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# Transitioning to Net-Centric Systems

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# Net-Centric Systems

- **Net-Centric** (DoD context) means:
  - being a part of a ***continuously-evolving***, complex community of people, devices, information, and services
  - interconnected by a ***communications*** network
    - To achieve optimal benefit of ***resources and services*** for warfighter
    - Better *synchronization* of events and their consequences

# Net-Centric Warfare Objectives

- Goal of Net-Centric Warfare (NCW) is to achieve a heightened state of *situational awareness* and knowledge among all elements of the force
  - A warfighting force with situational awareness in *physical, information, and cognitive* domains can increase combat power by

- Better *synchronizing effects* in the Battlespace,
- Achieving *greater speed* of command and
- *Increasing lethality, survivability, and responsiveness*

.....Alberts et al

# NCW Objectives (cont'd)

- DoD's Net-Centric Data Strategy's goals (May 2003) of making data assets **visible, accessible** and **understandable** go along with service-oriented approach
  - Service Oriented Approach and **Service Oriented Architecture (SOA)**
    - Provides users with common services (e.g., nighttime radar targeting) produced by others that are needed and can be used by all
    - Establishes a Net-Centric Environment (NCE) that increasingly leverages shared services and SOA

# Service Oriented Architecture (SOA)

- SOA is a sort of continuum, as opposed to distributed computing or modular programming
- SOA will package functionality as interoperable services
- Functions will be provided as a service to be used from systems created by other organizations
- Services will have standards, be secure, and be managed by Global Information Grid (GIG) netOps
  - GIG is envisioned to provide a common environment for conventional and nuclear Command and Control (C2), combat support, combat service support, intelligence, and business functions

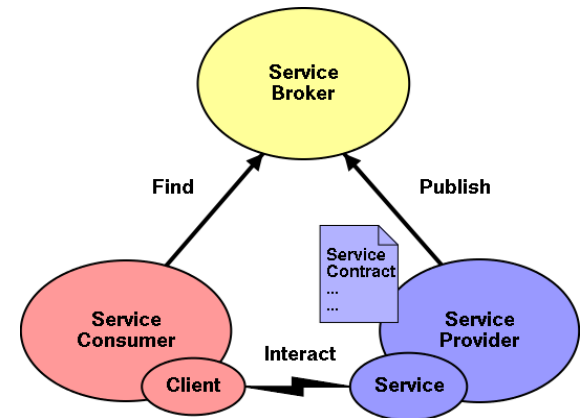
# DoD Net-Centric Data Strategy

All data, regardless of the final consumer, will be available to selected users (theoretically anyone, anywhere with granted access) on:

“publish-subscribe,”

“smart-push-pull” or

“query-response type mechanisms”



Source: [www.w3.org](http://www.w3.org)

Current data “stovepipes” established by C4I system design or by policy fail to make data available until after processing by appropriate entity, often long after it is tactically useful to another community

# The Big Picture

- DoD envisions NCW leveraging technologies in wide use in web enabled business-to-business transactions using **SOA** technology
  - Walmart has prearranged contracts with vendors that:
    - Allows them visibility into a current centralized inventory database
    - Permits vendors to automatically initiate shipment of items *directly* to stores when a particular item's stock has become depleted

e.g. A Walmart store is about to sell out of Zebra Pens

- Zebra Pen manufacturer, via visibility into Walmart's databases, determines their product below *agreed threshold level*, and
- Automatically, without personnel in Walmart having to place an order for more, initiates shipment of more Zebra Pens to the store

# NCW Services

Defense Information Systems Agency (DISA) directed to develop core set of web-based services for DOD Enterprise

- **Global Information Grid (GIG)** operational support and security
- **Net-Centric Enterprise Services (NCES)** program (FY04 start)
  - Initial set of core services include:

Messaging	Application System Management (ASM)
Discovery <sup>1</sup>	IA/Security
Mediation	Storage
Collaboration	Enterprise Service Management

