An Overview of the DoD Architecture Framework
Today’s Objectives

• Communicate
  – What is DoD AF?
  – The reasons for doing DoD AF
  – An approach for building a DoD AF conformant architecture

• After this seminar you should:
  – Know each of the DoD Architecture views and work products within them.
  – Understand the relationships among the information the work products represent
  – Have an understanding of why you would want to build a DoDAF Conformant Architecture
Why Enterprise Architecture?
Enterprise Architecture: The Problem / Solution Space

• Linear, Text-based descriptions are no longer adequate for understanding and communicating complex requirements and interfaces.

• Help comes in the form of two or more dimensional symbol-based models supplemented with structured character-based facts.
  – They give better visibility to relationships and interfaces
  – Give expression to our visual thinking capabilities
  – Increase the effectiveness of communication
  – Improve Understanding
  – Facilitate quicker identification of missing elements of requirement specifications, errors in business and solution logic, risk management issues, process improvements, etc.
Basic Uses of an Enterprise Architecture

- An Enterprise Architecture allows you to answer who does what activity when, why, where, how and with what.
- It allows you to track changes within an enterprise, and analyze effects of those changes before implementation.
- It allows you to perform gap analyses As Is (now) and To Be (future) architectures of the same enterprise.
What is an Enterprise Architecture Framework?

- A Framework provides structure for architecture information:
  - It organizes the information
    - Where to put it
    - Where to find it
  - It defines relationships within the architecture
  - It provides structure
    - Consistent structure allows for interoperability between architectures
    - Delineates whether information should be stored as diagrams or text
There have been a number of frameworks developed for EA use.

**Framework Examples**

- **Zachman Framework**
  - Used extensively in the commercial world
- **TOGAF**
  - The Open Group Architecture Framework
- **TEAF**
  - Treasury Enterprise Architecture Framework
- **FEAF**
  - Federal Enterprise Architecture Framework
- **DoD AF**
• The Department of Defense Architecture Framework allows easy organization and access to the specific data that comprise an Architecture within DoD applications.

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Why are we doing DoD AF?

- To speak the DoD language.
- To support the DoD procurement decisions.
- To deal with changes.
- To save time and money designing and building systems.
- To build horizontal integration into systems.
- To assist system engineers in their work.
- To assist software engineers in their work.
Importance of Architecture

- OMB Circular A-130 mandates creation of Enterprise Architecture Framework

- CJCSI 3170.01C (6/24/2003) “JCIDS*…implements a capabilities-based approach that utilizes joint architectures and integrated architectures……”Architectural views are mandatory appendices to ICD, CDD, and CPD”

- DoD Directive 5000.2R – requires development of C4I Support Plan (C4ISP) by the customer, however the C4ISP is developed from information supplied by the contractor and must be sufficient to produce the required views.

*JCIDS - Joint Capabilities Integration and Development System
Why Enterprise Architecture?

Importance of Architecture (cont.)

- Return on investment:
  - Desire for “plug-able” architectures across the services
  - Operator understands needs and requirements
  - Testing and training occur earlier in the requirements process
  - Reuse is easier to identify
  - Deals with smaller components
  - Provides open design space
  - Focus is on interfaces to systems
Acquisition Landscape Has Changed

• Statement Of Objectives (SOO)
• Architecture Driven
• Supplier Provides Architecture
• No Product Specification from Customer
• The DoD is:
  – No longer telling the contractor the solution they have chosen.
  – Seeking to leverage the expertise of the contractor.
  – Seeking to have a their choice of the best options available against which they will write the SRD.
  – Stating their goals for the product in an SOO.
  – Asking the contractor to tell them what it really takes to achieve that SOO.
An EA is done prior to Milestone A and revised prior to milestone A, B, and C in the Acquisition Process.
Relationship to the Requirements, Acquisition and Budgeting Process
Requirements Documents

Common element is CAPABILITIES

- Initial Capabilities Document (ICD) replaces MNS at Milestone A
  - Describes desired capability. Evaluates multiple materiel approaches. Recommends a materiel approach.

- Capability Development Document (CDD) replaces ORD at Milestone B
  - Describes the SDD effort and provides KPPs for the increment. Describes program to get to complete solution.

- Capability Production Document (CPD) replaces ORD at Milestone C
  - Describes the SDD effort to produce materiel solution for the increment and provides KPPs for the production increment.
Overview of the DoD Architecture Framework (DoD AF)
Enterprise Architecture

• Defines the mission, the information necessary to perform the mission and the technologies necessary to perform the mission.

• Is used to manage change when implementing new technologies in response to the changing mission needs.

• Includes a baseline architecture, target architecture, and a transition plan.
Important Definitions

- **Framework**
  - a logical structure for classifying and organizing information

- **View**
  - a perspective of the information within the architecture

- **Model**
  - representations of reality: the information, activities, relationships, and constraints

- **Methodology**
  - a prescribed way of approaching a particular problem

- **Capability (according to DoDAF Vol II)**
  - The ability to execute a specified course of action. (JP 1-02) It is defined by an operational user and expressed in broad operational terms in the format of an initial capabilities document or a DOTMLPF change recommendation. In the case of materiel proposals, the definition will progressively evolve to DOTMLPF performance attributes identified in the CDD and CPD. (CJCSI 3170.01C)
The DoD AF Version 1.0 Provides:

- Guidance as to **why** enterprise architecture is done in the DoD and examples of how it is to be used.
- Definition of the data collected as part of the architecture effort and the Views and “Work Products” to used to present the data.
- Formats for presenting the architecture information
- A Logical Data Model (i.e. CADM) that defines the relationships between the information gathered in each work product.
Key Differences between DoD AF 1.0 and C4ISR 2.0/2.1

