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

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

Table of Contents

List of Figures

Table

1 Introduction

The term "Reference Architecture", within the Information Technology community, has various meanings, multiple purposes and uses, varying levels of detail and abstraction, and very little common guidance. The Deputy Assistant Secretary of Defense (DASD) for Information Management, Integration and Technology (IMI&T)/DoD Deputy CIO requested a position on and strategy for Reference Architecture in the Department. The Reference Architecture Description document is in response to this request. The objective is to provide useful guidance and direction on the development and use of Reference Architecture as a tool to guide and constrain architecture and solution development.

1.1 Purpose

This document provides guidance for the development and use of Reference Architecture in the form of a DoD definition for Reference Architecture and a description for DoD-wide Reference Architecture. The definition is applicable to all DoD Reference Architectures, while the description focuses on a unique set of DoD Reference Architectures that provide guidance to the entire Department, hereafter referred to as DoD-wide Reference Architectures. This description establishes standard criteria for DoD-wide Reference Architectures. Reference Architectures developed by Components for their specific purposes and uses are not constrained by the description of DoD-wide Reference Architecture in this document.

1.2 Background

Reference Architectures have been used in DoD, other Federal Agencies, and Industry to provide information, guidance, and direction for focused subject areas. These Reference Architectures have wide-ranging purposes, uses, levels of detail, and levels of abstraction. The term itself has multiple definitions and meanings and seems to be relative to the context of the environment in which it is used. A Google search for *Reference Architecture* returned more than 705,000 results.

Reference Architecture literature can be found throughout DoD, other Federal Agencies, and Industry addressing various subject areas. Due to current interests in Service Oriented Architecture (SOA), a good amount of existing Reference Architecture literature is focused on this area. Most notable are the efforts by the Organization for the Advancement of Structured Information Standards (OASIS), The Open Group Architecture Forum (TOGAF), and the Object Management Group (OMG).

As information, services, and infrastructure requirements and solutions continue to evolve, the need for Reference Architecture increases. Reference Architecture serves as a tool for providing common information, guidance, and direction to guide and constrain architecture and solutions. A DoD definition is needed to establish this broader perspective of Reference Architecture as the common position across the Department. While Reference Architectures with varying purposes, uses, and content exist at many levels throughout the Department, and will continue to do so, a standard set of criteria needs to be established for DoD-wide Reference Architecture. A standard set of criteria for DoD-wide Reference Architecture enables consistent development, use and assessment of these architectures. It also establishes a common DoD expectation of the content provided by a DoD-wide Reference Architecture. This document focuses on describing the standard criteria.

1.3 Approach

The approach for developing this document involved three steps:

a. The first step was to research and gather existing Reference Architecture documents and information from commercial, Federal, and DoD sectors. The intent was to pull together the broadest, representative sample of Reference Architecture materiel as possible.

b. The second step was to examine and analyze the Reference Architecture materiel to better understand existing concepts of Reference Architecture, what it is used for, its goals, objectives, characteristics, and key elements. The intent was to discover common threads for defining best practices for developing Reference Architectures. An additional benefit of this step was discovering that we already have information sources serving as Reference Architectures that are not specifically called out as Reference Architectures.

c. The third step was to develop a DoD definition for Reference Architecture and a description for DoD-wide Reference Architecture based on the analysis of Reference Architecture material and the intent of the Deputy CIO.

1.4 Document Structure

This document is structured to provide a logical progression of information about Reference Architecture in DoD. It consists of five sections and a set of appendices.

a. Section 1: Provides an introduction that describes the purpose, background, approach, and structure for this document.

b. Section 2: Provides the DoD definition for Reference Architecture.

c. Section 3: Provides a description for the DoD-wide Reference Architecture. This section describes and discusses the five elements of a DoD-wide Reference Architecture.

d. Section 4: Provides a sample of DoDAF v2.0 views and models that could be used in describing the five Reference Architecture elements.

e. Section 5: Provides a summary of the key points and positions described in this document.

f. Appendices A-C: Appendix A provides a sample Reference Architecture outline; Appendix B provides examples of existing Reference Architectures; and Appendix C provides a list of References in this document.

2 Reference Architecture Definition

An examination and analysis of numerous existing Reference Architecture definitions within DoD, other Federal Agencies, and Industry revealed common points among them. A common theme among the definitions is that the primary purpose of a Reference Architecture is to guide and constrain the instantiations of solution architectures as depicted in **Figure 1**. Based on this, a Reference Architecture is considered an organizational asset in [A&C, 2007]:

- Providing common language for the various stakeholders
- Providing consistency of implementation of technology to solve problems
- Supporting the validation of solutions against proven Reference Architectures
- Encouraging adherence to common standards, specifications, and patterns

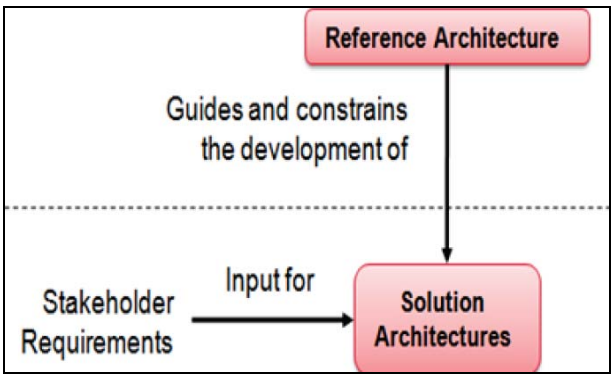

Figure 1 - Reference Architecture Purpose

Other relevant terms used in the definitions include "patterns" and "solution architectures". Patterns are models of architecture representations at a level of generality that provides some degree of reuse. The DoD Architecture Framework (DoDAF)[1] defines Solution Architecture as a framework or structure that portrays the relationships among all the elements of something that answers a problem. It describes the fundamental organization of a system, embodied in its components, their relationships with each other and the environment, and the principles governing its design and evolution. Solution architecture instantiations are guided and constrained by all or part of a Reference Architecture where the generalized and logical abstract elements of the Reference Architecture are replaced by real world, physical elements according to the specified rules, principles, standards and specifications.