<sup>1</sup> Processes for discovery of information content, people or services that exploit metadata descriptions of network resources stored in Directories, Registries, and Catalogs



# Community of Interest (COI)

- To process and make available information the concept of community of interest (COI) was created

*COI is a collection of people, assets, and organizations that are concerned with exchange of information in some subject area (e.g., a joint functional capability, multiple missions with a common goal or a specialized mission area)*

DISA sees three types of COIs:

Expedient (ad hoc)

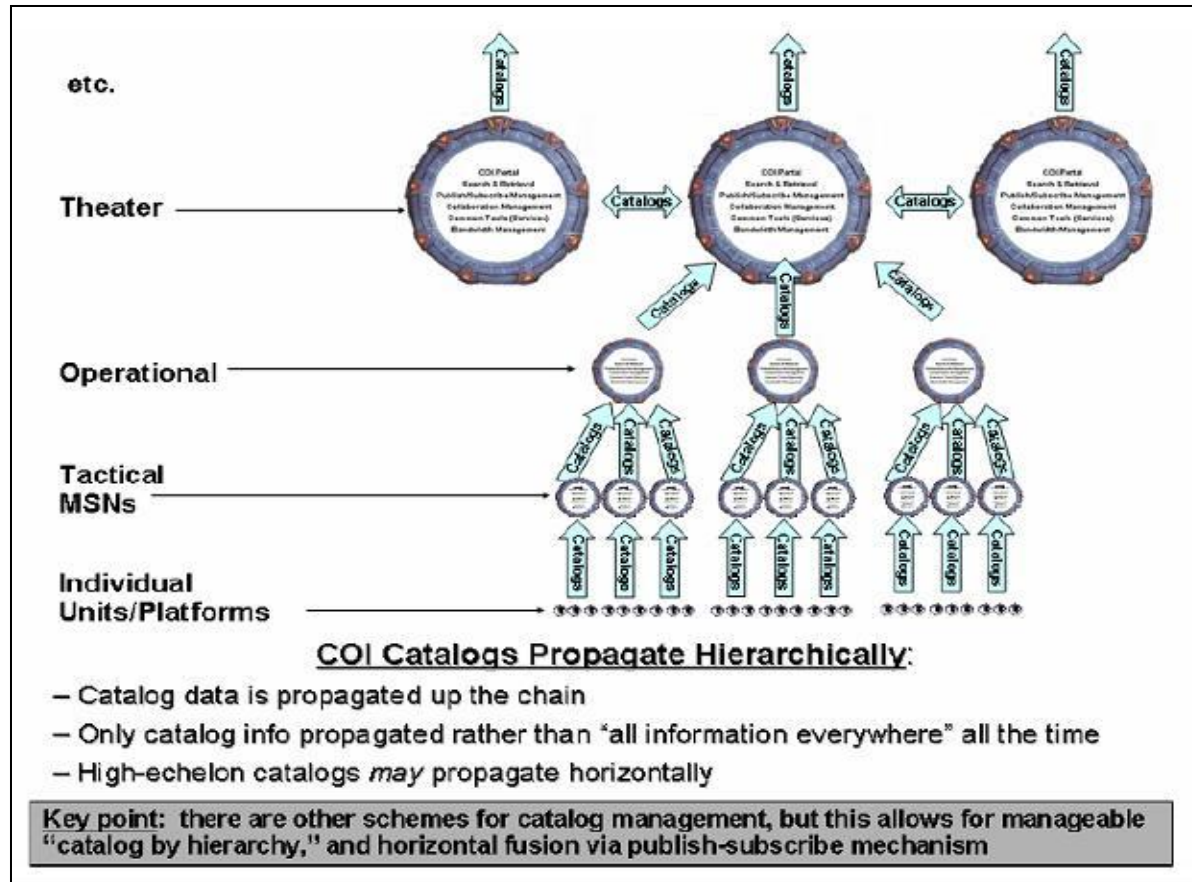
Institutional (predefined), usually mission based