- AV-3 Capability Maturity Profile of C4ISR 2.1 (Draft) – removed.
- “Essential and Supporting” Work Product Notion of C4ISR 2.0 no longer used.
- System Element Deleted from SV-1.
- Better Definitions of Views and Work Products.
- OV-6c supports Event Trace and Process Flow Diagramming.
- CADM sub-sets included in the Architecture framework Documentation.
- Discussion of the use of UML work products included in the main body of the DoD AF documentation.
Results of applying the DoD AF

- An understanding of the mission needs of the customer.
- What the operational environment will need to do to deliver the mission needs.
- How the system (and/or system of systems) will support the operational environment and ensure the mission needs are met.
- How and where the required concepts (TPPU, TCPED, etc.) and technical standards (JTA/DISR) are included in the architecture.
All Views (AV)

- States the PURPOSE of the architecture i.e. the GOAL that will be achieved.
- Captures the overarching aspects of the architecture that relate to the other three views.
- Sets the scope and context of the architecture.
- Provides information pertinent to the entire architecture (data dictionary).
## DoD AF AV Work Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV-1</td>
<td>Overview and Summary Information</td>
<td>Scope, purpose, intended users, environment depicted, analytical findings</td>
</tr>
<tr>
<td>AV-2</td>
<td>Integrated Dictionary</td>
<td>Architecture data repository with definitions of all terms used in all products</td>
</tr>
</tbody>
</table>
Fundamental Linkages Among Views

Keypoint
The Views are interrelated!

Operational View
Identifies What Needs To Be Done And Who Does It

Systems View
Relates Systems and Characteristics to Operational Needs

Technical Standards View
Prescribes Standards and Conventions

Communications

Data Flow

Information Flow

Activities/Tasks

Operational Elements

• Specific Capabilities Required to Satisfy Information Exchanges

• Technical Standards Criteria Governing Interoperable Implementation/Procurement of the Selected System Capabilities

• New Technical Capabilities

• Basic Technology Supportability

• Operational Requirements and Capabilities

systems

• What Needs to Be Done
• Who Does It
• Information Exchanges Required to Get It Done
• Systems that Support the Activities and Information Exchanges

Standards

Rules

© 2004 EA Frameworks, LLC • www.eaframeworks.com • DoD Architecture Framework Overview
Operational View (OV)

- Provides the specification of the tasks, operational elements, and information exchanges required to accomplish the GOAL (mission).
- Comprised of graphical and textual work products that identify the operational nodes, assigned activities, and information flows required between nodes.
- Defines the types of information exchanged, the frequency of exchange, which activities are supported by the information exchanges, and the nature of information exchanges.
## DoD AF OV Work Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV-1</td>
<td>High-Level Operational Concept Graphic</td>
<td>High-level graphical/textual description of operational concept</td>
</tr>
<tr>
<td>OV-2</td>
<td>Operational Node Connectivity Description</td>
<td>Operational nodes, connectivity, and information exchange needlines between nodes</td>
</tr>
<tr>
<td>OV-3</td>
<td>Operational Information Exchange Matrix</td>
<td>Information exchanged between nodes and the relevant attributes of that exchange</td>
</tr>
<tr>
<td>OV-4</td>
<td>Organizational Relationships Chart</td>
<td>Organizational, role, or other relationships among organizations</td>
</tr>
<tr>
<td>OV-5</td>
<td>Operational Activity Model</td>
<td>Capabilities, operational activities, relationships among activities, inputs, and outputs; overlays can show cost, performing nodes, or other pertinent information</td>
</tr>
</tbody>
</table>
## OV Work Products (cont.)

<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV-6a</td>
<td>Operational Rules Model</td>
<td>One of three products used to describe operational activity—identifies business rules that constrain operation</td>
</tr>
<tr>
<td>OV-6b</td>
<td>Operational State Transition Description</td>
<td>One of three products used to describe operational activity—identifies business process responses to events</td>
</tr>
<tr>
<td>OV-6c</td>
<td>Operational Event-Trace Description</td>
<td>One of three products used to describe operational activity—traces actions in a scenario or sequence of events</td>
</tr>
<tr>
<td>OV-7</td>
<td>Logical Data Model</td>
<td>Documentation of the system data requirements and structural business process rules of the Operational View</td>
</tr>
</tbody>
</table>
OV-1 Is:

• Graphical in nature.
• An easy way to understand what is trying to be explained by the architecture as a whole.
• Provides an excellent summary of an architecture when combined with AV-1.
• A mission and highlighted primary operational nodes.
OV-1 Primary Features

- A freeform and variable format.
- Flexible.
OV-2 Is:

- Graphical in nature.
- One of the work products required for an integrated architecture.
- A way to track the need to exchange information from specific Operational Nodes (that play a key role in the architecture) to other Nodes.
OV-2 Primary Features

• Operational Nodes:
  – Operational Activities (from the OV-5 Operational Activity Model) performed by a given Node may be listed on the graphic, if space permits.
  – The notion of Operational Node will vary depending on the level of detail addressed by the architecture effort.

• Needlines:
  – Indicate a need to exchange information
  – An aggregation of specific Information Exchange Requirements
  – Have source and destination Nodes
  – System implementations are not included here
Acquire Target Data

- **Observer**
  - Activities
  - "Manage UAV Mission Schedule"

- **GPS Satellite**
  - Activities
  - "Manage Camera Operation"

- **Target Control**
  - Activities
  - "Manage Stored Target Data"

- **UAV**
  - Activities
  - "Manage UAV"
OV-5: Operational Activity Model

The OV-5 Activity Model definition:
The operations that are normally conducted in the course of achieving a mission or a business goal.
OV-5 Activity Model Is:

- Graphical in nature.
- One of the work products required for an integrated architecture.
- Seen by most as the primary work product of the architecture.
  - A simple Activity Model helps in understanding the architecture
- **NOT** a process model.
- Modeled starting at a very abstract level and then in ever increasing levels of detail until the desired analysis can be performed
  - Multiple diagrams are created and linked together in a parent/child fashion
OV-5 Primary Features

