Role of Reference Architectures

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Enterprise Architecture Certificate, NDU
Chief Information Officer Certificate, NDU
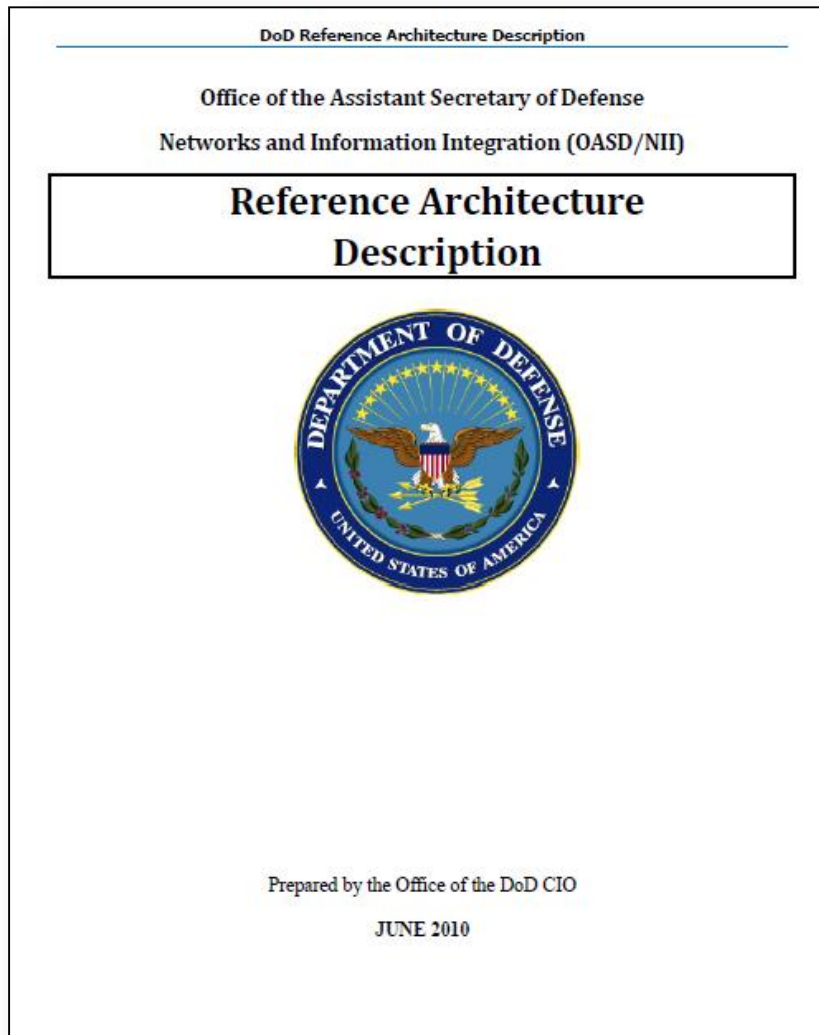
March 5, 2015

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BLUF

- **DoD using Reference Architectures as a means to provide Department-wide guidance for architectures and solutions**

"Reference Architecture is an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions"

- <u>**NOT**</u> **limited to DOD – applicable to all Federal agencies and general Enterprise Architecture environments**

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Published Reference Architecture Description

http://dodcio.defense.gov/Portals/0/Documents/DIEA/Ref_Archi_Description_Final_v1_18Jun10.pdf

DoD Reference Architecture Description

Office of the Assistant Secretary of Defense

Networks and Information Integration (OASD/NII)

Reference Architecture Description

Prepared by the Office of the DoD CIO

JUNE 2010

Sponsored by the DoD CIO Architecture & Interoperability Directorate

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Background

- **DoD/CIO intends to use Reference Architecture as a means to provide Department-wide guidance for architectures and solutions**

- **However … Reference Architectures …**
  - ☒ Were defined at different levels of detail and abstraction (from specific to generalized)
  - ☒ Had little agreement, and much confusion
  - ☒ Had multiple meanings relative to the context of the environment

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What Was Needed?

- **To support intent, a common definition of a Reference Architecture was needed that …**

  ☑ Provided policy and direction for guiding and constraining their solution architectures

  ☑ Can be equally applied across wide spectrum of DoD and Federal environments

  ➢ IT/ Business subject areas, Service (SOA) domains

  ➢ Warfighter Doctrine, Organization, Training, Material, Leadership, Personnel and Facility [DOTMLPF] subject areas

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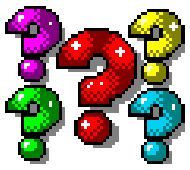
But.... *(Answers at end)*

? Don't all architectures serve as a "**reference**" by architects and engineers to develop something?

? What do we **mean** by a Reference Architecture? Why is it needed, how would I use it and what does it do for me?

? How do you **build** one? What type of information do I need to provide?

? Aren't all Reference Architectures the **same**?

? Does a Reference Architecture have a **temporal** aspect – from current (today) to some future point in time?

? Can an architecture **itself** be a Reference Architecture?

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Approach

Synthesize government and industry best Reference Architecture practices

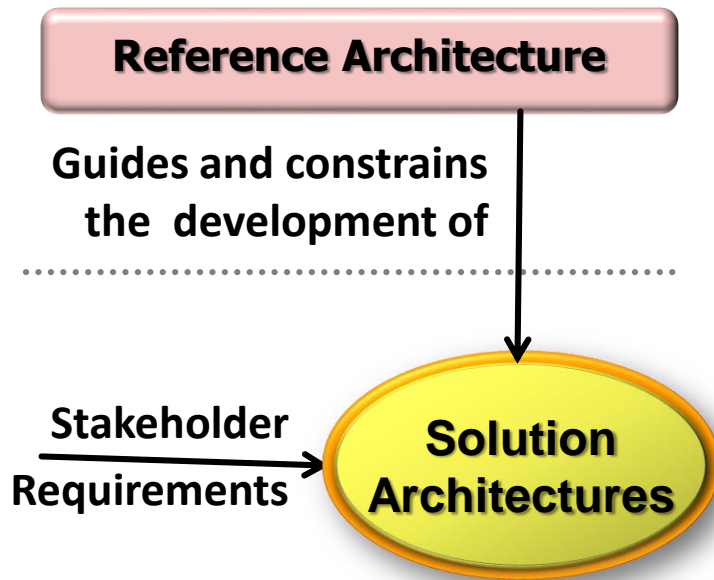**Define concepts, objectives, characteristics, and components making up a Reference Architecture**

Broaden perspective to capture Reference Architecture practices from SOA

Encompass DOTMLPF perspectives (DoDAF)

Reach common understanding for a more generic definition that can be applied equally across broad subject area spectrums

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Objectives: Common Understanding

Reference Architecture

Guides and constrains
the development of

Stakeholder
Requirements

**Solution
Architectures**

- **To direct, guide and constrain architectures and solutions within a subject area ****

- **To serve as a reference foundation of concepts, components and their relationships for solution architectures**

- **May be used for comparison and alignment purposes by Solution architectures**

** *The Importance of Reference Architecture, Architecture and Change* (A&C), 2007,
http://www.architectureandchange.com/2007/12/29/the-importance-of-reference-architecture/

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What are Solution Architectures?

Reference Architecture → Solution Architectures / Solution Architectures / Solution Architectures
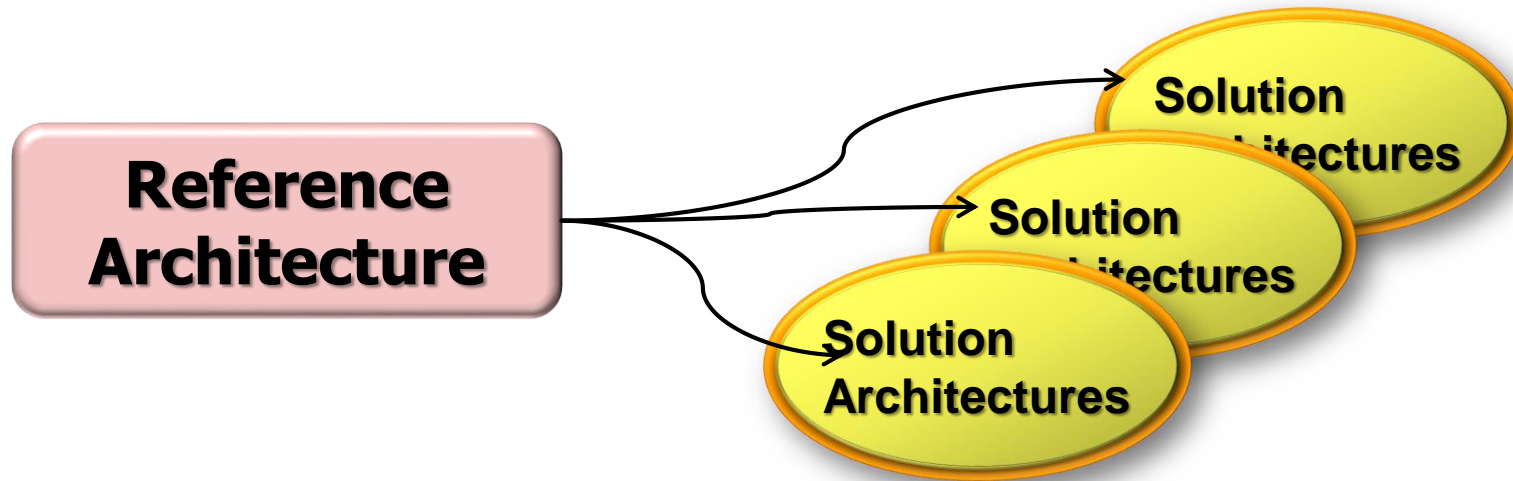
- **Instantiations** **of all or part of a Reference Architecture within a subject area**

