Metamodels and Mappings

Ending the Interoperability War

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What is this all about?

- Status quo
  - Everybody is modular, composable, interoperable
  - Everything is based on standards
- But
  - Standardized solutions differ between the communities (M&S and C4I)
  - Standardized solutions differ within the communities (HLA and DIS, RTI 1.3 NG and RTI 1516)

How to insure mapping between standard solutions to avoid dead ends in IT solutions?

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Presentation Outline

- Some Legacy Concepts
  - ISO/OSI Model for Network Standards
  - Service Oriented Architectures, Computer Grids, and Enterprise Architectures
- Some related Military Frameworks and Standards
  - DoD Architecture Framework (DoDAF)
  - Command and Control Information Exchange Data Model (C2IEDM)
  - Global Information Grid (GIG)
- Metamodels and Mappings

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Some Legacy Concepts

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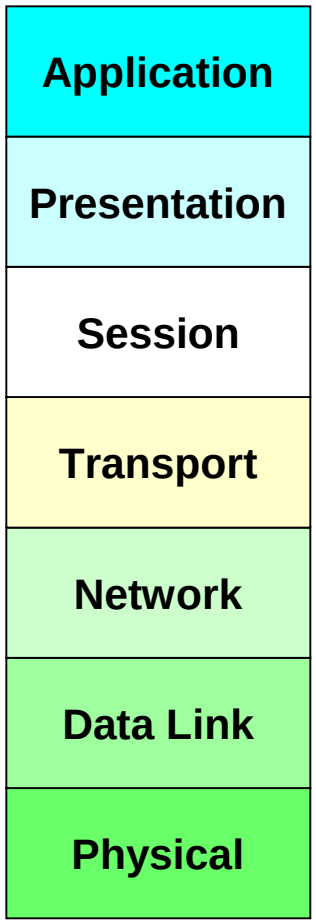
The "Perfect Example:" ISO/OSI Network Model



- Layers of Network Operating Systems
  - Clearly defined functions
  - Clearly defined interfaces
  - **Not a Solution, but a Structure for a Solution**
- Some Rules of ISO/OSI Framework
  - How network devices contact each other
  - How does the device to transport data and where
  - How to arrange and connect physical devices
  - How to maintain consistent rate of data flow
  - How electronic data is presented on the network media

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ISO/OSI

Application
Presentation
Session
Transport
Network
Data Link
Physical

Internet Protocol Suite

NFS / XDR / RPC	SNMP	FTP	Telnet	SMTP
TCP				
IP				
LAN Drivers				
Media Access Control				
Physical				

MS Windows NT

Redirectors	Server		
TDI			
TCP/IP	NWLink	NBT	DLC
NDIS 4.0			
NDIS wrapper	NDIS network interface card drivers		
Physical			

ISO/OSI

Application
Presentation
Session
Transport
Network
Data Link
Physical

Netware

Netware core protocol	
Named pipes	NetBIOS
SPX	
IPX	
LAN drivers	
ODI	NDIS
Physical	

Apple

Apple Share			
Apple Talk Filing Prot. (AFP)			
ASP	ADSP	ZIP	PAP
ATP	NBP	AEP	RTMP
Datagram Delivery Prot. (DDP)			
LAN drivers			
LocalTalk	TokenTalk	EtherTalk	
Physical			

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Why is this the Perfect Model?

- ISO/OSI model ensures that manufacturers build equipment that intercommunicates and interoperates
  - Transparent model of functionality and interfaces
  - Creating a “virtually homogeneous” network implemented by heterogeneous devices
  - Mapping of alternative solutions supported

  The ISO/OSI model presents the heterogeneous and multi-standard environment as one network to the user!

How can we apply this to M&S needs?

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Computer Grids

- As the heterogeneity of networks is captured by the ISO/OSI layers, computer grids must be managed as well
- Grid Objectives
  - Distributed computing environments operating as a uniform service
  - Research management and security independent from individual technology choices
  - Virtualization of distributed computing and data resources

Creating a Single System Image granting Users and Applications seamless Access to available IT Capabilities

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Service Oriented Architecture

- Objective
  - Composable Services delivering the functionality for the user based on his current needs

- Definition of Services
  - Well defined software component
    - Implementation
    - Operational functionality
    - Self descriptive
  - Service is independent
    - Doesn't depend on the status or context of the caller

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The Challenge: Composable Services

- What is needed
  - Migration of Solutions into Services (Reuse)
  - Composition of Services
  - Orchestration of Services
- Current technological solution
  - Web Services / Grid Services
  - XML, SOAP, WSDL, UDDI

Is this sufficient for the Grid?
Is this sufficient for M&S and C4I?

