virginia) Class Submarine.

Schedule

	1/00	08/01	/04	/07
- CCS Mk 2 Block 1C Sell-Off	▽			
- Virginia Combat Control Sell-Off		▽		
- Virginia Dockside Trials			▽	
- Virginia Initial Operational Capability (IOC)				▽

Non-Propulsion Electronic Subsystem Interfaces



ACINT -	Acoustic Intelligence
CKT D -	Circuit D
DAWG -	Deployable Array Working Group
ECS -	Exterior Communication System
ESM -	Electronic Warfare Support Measures
HFCA -	High Frequency Chin Array
IC -	Interior Communications
IFF -	Identification Friend or Foe
LWR -	LIDAR Warning Receiver
LWWAA -	Light Weight Wide Aperture Array
ND³ -	Navigation, Data, Distribution and Display
NTDPS -	Non-Tatical Data Processing SubSystem
OBTT -	On-Board Team Trainer
PSCU -	Portable Ship Control Unit
SCS -	Ship Control System
SOF -	Special Operations Forces
SRWS -	Submarine Regional Warfare System
TACS -	Tactical Acoustic Communications System
TSMS -	Total Ship Monitoring SubSystem
TSS -	Tactical Support Subsystem

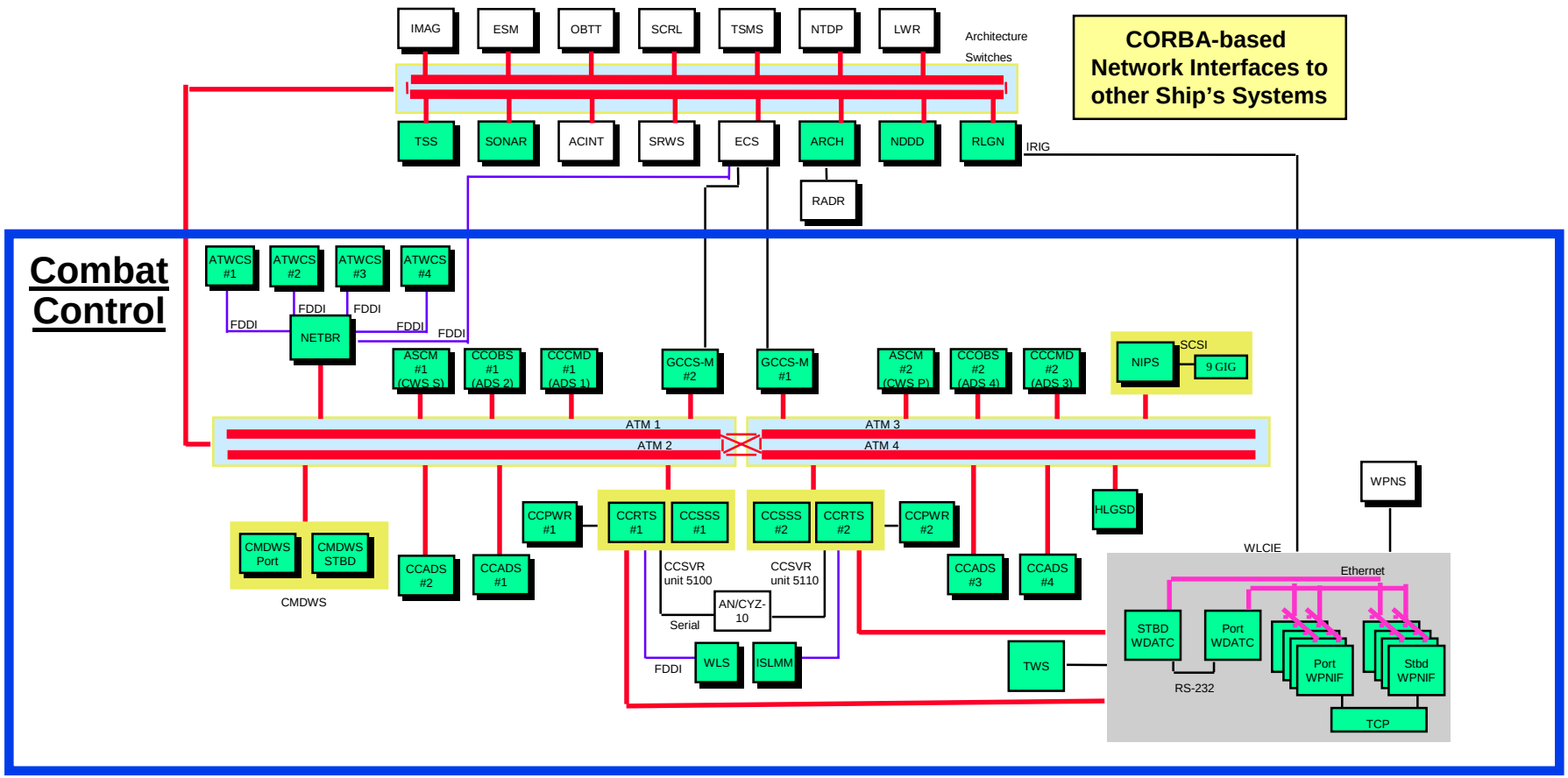
All Subsystems Are Physically Connected to the Architecture ATM LAN. Logical Connections (Established at IPL) Provide Data Pathways Among Subsystems