From all of this, the derived DoD definition for Reference Architecture is:

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

Reference Architecture serves as a reference foundation for architectures and solutions and may also be used for comparison and alignment purposes. There may be multiple Reference

[1] Department of Defense Architecture Framework (DoDAF) Version 2.0, Volume 1, 28 May 2009, Pg. 6.

Architectures within a subject area where each represents a different emphasis or viewpoint of that area as depicted in Figure 2. For each Reference Architecture, there may be any number of architectures and solutions corresponding to different aspects of the subject area viewpoint.

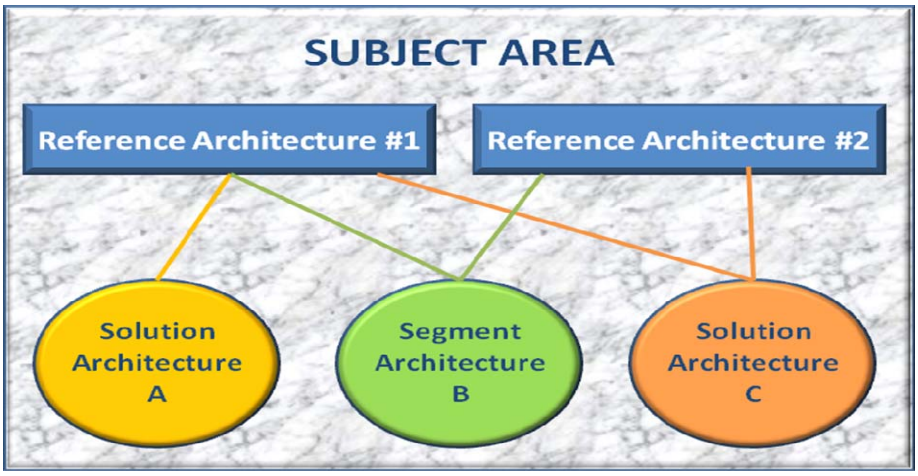

Figure 2 - Reference Architecture Relationships

Reference Architectures may be defined at many levels of detail and abstraction (from specific to generalized) and for many different purposes. In fact, a Reference Architecture for one subject area can be a specialization of a more general Reference Architecture in another subject area. The level of abstraction provided in a Reference Architecture is a function of its intended usage. Where solution architectures are to be developed based on a specific Reference Architecture, the level of detail provided as a reference may have to be greater than if a Reference Architecture is intended to be used for alignment purposes only.

Reference architectures may also be complimentary in guiding architectures and solutions. Figure 2 also shows that Reference Architecture may guide and constrain various types and instantiations of architecture depending on the purpose and scope. DoD-wide Reference Architecture, due to its broader purpose and scope, may guide and constrain Enterprise, Segment, Capability, and Solution Architectures.

3 DoD-wide Reference Architecture Description

DoD-wide Reference Architecture is part of the DoD Enterprise Architecture (EA). **Figure 3**, DoD Enterprise Architecture (EA), shows the construct of the DoD EA depicting its components and their general relationships.