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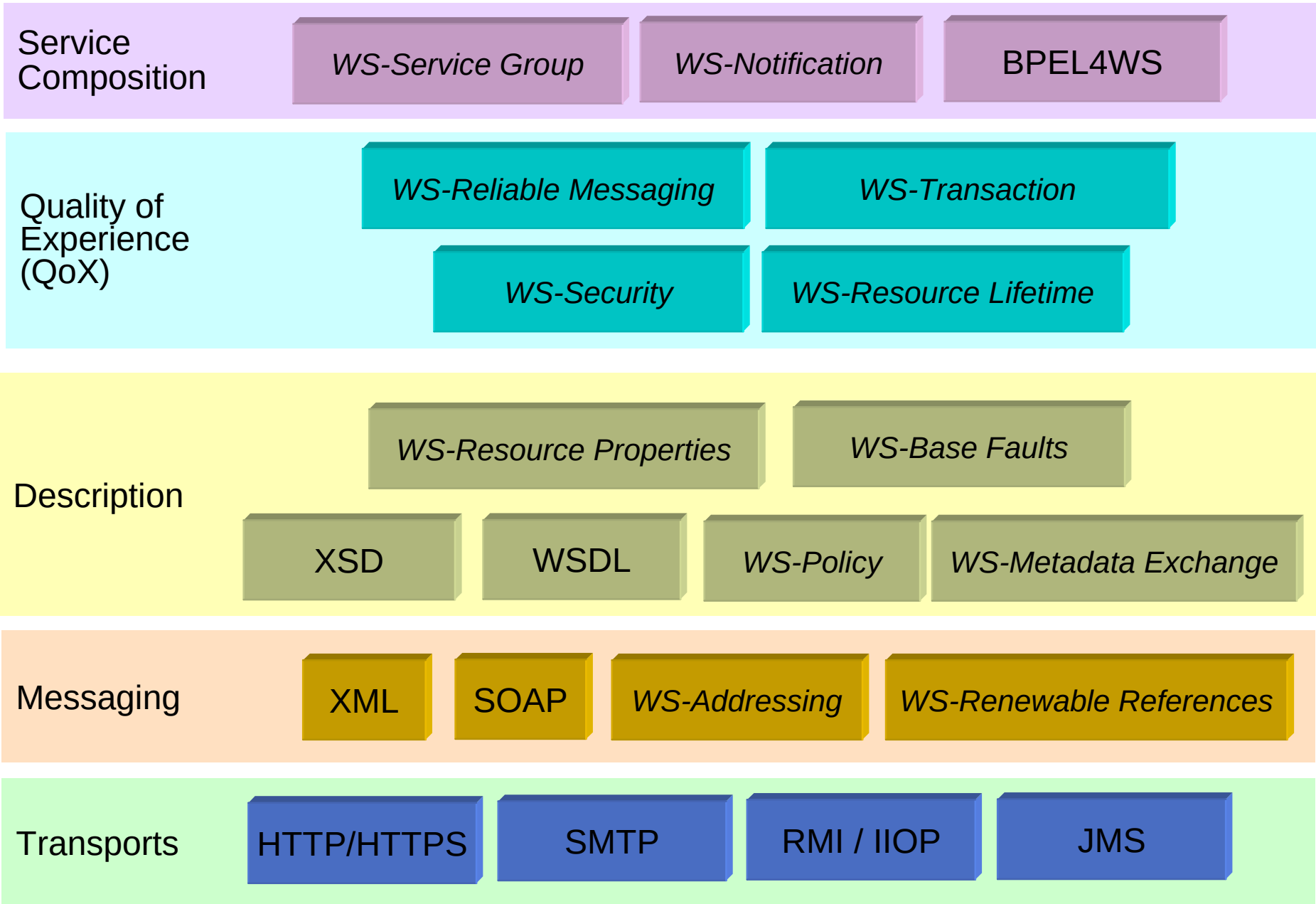

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Enterprise Architecture

- Strategic Capabilities Architecture
  - Strategic vision
- Business Architecture
  - Core competencies and IT support
- Information Architecture
  - Information/Information exchange requirement
- Data Architecture
  - Data management
- System/Computer Architecture
  - Implementation (SOA is one option)

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There is not one generally supported and accepted standard!

