LOCKHEED MARTIN

Creating an Evolutionary Environment to Foster Capability-Oriented Interoperability

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Agenda

- Scope of the Interoperability Problem
- System Evolution Models
- Advent of Component-Based Technology
- Fostering Interoperability Across Programs
- Summary

Systems of Systems (SOS)

- Systems of Systems typically consist of component systems with heterogeneous ownership / management
- SOS interoperability is motivated by achieving a greater functional capability than any one component system
- Systems of Systems characteristically have no explicit overall design
  - No one organization responsible for SOS design
  - Systems of systems behave more like an “ecology”
  - Building code and zoning rule model is a good metaphor
- Interoperability is essential for realizing a level of autonomy that makes Systems of Systems work in the face of change
- Pace of change of component systems precludes tightly-coupled top-down engineering approaches

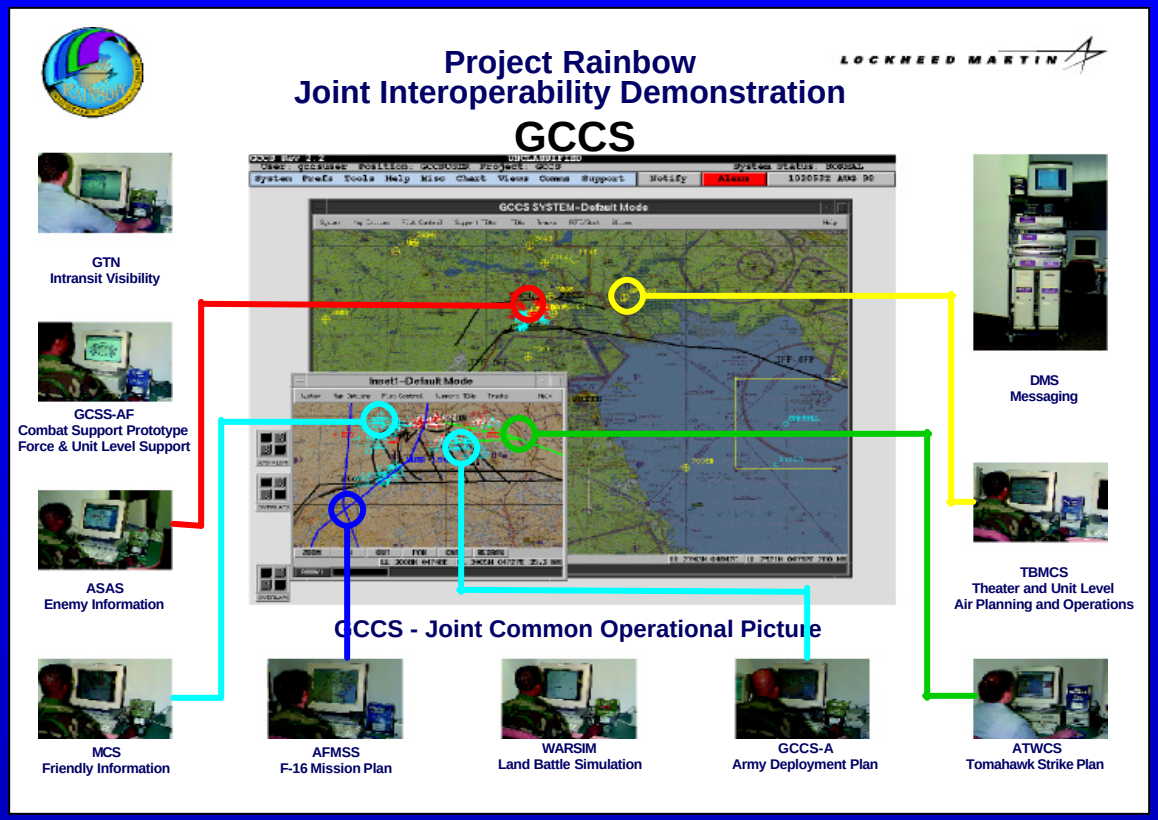
System of Systems Test Bed

GTN
Intransit Visibility

GCSS-AF
AF Logistics

ASAS
Army Intelligence

MCS
Army Tactical Cmd



Silent Sentry
Passive Ground-Based Surveillance

DMS
Secure Messaging