- **Describe processes and resources (human and IT) necessary to enable the enterprise to achieve its business/ warfighting goals and objectives in accomplishing its mission**

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Foundations

- **Reference Architecture Is general in nature to some level of abstraction**

- **Provides concepts, components and their relationships used to direct/guide and constrain the instantiation of (repeated) concrete solutions**

Patterns

Principles & Rules

Technical Positions

May serve as a reference basis for alignment of enterprise intentions, needs, goals, objectives, and requirements and what it takes to meet them
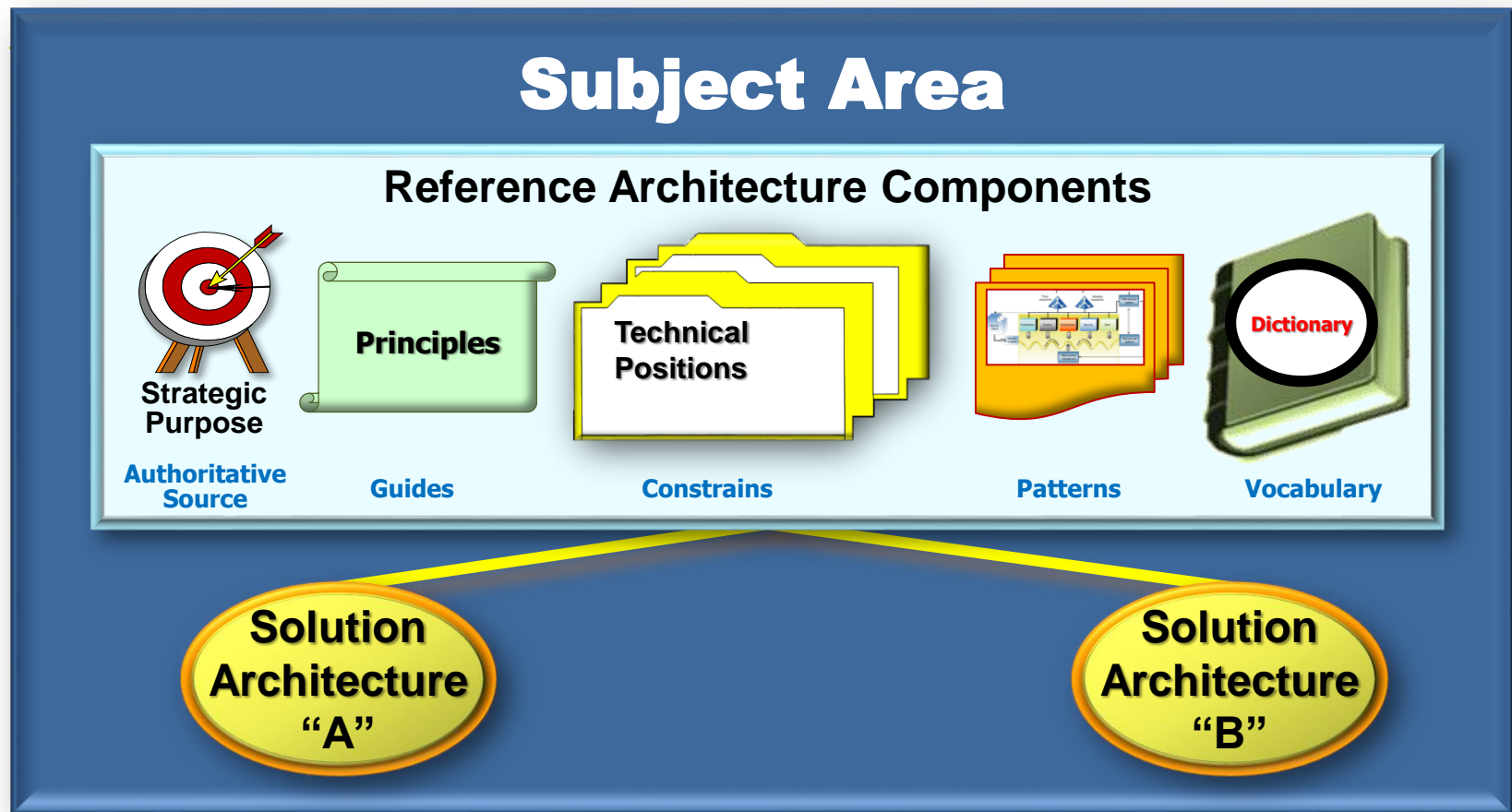
May serve as a reference foundation for comparison purposes

May be used to solve a specific (recurring) subject area problem

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Definition:

> *"Reference Architecture is an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions"***

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Building a Reference Architecture: 5 Components

Subject Area

Reference Architecture Components

Principles

Technical Positions

Dictionary

Strategic Purpose

Authoritative Source

Guides

Constrains

Patterns

Vocabulary

Solution Architecture "A"

Solution Architecture "B"

It does this by providing patterns of abstract architectural elements, based on a strategic purpose, principles, and technical positions together with a common vocabulary within a Subject Area

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1. Strategic Purpose

Explains **context**, scope, goals, objectives and purpose of the Reference Architecture, why is it needed, and when and how it should be used.

Identifies key **stakeholders**: 1) producing subject area <u>owners</u> of the solution architectures and their implementations and 2) <u>customers</u> of the delivered solution products

May explicitly describe what subject area **issue(s)** and stakeholder **concern(s)** will be addressed by one or more of the concrete solution architectures

May provide **Capabilities** required by solution architectures to meet strategic goals and objectives

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2. Principles

- **Sufficient high level foundational statements of organizational subject area rules, culture and values**

- **Drive technical positions and patterns in defining how an organization fulfills its mission**

- **Intended to be enduring and seldom amended**

THE *Open* GROUP

Example of Suggested Template ******

Name

Short statement of the principle

Definition

Unambiguous explanation of the principle

Rationale

Reason why it is important and benefit

Implications

(or consequences) of adopting (or ignoring) the principle in terms of impact of carrying it out

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Example of Principles
OMB Federal Architecture Principles

Principles

**Office of Management and Budget (OMB) and
CIO Council set of guiding U.S. Government architecture principles** ******

- **The Federal government focuses on citizens**
- **The Federal government is a single, unified enterprise**
- **Federal agencies collaborate with other governments and people**
- **Security, privacy and protecting information are core government needs**
- **Information is a national asset**
- **The Federal architecture is mission-driven**
- **The Federal architecture simplifies government operations**

** *Seven Rules for Using EA*, Burke, R., IDGA's 5th Annual DOD Architectures Summit, April 11, '07

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Example of A Principle Definition
OMB Federal Architecture Principles

Principles

Office of Management and Budget (OMB) and CIO Council set of guiding U.S. Government architecture principles *

Name	The Federal government focuses on citizens
Definition	Citizens' needs determine how government functions are defined and delivered. Functions include direct services and regulating society to serve the public.
Rationale	The federal government exists to serve the American public who want simpler, faster, better and cheaper access to government services and information.
Implications	• Agencies will design and apply their business processes and services to benefit citizens, even when the services cross lines of business and agency missions. • The federal government offers citizens a single, "unified" face, reducing duplicate, needlessly complex, inconsistent ways of using government services. • Citizens can access government services through various means.

*** *Seven Rules for Using EA*, Burke, R., IDGA's 5th Annual DOD Architectures Summit, April 11, '07

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3. Technical Positions

Technical Positions

Principles

- **Based on subject area principles**

- **Constrains development of real world solutions stemming from solution architectures**

- **Forces an organization to identify relevant subject area standards and specifications and justify their choices and tradeoffs**

- **Followed and implemented as part of the solution to drive compliance**

*Example of Suggested Template ***

APS TECHNICAL POSITIONS

STATEMENT OF PROBLEM

TYPICAL REQUIREMENTS

ALTERNATIVES

FUTURE DEVELOPMENTS

EVALUATION CRITERIA

STATEMENT and BASIS for POSITION

RELATIONSHIP to other COMPONENTS

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Example of Technical Standards **