There will always be proprietary and highly adapted system solutions!

Standards will continue to evolve!

Migration and Mapping Management is needed!

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Level 5
Conceptual Interoperability

Level 4
Dynamic/Pragmatic Interoperability

Level 3
Semantic Interoperability

Level 2
Syntactic Interoperability

Level 1
Technical Interoperability

Level 0
No Interoperability

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Some related Military Frameworks and Standards

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Military IT is facing the same Challenges

- Generally, military IT is moving towards Enterprise Solutions based on Service Oriented Architectures
  - DoD Architecture Framework
  - Global Information Grid
  - Information Exchange Standards
  - …
- Specifically for M&S, a model is a **Meaningful Abstraction of Reality**, so we have to cope with the assumption and constraints in a consistent way
  - Conceptual Modeling
  - Engineering Standards
  - …

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DoD Architecture Framework (DoDAF)

- DoDAF is a tool to structure the Enterprise Architecture in the military domain
  - Business model in operation views
  - Implementation in system views
  - Standards applied in technical views
- DoDAF is using increasingly UML and SysML artifacts
  - Better communications between users, developers, and supporters
- Core Architecture Data Model (CADM) represents DoDAF artifacts in an exchangeable data format
  - Data model for architectures
  - Describes information exchange requirements, not information exchange format

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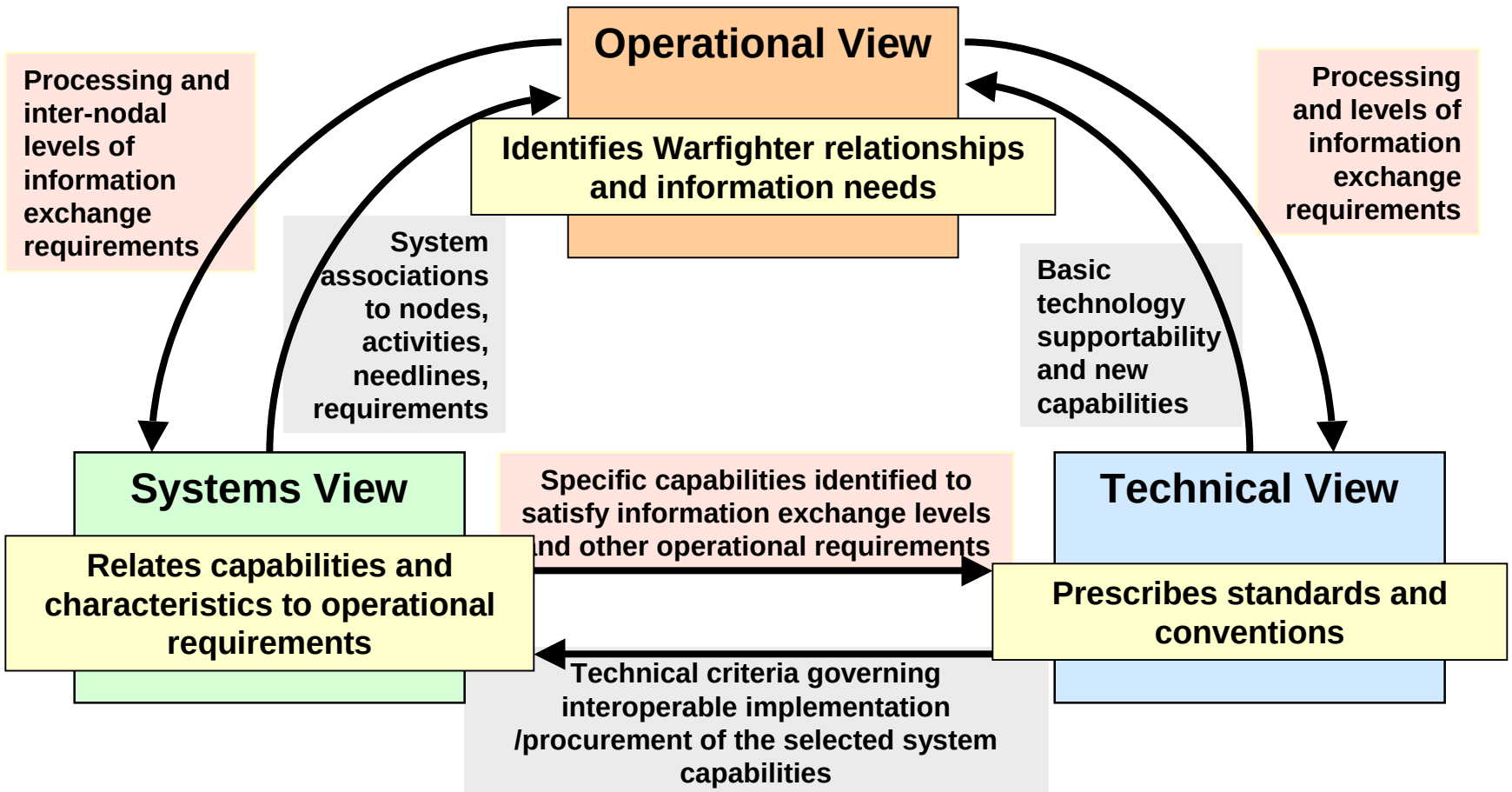
DoDAF Fundamental Linkages