Cross-functional

# COI-based Portals

- Access to COIs is gained through COI-based portals
  - Portal is an agreed upon address through which access to COI services and information is gained
    - It's similar to a company intranet through which corporate information and services are provided
- Services provided through a COI portal may include:
  - Search and Retrieval
  - Collaboration Management
  - Publish/Subscribe Management
  - Common Tools (Services) and
  - Bandwidth Management

# COI Catalogs Propagation Hierarchy



**Figure 1. Hierarchical Propagation of COI Catalogs\***

\*McCaskill, L. P., "Beyond Power Point Deep: a Concept of Operations Implementing Net-Centric Warfare, 12<sup>th</sup> International Command and Control Research and Technology Symposium (ICCRTS), 19-21 June 2007

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# SOA Challenges

- SOA challenges include:
  - managing services metadata
  - lack of sophisticated tools for testing
  - providing appropriate levels of security, and
  - interoperability
- SOA concerns include:
  - could run slower
  - require more processing power
  - web service standards are still evolving

# Transitioning from IPv4 to IPv6

- Transitioning from **Internet Protocol version 4 (IPv4)** to IPv6 on key service network architectures for implementing GIG
  - Air Force C2 Constellation,
  - Navy and Marine Corp ForceNet, and
  - ArmyLandWarNet
- **Exhaustion** of IPv4 addresses

# Transitioning from IPv4 to IPv6

- Disadvantages:
  - More bandwidth needed
    - Speed impaired
  - Lack of interoperability with IPv4
    - IPv4 supported alongside IPv6 for long time
    - IPv4 nodes not able to communicate directly with IPv6 nodes without intermediary

# Transitioning from IPv4 to IPv6

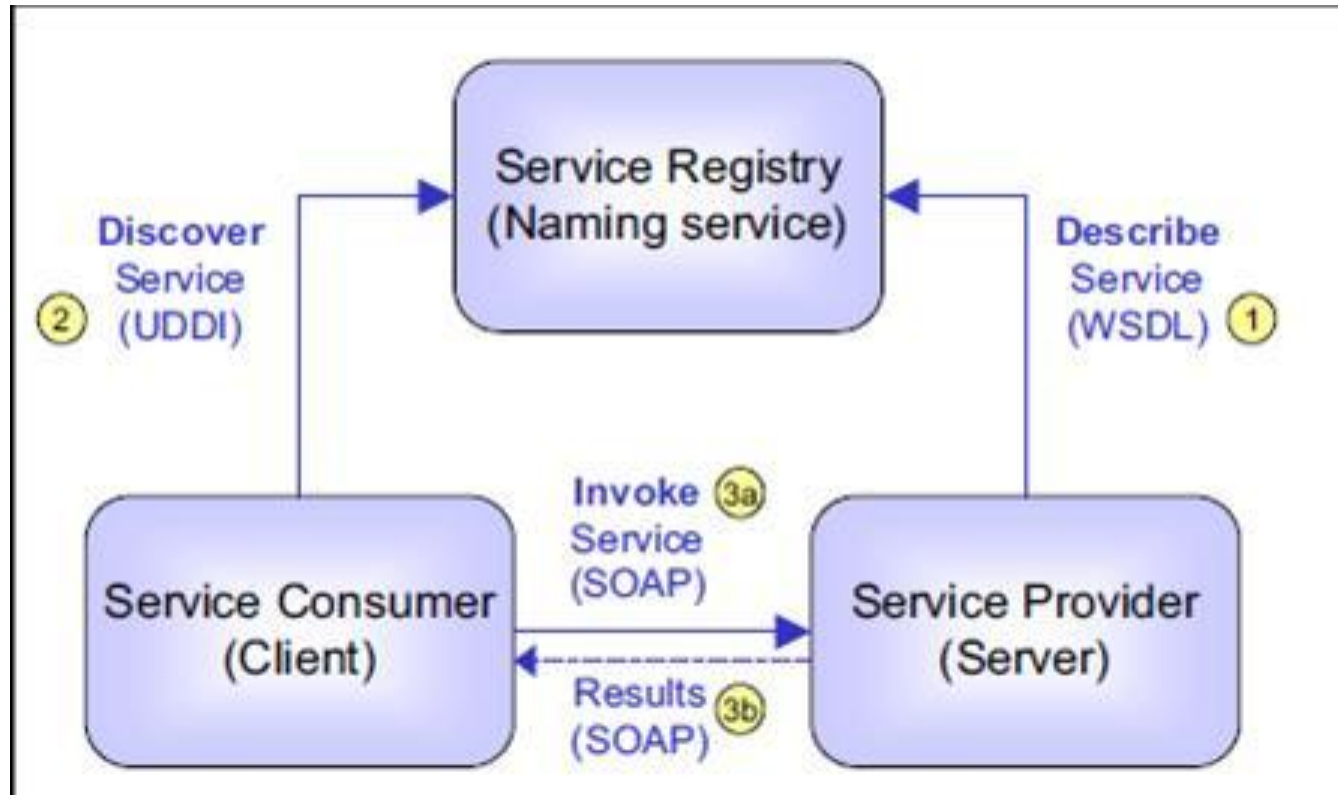
Characteristics	IPv4	IPv6
Standard	IETF Pub RFC 791 (Sep 1981) MIL-STD-1777	IETF Pub RFC 2460 (Sep 1998)
Guarantee	Header integrity achieved by checksum.	Header not protected by checksum; integrity protection assumed to be assured by both link layer checksum and higher layer (TCP, UDP, etc.) checksum.
Addresses Capability to support	32-bit (four-byte) field 4,294,967,296 (2 <sup>32</sup> ) addresses	128-bit field 2 <sup>128</sup> = about 3.4x10 <sup>38</sup> addresses 60 thousand trillion-trillion
Bandwidth/Speed		More needed/Maybe slow
Flexibility/Ease of configuration		New features: 1) Stateless address auto configuration IPv6 hosts 2) Network renumbering (prefix and router announcements)
Process technique	Subscribe	Publish and subscribe
Security/Information Assurance		Features encryption at IP level. Internet Protocol Security (IPsec) reqr originally developed for IPv6.