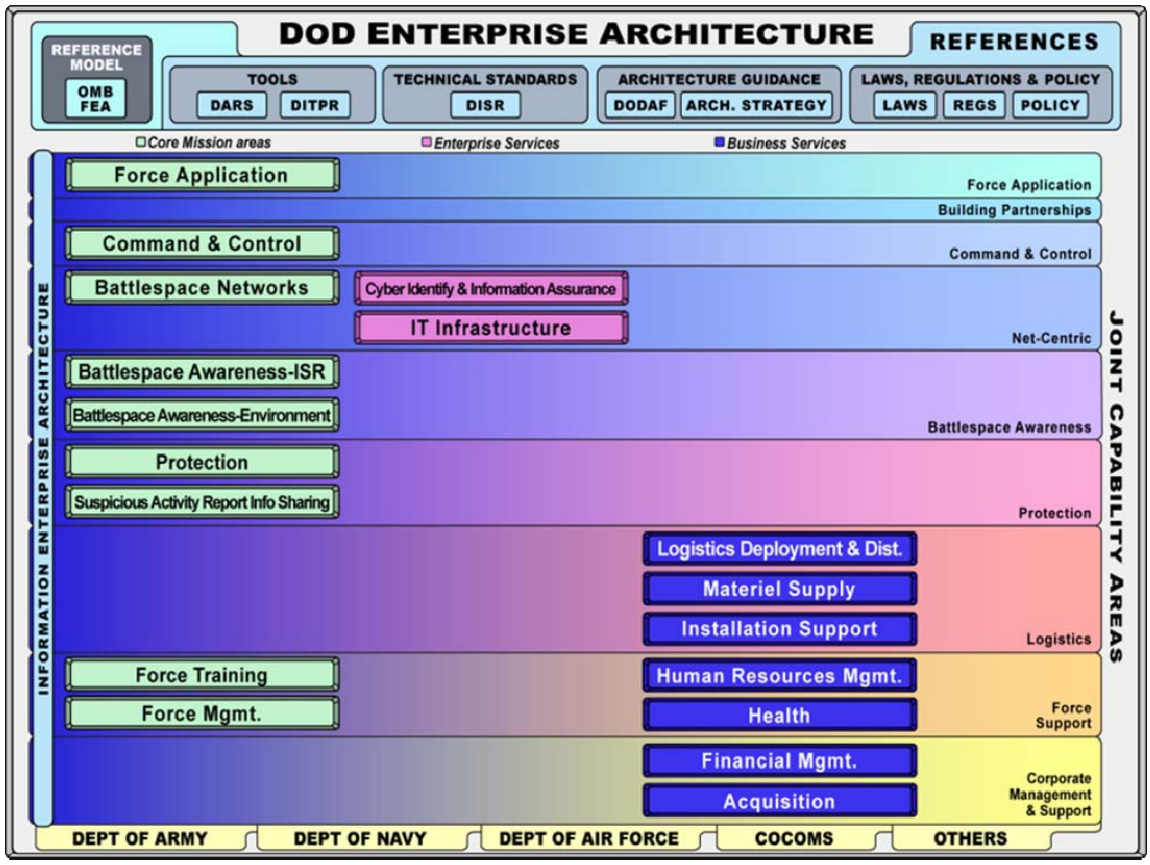

Figure 3 - DoD Enterprise Architecture

DoD-wide Reference Architecture is part of the "Architecture Guidance" block under the "References" label in the upper portion of the diagram. In this position, it guides and constrains all architectures in the DoD EA.

The DoD-wide Reference Architecture provides information, guidance, and direction that is applicable across DoD. This information, guidance, and direction are provided in the five (5) elements that comprise a DoD-wide Reference Architecture.

a. **Strategic Purpose** – Identifies goals and objectives of the Reference Architecture and describes the specific purpose of and the problem(s) to be addressed by the Reference Architecture.

b. **Principles** – Sufficient high level foundational statements of rules, culture, and values that drive technical positions and patterns.

c. **Technical Positions**– Technical guidance and standards, based on specified principles that need to be followed and implemented as part of the solution.

d. **Patterns (Templates)**[2] – Generalized architecture representations (viewpoints, graphical/textual models, diagrams, etc.) that show relationships between elements and artifacts specified by the technical positions.

e. **Vocabulary** – Acronyms, terms, and definitions that are used in the Reference Architecture and relevant to architectures and solutions that are guided and constrained by the Reference Architecture.

3.1 Strategic Purpose

The Strategic Purpose describes the context for the Reference Architecture and provides the basis for the principles, technical positions, patterns, and vocabulary in the Reference Architecture. The context includes descriptions of the scope, goals, and purpose of the Reference Architecture, why it is needed, and when and how it should be used. The key authoritative sources used in the development of the RA, as well as the intended audience (to whom the architecture is directed), should also be included in this section. The strategic purpose should explicitly identify the primary producing stakeholder (owner) organizations that will develop and implement related architectures and solutions. It should also explicitly describe the issue(s) and stakeholder concern(s) that will be addressed by the Reference Architecture. Understanding and consensus on the strategic purpose of the Reference Architecture will enable end-to-end traceability between organizational context and an eventual solution implementation.

3.2 Principles

Principles are high-level statements that apply to the subject area and tie back to business/warfighting requirements. They incorporate values and organizational culture, and drive technical positions and patterns in defining how an organization fulfills its mission. The identification of assumptions and constraints can assist in gaining an understanding of the context of the RA, which can provide a helpful perspective on the guiding principles.

Principles are general rules and guidelines that should be understandable, robust, complete, independent, and are not intended to state the obvious. They inform and support the way in which an organization sets about fulfilling its mission and are intended to be enduring and seldom amended. In DoD-wide Reference Architectures, principles without any additional information should be sufficient to clearly convey the general intent of the Reference Architecture. In some cases, principles may be extracted from relevant subject area policy. In other cases, they may be created as a result of the development and analysis of the Reference Architecture. The following are examples of principles from existing Reference Architectures:

a. Authoritative data assets, services, and applications shall be accessible to all authorized users in the Department of Defense, and accessible except where limited by law, policy, security classification, or operational necessity (DoD IEA v1.2).

b. All authorized entities have one identity and universal credentials are recognized by all producers of information and service (GIG 2.0 Operational RA).

c. All users must have a portable identity credential for authentication (Enterprise-wide Access to Network and Collaboration Services RA [EANCS RA]).

[2] **Patterns** is the most commonly used term to describe these kinds of abstract models and diagrams and will be used in place of Templates in this document.

d. Each Military Department will determine its own appropriate number of AD forests based on the risks and benefits of different size forests and the specific resources managed within each (Active Directory Optimization RA [ADORA])

3.3 Technical Positions

Technical positions describe the technical guidance and standards established for a subject area. Due to rapidly evolving technology, technical positions are likely to change often to keep up with industry. Required services, standards, agreements, security model, communication protocols, web services, XML namespaces, data quality, etc. are all technical positions that must be described and addressed in a DoD-wide Reference Architecture.

Defining technical positions forces an organization to identify relevant technical guidance and standards and justify their choices and tradeoffs. For example, a SOA Reference Architecture would include descriptions of the services and standards to assist architects in understanding and incorporating them in solution architectures for the subject area. The *Army Reference Architecture for Security for Web Services* [CERDEC, SWS, 2007] has definitions for security capabilities that include authentication, authorization, etc. requiring such standards as WS-I Basic Security Profile, Security Assertion Markup Language (SAML) and others.

An effective way for conveying technical positions is via a table that contains information relevant to a StdV-1, but technical positions may be described in various ways. The following are examples of technical positions from existing Reference Architectures:

a. Available Mandatory Core Designated DoD Enterprise Services, as listed in Appendix G, are mandatory for use regardless of capability delivered [Appendix G lists Collaboration Service, Content Discovery Services, and Content Delivery Services] (DoD IEA v1.2).

b. DoD CAC Middleware Requirements Release 3.0 - The Middleware Requirements defines the standard set of services, interfaces, and configuration options that must be implemented by all middleware for use on supported Microsoft-Intel (WINTEL) server and desktop operating systems platforms within the DoD (EANCS RA).

c. DoD Active Directory User Object Attribute Specification - Document developed to provide common naming and attribute guidance to DOD Components that deploy AD. This standard is applicable to the Contact Sharing capability being implemented (ADORA).