CORBA Data Organization

- Data shared between systems was organized into CORBA and Non-CORBA Groups
- CORBA data was grouped by like objects
  - Orientation is shared data v.s. supplier-consumer view
  - Most involved subsystem assigned as lead to define interface
  - Interface designed as superset of all user needs
  - Modules logically organized within an interface
- Interfaces employ Push/Push event channel
  - Supports shared data view with multiple suppliers and consumers
  - Naval Undersea Warfare Center OMG CORBA compliant implementation event channel developed due to lack of COTS
- Redundant CORBA Name Servers custom designed and implemented for availability
  - Name Servers monitor each other as hot spares

NSSN Combat Control (CC) Block Diagram

CORBA used on inter-subsystem interfaces and for major CC internal components



= COTS component

CC Middleware Was Influenced by Many Factors

- Virginia CC development was based on extensive reuse
- Weapon Interfaces Have Unique Demands
  - real-time constraints
  - resource limitations and resource requirements
- Existing In-house middleware for distributed systems (Realtime Distributed Environment for POSIX (RADEX))
- Compatibility with other SoS subsystems, particularly Architecture subsystem
- DII COE Components
- Maturity level of CORBA products and standards when the system architecture was established
- Benefits of CORBA in a heterogeneous distributed environment (anticipating ever-present interface issues)