Technical Positions
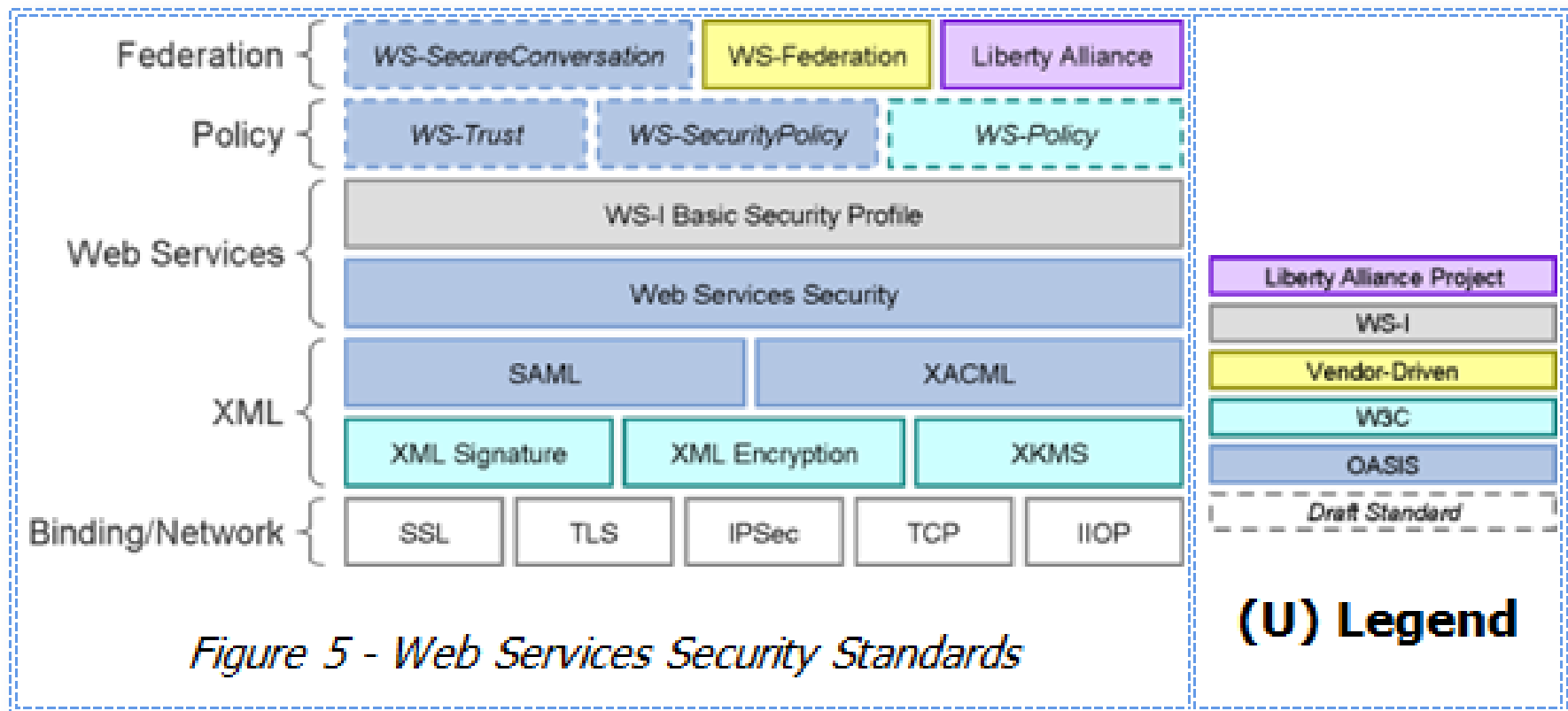
Figure 5 - Web Services Security Standards

** CERDEC *SOAF-A 1.0, Security for Web Services (SWS) Reference Architecture Guide*, U.S. Army Communications Electronics
Research, Development and Engineering Center (CERDEC) v1.4, 28 Sept '07

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4. Patterns
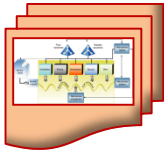
Model or facsimile of an actual thing or action which provides some degree of representation to enable recreation of that entity over and over again

Example of Template **

- Name
- Problem
- Context
- Constraints
- Solution
- Resulting Context
- Examples
- Rationale
- Related Patterns
- Known Uses

- **Shows how subject area elements and artifacts may be organized and related**

- **Typically tabular, structural, textual, behavioral, or graphical models (e.g., BPMN) of subject area elements and artifacts**

- **Becomes standardized with multiple implementations**

** *Pattern-Oriented Software Architecture: A System of Patterns*, Buschmann, F., Meunier, R., Rohnert H., Sommerlad, P., Stal, M., John Wiley and Sons, 1996, ISBN 0-471-95869-7

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Example of Pattern Architecture **
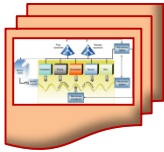
The combined process pattern describes the common set of process steps required to provide authentication, authorization and access control capabilities.
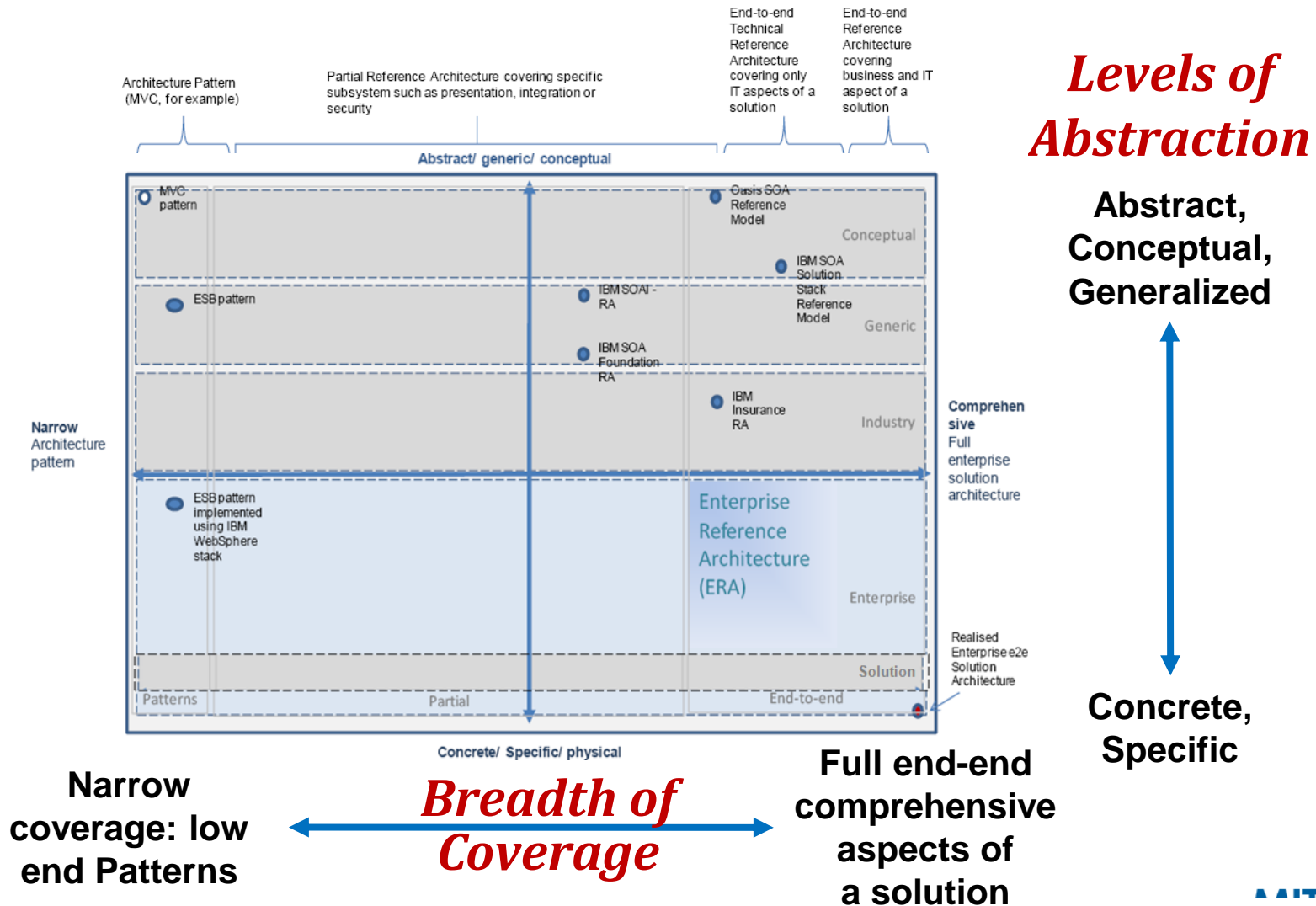

Provide Enterprise-wide Access to Network and Collaboration Services (EANCS): Process Pattern