3.4 Patterns

Patterns show how artifacts may be organized and related for repeated use. They are typically low to mid level tabular, structural, behavioral, or graphical model abstractions that focus on interaction of the artifacts. Patterns undergo change most often as new pattern concepts are discovered and emerge from solution architectures.

Patterns may be conveyed through various means such as Activity Models, Process Models, and Behavioral Models. It is important to identify the pattern and describe it with enough detail for it to be clearly understood and used appropriately.

Three potential benefits of architecture patterns are: 1) they enable improved communication between stakeholders; 2) they facilitate application of sound architectural concepts and implementations; and 3) they can become standardized through multiple implementations [Cloutier, May 2006]. An effective way to develop a foundation to provide patterns of operational behavior is to leverage the activities of OV-5a (Activity Node Tree) with the OV-6c

(Activity Event sequence diagram. This combination of viewpoints exploits the relationship between the process model and the operational activities, while supporting the concept of integrated architectural viewpoints.

3.5 Vocabulary

The vocabulary provides the acronyms, terms, and definitions that are pertinent to the Reference Architecture. It enables a common understanding of terms and consistency of definitions across the subject area. This highlights the importance of a common vocabulary of terms as key content of a Reference Architecture. As well, the authoritative nature of a Reference Architecture can be reinforced through the practice of documenting the sources of all activities, process steps and performers within the vocabulary (Integrated Dictionary).

4 DoDAF Models Utilized in RA

Architecture can be considered a Reference Architecture as long as it follows the guidelines specified in this paper as being general in nature and targeted towards solving specific issues within a single focused environment. A DoD-wide Reference Architecture must also provide the necessary elements – purpose, principles, technical positions and policies, patterns, and vocabulary – in some form or another within the architecture.

The latest version of the DoD Architecture Framework, DoDAF v2.0 [DoDAF, 2008], provides an extensive number of compliant views/models and allows the use of "Fit-for-Purpose" artifacts as needed to sufficiently document the five elements. The DoDAF v2.0 Operational, Service, and System viewpoints and their models may all be used to formulate patterns of operational activities and their resources, service level functionality and service resources, and system level functionality and system resources.

Table 1 provides a sample listing of DoDAF v2.0 views and models utilized in a DoD-wide Reference Architecture. This listing is neither exhaustive nor prescriptive.

Table 2 - DoDAF Models Utilized in RA

Content	DoDAF 2.0 Views/Models	
Purpose: Introduction, overview, context, scope, goals, purpose, why needed, and when and how used	• **AV-1 Overview & Summary Information** • **CV-1: Vision** – overall strategic concept and high level scope • **OV-1 High Level Operational Concept Graphic** – executive operational summary level of what solution architectures are intended to do and how they are supposed to do it	
Principles: foundational organizational rules, culture, and values that drive technical positions and patterns	• **OV-6a Operational Rules Model** • **OV-6b Operational State Description** • **SvcV-10a Services Rules Model** • **SV-10a Systems Rules Model** • **OV-4 Organizational Relationships Chart** – architectural stakeholders	
Technical Positions & Policies	• **StdV-1 Standards Profile** – standards, specifications, guidance, policy applying to elements of the solution architectures	
Architectural Patterns: generalized patterns of activities, service functionality and system functionality and their resources, providers and information/ data resource flows Generalized scenario patterns of sequenced (sequential/	**Operational Patterns** • **OV-2 (multiple) Operational Resource Flows** • **OV-5 {a, b} Activity diagrams** • **OV-6c Event-Trace Description** **Service Patterns** • **SvcV-1 (multiple) Service Interfaces** • **SvcV-2 Service Resource Flows** • **SvcV-4 Service Functionality** • **SvcV-10b Service State Transitions** • **SvcV-10c Services Event-Trace**	**System Patterns** • **SV-1 (multiple) System Interfaces** • **SV-2 System Resource Flows** • **SV-4 System Functionality** • **SV-10b System State Transitions** • **SV-10c Systems Event-Trace Description**

concurrent) responses by activities, services and system functions (together with their resources) to synchronous/ asynchronous timed events	**Description**	
	Event-Based Scenario Patterns of Dynamic Behavior • **OV-6c Event-Trace Description** • **SvcV-10c Services Event-Trace Description** • **SV-10c Systems Event-Trace Description**	
Vocabulary	• **AV-2 Integrated Dictionary**- definitions of terms used throughout solution architectures	

The DoDAF Metamodel (DM2) defines architectural data elements and enables the integration and federation of Architectural Descriptions. It establishes a basis for semantic (i.e., understanding) consistency within and across Architectural Descriptions. In this manner, the DM2 supports the exchange and reuse of architectural information among Joint Capability Areas (JCAs), Components, and Federal and Coalition partners, thus facilitating the understanding and implementation of interoperability of processes and systems. Data collected for and presented by a Reference Architecture should conform to the DM2 so the RA can be federated into the DoD EA and shared with all appropriate users.

Related elements may be developed for DoD that are not part of the Reference Architecture. These include CONOPS and Transition Planning Guidance.

5 Summary

The purpose of this work was to provide guidance and direction to the DoD enterprise on the better use of Reference Architectures for guiding and constraining architecture descriptions, developments, and usages for current and future capabilities. The approach taken was to research and leverage Reference Architecture information and best practices to develop a DoD definition for Reference Architecture and describe the elements that compose a DoD-wide Reference Architecture. The key points made in this document are:

a. Reference Architecture is defined as an authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions. This definition is applicable to all of DoD.

b. Reference Architecture may be developed by various organizations throughout DoD for their own purposes and intended uses, but DoD-wide Reference Architecture must contain the five elements described in this document.

c. DoD-wide Reference Architecture is a specific Reference Architecture that provides information and guidance that is applicable to all of DoD and contains five key elements.

d. The five key elements of a DoD-wide Reference Architecture are:

    1) Strategic Purpose - explains context, scope, goals, purpose, and intended uses.