- OV-5 can be used to:
  - Clearly delineate lines of responsibility for activities
  - Uncover unnecessary operational activity redundancy
  - Make decisions about streamlining, combining, or omitting activities
  - Define or flag issues, opportunities, or operational activities and their interactions (information flows among the activities) that need to be scrutinized further
  - Provide a necessary foundation for depicting activity sequencing and timing in a process flow model such as an OV-6c
Example OV-5

Manage UAV Data Acquisition

A.1

Manage UAV Mission Schedule

Laws

Data Acquisition Request

UAV Schedule Entry

A.2

Manage UAV

Requested Target Data

UAV Position Data

Target Data

A.3

Manage Camera Operation

Requested Target Data

A.4

Manage Stored Target Data

Requested Target Data Set

Target Data Retrieval Request

UAV Position

UAV Schedule Entry
OV-3: Operational Information Exchange Matrix

Information Exchange definition:

The act of exchanging information between two distinct Operational Nodes and the characteristics of the act.
OV-3 Is:

- Textual/tabular in format.
- One of the work products required for an integrated architecture.
- A description of “who exchanges what information, with whom, why the information is necessary, and how the information exchange must occur.” [CJCSI 6212.01B, 2000].
OV-3 Primary Features

- Identifies information element (a formalized representation of information subject to an operational process (e.g., the information content that is required to be exchanged between nodes)).
- Includes all relevant attributes of an IE:
  - Information assurance, security
  - Timing, triggers, etc.
- Associates a particular IE with a particular Needline, and source & destination Operational Nodes.
Dependencies between Work Products

[Diagram showing dependencies between operational view (OV-2), activity (OV-5), role (OV-4), and operational activity.]
### Example OV-3

<table>
<thead>
<tr>
<th>IER</th>
<th>Valid</th>
<th>From Activity</th>
<th>From Node</th>
<th>To Activity</th>
<th>To Node</th>
<th>ICOM Arrow</th>
<th>From OpNodeActivity Roles</th>
<th>To OpNodeActivity Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Acquisition Request</td>
<td>T</td>
<td>Nominate</td>
<td>Control</td>
<td>Manage</td>
<td>Observer</td>
<td>Data</td>
<td></td>
<td>Operator</td>
</tr>
<tr>
<td>Requested Target Data</td>
<td>T</td>
<td>Manage</td>
<td>UAV</td>
<td>Manage</td>
<td>Target</td>
<td>Requested</td>
<td>Operator</td>
<td>&quot;Contract&quot;</td>
</tr>
<tr>
<td>Requested Target Data</td>
<td>T</td>
<td>Manage</td>
<td>UAV</td>
<td>Manage</td>
<td>Target</td>
<td>Requested</td>
<td>&quot;GPS Technician&quot;</td>
<td>&quot;Contract&quot;</td>
</tr>
<tr>
<td>Requested Target Data Set</td>
<td>T</td>
<td>Manage</td>
<td>Issue</td>
<td>Control</td>
<td>Requested</td>
<td>Target</td>
<td>&quot;Contract&quot;</td>
<td></td>
</tr>
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<td>Manage</td>
<td>UAV</td>
<td>Manage</td>
<td>UAV</td>
<td>Target</td>
<td>&quot;Service Provider&quot;</td>
<td>Operator</td>
</tr>
<tr>
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<td>T</td>
<td>Manage</td>
<td>GPS</td>
<td>Manage</td>
<td>UAV</td>
<td>Target</td>
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<td></td>
</tr>
<tr>
<td>Target Data Retrieval Request</td>
<td>T</td>
<td>Nominate</td>
<td>Control</td>
<td>Manage</td>
<td>Target</td>
<td>Target</td>
<td>&quot;Contract&quot;</td>
<td></td>
</tr>
<tr>
<td>UAV Position</td>
<td>T</td>
<td>Nominate</td>
<td>Control</td>
<td>Manage</td>
<td>UAV</td>
<td>UAV</td>
<td>Operator</td>
<td></td>
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<td>UAV</td>
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<td>UAV</td>
<td>Manage</td>
<td>GPS</td>
<td>UAV</td>
<td>&quot;GPS Technician&quot;</td>
<td></td>
</tr>
<tr>
<td>UAV Schedule Entry</td>
<td>T</td>
<td>Manage</td>
<td>Observer</td>
<td>Manage</td>
<td>UAV</td>
<td>UAV</td>
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<td>GPS</td>
<td>UAV</td>
<td>Operator</td>
<td></td>
</tr>
</tbody>
</table>
OV-7: Logical Data Model

Logical Data Model definition:
An LDM describes the structure of an architecture domain’s system data types and the structural business process rules (defined in the architecture’s Operational View) that govern the system data.
OV-7 Is:

- Graphical in nature.
- A key element in supporting interoperability between architectures.
OV-7 Primary Features

• Architecture data elements that describe entity, attribute, and relationship types.

• Various methodologies may be used:
  – Entity Relationship Diagrams (ERD)
  – IDEF1X
  – UML class diagram
An Example

• For example, if the domain is missile defense, some possible system data types may be *trajectory* and *target* with a relationship that associates a target with a certain trajectory.
Example OV-7

OV-7 UAV Logical Data Model

- Observer
- Picture_Display_Request
- Picture
- Picture_Store
- Picture_Taking_Request
- UAV
- UAV_Pod
- Camera
- GPS_Satellite

Relationships:
- submits: Observer to Picture_Taking_Request
- submits: Picture_Taking_Request to Picture_Store
- applies_to: Picture_Display_Request to Picture
- is_stored_in: Picture to Picture_Store
- carries: UAV_Pod to UAV
- supports: UAV_Pod to Camera
- tracks: GPS_Satellite to Observer
OV-6: OPERATIONAL ACTIVITY SEQUENCE AND TIMING DESCRIPTIONS