*** *EANCS Reference Architecture, DoD CIO, Oct '09*

5. Vocabulary

Joint Publication 1-02

Department of Defense Dictionary of Military and Associated Terms

8 November 2010

(As Amended Through 15 March 2012)
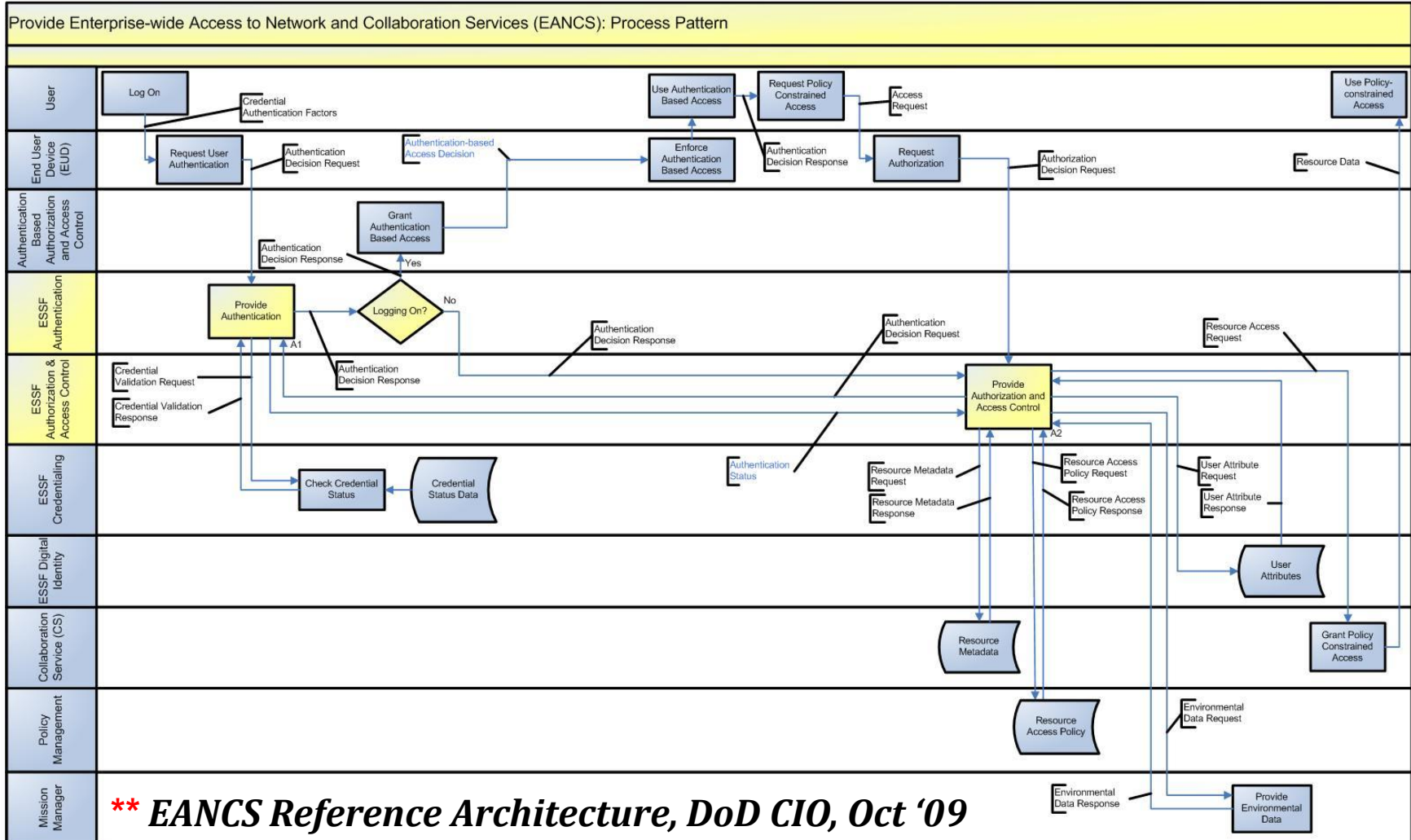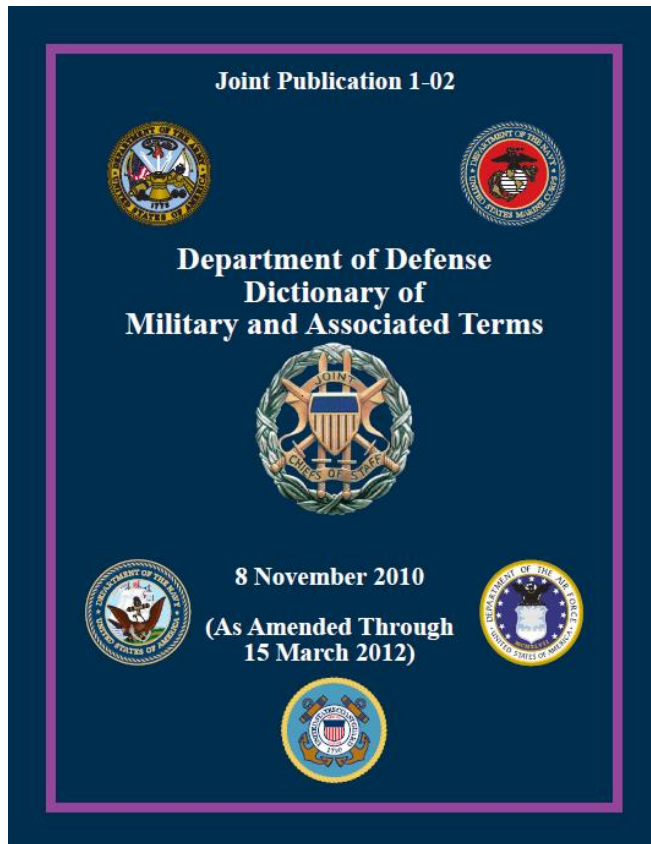
- **Provides context dependent semantic classification and meaning of the acronyms, terms and definitions of architecture elements used within the subject area**

- **Must have consistency of definitions**
  - Can't have one set of terms in one solution architecture being completely different in another solution architecture
  - e.g., *Tanker* (C130) vs. *Tanker* (Tank Soldier)

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Not All Reference Architectures are the Same**
Two Classification Dimensions: Abstraction, Coverage

Defined at many Levels of Abstraction and Breadth of Coverage for many different purposes

Levels of Abstraction

Abstract, Conceptual, Generalized

Concrete, Specific

Breadth of Coverage

Narrow coverage: low end Patterns

Full end-end comprehensive aspects of a solution

Subject Area Environments

- **May have multiple Reference Architectures within a single subject area**
  - Each (#1 and #2) represents different emphasis or viewpoints
- **May be complementary in guiding single "C" solution architecture**
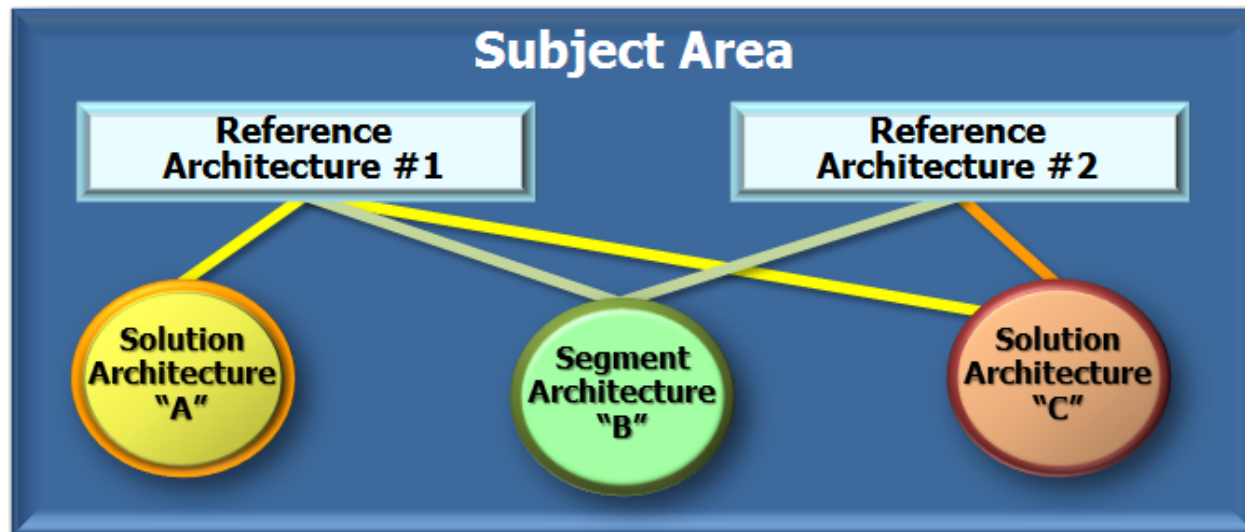
- **May have temporal aspects based on**
  - Subject area environment having a time frame or
  - Individual solution architectures having their own time frames

Epoch 1   Transitional   2016-2020   Objective   As-Is   2025   To-Be

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Other Forms

Technical Positions & Policies may be an external document

ABC

Reference Architecture "A" — Principles, Patterns, Strategic Purpose, Dictionary, Vocabulary

Technical Positions & Policies

Reference Architecture "B" — Principles, Patterns, Strategic Purpose
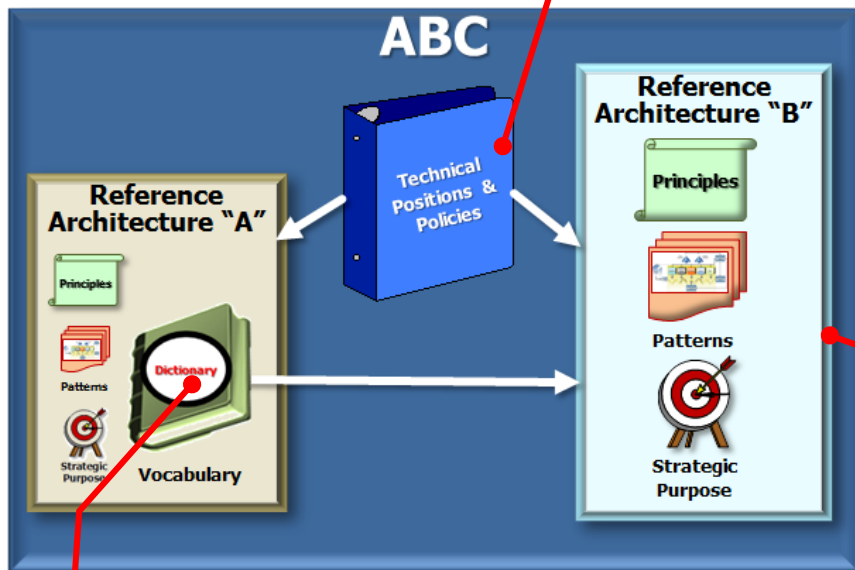
May share same vocabulary