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Command & Control Information Exchange Data Model (C2IEDM)

- Automated C2 Interface Exchange Mechanism To Support Liaison and Automation
  - Exchange Of Orders/Graphics
  - Holdings/Status Information
- Operational exchange standards use a common vocabulary consisting of 176 information categories that include over 1500 content elements.

Fire Support:	**4**	**IEW:**	**16**
ADA:	**12**	**CSS:**	**37**
Maneuver:	**6**	**A2C2:**	**11**
NBC:	**19**	**MP:**	**9**
Engineer/Terrain:	**15**	**CMO:**	**21**
Weather:	**9**	**Signal:**	**9**
		Enemy:	**8**
		Total:	**176**

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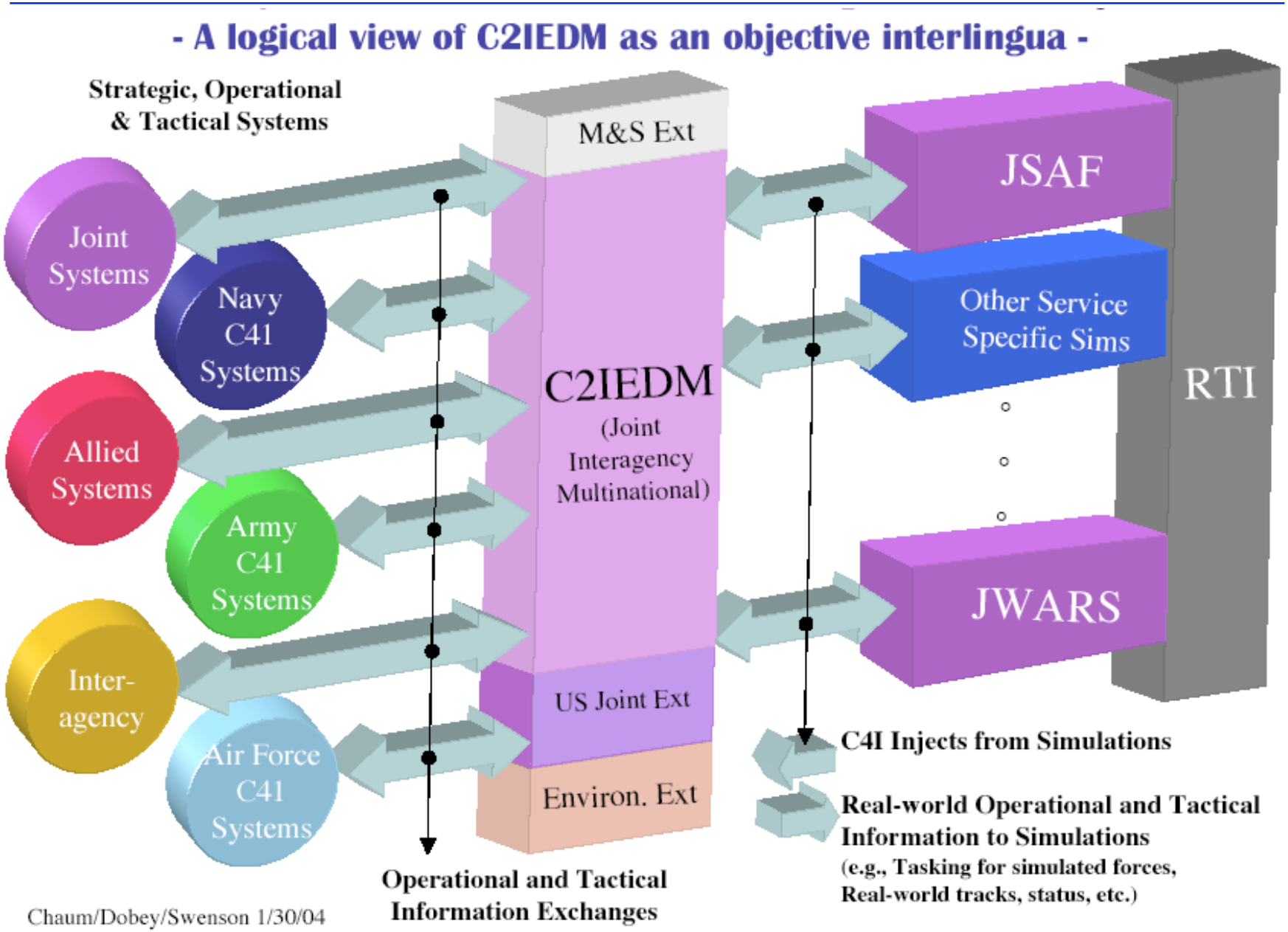
- A logical view of C2IEDM as an objective interlingua -
Strategic, Operational & Tactical Systems
Joint Systems
Navy C41 Systems
Allied Systems
Army C41 Systems
Inter-agency
Air Force C41 Systems
M&S Ext
C2IEDM
(Joint Interagency Multinational)
US Joint Ext
Environ. Ext
JSAF
Other Service Specific Sims
JWARS
RTI
C4I Injects from Simulations
Real-world Operational and Tactical Information to Simulations
(e.g., Tasking for simulated forces, Real-world tracks, status, etc.)
Operational and Tactical Information Exchanges
Chaum/Dobey/Swenson 1/30/04

More information on the C2IEDM

- Multilateral Interoperability Programme website
  - http://www.mip-site.org
- SISO Proceedings
  - **99F-SIW-008**: Using ATCCIS as an Information Layer to couple CGF Federates and Closed Combat Simulations
  - **04E-SIW-016**: Moving towards a Lingua Franca for M&S and C3I – Developments concerning the C2IEDM
- C2IEDM Workshop March 2004