The dynamic behavior concerning the timing and sequencing of events that capture operational behavior of a business process or mission thread. Thus, the behavior expressed in OV-6 is related to the activities of OV-5.
OV-6 Has Three Options

- **OV-6a Operational Rules Model**
  - Identifies business rules that constrain operational activities

- **OV-6b Operational State Transition Description**
  - Identifies business process responses to events
  - IDEF3 Object State Transition Network diagram used for this product

- **OV-6c Event Trace Description**
  - Traces actions in a scenario or sequence of events
  - A new diagram having the appearance of a UML Sequence diagram but whose symbols are related to DoDAF definitions was used
  - As an alternative, the IDEF3 Process Flow diagram can be used for this work product (OV-6a in C4ISR v2.0)
OV Summary

- Build OV-1 (High-Level Operational Concept Graphic) first, at least in draft form:
  - Continues to organize thoughts, involves graphical thinking team members

- Build OV-5 (Operational Activity Model):
  - Start with Node Tree, establish Operational Activity hierarchy
  - Complete Activity Model by connecting Activities with Information Exchanges
  - Repository based tools may be able to generate starting diagrams for Activity Model

- Determine Operational Nodes
- Assign Operational Activities to Nodes
OV Summary (cont.)

- **Build OV-2 (Operational Node Connectivity Description):**
  - Needlines determined by IEs
  - An automated option in some tools (Popkin System Architect®, Metis), as long as Activities have been assigned to Nodes

- **Build OV-3 (Operational Information Exchange Matrix) Report:**
  - All of the necessary information can be collected from OV-2 and OV-5
  - An automatic report in repository based tools

- **Build OV-4 (Organizational Relationships Chart):**
  - If needed
  - Assign Operational Nodes to Organizational Units
OV Summary (cont.)

- Build OV-7 (Logical Data Model):
  - If needed
  - Important if there is any potential conflict with entity terminology between architectures

- Build OV-6 (Operational Activity Sequence and Timing Descriptions), if needed:
  - Select one (a, b, or c) depending on needs
  - Can increase level of detail
  - Needed to run simulations
  - Based on OV-5
Systems View

The SV describes systems and interconnections providing for, or supporting, DoD functions.
Systems View (SV)

- Comprised of a set of graphical and textual work products that describes systems and interconnections providing for, or supporting, DoD functions.
- The SV associates systems resources to the OV indicating what system resources support the operational activities and facilitate the exchange of information among operational nodes.
<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV-1</td>
<td>Systems Interface Description</td>
<td>Identification of systems nodes, systems, and system items and their interconnections, within and between nodes</td>
</tr>
<tr>
<td>SV-2</td>
<td>Systems Communications Description</td>
<td>Systems nodes, systems, and system items, and their related communications lay-downs</td>
</tr>
<tr>
<td>SV-3</td>
<td>Systems-Systems Matrix</td>
<td>Relationships among systems in a given architecture; can be designed to show relationships of interest, e.g., system-type interfaces, planned vs. existing interfaces, etc.</td>
</tr>
<tr>
<td>SV-4</td>
<td>Systems Functionality Description</td>
<td>Functions performed by systems and the system data flows among system functions</td>
</tr>
<tr>
<td>SV-5</td>
<td>Operational Activity to Systems Function Traceability Matrix</td>
<td>Mapping of systems back to capabilities or of system functions back to operational activities</td>
</tr>
<tr>
<td>SV-5</td>
<td>Capability to System Function Traceability Matrix</td>
<td>Mapping of Capability to System Function</td>
</tr>
</tbody>
</table>
## SV Work Products (cont.)

<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV-6</td>
<td>Systems Data Exchange Matrix</td>
<td>Provides details of system data elements being exchanged between systems and the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>attributes of that exchange</td>
</tr>
<tr>
<td>SV-7</td>
<td>Systems Performance Parameters Matrix</td>
<td>Performance characteristics of Systems View elements for the appropriate time frame(s)</td>
</tr>
<tr>
<td>SV-8</td>
<td>Systems Evolution Description</td>
<td>Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation</td>
</tr>
<tr>
<td>SV-9</td>
<td>Systems Technology Forecast</td>
<td>Emerging technologies and software/hardware products that are expected to be available in a given set of time frames and that will affect future development of the architecture</td>
</tr>
</tbody>
</table>
### SV Work Products (cont.)

<table>
<thead>
<tr>
<th>SV-10a</th>
<th>Systems Rules Model</th>
<th>One of three products used to describe system functionality—identifies constraints that are imposed on systems functionality due to some aspect of systems design or implementation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SV-10b</td>
<td>Systems State Transition Description</td>
<td>One of three products used to describe system functionality—identifies responses of a system to events.</td>
</tr>
<tr>
<td>SV-10c</td>
<td>Systems Event-Trace Description</td>
<td>One of three products used to describe system functionality—identifies system-specific refinements of critical sequences of events described in the Operational View.</td>
</tr>
<tr>
<td>SV-11</td>
<td>Physical Schema</td>
<td>Physical implementation of the Logical Data Model entities, e.g., message formats, file structures, physical schema.</td>
</tr>
</tbody>
</table>
SV-5: Operational Activity to Systems Function Traceability Matrix
SV-5 Is:

- A tabular work product.
- The bridge between the Operational View and the Systems View.
- An explicit map of the System Functions to the Operational Activities they support.
  - This notion aligns with the idea that the system architecture is designed to meet the mission/operational needs of the enterprise.
  - Therefore a vast majority of the system functions will support an operational activity in some way.
- An excellent analysis tool!
SV-5 Primary Features

- Can be extended to depict the mapping of capabilities to Operational Activities, Operational Activities to System Functions, System Functions to Systems, and thus relates the capabilities to the Systems that support them.
- Allows discovery of gaps and/or redundancies.
### Example SV-5

From Popkin System Architect, version 9.1.40
Red: functionality planned but not developed

Yellow: partial functionality provided or full functionality provided but system has not been fielded

Green: full functionality provided and system fielded.