Reference Architecture in one subject area (XYZ) may be specialization of a more generalized Reference Architecture (ABC) in another subject area

XYZ

Reference Architecture "B" — Principles, Patterns, Strategic Purpose

- **Typically a single document**

- **However, not all components required to be contained within same document**

- **Could have Principles and Technical Positions & Policies embedded within Patterns and as such, are masked by the detail of the patterns**

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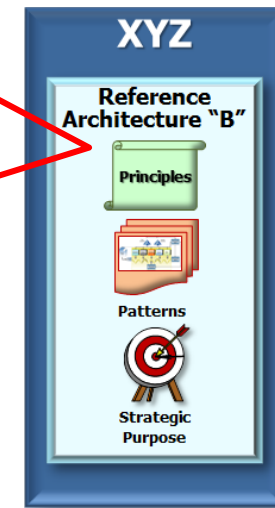
Two Conditions for a Reference Architecture

1 **Five components – purpose, principles, technical positions and policies, patterns, and vocabulary – be provided in some form or another**

2 **Be general in nature and used to solve specific issues within a single focused environment as a reference basis, foundation, or to guide and constrain solutions**

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http://dodcio.defense.gov/TodayinCIO/DoDArchitectureFramework.aspx

Suggested Mappings to

DoDAF v2.0

When an architecture is a Reference Architecture

Strategic Purpose

AV-1 Overview & Summary Information
CV-1 Overall vision for transformational endeavors providing strategic context for capabilities described
CV-2 Capability Taxonomy – hierarchy of capabilities ⟵ **Most Important**
OV-1 High Level Operational Concept Graphic – what solution architectures are intended to do and how they are supposed to do it

Principles

OV-6a Operational Rules Model
SvcV-10a Services Rules Model
SV-10a Systems Rules Model
OV-4 Organizational Relationships Chart – architectural stakeholders

Technical Positions

StdV-1 Standards Profile

Patterns

Operational Patterns
OV-2 Operational Resource Flows
OV-5 {a,b} Activity diagrams

Service Patterns
SvcV-1 Service Interfaces
SvcV-2 Service Resource Flows
SvcV-4 Service Functionality
SvcV-10b Service State Transitions

System Patterns
SV-1 System Interfaces
SV-2 System Resource Flows
SV-4 System Functionality
SV-10b System State Transitions
Event-Based Scenario Patterns of Dynamic Behavior
OV-6c Event-Trace Description
SvcV-10c Services Event-Trace Description
SV-10c Systems Event-Trace Description

Dictionary

AV-2 Integrated Dictionary of terms used throughout solution architectures

Example: EANCS Reference Architecture: Component Architecture Artifacts
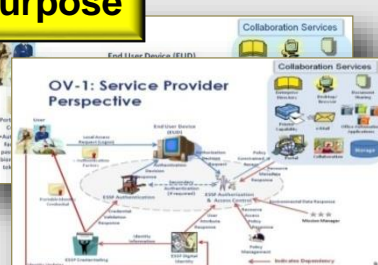

EANCS RA Document

Department of Defense

Enterprise-wide Access to Network and Collaboration Services (EANCS)

Reference Architecture

October 2009

Prepared by the Office of the DoD CIO
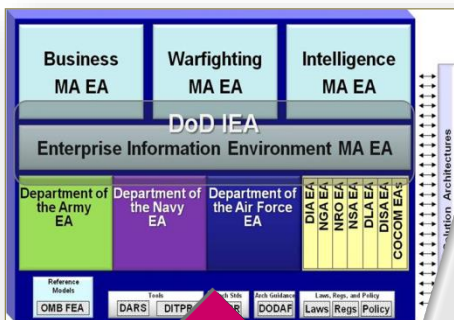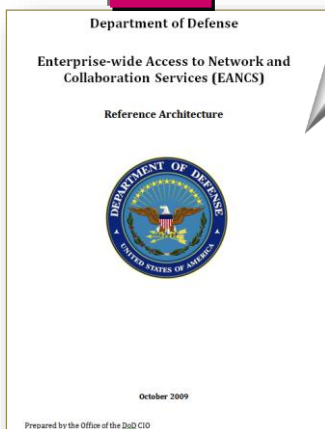
Provides DoD guidance for implementation of common access control elements

Strategic Purpose

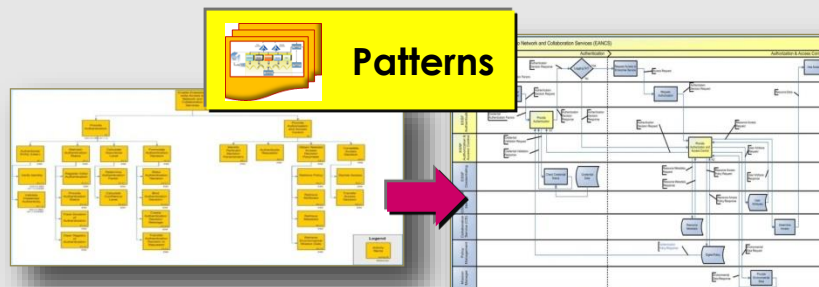**Principles**

AV-1 (Overview and Summary)

OV-1 (Concept – Consumer & Provider)

OV-6a (Operational Rules Model)

Patterns

Technical Positions

OV-5a (Activity Decomposition)

OV-6c (Event-Trace Description)

StdV-1 (Standards Profile)

Vocabulary

AV-2 (Integrated Dictionary)

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Reference Architecture Sample Outline

Following sample EANCS outline, while containing all five elements, is not meant to be prescriptive but to only to serve as a guide in organizing Reference Architecture content

Department of Defense

Enterprise-wide Access to Network and Collaboration Services (EANCS)

Reference Architecture

October 2009

Prepared by the Office of the DoD CIO
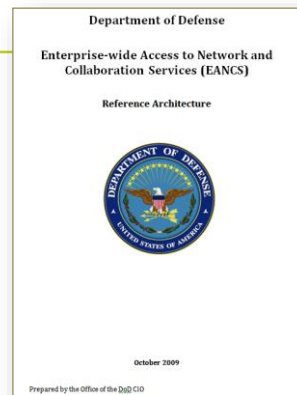
1   Introduction
1.1   Overview
1.2   Scope
1.3   Key Authoritative Sources

2   Context
2.1   Guiding Principles
2.2   Constraints and Assumptions
   2.2.1   Constraints
   2.2.2   Assumptions
2.3   Alignment with Joint Capability Areas (JCAs) and DoD IEA Priority Areas

3   Service Capability Description
3.1   Authentication
3.2   Authorization & Access Control
3.3   Activity Decomposition

4   Principles/Rules and Process Pattern(s)
4.1   EANCS RA Principles and Rules
4.2   Process Pattern (s)
   4.2.1   Combined Process Pattern
   4.2.2   Authentication Process Pattern
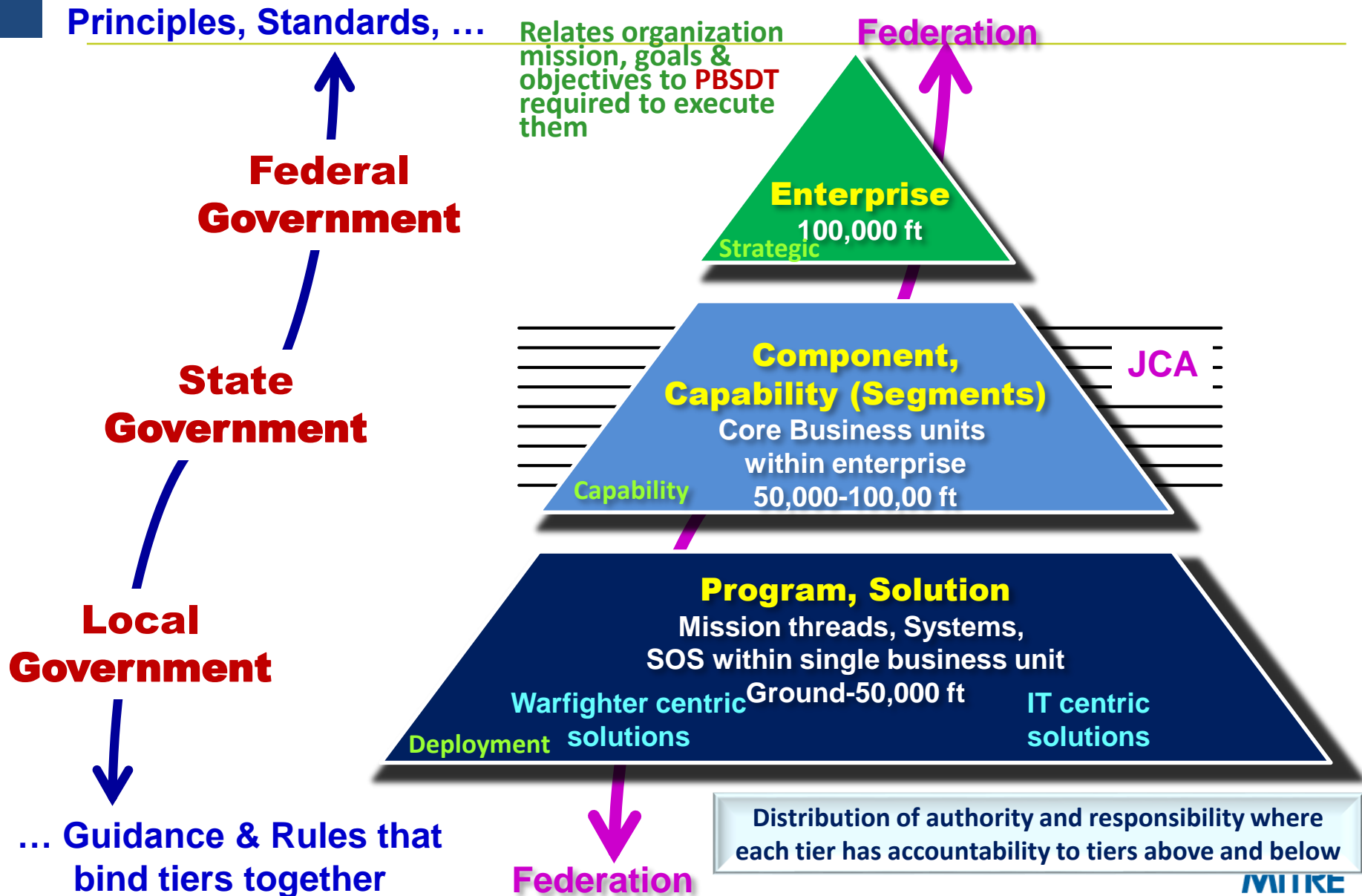   4.2.3   Authorization and Access Control Process Pattern