  - http://www.vmasc.odu.edu/c2iedm/ws2004.html

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Distributed Simulation

- If Simulation wants to reach to warfighter using his operational systems, the constraints must be met (running in the GIG/COE, DoDAF)
- DoDAF descriptions are a bridge between simulation and user (requirement driven)
  - Capability based procurement (04S-SIW-108)
  - VV&A (03S-SIW-029)
  - FEDEP (04F-SIW-015)
  - Operational Requirements (01F-SIW-112)

Connection for the Military EA already there!

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Live Cycle and Distributed Simulation

- User Requirements lead to DoDAF
- DoDAF as an “Executable Architecture” can lead to a first strawman solution
- DoDAF can be used to define constraints for solutions based on operational systems (including M&S)
- Platform Independent Models (metamodel) maps to system specific solutions / Reverse Engineering makes functionality visible for management

Migration and Mapping support whole Life Cycle

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Services in the Future IT Backbone

- Global Information Grid (GIG)
  - DoD Directive 8100.1.
    Global Information Grid (GIG) Overarching Policy.
    The Pentagon, Washington, D.C., September 2002
- Net Centric Data Strategy
  - DoD, Chief of Information Operations (CIO).
    Department of Defense Net-Centric Data Strategy.
    The Pentagon, Washington, D.C., May 9, 2003
- DoD Metadata
  - DoD, Deputy Assistant Secretary of Defense
    Department of Defense Discovery Metadata Specification (DDMS) – Version 1.0.
    The Pentagon, Washington, D.C.