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<table>
<thead>
<tr>
<th>System 1</th>
<th>Capability 1</th>
<th>Capability 2</th>
<th>Capability 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Function A</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>System Function B</td>
<td>Red</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>System Function C</td>
<td>Red</td>
<td>Red</td>
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<th>Capability 2</th>
<th>Capability 3</th>
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<td>System Function B</td>
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<td>Green</td>
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| System Function D | | Yellow | }
| System Function E | | Yellow | }
| System Function F | | Yellow | }

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<th>Capability 3</th>
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<td>Red</td>
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<td>System Function H</td>
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<td></td>
<td>Red</td>
</tr>
<tr>
<td>System Function I</td>
<td></td>
<td></td>
<td>Red</td>
</tr>
</tbody>
</table>

---

Figure 5-23. Capability to System Traceability Matrix (SV-5)

From DoD AF Version 1.0, Volume II
SV-1: Systems Interface Description

System Definition:
A Family of Systems (FoS), System of Systems (SoS), nomenclatured system, or a subsystem.
SV-1 Is:

- Graphical in nature.
- One of the work products required for an integrated architecture.
- An identification of Systems Nodes and Systems that support Operational Nodes.  
  - And as such, related to OV-2
- An identification of the Interfaces between Systems and Systems Nodes.
SV-1 Primary Features

- Systems Nodes.
- Systems.
- System Functions.
- Interfaces:
  - The systems representation of an OV-2 Needline
  - Details of the communications infrastructure are not included, but documented in the Systems Communication Description (SV-2)
  - An abstract representation of one or more communications paths
  - Key Interfaces may exist
Key Interfaces

- Meet one or more of the following criteria:
  - The interface spans organizational boundaries (may be across instances of the same system, but utilized by different organizations)
  - The interface is mission critical
  - The interface is difficult or complex to manage
  - There are capability, interoperability, or efficiency issues associated with the interface
Example SV-1

UAV Targeting Systems Interface
Connections

Target Control HQ

- Tracking System
  - Node Functions
    - GPS Satellite
      - "Track Position"
      - Target Control HQ
- UAV Mission Scheduling System
  - Node Functions
    - Observer Position
      - "Schedule Picture"

Target Acquisition System

- Node Functions
  - Observer Position
    - "Display Pictures"
    - Target Control HQ

UAV

- UHF Radio
  - Node Functions
    - UAV
      - "Take Picture Sequence"
- Camera Management System
  - Node Functions
    - UAV
      - "Take Picture Sequence"
- Camera Pod Positioning System
  - Node Functions
    - UAV
      - "Take Picture Sequence"
- Target Acquisition System
  - Node Functions
    - Observer Position
      - "Display Pictures"
      - Target Control HQ
Example SV-2

SV-2 UAV Targeting Systems Communication

DoD AF Overview

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SV-4: Systems Functionality Description

Systems Function definition:

An action (or task), executed by automated systems, that consumes or produces system data.
SV-4 Is:

• Graphical in nature.
• May be either a Functional Decomposition Diagram or a Data Flow Diagram (DFD).
• The systems description of OV-5.
• A way to track System Data Flows.
SV-4 Data Flow Diagrams Primary Features

- External sources and sinks
  - External to the diagram scope but not external to the architecture scope
- System Functions
- Flows of system data
- Internal system data repositories (system data stores)
- Does not necessarily map System Functions directly to Operational Activities
Example SV-4

UAV Targeting Control

P1.1 Adjust Camera Pod
Node Entities
- UAV
- "Camera Pod Positioning System"

P1.2 Display Pictures
Node Entities
- Observer Position
- "Target Acquisition System"
- "Target Data Storage System"
- UAV Targeting Control Vehicle

P1.3 Schedule Picture Taking
Node Entities
- Observer Position
  - "UAV Mission Scheduling System"
  - Target Control HQ
  - "UAV Mission Scheduling System"
  - "Tracking System"

P1.4 Take Picture Sequence
UAV
- "Camera Pod Positioning System"
- "Camera Management System"
- "Target Acquisition System"
- "UHF Radio"

P1.5 Track Position
Node Entities
- GPS Satellite
- "Tracking System"
- "Target Data Storage System"
- Target Control HQ
- "Tracking System"
- "Target Acquisition System"

P1.6 Picture Taking Request
- Camera Status
- Location Data Request
- Picture Taking Request
- Camera Schedule
- Actuator Positions
- Camera Schedule
SV-6: Systems Data Exchange Matrix

System Data Exchange definition:
An implementation of how system data is exchanged between Systems, in system-specific details covering periodicity, timeliness, throughput, size, information assurance, and security characteristics of the exchange.
SV-6 Is:

- Tabular in format.
- Focused on automated information exchanges (from OV-3) that are implemented in Systems.
SV-6 Primary Features

- Detailed descriptions of individual System Data Exchanges.
  - An *Information Exchange* is to a *System Data Exchange* as a birthday wish to a relative is to a *Hallmark card* (or a phone call, or an *email*, or an *e-card*, etc.).

- Includes all relevant attributes of an SDE:
  - Information assurance, security
  - Timing, triggers, etc.

