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DoD Architectures and Systems Engineering Integration
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Mr. Walt Okon
Mr. David McDaniel (ctr)
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Five Topics

1. DoDAF evolution plan
2. Fit-for-purpose (FFP) and legacy views
3. DoDAF reification, requirements, and SE “V” model
4. DoDAF meta-model for:
   – DOTMLPF
   – temporality, behavior, scenarios, M&S, executable architectures
5. DoDAF artifacts X SE documents and artifacts
DoDAF Evolution Plan

Framework Objective:
- Achieve a single integrated architecture framework for interoperability.
- Achieve a US, Canada, and United Kingdom single framework with a common data meta-model
- Achieve alignment with the US Government’s Common Approach to enterprise architecture

Key Features:
- Net-centricity and SoA
  - SvcV views
- JCIDS & NR-KPP
  - Applicability beyond C4ISR
  - Use-based
  - Integrated Architecture
- Joint Interoperability
  - 26 AV/OV/SV/TV views
  - Linked to I&S policies
  - CADM 2.0
- DoDAF/DNDAF
  - DoDAF v1.0
  - C4ISR F/W v1.0
  - 1995
- DoDAF v1.0
  - 1997
- DoDAF v1.5
  - 2003
- DoDAF v2.0
  - 2007
- DoDAF v2.01
  - 2009
- DoDAF v2.02
  - 2010
- DoDAF v2.03
  - 2012
- DoDAF v2.04
  - 2013
- DoDAF v2.05
  - 2014
- UAF
  - Standardization, e.g.,
    - ISO
    - OMG
    - OASIS

22 Oct 2012
Initiatives: Federal Government Common Approach

- primary outcomes (4)
- levels of scope (8)
- basic elements of an EA program (8)
- sub-architecture domains (6)
- 50 document artifacts
- reference models (6)
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**Business Domain Artifacts**

- **DoDAF SvcV-1** (Service Composition)
- **DoDAF CV-7** (Capabilities Services)
- **OMB Exhibit 300**
- **DoDAF OV-2** (Organizations and Resources)
- **DoDAF OV-5a&b** (Operational Activities), **Operational Activity Diagram, Business Process Diagram**
- **DoDAF OV-5a&b** (Operational Activities Support)
- **OV-6c** (Operational Activity Sequences)
- **DoDAF OV-6c** (Operational Activity Sequences)
- **DoDAF PV-2** (Project Schedules), **Business Operating Plan**
- **DoDAF OV-6a** (Operational Rules)
- **DoDAF PV-2** (Project Schedules) and **PV-3** (Projects and Capabilities)**
Convergence Approach for NAF: IDEAS Layered Approach

1. Foundation (upper ontology)
2. Common patterns
3. Common architecture domain objects & relationships

1. Ontologic concepts and relationships
2. Commonly used patterns (e.g., resource flow, exchange)
3. Consensus concepts and relationships (e.g., person, organization, material)

Views for:
1. NATO “core” architecture views
2. Specific to needs and policies of individual nations
Fit For Purpose (FFP) Views
Fit For Purpose (FFP) and Legacy Views

IDEAS Ontology

Set theoretic 4-D mereotopologic

supported processes

DM2

Views

Locations
Capabilities
Performers
Reification
Pedigree
Resource Flows
Projects
Rules
Services
DM2 Has Three Model Levels

• Conceptual Data Model (CDM)
  – Concepts and concept relationships
  – Propositions and definitions validated by SMEs

• Logical Data Model (LDM)
  – Reified and formalized relationships
  – This is where almost all DoDAF design and analysis work is done

• Physical Exchange Specification (PES)
  – XML encoding of LDM
  – Auto-generated from the LDM
  – No need to look at (unless you are a tool programmer)
Example FFP: OV-2 / SV-1 Hybrid

OV-2 [Architectural Description] Organizational Interactions

Legend:
- Organization Types
- Resource Flows
  - Location Type
  - Person Type
  - Resource (Resource)
  - Consume (Activity)
  - Produce (Activity)
  - System
  - Materiel

Diagram showing interactions and resources involved in a Boat Radio Communications System.

- **Search Org Type**: WO : warningOrder
- **Rescue Org Type**: DS : distressSignal
- **SAR Asset Controller**: Rqst : request
- **Tactical C2 Org Type**: Tsk : tasking
- **Monitoring Org Type**: TI : trackInfo
- **Boat Radio Communications System**: DS : distressSignal, keyDistressSignal
- **Person in Distress**: speak, voiceDistressSignal
- **Place of Safety (PoS)**: DS : distressSignal, key

Legend:
- **Organization Types**
  - Warning Order (WO)
  - Search (SAR)
  - Rescue (Rescue)
  - SAR Asset Controller
  - Tactical C2
  - Monitoring
  - Person in Distress
- **Resource Flows**
  - Consume (Activity)
  - Produce (Activity)
  - System
  - Materiel

Diagram notes:
- **Bounding box**: means Resource at Location
- **Key**: means Resource at Location
- **Materiel**: System
- **Consume (Activity)**
- **Produce (Activity)**
- **System**
- **Materiel**
Creating a FFP Model

- Use the DM2 Logical Data Model.
- Create a new diagram. Drag DM2 elements onto the diagram.
- Extend classes (including relationship classes) as needed.
- Use the IDEAS Profile to generate XSD.
- Develop narrative documentation.
- Share XSD and documentation with your COI.