    2) Principles - high-level statements, general rules and guidelines that constrain how an organization fulfills its mission.

    3) Technical Positions - technical guidance and standards that need to be implemented as part of the solution.

    4) Patterns - reusable models for doing something.

    5) Vocabulary - key terms and definitions to promote common understanding and use. A DoD-wide Reference Architecture requires all five elements to properly guide and constrain architectures and solutions.

e. The goals and objectives of Reference Architecture are numerous. They solve a specific (recurring) problem in a problem space; explain context, goals, purpose, and problem being solved including when and how Reference Architecture should be used; and provide concepts, elements and their relationships that are used to direct/guide and constrain the instantiation of repeated concrete solutions and architectures.

f. Reference Architectures may address different levels of abstraction (from the specific to the generalized) and at different levels of coverage (from patterns to full end-to-end coverage).

Appendix A: Reference Architecture Sample Outline

The following sample outline is the Table of Contents from the Enterprise-wide Access to Network and Collaboration Services (EANCS) Reference Architecture. The sample outline contains all the elements described in this paper. It is not meant to be prescriptive but serves as a guide to assist in organizing Reference Architecture content.

EANCS Reference Architecture

Appendix B: Examples of Reference Architectures

B.1 OASIS SOA Reference Architecture

The OASIS *Reference Architecture for Service Oriented Architecture* [OASIS RA, 2008] follows from the concepts and relationships defined in the OASIS *Reference Model for Service Oriented Architecture* [OASIS RM, 2008]. OASIS RA is an abstract realization of SOA, focusing on the elements and their relationships needed to enable SOA-based systems to be used, realized and owned; while avoiding reliance on specific concrete technologies. While it remains abstract in nature, the OASIS RA describes one possible template upon which a SOA concrete architecture can be built.

The OASIS RA goal is to show how SOA fits into the life of users and stakeholders in a SOA ecosystem, how SOA-based systems may be realized effectively, and what is involved in owning such a SOA-based system. The following diagram taken from the OASIS *Reference Model* depicts the overview of the OASIS SOA Reference Architecture and Reference Model space showing levels of artifacts from concrete to abstract.

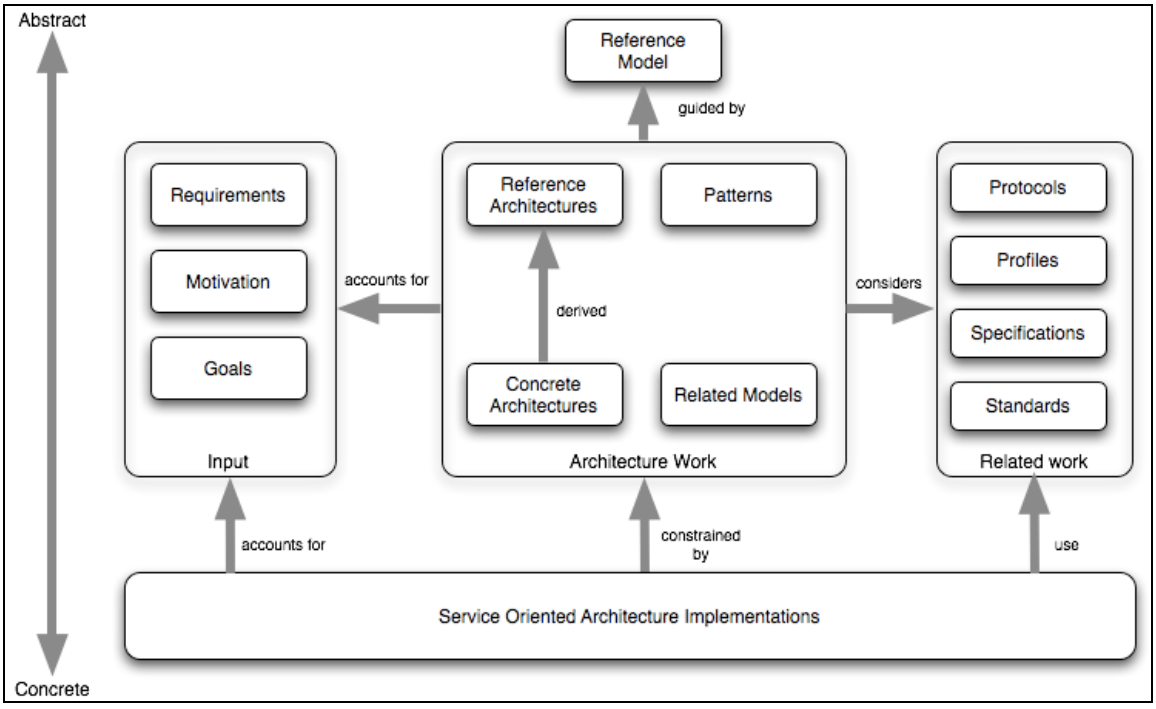

Figure B-1 - Overview of the OASIS SOA RA and RM

B2. The Open Group SOA Reference Architecture

The Open Group has published their SOA RA [TOGAF SOA RA, 2009]. This document provides *guidelines for making SOA architectural, design, and implementation decisions*. It provides patterns and insights for integrating the fundamental elements of a SOA solution composed of architectural building blocks (ABB) within a 9 layer structure. Their SOA Reference Architecture serves as a blueprint that includes templates and guidelines for architects. These will enable the process of modeling and documenting the nine architectural layers, their architectural building blocks (ABB), options for layers and ABBs, mapping of products to the ABBs and architectural and design decisions that contribute to the creation of a SOA.