Dependencies between Work Products

DoD AF: Systems View

Sys Node Sys Node
System System
Function Function

SV-4
SV-1

System
SV-7
Sys Node • Function

Data
Produced Consumed

Sys Node

Sys Node • System
System • Function

SV-6

Microsoft Office Excel 2003
### Example SV-6

<table>
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<tr>
<th></th>
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<td>T</td>
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<td>Take Picture</td>
<td>UAV</td>
<td>Camera Pod</td>
<td>UHF Radio</td>
<td>Actuator</td>
<td>*Camera Pod</td>
<td>*Camera Pod</td>
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<td>Tracking</td>
<td>Target</td>
<td>Camera</td>
<td>*UAV Mission</td>
<td>*Camera Pod</td>
</tr>
</tbody>
</table>
SV-10: SYSTEMS FUNCTIONALITY SEQUENCE AND TIMING DESCRIPTIONS

The dynamic behaviors concerning the timing and sequencing of events that capture system performance characteristics of an executing system.
SV-10 Has Three Options

- **SV-10a Systems Rules Model**
  - Identifies business rules that constrain operational activities

- **SV-10b Systems State Transition Description**
  - Identifies business process responses to events
  - IDEF3 Object State Transition Network diagram used for this product

- **SV-10c Systems Event-Trace Description**
  - Traces actions in a scenario or sequence of events
  - A new diagram having the appearance of a UML Sequence diagram but whose symbols are related to DoDAF definitions was used
SV-11: Physical Schema

Physical Schema Definition:
The structure of the various kinds of System Data that are utilized by the Systems in the architecture.
SV-11 Is:

- A graphical work product.
- An implementation-oriented data model that is used in the Systems View to describe how the information requirements represented in Logical Data Model (OV-7) are actually implemented.
SV-11 Primary Features

- A mapping from a given OV-7 to SV-11 (if both models are used).
- Entities that represent:
  - System Data flows in SV-4
  - System Data elements specified in SV-6
  - triggering events in SV-10b and/or events in SV-10c
SV-11 Representation Options

- MESSAGE FORMAT
  - STANDARDS REFERENCE
  - MESSAGE TYPE(S)
  - MESSAGE FIELDS WITH REPRESENTATIONS
  - MAP FROM LOGICAL DATA MODEL TO MESSAGE FIELDS

- FILE STRUCTURE
  - STANDARDS REFERENCE
  - RECORD AND FILE DESCRIPTIONS
  - MAP FROM LOGICAL DATA MODEL TO RECORD FIELDS

- PHYSICAL SCHEMA
  - DDL OR ERA NOTATION (WITH SUFFICIENT DETAIL TO GENERATE THE SCHEMA)
  - MAP FROM LOGICAL DATA MODEL TO PDM WITH RATIONALE

- OTHER OPTIONS

From DoD AF Version 1.0, Volume II
SV-11: Physical Schema

Physical Schema Definition:
The structure of the various kinds of System Data that are utilized by the Systems in the architecture.
SV-11 Is:

- A graphical work product.
- An implementation-oriented data model that is used in the Systems View to describe how the information requirements represented in Logical Data Model (OV-7) are actually implemented.
SV-11 Primary Features

- A mapping from a given OV-7 to SV-11 (if both models are used).
- Entities that represent:
  - System Data flows in SV-4
  - System Data elements specified in SV-6
  - triggering events in SV-10b and/or events in SV-10c
SV-11 Representation Options

From DoD AF Version 1.0, Volume II
Technical Standards View

The TV is the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements.
Technical Standards View (TV)

- Specifies the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements.
- Provides the systems implementer with the knowledge upon which to base engineering specifications, common building blocks, and product lines.
- Is the collection of the technical standards, implementation conventions, rules, and criteria that govern the systems of an architecture.
<table>
<thead>
<tr>
<th>Product</th>
<th>Name</th>
<th>General Description</th>
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<tr>
<td>TV-1</td>
<td>Technical Standards Profile</td>
<td>Listing of standards that apply to Systems View elements in a given architecture</td>
</tr>
<tr>
<td>TV-2</td>
<td>Technical Standards Forecast</td>
<td>Description of emerging standards and potential impact on current Systems View elements, within a set of time frames</td>
</tr>
</tbody>
</table>
TV-1 Primary Features

- Systems Standards rules.
- A source document is used for identifying each standard:
  - OMB’s Technical Reference Model (TRM) [OMB, 2003]
  - DoD TRM
  - DISR
## IA/Security

<table>
<thead>
<tr>
<th>Service</th>
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<th>Description</th>
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<td>SOAP</td>
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<td>Data Acquisition Policy</td>
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<td>Voice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UAV Track</td>
<td></td>
</tr>
</tbody>
</table>
DoD AF Overview

Some Important Notes
Some Important Notes

- Work product numbering does not correlate to the order in which they are created.
- Leveraging the relationships between views and work products is CRITICAL to building and using the architecture.
  - Corollary: Do Not have people working separately on related work products such as OV-2, OV-3, and OV-5.
- Pictures are worth a thousand words BUT make sure they are the correct and meaningful words.
  - That being said, a pretty picture is only eye-candy if it does not portray the meaning intended. Ensure the Architecture information is capture by the work products prior to engaging in “Art-itecture”.
The Minimum Requirements for an Integrated Architecture

- According to the DoD AF, an architecture is integrated when products and their constituent architecture data elements are developed such that data elements defined in one view are the same (i.e., same names, definitions, and values) as data elements referenced in another view.

- According to DoDAF, these work products must be included in order for an architecture to be considered integrated:
  - AV-1, AV-2
  - OV-2, OV-3, OV-5
  - SV-1
  - TV-1

- However, as you will see later this minimal set is not sufficient to get the full use and benefit of the DoDAF.
Building an Architecture
## Suggested Products Based On Use of Architecture

### From DoD AF Version 1.0, Volume I

#### RECOMMENDED USES OF ARCHITECTURE:

**Planning, Programming, Budgeting Execution Process**
- Capability-Based Analysis for IT Investment Decisions
- Modernization Planning and Technology Insertion/Evolution
- Portfolio Management

**Joint Capabilities Integration and Development System**
- JCIDS Analysis (FAA, FNS, FSA)
- JCD/DOD/CPD/CDR
- Analysis of Alternatives AoA