# eXtensible Mark-up Language (XML)

- Several **XML-based technologies** for defining available services and protocols for communication are in development
  - Web Services Definition Language [**WSDL**]
  - Simple Object Access Protocol [**SOAP**]
  - Defense Advance Research Projects Agency [DARPA] Agent Mark-up Language [**DAML**]
  - Electronic Business using eXtensible Markup Language [**ebXML**]
  - Security Assertion Markup Language [**SAML**] and
  - Universal Description, Discovery and Integration [**UDDI**]



# Modeling and Simulation



**Figure 2. Modeling and Simulation\***

\*Tolk, A., Turnisitsa, C., Diallo, S., and Winters, L.

“Composable M&S Web Services for Net-Centric Applications”

Journal Defense Modeling and Simulation (JDMS) , Jan 06

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# Net-Centric Operations Transformational Systems\*

- Key programs within these areas are:
  - **Joint Tactical Radio System (JTRS)**
    - JTRS program started in 1997 for a programmable, modular, multiband, multimode radio that would eventually replace over 200 radio types in DoD inventory
  - **Defense Information Systems Network-Next Generation (DISN-NG)**
    - In 2003 DoD started to procure a fiber-based Wide Area Network transport system called GIG Bandwidth Expansion Program (GIG-BE)
      - GIG-BE creates a ubiquitous, robust, trusted network where terrestrial bandwidth availability is no longer a constraint

\*Meink, T., "Transformational Communications Systems for DOD Net-Centric Operations," Crosstalk, July 2006