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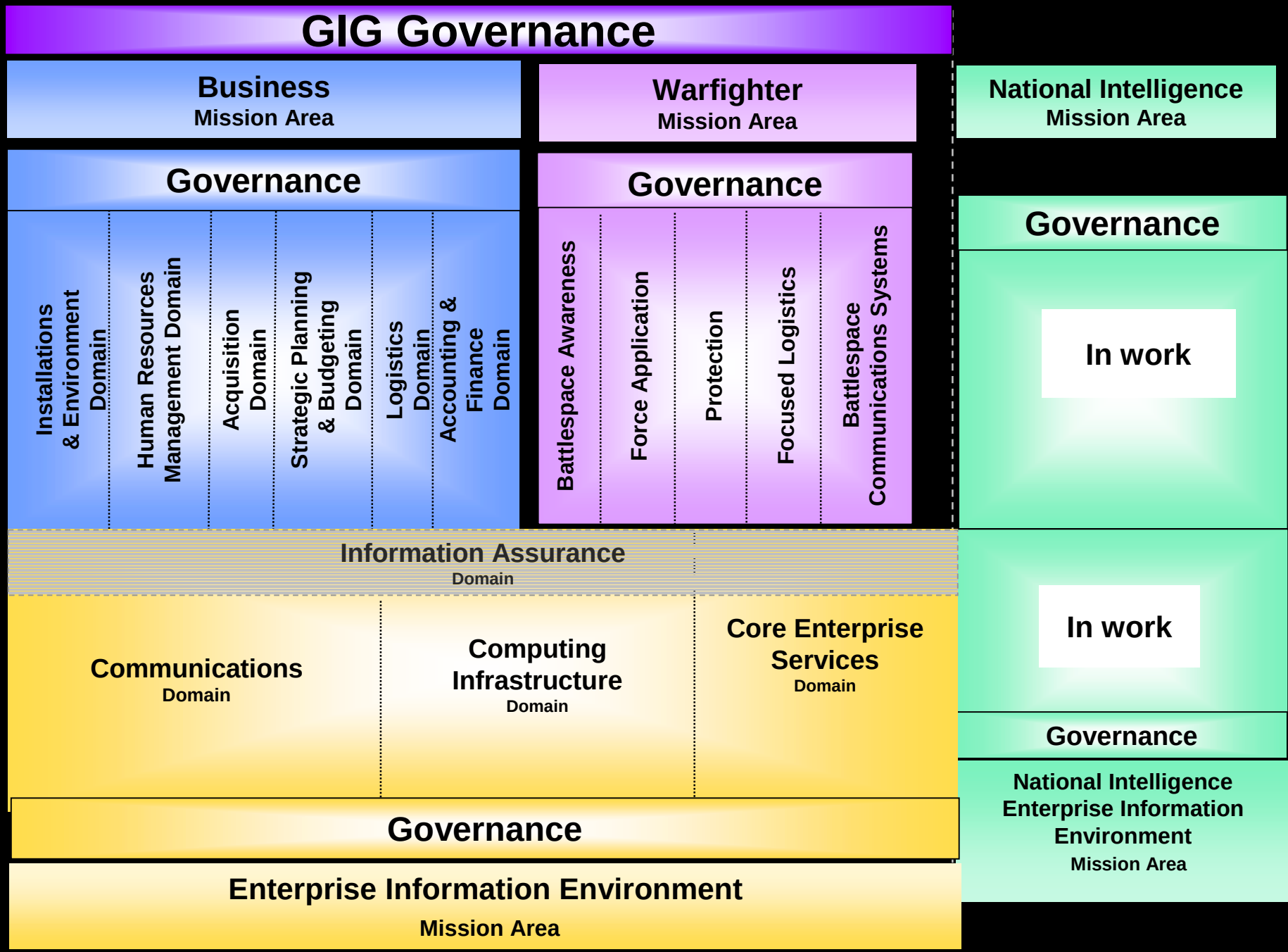
GIG Governance
Business
Mission Area
Warfighter
Mission Area
National Intelligence
Mission Area
Governance
Installations & Environment Domain
Human Resources Management Domain
Acquisition Domain
Strategic Planning & Budgeting Domain
Logistics Domain
Accounting & Finance Domain
Governance
Battlespace Awareness
Force Application
Protection
Focused Logistics
Battlespace Communications Systems
Governance
In work
Information Assurance
Domain
Communications
Domain
Computing Infrastructure
Domain
Core Enterprise Services
Domain
In work
Governance
National Intelligence Enterprise Information Environment
Mission Area
Governance
Enterprise Information Environment
Mission Area