The nine layers of the Open Group's SOA RA are designed to reinforce the various perspectives of SOA business value. For each layer, there are two aspects: logical and physical. The logical aspect includes all the architectural building blocks, design decisions, options, KPIs, etc.; the physical aspect of each layer is to cover the realization of each logical aspect using technology and products, and is determined by the different architectural decision points that get taken. This specification focuses on the logical aspect of the SOA Reference Architecture, while providing the model for the architectural decision points.

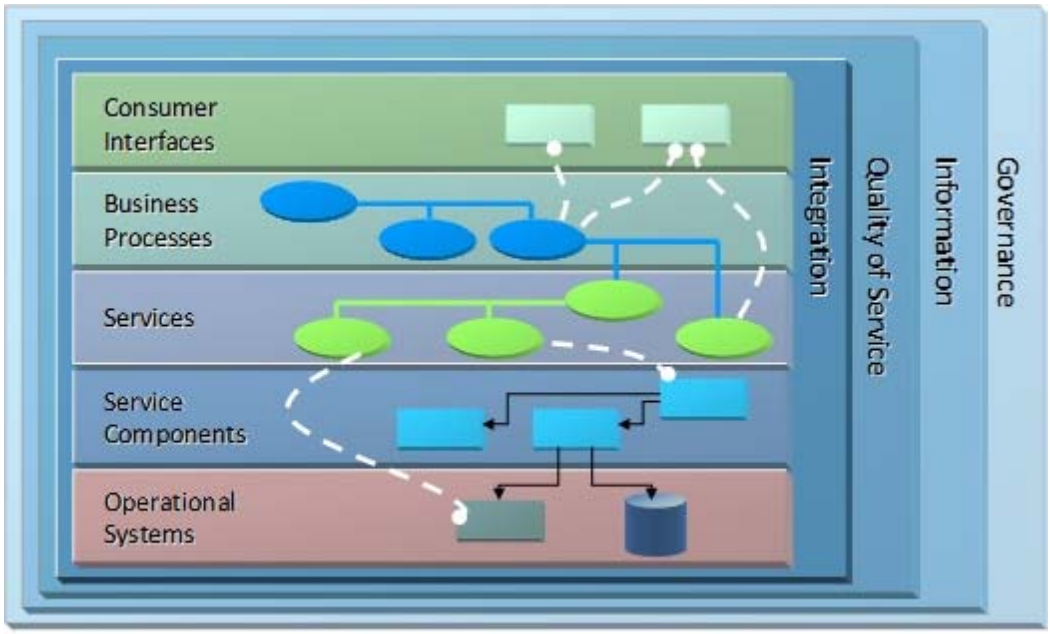

Figure B-2 - Layers of the Open Group SOA Reference Architecture

B3. Global Justice Reference Architecture (JRA)

The Justice Reference Architecture (JRA) is a product of the U.S. Department of Justice's Global Justice Information Sharing Initiative (Global) which serves as a Federal Advisory Committee (FAC) and advises the U.S. Attorney General on justice information sharing and integration initiatives [GISWG, 2009]. Global was created to support the broad scale exchange of pertinent justice and public safety information. It promotes standards-based electronic information exchange to provide the justice community with timely, accurate, complete, and accessible information in a secure and trusted environment.

The Global JRA Specifications Version 1.4 is a SOA reference architecture for justice and public safety information sharing and includes 1) a set of requirements for justice interoperability, 2) describes the Justice Reference Architecture (concepts, relationships, and high-level components), and 3) provides specifications that satisfy those requirements.

Justice defines a Reference Architecture as a tool practitioners can use to make it easier to develop a well-conceived, formal approach to designing information sharing solutions/systems. A key benefit of reference architecture for them is that it helps promote consistent thinking and approaches among the people who use it, even if they have not shared information with each other. In that context, they see a Justice Reference Architecture as a set of documents that the technologists — developers, architects, project managers — in a jurisdiction can use to accelerate the planning process for information sharing, while simultaneously aligning the final outcomes with proven best practices.

B4. DoD Information Enterprise Architecture

The *DoD Information Enterprise Architecture* [DoD IEA, 2009] is an example of a Reference Architecture that is not specifically called out to be a Reference Architecture. It states specifically "*DoD IEA 1.1 highlights the key principles, rules, constraints and best practices drawn from collective policy to which applicable DoD programs, regardless of Component or portfolio, must adhere in order to enable agile, collaborative net-centric operations*". This is in alignment with the concept of a Reference Architecture as guiding and constraining *applicable DoD programs.*

The DoD IEA provides a set of principles, rules, and activities. The activities contain associated constraints and mechanisms that are akin to technical positions. The hierarchical activity model (acting as a pattern) provides a means to navigate the many policies and standards applicable to the GIG and serves as a classification scheme for investment management. The portion of the DoD IEA that encompasses the "DoD Information Enterprise Priorities" provides a common taxonomy and lexicon for describing the use of GIG services and capabilities. Appendix D of the DoD IEA also defines where the DoD IEA should be applied, and explains the process for applying it to DoD architectures.

So, the case can be made that because it contains all the elements of a Reference Architecture, achieves the goals and objectives outlined here and has many of the characteristics defined in this paper, it could be considered as a Reference Architecture. As a Reference Architecture, the focus area of the DoD IEA is the Information Enterprise (IE). The DoD IEA provides strategic context, principles, rules, technical positions, and vocabulary to guide and constrain architecture and solution development associated with the IE.