TBMCS
Theater and Unit Level Air Planning and Ops

ATWCS
Navy Command

AFMSS
Flight Planning

WARSIM
Land Battle Simulation

GCCS-A
Army Strategic Command

JL ACTD

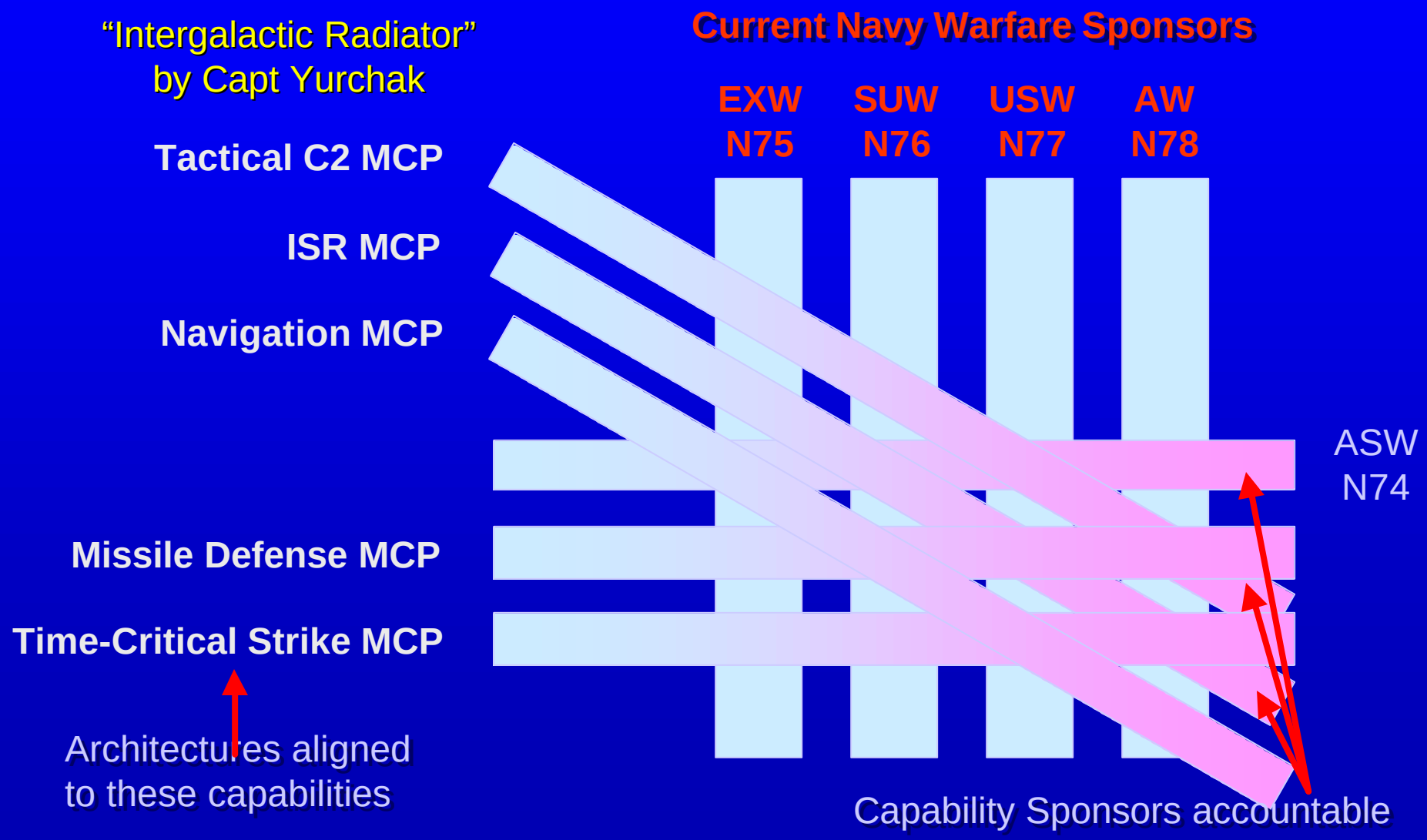
JTL ACTD

Joint Logistics

- **14 Operational, Developmental, and Prototype Systems**
  - C4I, Combat Support, Surveillance, Sim, Joint, AF, Army, and Navy
  - Supports Experimentation, Prototyping, Evaluation, and Demonstration
  - Driven by an extensive integrated joint warfighting scenario

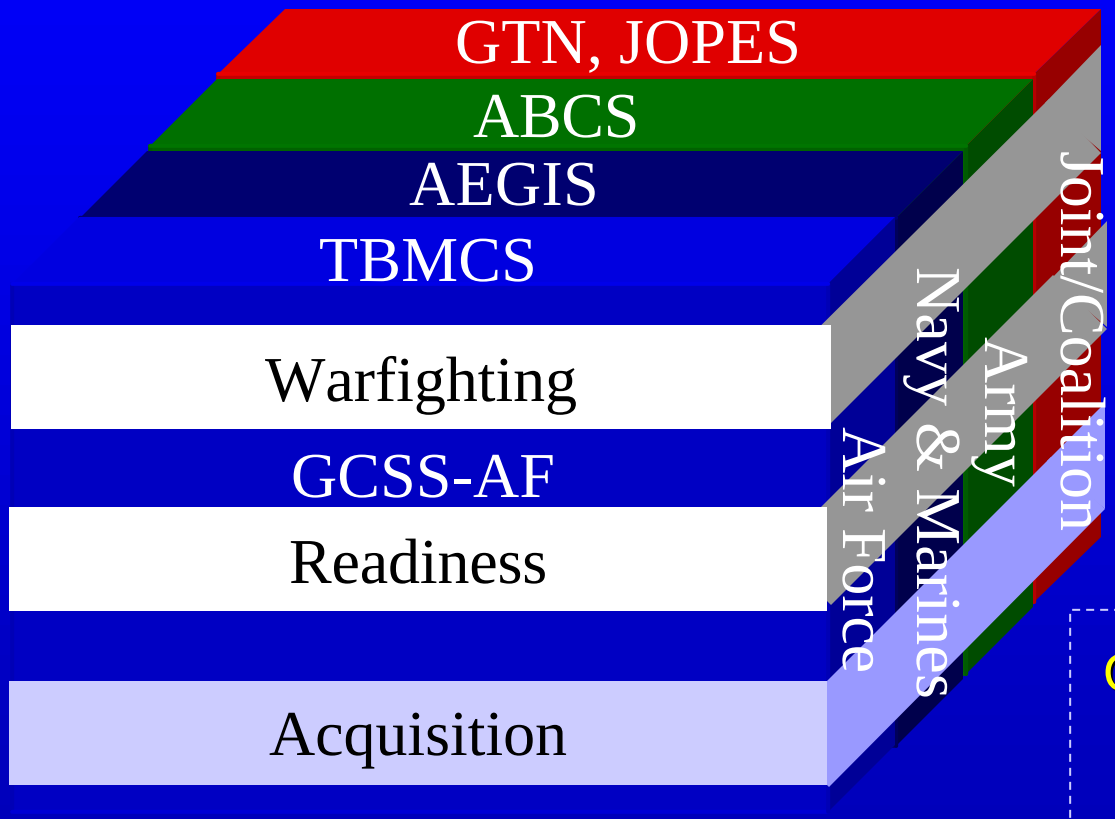
Intersecting Platforms / System Domains with Mission Capability Packages (MCPs)