Metamodels and Mappings

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Lessons learned so far

- There will be no Enterprise wide Data Model
  - Metadata
  - Data Mediation Services
- Multiple conceptual views are possible and needed
  - Assumptions and constraints
  - Heterogeneous solutions (divide and conquer)
- Diversity is good
  - Multiple views are needed to cope with the complete problem

Migration and Mapping Management to bring Everything back together!

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Metamodels and Mapping

- Metamodels
  - Precise definition of constructs and rules needed for semantic models
  - Implementation specific independent descriptions of the underlying algorithmic ideas
  - Abstraction and generalization
  - Avoid double work and enable reuse

What Metadata is for Data (Mediation, Unambiguity)
Will Metamodels be for Models

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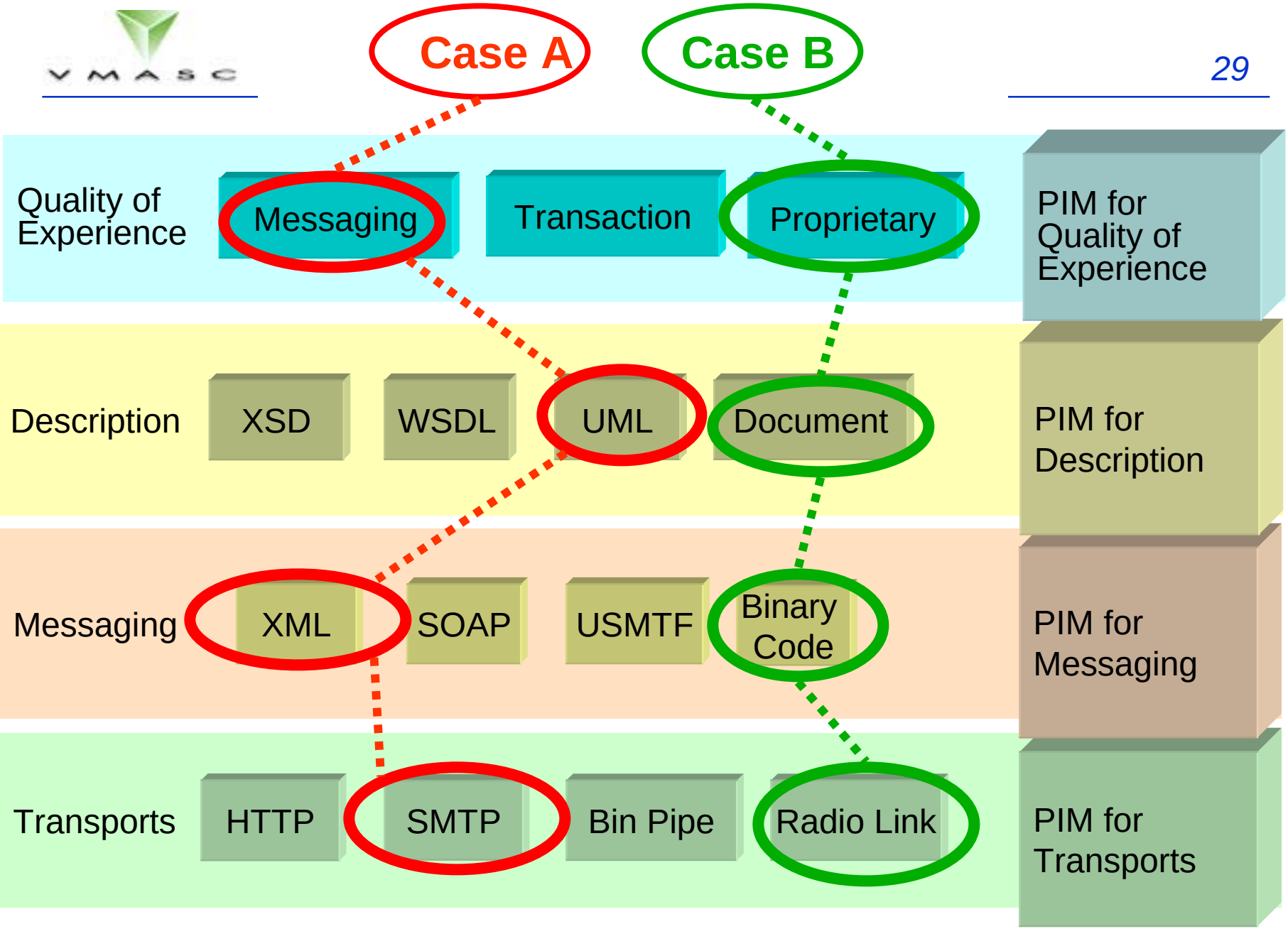