B5. Service Oriented Architecture Foundation – Army, SOAF-A

In 2007, the U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC), a subordinate R&D center of the Army's Research, Development and Engineering Command (RDECOM), put forward a *Service Oriented Architecture Foundation - Army (SOAF-A)* effort intended to provide the Army with a reusable and easily deployable baseline SOA capability. The goal was to foster the adoption and implementation of SOA across information systems throughout the Army, and to ensure the interoperability of the individual SOA instances. They established a series of baseline Reference Architecture documents for the component systems within the SOA Foundation. These documents describe the capabilities provided by the individual components and provide reference use cases and implementation scenarios. The purpose of the documents was to assist enterprise architects throughout the Army with understanding the capabilities offered by a SOA and the key issues to be considered within each capability.

Four such SOAF-A 1.0 documents were produced. They were validated by Gartner Group and follow the discussion on Bricks and Patterns [Schulman, 2004] which represents a model the Army is following for reference architectures in their practice [Damashek (Army), 2009].

- Enterprise Directory Services (EDS) RA [CERDEC, EDS, 2007]
- Enterprise Service Bus (ESB) RA [CERDEC, ESB, 2007]
- Enterprise Service Management (ESM) RA [CERDEC, ESM, 2007]
- Security for Web Services (SWS) RA Guide [CERDEC, SWS, 2007]

There are 3 common guiding principles across each SOAF-A Reference Architecture:

1. **Open Standards**: Prescribes an open standards-based approach to realize security within an SOA environment.
2. **Iterative/Agile Realization**: Each Reference Architecture will evolve and mature iteratively with the goal of achieving a ubiquitous "identity management layer" for EDS and EBS and "SOA Security layer" for SWS across the Army.
3. **Simplicity/Ease of Implementation**: Guidance prescribed is intended to be both simple to use and as non-intrusive as possible to develop.

The Army data strategy team is working on reference architecture in the Data space, but it's in a seminal stage. The Army believes that a reference architecture template may actually vary between strategic (enterprise), operational (segment) and tactical (solution) levels. As such, the templates embodied in the SOA reference architectures follow a common template, based on Gartner's work, for an enterprise-level. The Army plans to establish the same for segment or solution level architectures and integrate reference architecture development into the Army's Methodology for Enterprise Transformation (MET), which represents an EA process.

B6. IBM Insurance Application Architecture

The IBM Insurance Application Architecture is an example of a Reference Architecture within the commercial insurance industry. It encapsulates Insurance focus area best practices in the form of business process, business activities, business objects, business rules etc. [IBM, 2006]. The IAA supports over 80 percent of an insurer's business requirements and is designed to be easily customized and extended to cover any specific requirement.

IAA comprises five (5) models that identify, describe, and structure all of the insurance business functions, data, and processes.

- **Foundation Models**: insurance terms and definitions for communication and standardization
- **Information Models**: insurance data content for an enterprise-wide view of information and data rationalization
- **Process Models**: insurance business processes content for areas such as business process modeling, simulation, and execution
- **Integration Models**: business services content for component based development and services oriented architectures
- **Product Models**: a method for accelerating insurance product design

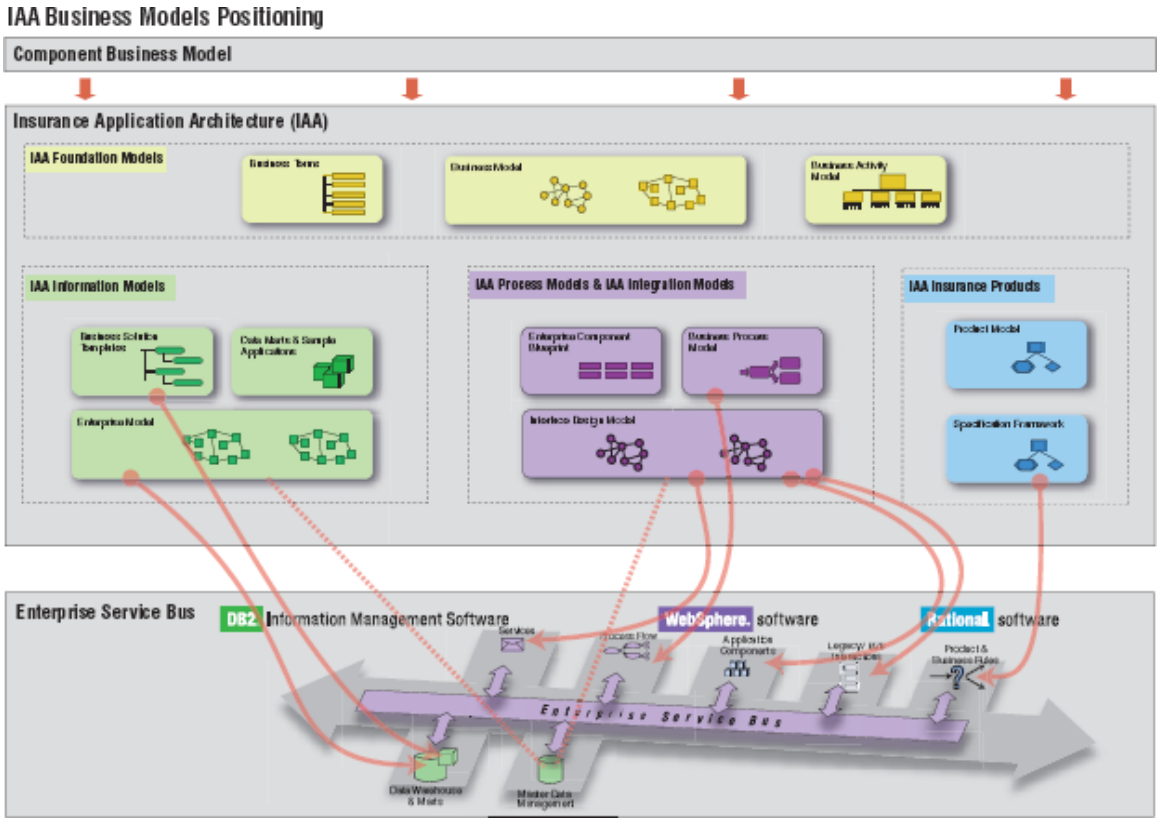

Figure B-3 - IBM Insurance Application Architecture

These five models ensure that business requirements for major initiatives are captured and expressed in a manner that can be understood and used by the IT organization and that are reflected in all subsequent levels of the application development process.