5   Technical Position

Appendix A. Acronyms

Appendix B. AV-2 Integrated Dictionary

Appendix C. OV-1, OV-5a, and OV-6c Diagrams

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Tiered Levels of Architecture Accountability

Principles, Standards, …

Relates organization mission, goals & objectives to **PBSDT** required to execute them

Federation

Federal Government

State Government

Local Government

Enterprise
100,000 ft
Strategic

Component, Capability (Segments)
Core Business units within enterprise
50,000-100,00 ft
Capability

JCA

Program, Solution
Mission threads, Systems, SOS within single business unit
Ground-50,000 ft

Warfighter centric solutions

IT centric solutions

Deployment

… Guidance & Rules that bind tiers together

Federation

Distribution of authority and responsibility where each tier has accountability to tiers above and below

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Role of *Reference Architectures* in Tiered Hierarchy

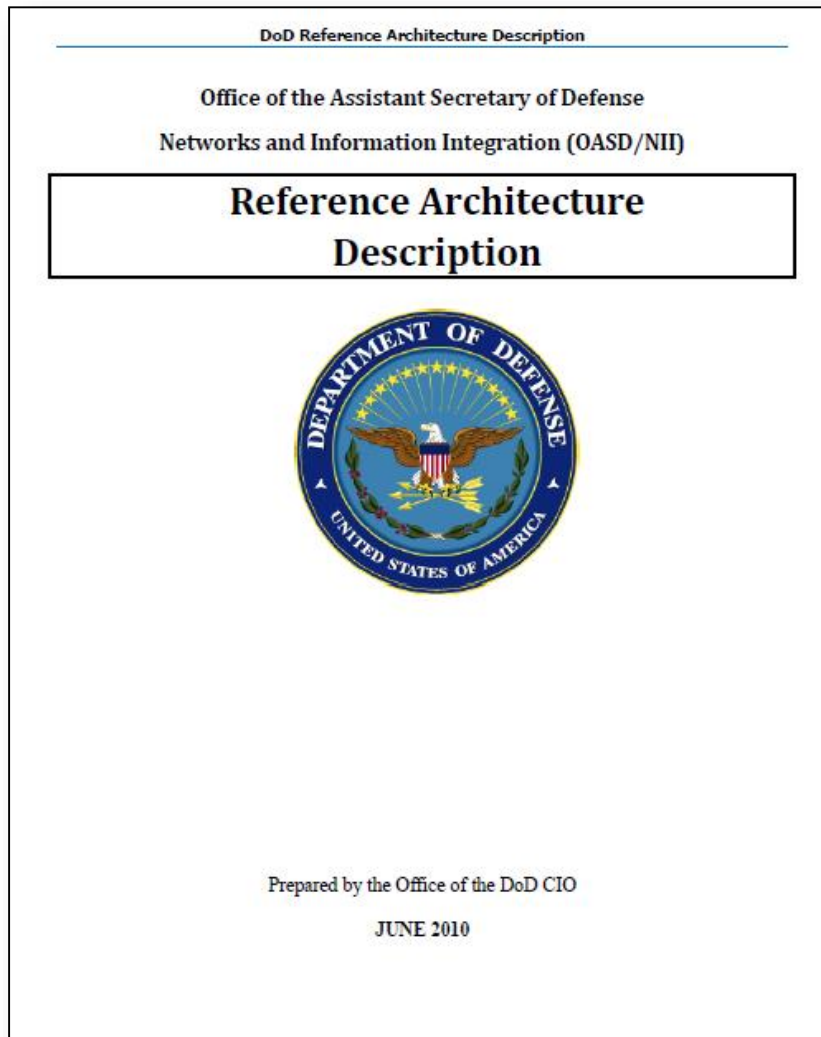*"Reference Architecture is an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions"* **

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Published Reference Architecture Description

http://dodcio.defense.gov/Portals/0/Documents/DIEA/Ref_Archi_Description_Final_v1_18Jun10.pdf

DoD Reference Architecture Description

Office of the Assistant Secretary of Defense

Networks and Information Integration (OASD/NII)

Reference Architecture Description

Prepared by the Office of the DoD CIO

JUNE 2010

Sponsored by the DoD CIO Architecture & Interoperability Directorate

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DoD Promulgation Memo

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
6000 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-6000

NETWORKS AND
INFORMATION
INTEGRATION

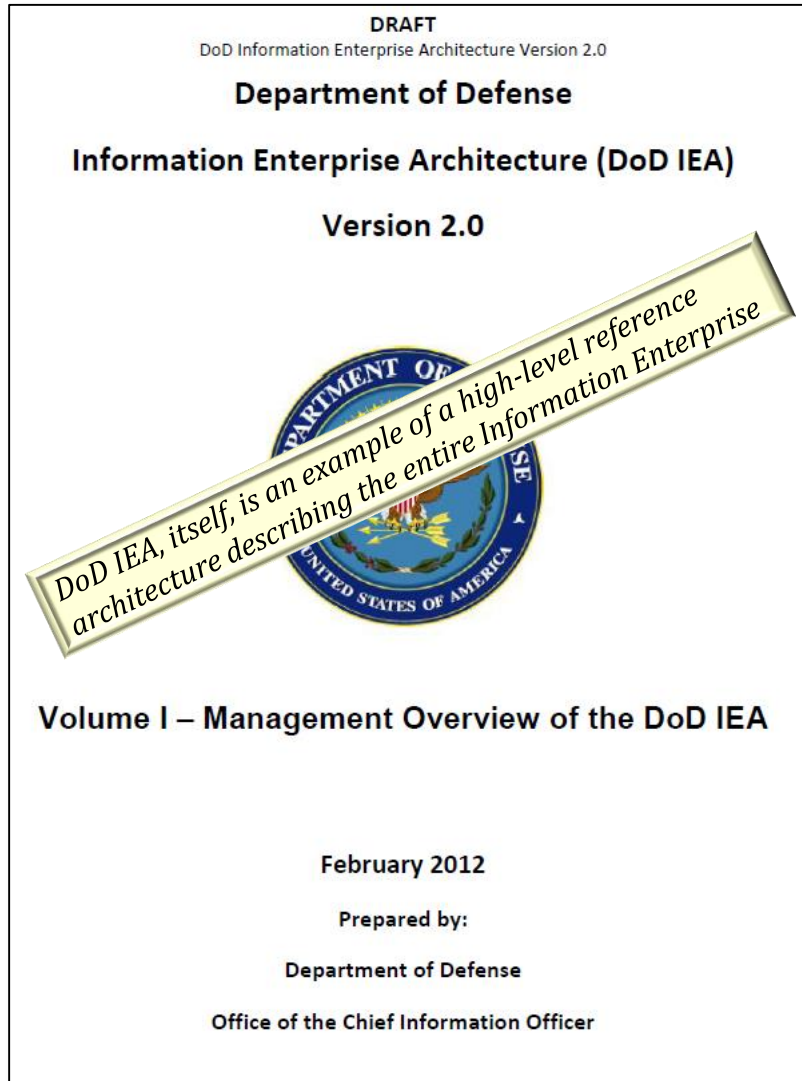MEMORANDUM FOR ARCHITECTURE AND STANDARDS REVIEW GROUP
(ASRG)

SUBJECT: Reference Architecture Description dated June 2010

The ASRG promulgates guidance for the development and approval of architectures to be incorporated into the DoD Enterprise Architecture. To that end, the Reference Architecture Description is a detailed overview of the DoD CIO's position on what, generically, constitutes a reference architecture. The Description has been reviewed by the member organizations of the ASRG and comments adjudicated appropriately. The Description will be used by the ASRG as a metric for compliance when assessing Enterprise-level Reference Architectures. Components are encouraged to adopt and incorporate the Description into their architectural guidance. This document is located on the ASRG web page: https://www.us.army.mil/suite/folder/18739044.