"Intergalactic Radiator"
by Capt Yurchak

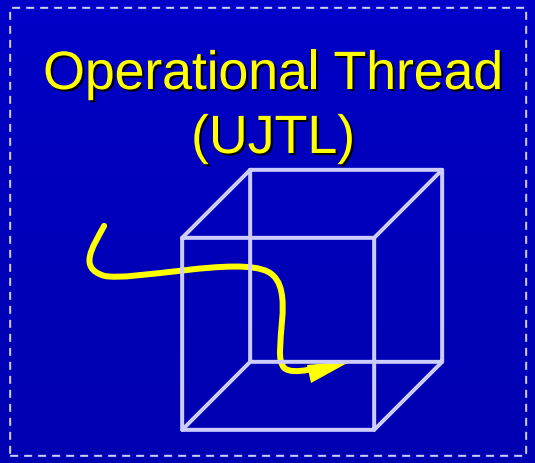


Shows some of the Complex Dependencies in Interoperability Issues

DIAMONDS* Information Model



* DoD Interoperability Assessment MOdel of Network-Centric Domains and Systems



Note: The model is not constrained by the systems listed here. The systems listed are provided as examples that may exist in a specific domain.

Technical Scope Dimensions

Level of information abstraction

Hardware Signaling ⟷ Conceptual models

Architecture binding

ASCII Text ⟷ DII COE COP

Time binding

Off-line Batch ⟷ Hard Real Time

Information Assurance

None – e.g, UDP ⟷ Digital Signatures

Resource Requirements

Bits/sec ⟷ High resolution video

Increasing Cost, Schedule, Risk →

Capability Scope Dimensions

Enterprise scope

Unit/system — Global/Space

Business process breadth

Single domain — Cross-enterprise

Business process depth

Single Echelon — All Echelons

Enterprise control/ownership

All components under single entity — Multi-national

Semantic congruence

Single vocabulary — Different languages

Increasing Cost, Schedule, Risk

System Evolution Models

Centralized, Top-Down

- House building, blueprints
- Soviet Union economy
- GCCS, COE
- DoD Major Programs
- Space Shuttle

Decentralized, Bottom-Up

- City evolution, zoning laws
- US economy
- Internet, DNS, Web Services
- E-Commerce, FIOP, ACTDs
- US Transportation System

- Both models are appropriate in different situations
  - Few systems are purely of one type or the other
  - Not a value judgment
  - Centralized, top-down models become more difficult to execute as System of Systems complexity and rate of change increases