Appendix C: References

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

[Burk, 2007], *Seven Rules for Using EA*, Burke, R., IDGA's 5th Annual DOD Architectures Summit, April 11, '07

[Burton, 2004], *Reference Architecture Overview*, Burton Group, Mar 9, '04, www.burtongroup.com

[Burton, 2008], *Burton Group's Reference Architecture Principles: Data Management Strategies*, Phil Schacter, Burton Group, June 24, '08

[Buschmann, 1996], *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

[CERDEC, EDS, 2007], *SOAF-A 1.0, Enterprise Directory Services (EDS) Reference Architecture*, U.S. Army Communications Electronics Research, Development and Engineering Center (CERDEC), v1.4, 28 Sept '07

[CERDEC, ESB, 2007], *SOAF-A 1.0, Enterprise Service Bus (ESB) Reference Architecture*, U.S. Army Communications Electronics Research, Development and Engineering Center (CERDEC), v1.4, 28 Sept '07

[CERDEC, ESM, 2007], *SOAF-A 1.0, Enterprise Service Management (ESM) Reference Architecture*, U.S. Army Communications Electronics Research, Development and Engineering Center (CERDEC), v1.4, 28 Sept '07

[CERDEC, SWS, 2007], *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

[Cloutier, Apr 2008], *Is There a Role for Patterns in Enterprise Architecture?*, Cloutier, K., Architecture & Practice, April '08

[Cloutier, May 2006], *Applying Pattern Concepts to Enterprise Architecture*, Cloutier, R.J., Verma, D., Journal of Enterprise Architecture, pgs 34-50, May '06

[Cloutier, May 2008], *Applying the Concept of Patterns to Systems Architecture*, Cloutier, R.J., Verma, D., Stevens Institute of Technology, DOI 10.1002/sys, May, '08

[Cureton, 2008], *Network-Centric Operations Industry Consortium (NCOIC™) Interoperability Framework (NIF) and Patterns Overview*, Cureton, K., Feb '08, www.ncoic.org

[Damashek (Army), 2009], *Emails and Discussions*, Damashek, R., Enterprise Architect, Architecture Operations Network and Space (AONS) HQDA (SAIS-AOE) / Binary Group, CIO/G-6, Apr-June '09, <mailto:Robert.Damashek@hqda.army.il>

[DoDAF, 2008], *DoD Architecture Framework Version 2.0, Volumes I, II, and III,* US Department of Defense, 24 December '08, https://dars1.army.mil/MetadataWizard/CommunityDocument.do?action=getGeneralPublicDocs

[DoD IEA, 2009], *Department of Defense Information Enterprise Architecture Version (DoD IEA)*, v1.1, Department of Defense (DoD) Office of the Chief Information Officer (CIO), May '09

[Fattah, 2009], *Enterprise Reference Architecture: Addressing Key Challenges Facing EA and Enterprise-wide Adoption of SOA,* Ahmed Fattah, Executive IT Architect, IBM Australia, 22nd Enterprise Architecture Practitioners Conference, London, UK, April 28-30, '09

[FCW, 2007], *OMB, CIO Council Issue Architecture Principles*, Federal Computer Week, Aug 27, 2007, retrieved from http://fcw.com/articles/2007/08/27/omb-cio-council-issue-architecture-principles.aspx

[Gamby, 2002], *Developing Identity Management and Directory Services Architecture Principles*, Technical Positions, and Templates, Gamby, R., Blum., D., Burton Group, Nov '02

[GISWG, 2009], U*.S. Department of Justice's Global Justice Reference Architecture (JRA),* Global Infrastructure/Standards Working Group (GISWG), v1.7, Mar '09, retrieved from http://it.ojp.gov/default.aspx?area=nationalInitiatives&page=1015

[IBM, 2006], *Industry Models for Insurance*, The Insurance Application Architecture (IAA), IBM, '06

[Kreger, et. al, 2009], *Navigating the SOA Opens Standards Landscape Around Architectures*, White Paper edited by Heather Kreger, IBM and Jeff Estefan, NASA/Jet Propulsion Laboratory, Published by the Open Group, June '09

[OASIS RA, 2008], *Reference Architecture for Service Oriented Architecture*, Version 1.0, The Organization for the Advancement of Structured Information Standards (OASIS), Public Review Draft 1, 23 April '08

[OASIS RM, 2006], *OASIS Reference Model for Service Oriented Architecture* 1.0, 31 May '06

[Rosen, 2006], *What Is a Reference Architecture?*, Rosen, M., Cutter Consortium Enterprise Architecture Practice, 15 Nov '06

[Schulman, 2004], *Patterns and Bricks are an Architects' Two Best Friends*, Schulman, J., Gartner Research Note, COM-21-7390, 5 January '04

[TOGAF Patterns, 2005], *The Open Group Version 8.1 Enterprise Edition, Architecture Patterns,* The Open Group (TOGAF), Chapter 28, pgs 249-256, 2005, www.opengroup.com

[TOGAF Principles, 2005], *The Open Group Version 8.1 Enterprise Edition, Architecture Principles*, The Open Group (TOGAF), Chapter 29, pgs 257-273, '05, www.opengroup.com

[TOGAF SOA RA, 2009]. *Technical Specification: SOA Reference Architecture*, The Open Group, May '09, www.opengroup.com