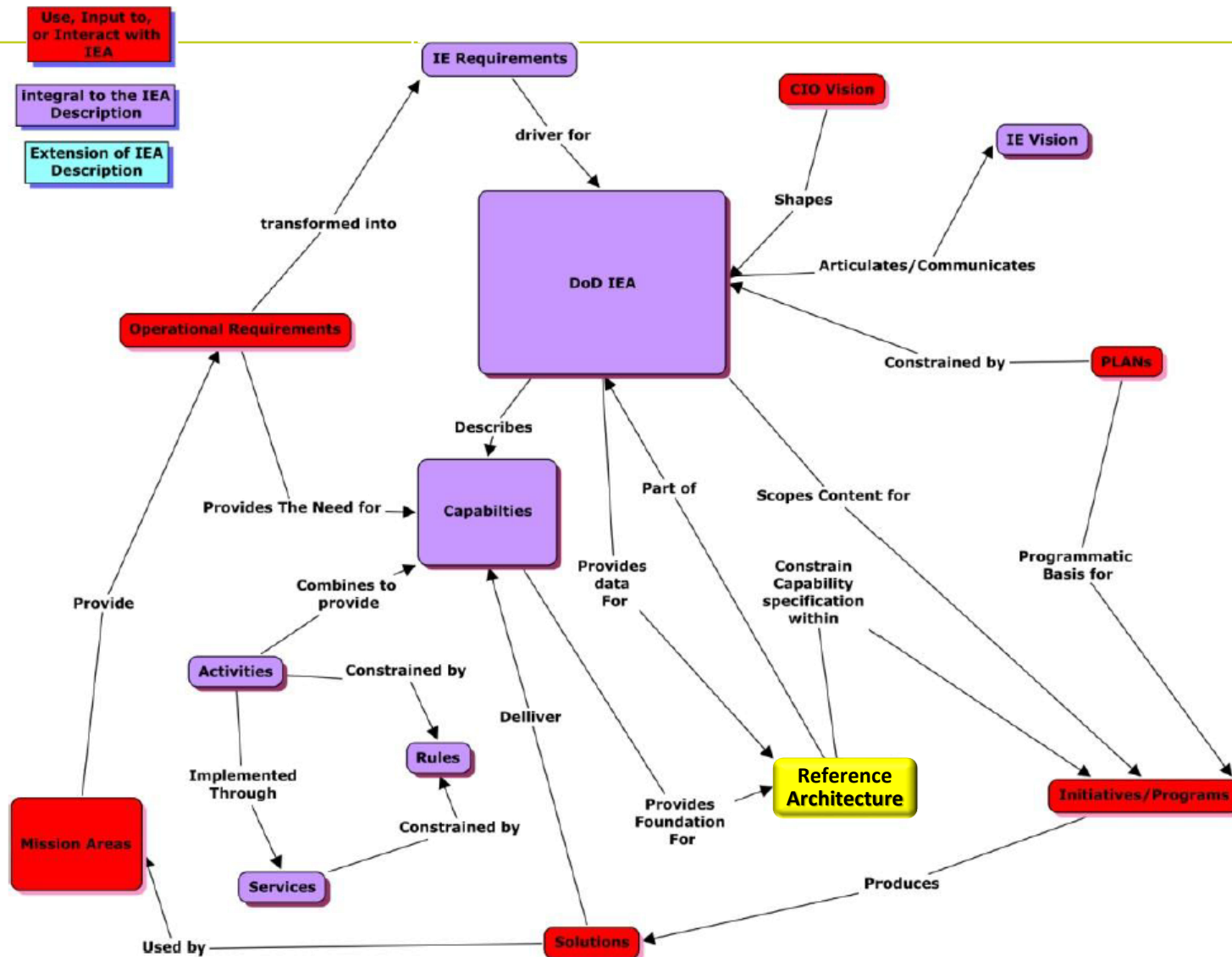Gerry Doyle, SES
Chief, Systems Engineering Center, GE3
ASRG Co Chair

Brian Wilczynski, SES
Director, Architecture and Infrastructure
ASRG Co Chair

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Role of Reference Architecture within DoD IEA

DRAFT
DoD Information Enterprise Architecture Version 2.0

Department of Defense

Information Enterprise Architecture (DoD IEA)

Version 2.0

DoD IEA, itself, is an example of a high-level reference architecture describing the entire Information Enterprise

Volume I – Management Overview of the DoD IEA

February 2012

Prepared by:

Department of Defense

Office of the Chief Information Officer

- **DoD IEA provides description of what the IE must be and how its elements should work together**

- **includes collection of artifacts – one of which is Enterprise Reference Architectures (RA)**

- **Enterprise RAs play key role in extending the DoD IEA and providing more detailed information to guide and constrain solutions and implementations for a specific focus area**

- **DoD IT architects required to conform to approved RAs for IE-related solutions**

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DoD IEA Concept Map **

*** DoD Information Enterprise Architecture (DoD IEA) v2.0, Vol I – Management Overview of the DoD IEA,*
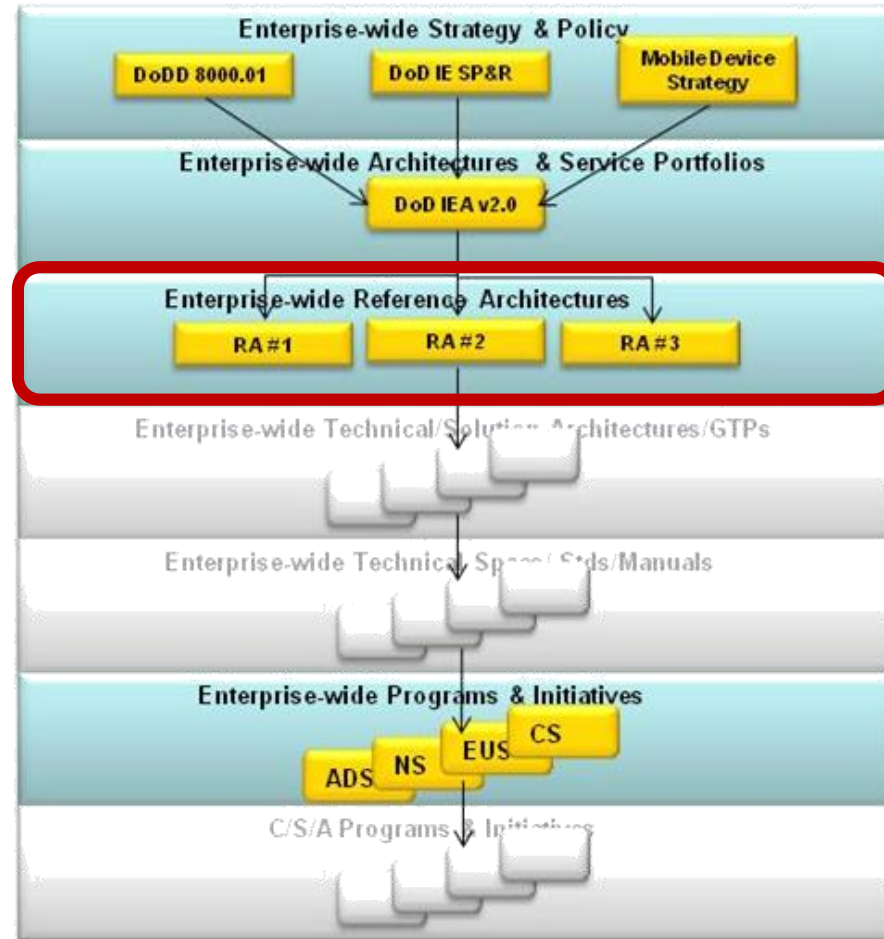*Prepared by DoD CIO, Feb 2012, Final Draft*

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DoD Enterprise Architecture (EA) **