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Summary and Recommendations

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Recommendations

- We need to shift from standards to
  - Metamodels and Mapping Frameworks supporting Family of Standards
- Evaluation of proposed solution for M&S
  - Model Driven Architecture (OMG)
  - Global Information Grid (COI M&S)
  - Semantic Web, Ontologies
  - Next Generation Web Services and Grid Services

Active Participation of the M&S Community is needed

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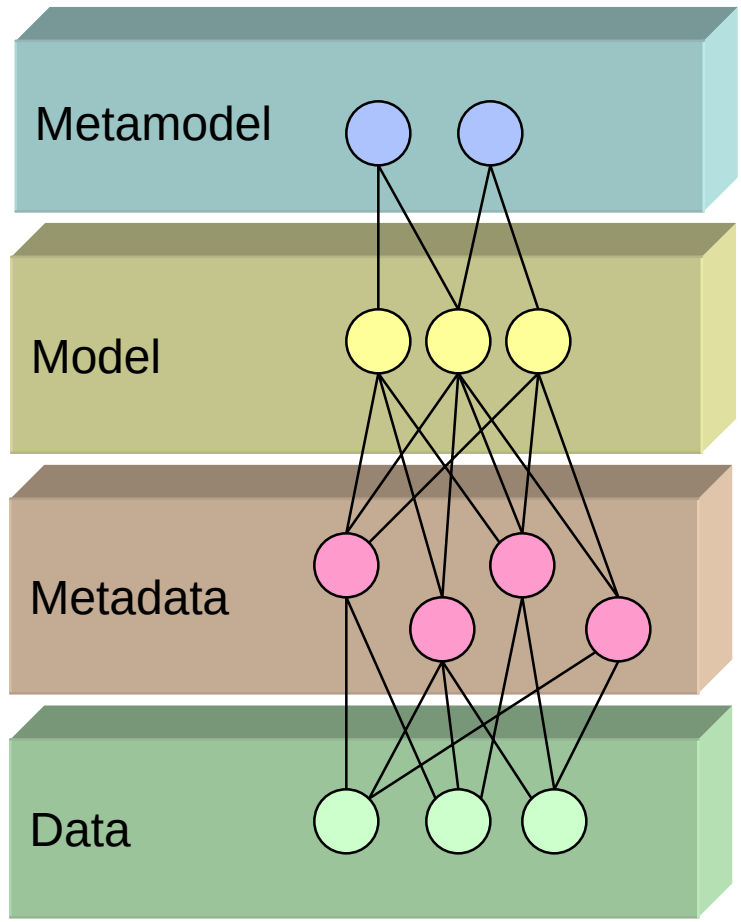
Metamodels and Mapping – Bridging the Gap

- Framework is needed for Metamodels and Mappings
  - Identify and manage
    - Alternative solutions
    - Complementary solutions
  - Show
    - Common ground
    - Contradictions (assumptions, constraints)
- Applicable to Forward- and Reverse-Engineering



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Questions

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