Tutorial at [www.rdte.us/FFP](http://www.rdte.us/FFP) tutorial
DoD AF reification, requirements, and SE “V” model
Some Life-Cycle Models

Concept of Operations

Traceability

System Requirements

Traceability

Subsystem Requirements

Traceability

Subsystem Verification

System Validation

Delivery

Decomposition and Traceability

Component Requirements

Unit Verification

Implementation

Recombination and Integration

Time

When you look up it’s requirements

When you look down it’s design
How DoDAF Supports Reification

An Architectural Description:

- **Identifies**
  - Traceability (Pedigree)
  - Rules constrain (requirements)

- **Defines**
  - Traceability (Pedigree)
  - Rules constrain (requirements)

- **Represents**
  - Traceability (Pedigree)
  - Rules constrain (requirements)

- **Specifies**
  - Traceability (Pedigree)
  - Rules constrain (requirements)

- **Configures**
  - Traceability (Pedigree)
  - Rules constrain (requirements)

- **Instantiated**
Reification Pattern Applies To:

- Capabilities
- Acquisitions
- Consolidations
- Migrations
- Life-Cycle Sustainment
Plumbing is via Pedigree (Provenance)

- workflow model, e.g., open provenance model (provenance = linked together pedigrees)
- = activity model (OV-5 + 6c)
- “link while you think”
DoDAF meta-model for:

- DOTMLPF
- temporality, behavior, scenarios, M&S, executable architectures
Temporality, Behavior, Scenarios, M&S, Executable Architectures
DM2 is founded on 4D ontology

- Four dimensionalist -- xyzt
- Extensional -- physical existence is the criterion for identity
- Signs and representations are separated from referents

Mathematics:
- Type theory ~ Set theory
- Mereology (wholes and parts)
- 4D Mereotopology (spatio-temporal relations)

Example OV-1
Maritime Interdiction / ISR
“National Critical Contact of Interest”
National Assets report CCOI (Critical Contact of Interest) enroute Battlegroup ‘Alpha’

SUW CDR embarked aboard DDG generates cueing order and directs launch of SSC aircraft from CVN; request P-3 for maritime surveillance

E2-C locates COI with radar approaching surveillance area outside normal shipping traffic lanes

SSGN + embarked SOF teams monitor situation by searching for relevant reports from area; study possibility of take-down mission

P-3 checks into TADIL; SUW CDR provides search area coordinates and possible CCOI track information

S-3 & SH-60 assets are coordinated for shipping lane traffic ID; imagery from H-60 provided for Intel cell analysis; CCOI ID confirmed

CVN (SOF Capable) provides assets for board & search; SSBN directed to scene for inspection/seizure if required

DDG directed to provide area security; designated OSC (On-Scene-Commander)

SH-60 reports SOF onboard vessel; no resistance

SSBN reports on station; on board SOF disembarks to assist search

SOF reports sensitive material secured; vessel underway and escorted by DDG
DoDAF and SE Documents and Artifacts
DoDAF Artifacts Overlaid on “V”
Notional Systems Engineering Documents with embedded DoDAF artifacts

• System Specification (SSS, SDS, SDD, etc.)
  – Functional Description – SV-4
  – Performance Specification – SV-7
  – Interfaces – SV-1, high-level SV-2 and 6
  – Standards to Comply – StdVs mapped to SV’s
  – Components – SV-1

• Interface Specification (IRS, ICD, etc.) – SV-2 and 6, possibly linked to DIV-2 and 3
Elements of Quality Architecture

- Single Architecture Framework
- Policy, Direction, Guidance
- Exchange
- Architecture Tools
- Certified Architects

Enabling efficient and effective acquisition of hardware, software and services used by DoD and Partners in mission performance.

Unified Architecture Framework
Summary

- DoDAB is foundational to Federal Government and NATO
- FFP + DM2 enables more sophisticated modeling than legacy views
- DoDAB’s model for reification supports many life-cycle models, including SE “V”
- The DoDAB Meta Model (DM2) was designed to allow modeling beyond the legacy views
- DoDAB artifacts, SE documents, and artifacts should be complimentary
Questions?