**Acquisition Process**
- Acquisition Strategy
- C4ISP
- System Design and Development
- Interoperability and Supportability of NSS and IT Systems
- Integrated Test & Evaluation

**Operations Assessment, Planning, Execution, ...**
- Operations Planning & Execution
- CONOPS & TTP
- Communications Plans
- Exercise Planning & Execution
- Organizational Design

**BPR/FPI**

<table>
<thead>
<tr>
<th>Product Code</th>
<th>All View</th>
<th>Operational View (OV)</th>
<th>Systems View (SV)</th>
<th>Tech Stds View</th>
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<td>1 2</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2</td>
</tr>
</tbody>
</table>

- = Product is highly applicable
- = Product is often or partially applicable
- = Product is specifically addressed in policy
- = Product is required for an integrated architecture
- = Product is usually not applicable
Architecture Prerequisites

- Define the “Enterprise”
- Define the stakeholders of the enterprise
- Define the perspective of the architecture to be built
- Define what ‘System’ and other key architecture terms mean to the enterprise.
- Organization wide (as a minimum), determine naming conventions for new data.
- Clean Data!
Clean Data

- Be aware of Synonyms: DoD and Department of Defense mean the same thing.
- And also Homonyms: a tank means one thing to an Army General and another to a Navy diver.

Where can naming conventions be found?
- DARS
- Organizational resources (e.g. Navy Common Operational Activity List)
Using an Activity-Based Methodology* to create an Integrated Architecture

- Consists of a tool-independent approach to developing fully integrated, unambiguous, and consistent DoD AF views.
- Enables both:
  - "As-Is" (now) architectures - all details known
  - "To-Be" (future) architectures - based on unknowns and abstract elements where not all details known
- "To-Be" architectures must support "gap-analysis" to discover future unknown rules, patterns, practices, relationships, and requirements

*Activity-Based Methodology is a concept developed by The MITRE Corporation and Lockheed-Martin, Copyright © 2003
Activity-Based Methodology (cont.)

• Uses *data centric* approach for architecture element and product rendering:
  – Supports cross-product relationships based on core set of architecture elements
  – Simplified “architecture specification model” of architecture elements and their associations/relationships based on DoD AF and *not* CADM

• Captures sufficient representations of architectures models to transition to “*dynamic*” executable process models
An Activity-Based Methodology for Development and Analysis of Integrated DoD Architectures, Steve Ring, Mitre Corporation, March 2003
Core Artifacts in an Integrated Architecture

From An Activity-Based Methodology for Development and Analysis of Integrated DoD Architectures, Steve Ring, Mitre Corporation, March 2003

Operational Node

- Information
- Operational Activity
- Role

System Node

- Data
- System Function
- System

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Building an Architecture

Relationships of Core Artifacts

Operational View
- Attributes
- Relationships
- Entities
- CONOPS

System View
- Entities
- Relationships
- Attributes

Core Artifacts
- Why
- Design Strategy
- Strategy
- Who
- Role
- System
- Process
- When
- Behavior
- System Function
- Data
- Network
- Performance

Info Exchange
- Knowledge Skills & Abilities
- Info
- Exchange
- Org
- Process

Need Line
- Activity
- Op Node
- Where
- Container
- System Node

What
- Product
- Info

How
- Function
- System Function
- Interface

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A Suggested Architecture Development Process

• Begin With:
  – AV-1: It starts to organize the architecture
    • Defining the scope and purpose delineates the workspace and allows the selection of work products
    • Serves as a comparison reference when the architecture is complete
  – OV-1: Again, it helps to organize thinking. However this product may be updated and adjusted throughout the development process
A Suggested Architecture Development Process

- **Operational View:**
  - Develop OV-5
  - Assign Operational Activities to Nodes
  - Build OV-2
  - Build OV-3 Report
  - Build OV-4 (optional)
  - Build OV-7
  - Build OV-6 (if needed)

- **System View:**
  - Develop SV-5
  - Develop SV-4
  - Develop SV-1
  - Assign System Functions to Systems
  - Build SV-6 Report
  - Build SV-7 Report
  - Build SV-2; SV-3; SV-10; SV-11; SV-8; SV-9 as needed
A Suggested Architecture Development Process

• Technical Standards View:
  – List the standards that apply to Systems View elements (TV-1)
  – Describe the emerging standards and potential impact on current Systems View elements (TV-2)

• AV-2:
  – This work product is automatically created in a repository based tool
Keypoint Development is not necessarily in a straight line!

Building an Architecture

Figure 2.2-2. Data-Centric Build Sequence

From DoD AF Version 1.0, Deskbook
Uses of a Completed Architecture

- **Op Node**: Performed At
- **Activity**: Supports
- **Function**: Performs
- **Sys Node**: Located At
- **Info**: Performs
- **Data**: Supports
- **Role**: Consists Of
- **System**: Consists Of
- **Org Unit**: Supports

Building an Architecture
Uses of a Completed Architecture

- **Op Node**: Performed At
- **Activity**: Performs
- **Function**: Supports
- **Sys Node**: Located At
- **Info**: Produces
- **Data**: Performs
- **Role**: Performs
- **System**: Consists Of
- **Org Unit**: Performs
- **Supports**: Supporting Analysis
Uses of a Completed Architecture

- **Op Node**: Located At
- **Activity**: Performs At
- **Info**: Produces
- **Role**: Consists Of
- **Org Unit**: Supports
- **Sys Node**: Located At
- **Function**: Supports
- **Data**: Performs
- **System**: Consists Of
- **Product Analysis**: Supports
Uses of a Completed Architecture

Building an Architecture

Op Node
- Perform At
- Located At

Activity
- Produces
- Performs

Function
- Supports

Sys Node
- Perform At
- Located At

Info
- Performs

Data
- Performs

Role
- Consists Of

System
- Consists Of

Org Unit

‘Plug and Play’ Analysis
The Relationship to DOTLMPF

- **Op Node**
- **Activity**
- **Function**
- **Sys Node**
- **Role**
- **System**
- **Org Unit**
- **Doctrine**
- **Info**
- **Data**
Building an Architecture