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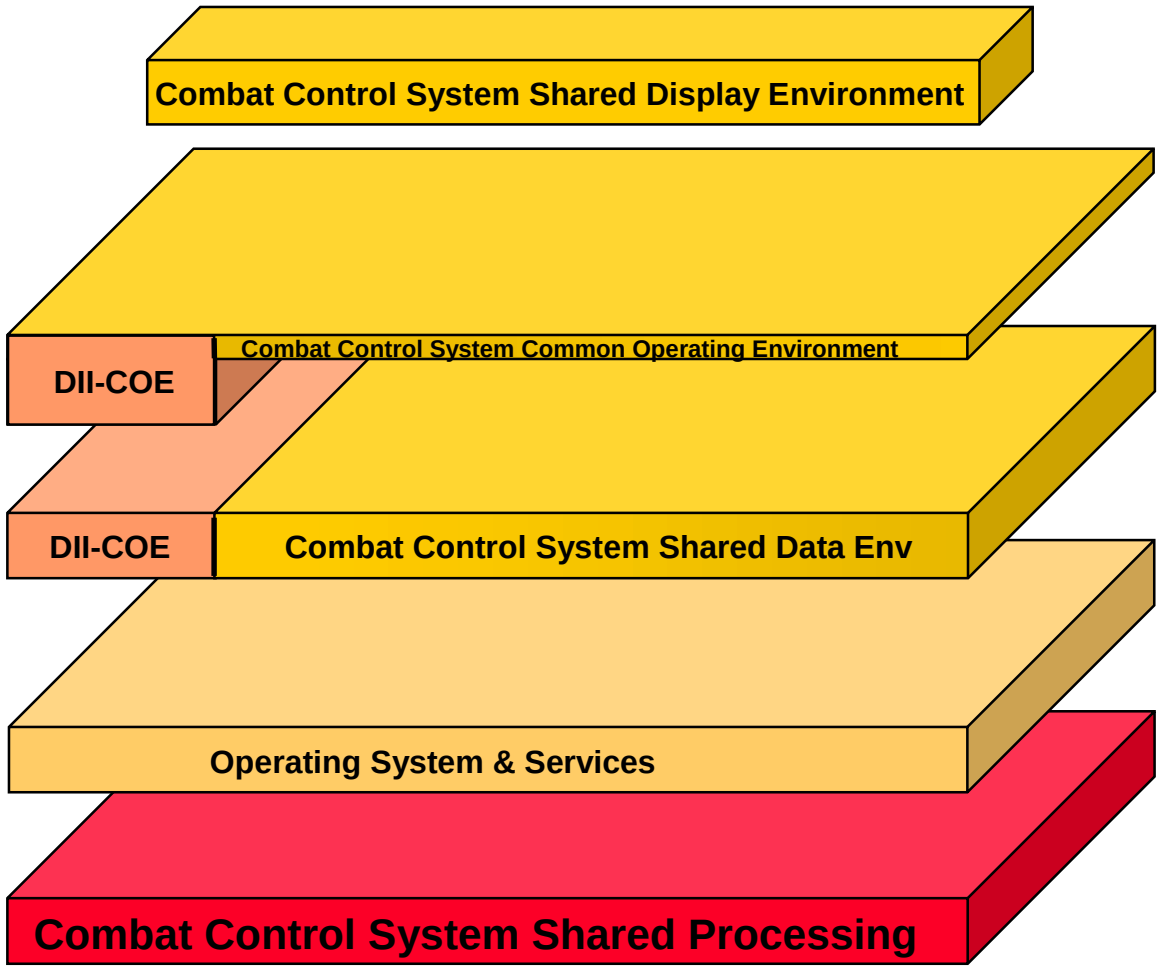
Infrastructure Profile