# Standards and Certification

- The U.S. Department of Defense uses **DoD Architectural Framework (DoDAF)** versions 1.5 and 2.0 to describe and standardize military systems architectures
  - Four views describing types of interactions of components of the systems:
    - All View (AV)
    - Operational View (OV),
    - Systems View (SV),
    - Technical Standards View (TV)
- Net-Centricity requirements captured in TV-1 and TV-2 views
  - **TV-1 View** provides:
    - Technical systems implementation standards upon which engineering specifications are based
      - IPv6 -IETF Pub RFC 2460 of Sep 1998 would be Net-Centric requirement
      - DoDAF version 2.02 found @ <http://www.defenselink.mil/cio-nii/policy/eas.shtml>

# Conclusions

- **Transitioning from IPv4 to IPv6** biggest challenge (time constraint)
  - Address capability goes from a 32-bit field to a 128-bit field capable of supporting 60 thousand trillion-trillion addresses
  - IPv6 has a **publish** function as well as a **subscribe** function but
  - **Better information assurance** since Internet Protocol Security (IPsec) requirement was originally developed for IPv6
  - Major drawback of IPv6 is that it is not backward-compatible to IPv4
- **Hardware lagging software**
- **Net-Ready Key Performance Parameter (KPP) for all major programs**
  - Big systems interface to external world designed to IPv6
  - Little lower level evidence of any significant progress
  - DISA Budget
    - NCES line item +11.7% FY10, +8.6% FY11 budget
    - GIG Engineering Services line item very slight increase

Questions?

# Back Up Slides

# Standards and Certification (cont'd)

Service Area	Service	Standard
Operating System	Kernel	FIPS Pub 151-1 (POSIX.1)
	Shell and utilities	IEEE P1003.2
Software Engineering Services	Programming Languages	FIPs Pub 119 (ADA)
User Interface	Client Server Operations	FIPS Pub 158 (X-Window System)
	Object Definition and Management	DoD Human Computer Interface Style Guide
	Window Management	FIPS Pub 158 (X-Window System)
	Dialogue Support	Project Standard
Data Management	Data Management	FIPS Pub 127-2 (SQL)
		ISO/IEC 11179 On Information Technology-Metadata Registries (MDR)
Data Interchange	Data Interchange	FIPS Pub 152 (SGML)
	Electronic Data Interchange	FIPS Pub 161 (EDI)
Graphics	Graphics	FIPS Pub 153 (PHIGS)
Internet	Internet Protocol	IETF RFC 791 (IPv4) MIL-STD-1777
		IETF Pub RFC 2460 (IPv6)

**Figure 3. Notional Example of a TV-1 Product\***

\*DoD Architectural Framework Version 1.5 Volume III:

Architectural Data Description, 23 April 2007, Pg 6-1

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# Conclusions

- Alberts et al<sup>1</sup> Net-Centric Warfare (NCW) goal to achieve a ***heightened state of situational awareness*** and knowledge among all elements of the force
  - *by making information and communication services more accessible in an effective amount of time to all elements*
- **Service Oriented Architectures** based on e-commerce models are being incorporated in all major computer hardware and software programs



# NCW Portals

- The previous types of business to business transactions are enabled by Web-based **portal** technology
  - A **portal** is an *agreed upon entry point* into Internet/intranets (i.e., Website), defined by Uniform Resource Locator (URL) – the Website address. Commercial examples include Google, Yahoo, and America Online (AOL)
- **Portals** for NCW are generally a specialized enhanced type of portal called an Enterprise Knowledge **Portal**. Characteristics include:
  - Focus on knowledge production, knowledge integration, and knowledge management
  - Focus on validity of the information provided
  - Provides information about your business/warfighting area and degree you can rely on the information
  - Distinguishes knowledge from mere information
  - Provides a facility for producing knowledge from information (services)

# COI Services

1. A COI **search** can be performed for “tagged” information that includes:
  - Resource Metadata (who produced the information)
  - Content Metadata categories and key words
  - Information Metadata Ontologies, Taxonomies, models that describe the formatting of the information and
  - Access Metadata Security
  - Required technologies
  - Application Program Interfaces (APIs) etc
- **Standardizing** data tagging is a **major problem/issue**
  - DISA’s trend is to use eXtensible Mark-up Language (XML)