The Relationship to DOTLMPF

Op Node  Activity  Function  Sys Node

Role  Doctrine  System

Org Unit

Info  Data
Building an Architecture

The Relationship to DOTLMPF

Op Node → Activity → Function → Sys Node

Op Node → Role

Activity → Info

Function → Data

Sys Node → System

Role → Op Node

Info → Organization

Data → Organization

System → Organization

Organization → Role

Role → Organization

Op Node → Organization

Activity → Organization

Function → Organization

Sys Node → Organization
The Relationship to DOTLMPF
The Relationship to DOTLMPF

Building an Architecture

- Op Node
- Activity
- Function
- Sys Node
- Info
- Data
- Role
- System
- Org Unit
- Leadership
The Relationship to DOTLMPF
The Relationship to DOTLMPF

- Op Node
- Activity
- Function
- Sys Node
- Info
- Data
- Role
- System
- Org Unit
- Personnel
The Relationship to DOTLMPF
The Relationship to DOTLMPF

Building an Architecture

Facilities

Op Node

Activity

Function

Sys Node

Doctrine

Doc

Role

Info

Data

Personnel

System

Training

Leadership

Organization

Org Unit

Role

Activity

Function

Sys Node

Doctrine

Doc

Personnel

System

Training

Leadership

Organization

Org Unit
Core Architecture Data Model (CADM)

- The Framework defines standard architecture product names, data elements, data attributes, and relationships between products and data.
- The CADM defines the standard for these architecture data elements as entities and defines their relationships.
- The CADM provides the logical basis for moving architectures from compendiums of documents, spreadsheets, and graphics to architecture data that can be stored in architecture data repositories and manipulated with automated tools.
DoD Architecture Repository System (DARS)

• The Office of the Assistant Secretary of Defense for Networks and Information Integration is developing DARS as a DoD AF-compliant, CADM-compliant architecture data repository for hosting accredited DoD architecture data.

• The repository is intended to be a central location for storing approved/ accredited architectures developed by the Commands, Services, and Agencies (C/S/As), and includes both legacy and newly accredited architectures.
Successful demonstration of round trip via CADM XML – 30 Sep 03

DARS full round trip supported

Not doing tool interoperability
DARS AIPP PHASE I – PROOF OF CONCEPT

- Achieve a Structured architecture data interface between COTS tools and DARS for data required for integrated Architecture Products as defined in DODAF ver 1 using CADM XML
- Achieve ‘full’ data-centric architecture creation and maintenance
- Develop technical know-how and expertise for the entire ‘data layer’ needed to support the entire DoDAF requirements (ultimate goal)

- Original Vendors
  - Popkin (System Architect)
  - Proforma
  - IBM / Rational (Rose)
  - Computas (Metis)
“DoD AF Tools”

- Data Gathering Tools
- Requirements Tools
- Modeling Tools
- Repository Tools
- Configurations Management and Version Control Tools
- Analysis Tools
  - Simulation Tools
  - Reporting Tools
  - Costing Tools, etc.
- Presentation Tools
Building an Architecture

One Concept

I1 Subject Matter Expertise → C1 Customer Mission Needs and Requirements

A1 Gather Information and Expertise

A2 Standardize Information and Assemble into DoDAF Compliant Format

A3 Validate, Analyze and Improve the Architecture

A4 Use the Architecture

A5 Disseminate the Architecture

O1 System or Service that Meets the Mission Needs

O2 Web Accessible Architecture
DoD AF and the Zachman Framework

<table>
<thead>
<tr>
<th>Data (What)</th>
<th>Function (How)</th>
<th>Location (Where)</th>
<th>Org (Who)</th>
<th>Time (When)</th>
<th>Strategy (Why)</th>
</tr>
</thead>
</table>

- **Operational Views**
  - Activities
    - Information Elements
    - Ops Nodes
    - Roles
    - Process & Rules

- **System Views**
  - System Functions
    - Data
    - System Nodes
    - Systems
    - Process & Rules

- **Technical Views**
  - Standards/Components
    - Standards/Components
    - Standards/Components
    - Standards/Components
The FEA is Five (5) Reference Models

Performance Reference Model (PRM)
- Strategic Outcomes
  - Customer Results
  - Business Results
  - Processes and Activities
- People
- Technology
- Other Fixed Assets

Technical Reference Model (TRM)
- Svc Areas (e.g., Component Framework)
- Svc Categories (e.g., Data Mgt)
- Svc Standards (e.g., Reporting and Analysis)

Business Reference Model (BRM)
- Business Areas (e.g., Mgt of Gov’t Resources)
- Lines of Business (e.g., Financial Mgt)
- Sub-Functions (e.g., Accounting)

Service Domains (e.g., Back Office Svcs)
- Service Types (e.g., Financial Mgt)
- Components (e.g., Billing and Acctg)

Data Reference Model (DRM)*
- Business Context
- Information Flows
- Data Element

These documents are located at www.FEAPMO.gov.

Agency specifies Measure detail for business function

Service Components support business function

Standard or Specification for specific component

*Under Development

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DoD AF and the FEA Reference Models

• The Views created in the DoD AF will be mapped to the appropriate artifacts in the FEA Reference Models.

• The DoD AF Instructs that the OV-5 be created as additional detail of one or more appropriate levels of the FEA BRM line of business or sub-functions.
DoD AF and UML

- **Pros:**
  - UML is widely used and understood
  - Fits well with Software design
  - DoD AF documentation relates UML and work products*

- **Cons:**
  - Some work products have to be represented with UML adornments (therefore it is not ‘standard’)
  - Some work products cannot be represented in UML at all

*See UML/DoD AF Table on the EAF web site
Thank You!