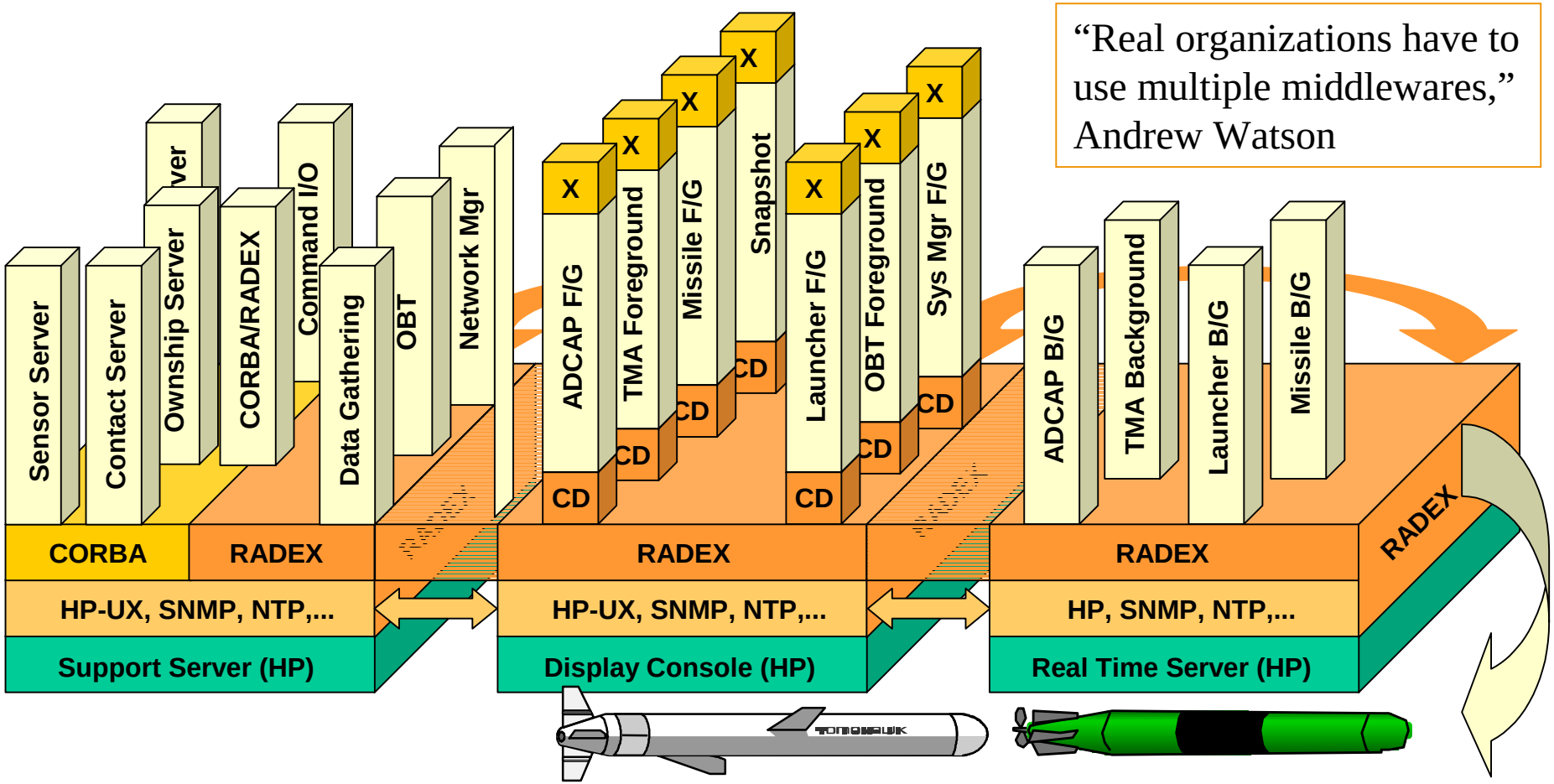


- ⇐ X Windows, CDE, Application remote launch, DII-COE
- ⇐ RADEX Registration & Control Flow, DII-COE, Network Node Manager
- ⇐ ***CORBA Data Servers***, RADEX Data Tables, RADEX Messaging, DII-COE Data Services
- ⇐ HP-UX, SNMP, NTP, DII-COE, TCP/IP, UDP, LANE
- ⇐ HP Processors, FORE ATM, Q-70 Consoles, VME, FWD SCSI