# COI Services (cont'd)

2. **Retrieval:** obtains data from COI “enterprise–level” datamart, or from Sub-COI Datamarts and Datastores
3. **Publish and Subscribe management:** examples of these are automated stock tickers, weather reporting, and pointcast, Infogate, trafficland, and weatherbug – they provide a smart filtered push of information as it changes within the COI, based on filters and attributes selected by the user on either an ad hoc basis, or user profiles
4. **Collaboration management:** chat rooms with whiteboards and shared applications are examples of this capability
5. **Common Tools (Services):** each COI will have tools that are common to it, but not necessarily to other COIs
6. **Bandwidth Management:** This is necessary to provide the equivalent of the priority system on Autodin/Defense Switching Network (DSN). An emerging technology that will make allowances for priority-based schema for message delivery. ASD (NII) memo, “Internet Protocol Version 6”(IPv6), June 9, 2003 mandates IPv6 implementation by 2008

# Standards and Certification

- U.S. Department of the Navy (DoN) efforts towards Net-Centric standards are part of the FORCEnet enterprise architecture
  - Also, commercial industry groups such as the Telecommunications Forum IPsphere project have already published a set of standard network-centric requirements, and
  - Network-Centric Operations Industry Consortium (NCOIC) is working towards establishing network-centric standards.

# Transitioning from IPv4 to IPv6

Characteristics	IPv4	IPv6	Comments
Mobility	Mobile IPv4 triangular routing	Mobile IPv6 avoids triangular routing and efficient as normal IPv6	
Jumbograms	64KiB of payload	Optional support for >64KiB as large as 4 GiB	May improve performance over high-MTU networks
Packet format		Fixed header Optional extension header payload	
Addressing	Dot -decimal	1) Hexadecimal digits and colon separators 2001:db8:85A3::8a2e:370:7334 2) Two parts 64-bit (sub-)network prefix & 64-bit host part	
Tunneling		Encapsulating IPv6 packets within IPv4 or in effect using IPv4 as a link layer	

# Modeling and Simulation

- Use of Extensible Mark-up Language (XML) for integration with web services
- SOA and theory of:
  - composability
  - data mediation
  - interoperability
- Command and Control Information Exchange Data Model (C2IEDM) is a candidate for a Common Reference Model
  - currently applied by NATO Data Administration Group to insure semantic interoperability for operational NATO systems among themselves as well as with contributing national systems

# eXtensible Mark-up Language (XML)

- **XML** is tag-based, hierarchical markup language for description of data and its relationships
  - Differs from Hyper Text Markup Language (HTML) in that it allows users to define the tags which are used to describe data in a page
  - XML tags are standardized in communities by definition of **Namespace**
    - Within DoD, namespaces being managed by DISA are on the DoD Metadata Registry and the Clearinghouse website
- Each COI must have a **steward** that is responsible for maintaining the definitions of the namespaces within the COI
- **Unicode** is the standard format for XML, which in most implementations takes 16 bits per character (most computers use the American Standard Code for Information Exchange (ASCII), which takes 7 or 8 bits, depending on the implementation) which may have implications on the size of information being transferred
  - Several data compression techniques have been used to resolve this problem

# Biography



- Fred C. Briggs is currently a senior program analyst for Wyle's Aerospace Group and is based in Lexington Park, Md., providing engineering support to the Navy's E-2/C-2 Aircraft PMA-231 Program Office. He has more than 35 years engineering experience with Navy aircraft programs including F/A-18, V-22, AV-8B, SH-60B, E-2C and six years experience providing systems engineering support to the Space Station Freedom Program. He received a BS Aerospace Engineering ('68) from Pennsylvania State University, a Master's in Engineering Administration ('83) from George Washington University, a MS ('04), and PMC ('07) in Computer Science from Johns Hopkins University. He is also an AIAA senior member active with the Software Technical Committee.