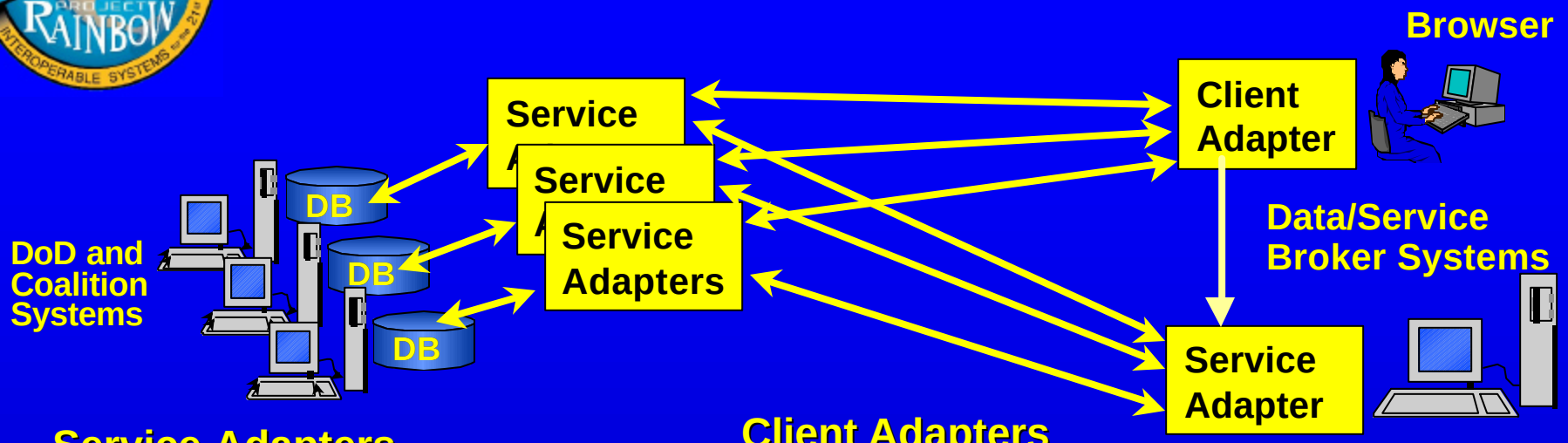
Advent of Component-Based Technology

- Internet and the Web
  - Made software/data systems accessible across enterprise and program boundaries
- DCE and CORBA
  - Provided increasingly abstract mechanisms for accessing software/data services
- XML
  - Allowed exchange of data without prior agreement on message format/content
- Web Services (UDDI, SOAP, WSDL)
  - Allows CORBA-like access to software/data services without prior agreement on interface definition or specific language bindings

Fostering Interoperability Across Programs

- Encourage Program Acquisition Executives to identify and expose program functionality via network-accessible services
  - Extend IER concepts in 5000.2R to include services
  - Establish as a “meta-requirement” for all major programs
    - Inherent in Network-Centric Warfare and JBI concepts
  - Reward Program Managers for using such services and providing them to others
- Establish Enabling Infrastructure
  - Provide domain directories of available services
  - Create usage metering capability
  - Improve network bandwidth and accessibility

Interoperating via Service Adapters



Service Adapters

- Provide access to data and applications through standard interfaces (e.g., web services)
- Isolate clients from server design and implementation decisions
- Provide a cost effective approach to modifying legacy systems

Client Adapters

- Integrate data and services provided by service adapters
- Perform client-specific formatting, database access

Data/Service Brokers

- Provide domain-specific look-up services
- Fuse information from multiple sources
- Bridge semantic and domain model gaps

Multiple Commercial Technologies

Web Services	XML	Java
Data Mediation	CORBA	Replication
Intelligent Agents	Publish/Subscribe	Messaging

Possible Incentive Mechanisms

- Improved mission capability interoperability and effectiveness across programs
- Reduced program risk through use of established services
- Establish a TRANSCOM-like fee for service structure
  - Fees for use of Program A's services accrue to Program A's development or life-cycle support budget
  - Program B's development and life-cycle support costs reduced by leveraging Program A's services
    - Fee to Program A decrements Program B's budget
    - May be subsidized at Service/DoD level for added incentive
  - Codified via MOA and Quality of Service agreements
  - Implemented through usage metering infrastructure
- Allow contractors to charge for software/data services to other programs

Some Candidate Services

- Order of Battle (Red and Blue)
  - Personnel, equipment, location, readiness, organization
- Situational Awareness (e.g., TDBM, CTP, SIAP, etc.)
- Plan access services
- Planning/simulation models – all types
- Data subscription services (customer system feeds)
- Transportation access/visibility
- Asset inventory/management
- Security domain transfer services
- Reference data services, including maps, collateral data
- User account/role/access management services
- User collaboration services – network accessible work products

Summary

- Developing major cross-program capabilities is inherently difficult and runs counter to current program incentives
- Attempting to implement SIP or similar capabilities in top-down, grand design fashion is likely to fail
- Emerging network-accessible component technologies offer the possibility of a more evolutionary approach
- Creating an environment which motivates programs to view themselves as components in a larger system of systems will drive them to be more interoperable
- New capabilities will emerge based on this evolution
  - Currently planned or envisioned capabilities
  - Unanticipated capabilities
- Requires leadership at senior levels in DoD – will not happen by itself