Virginia FCS Software Profile

- CORBA External Interfaces
- RADEX Internal Data Services & Run-time Management

"Real organizations have to use multiple middlewares," Andrew Watson



Lessons Learned

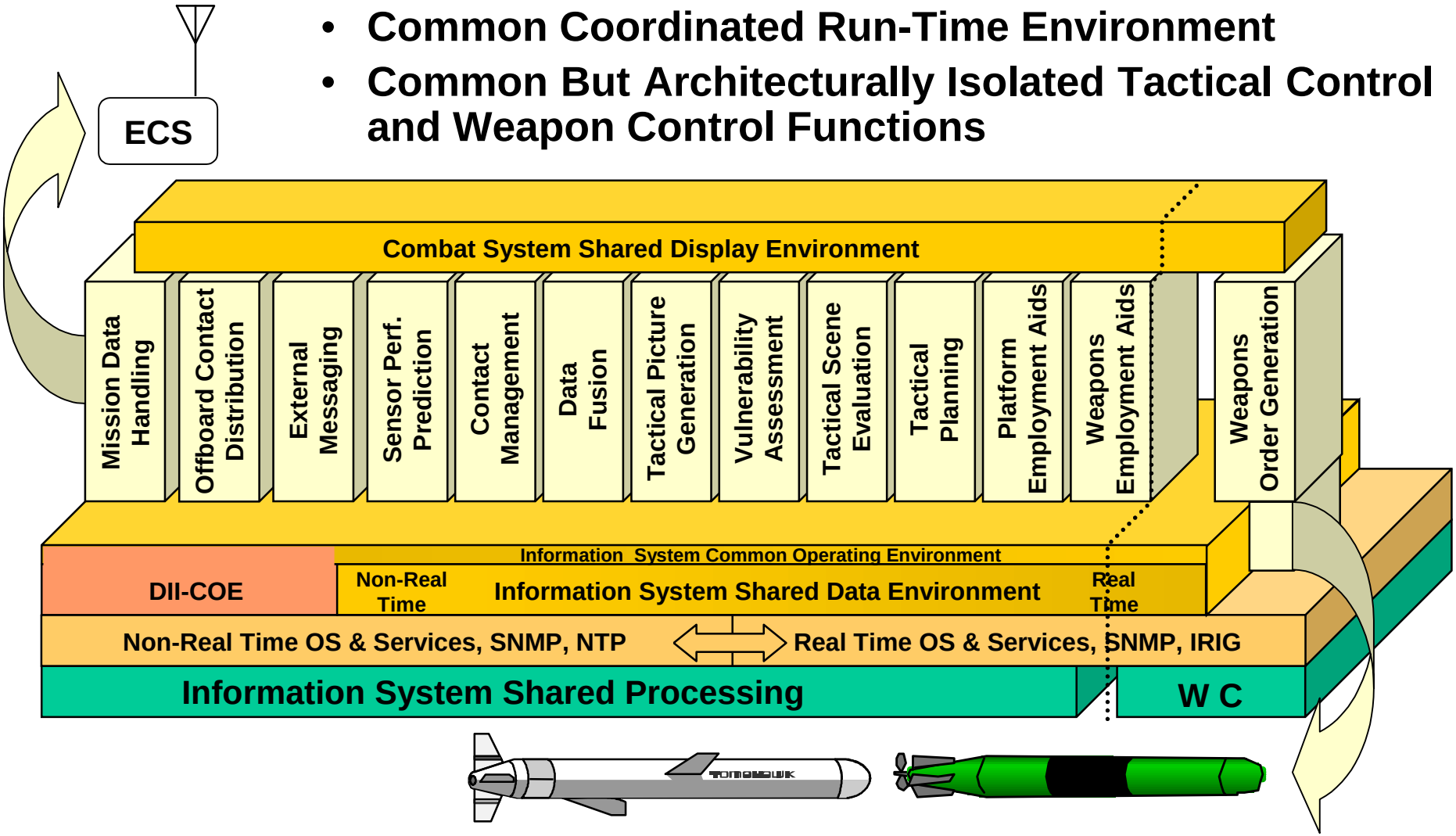
- ORB Selection
- Common to all embedded COTS . . .
  - Plan vendor support, monitor vendor directions, plan version migrations
  - Not all ORBs or ORB vendors are equal
  - Not all ORBs are equally inter-operable
- Due diligence required in crafting IDL
  - Per object methods (accessor functions)
  - Aggregate (batch) methods for performance efficiency
- CORBA Services, especially Event and Naming Service, are critical to the systems we build
  - Events act primarily as notifications to minimize throughput
- Size of executables are a concern

Lessons Learned (cont.)

- Develop robust interface early with initialization, error recovery leading application integration
- Create auxiliary functions once and share across classes
- Learning Curve - Training and Mentoring needs

Goal System Model for Combat System

- Common Shared Data Exchange Mechanisms
- Common Coordinated Run-Time Environment
- Common But Architecturally Isolated Tactical Control and Weapon Control Functions



Next Steps

- Mk 2 Combat Control System Open System Enhancement ECP 004 takes the next evolutionary step
  - Migrating to more current ORB, selected within constraints of system of systems
- Long term goal is to move to common middleware for CC internal and external communications
- RT-CORBA
  - Real-time performance
  - QoS guarantees
- Fault Tolerance
  - Common COTS based solution/ dynamic reconfiguration
  - Avoid re-implementing unique system solutions
  - Investigating use of FT-CORBA

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