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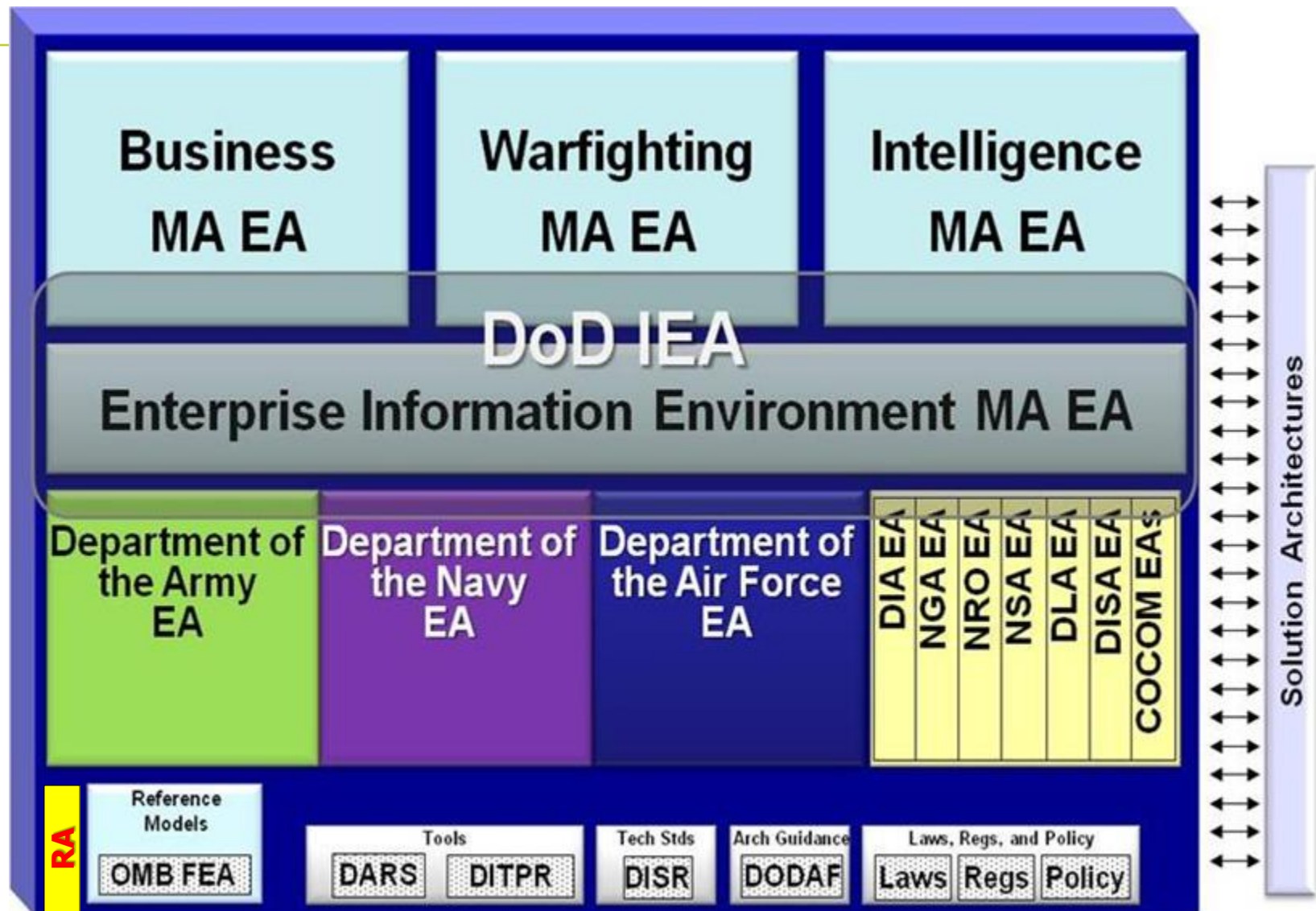
Role of Reference Architecture in IE Continuum

- **Ensures Reference Architectures will properly inform and guide the ultimate goal of enabling a particular set of IE capabilities**
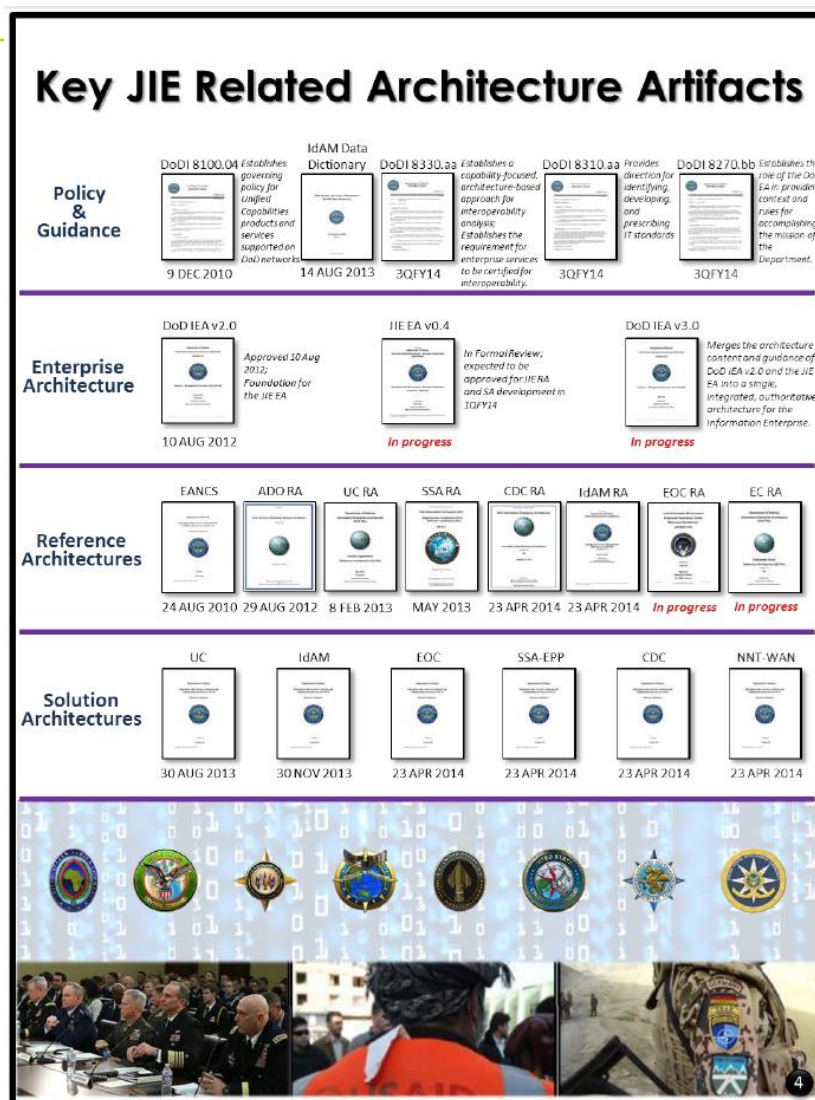

Document Framework Construct

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JIE Related Architecture Artifacts**

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DoD Enterprise-Wide Reference Architectures

Enabling the Joint Information Environment, JIE 101, DISA, May 2014

Reference Architecture	Brief Description	Approval Date
Enterprise-wide Access to Network & Collaboration Services RA (EANCS RA)	Guides, standardizes, and enables the implementation of authentication and authorization capabilities to access collaboration services in support of secure information sharing across the Department.	**Aug 2010**
Active Directory Optimization RA (ADORA)	Guides the transformation of legacy Windows networks that use AD to improve security, facilitate secure info sharing across networks, and achieve efficiencies through network consolidation.	**Aug 2012**
Core Data Center RA (CDCRA)	Defines & standardizes necessary attributes for Core DoD computing Centers integrating DoD cloud and server virtualization concepts.	**Apr 2014**
IT Infrastructure Optimization RA (ITIORA)	Leverages Defense ITIL Catalog to provide rules and standards for the optimal level (Enterprise, Theater, Installation) from which IT services are delivered.	**Apr 2014 (planned)**
Network Optimization RA (NORA)	Guides the implementation of joint networks using network virtualization or federation techniques and leveraging regional boundary protection (TLA) concepts.	**Apr 2014 (planned)**

Two Published DoD *Reference Architectures*

Department of Defense

Enterprise-wide Access to Network and Collaboration Services (EANCS)

Reference Architecture

October 2009

Prepared by the Office of the DoD CIO

Unclassified

Active Directory Optimization Reference Architecture

Version 1.0

December 15, 2010

Office of the Assistant Secretary of Defense
for
Networks and Information Integration/DoD Chief Information Officer

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Other DoD Enterprise-Wide Reference Architectures**

Reference Architectures Planned	Development Lead
NIPRNET Regional Security Architecture (NRSA) **DoD Enterprise Security Architecture (DESA)**	DISA PEO-MA/PEO-GE
DoD Biometrics Enterprise Architecture	BIMA
Command & Control On the Move RA (C2OTM RA)	Joint Staff (J8)
Joint Information Environment Operational RA (JIE ORA)	Joint Staff (J8)
Mission Secret Network RA	Joint Staff (J8)

** *Briefing for DoD Architecture Framework (DoDAF) 2.0 Plenary,* **Al Mazyck, Jan 2012**

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So....

No	Don't all architectures serve as a "**reference**" by architects and engineers to develop something?
Defined	What do we **mean** by a Reference Architecture? Why is it needed, how would I use it and what does it do for me?
5	How do you **build** one? What type of information do I need to provide? *5 Components*
No	Aren't all Reference Architectures the **same**? *Depends on intended usage*
Yes	Does a Reference Architecture have a **temporal** aspect – from current (today) to some future point in time?
Yes	Can an architecture **itself** be a Reference Architecture? – see suggested DoDAF2 models

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Case for Reference Architectures

- **Easier and quicker to develop**
  - Patterns at sufficient levels of abstraction
  - Not all concrete, detailed aspects of solutions need be known
- **Equally applicable in DoD/ Federal sectors**
- **DODAF not required … But if DoDAF used…**
  - Not building complete integrated architectures – No exchanges !!
  - Requires fewer DoDAF 2 products
  - Suggested DoDAF2 models provide guidance
- **With less detail required it is more easily possible to integrate and federate high level capabilities from both within and across tiers at the macro level**
- **Organizations can concentrate on capability concepts and not on specific implementation and delivery of systems, services and solutions**
  - Allows capabilities to be identified and compared side-by-side across service and joint components
  - Can be force multiplier in creating strategic synergy across programs

MITRE