FINAL DRAFT

DoD Architecture Framework Version 2.0

Volume 1: Introduction, Overview, and Concepts

Manager's Guide

18 May 2009

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EXECUTIVE SUMMARY

The Department of Defense Architecture Framework (DoDAF), Version 2.0 serves as the overarching, comprehensive framework and conceptual model enabling the development of architectures to facilitate the ability of Department of Defense (DoD) managers at all levels to make key decisions more effectively through organized information sharing across the Department, Joint Capability Areas (JCAs), Mission, Component, and Program boundaries. The DoDAF serves as one of the principal pillars supporting the DoD Chief Information Officer (CIO) in his responsibilities for development and maintenance of architectures required under the Clinger-Cohen Act. It also reflects guidance from the Office of Management and Budget (OMB) Circular A-130, and other Departmental directives and instructions. This version of the Framework provides extensive guidance on the development of architectures supporting the adoption and execution of Net-centric services within the Department.

DoD managers, as process owners, specify the requirements and control the development of architectures, as described in this volume, within their areas of authority and responsibility. In that role, they select an architect and an architecture development team to create the architecture in accordance with the requirements defined by the process owner. As described in Volume 1, architecture concentrates on those data that correspond to architecture requirements.

The duties of the architect and the architecture team that create the architecture are further described in more technical language in Volume 2 of DoDAF. The architect supervises development of the architecture, and ensures that the requirements and visual representations of the architecture meet process owner requirements and ensures that conformance requirements described in this volume and in Volume 2 are met.

DoD Components are expected to conform to DoDAF in development of architectures within the Department. Conformance ensures that reuse of information, architecture artifacts, models, and viewpoints can be shared with common understanding.

DoDAF conformance is achieved when:

- The data in a described architecture is defined according to the DoDAF Meta-model (DM2) concepts, associations, and attributes
- The architecture data is capable of transfer in accordance with the Physical Exchange Specification (PES)
  - The mapping of the DM2 Concepts, Associations, and Attributes to each DoDAF-described Model is listed in Table B-1, “DM2 Concepts (Classes, Aliases, and Composite Terms) Mapping to DoDAF Models” in Volume 2 indicates the related metadata in the PES.

DoDAF V2.0 focuses on architectural data, rather than on developing individual products as described in previous versions. In general, data can be collected, organized, and stored by a wide range of architecture tools developed by commercial sources. It is anticipated that these tools will adopt the DM2 PES for the exchange of architectural data.

A Data Capture Method for each data group of the DM2 is provided in Volume 2 to guide architects in collecting and organizing the necessary architectural data.

The DoDAF enables architectural content to be built that is "Fit-for-Purpose", defined and described in Volume 1 as an Architectural Description consistent with specific project or mission objectives. Because an Architectural Description can be applied at myriad levels of an enterprise, the purpose or use of an Architectural Description at each level will be different in content, structure, and level of detail. Tailoring the Architectural Description development to address specific, well-articulated, and understood purposes, will help ensure the necessary data is collected at the appropriate level of detail to support specific decisions or objectives.

Visualizing architectural data is accomplished through ***models*** (e.g., the products described in previous versions of DoDAF). Models (which can be documents, spreadsheets, dashboards, or other graphical representations) serve as a template for organizing and displaying data in a more easily understood format. When data is collected and presented in this way, the result is called a ***view***. Organized collections of views (often representing processes, systems, services, standards, etc.) are referred to as ***viewpoints,*** and with appropriate definitions are collectively called the ***Architectural Description.***

DoDAF V2.0 discusses DoDAF-described Models and Fit-for-Purpose Views:

- ***DoDAF-described Models (also referred to as Models)*** are created from the subset of data for a particular purpose and are fully explained in DoDAF V2.0, Volume 2. Once the DoDAF-described Models are populated with data, these "views" are useful as examples for presentation purposes, and can be used as described, modified, or tailored as needed.
- ***Fit-for-Purpose Views*** are user-defined views of a subset of architectural data created for some specific purpose (i.e., "Fit-for-Purpose"). While these views are not described or defined in DoDAF, they can be created, as needed, to ensure that presentation of architectural data is easily understood within an agency. This enables agencies to use their own established presentation preferences in their deliberations.

The Models described in DoDAF, including those that are legacy products from previous versions of the Framework, are provided as pre-defined examples that can be used when developing presentations of architectural data.

DoDAF is prescribed for the use and development of Architectural Descriptions in the Department. Specific DoDAF-described Models for a particular purpose are prescribed by process-owners. All the DoDAF-described Models do not have to be created. DoDAF V2.0 is "Fit-for-Purpose", based on the decision-maker needs. DoDAF concentrates on data as the necessary ingredient for architecture development. If an activity model is created, a necessary set of data for the activity model is required. Key process owners will decide what architectural data is required, generally through DoDAF-described Models or Fit-for-Purpose Views. However, other regulations and instructions from the DoD and the Chairman, Joint Chiefs of Staff (CJCS) have particular presentation view requirements. These views are supported by DoDAF V2.0, and should be consulted for specific view requirements. The architectural data described in DoDAF V2.0 can support many model and view requirements and the regulations and instructions should be consulted for those specific requirements.

The architect and stakeholders select views to ensure that the Architectural Descriptions will support current and future states of the process or activity under review. Selecting Architecture Viewpoints carefully ensures that the views adequately frame concerns, e.g., by explaining the requirements and proposed solutions, in ways that enhance audience understanding.

DoDAF also serves as the principal guide for development of integrated architectures as defined in DoD Instruction 4630.8[1], which defines an integrated architecture as "*An architecture consisting of multiples views or perspectives facilitating integration and promoting interoperability across capabilities and among integrated architectures"*. The term *integrated* means that data required in more than one instance in architectural views is commonly understood across those views.

The DM2 provides information needed to collect, organize, and store data in a way easily understood. The presentation description of various types of views in Volumes 1 and 2 provide the guidance for developing graphical representations of that data that is useful in defining acquisition requirements under the DoD Instruction 5000-series.

The DM2 replaces the Core Architecture Data Model (CADM) which supported previous versions of the DoDAF. DM2 is a data construct that facilitates reader understanding of the use of data within an architecture document. CADM can continue to be used in support of architectures created in previous versions of DoDAF.

DoDAF V2.0 is a marked change from earlier versions of Command, Control, Communications, Computers, and Intelligence Surveillance Reconnaissance Architecture Framework (C4ISRAF)

[1] *Department of Defense Instruction 4630.8, Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)* 30 June 2004. Office of the Assistant Secretary of Defense (Networks & Information Integration) (NII)/ DoD Chief Information Officer (DoD CIO). The current version is found at: www.dtic.mil/whs/directives/corres/pdf/463008p.pdf

or DoDAF, in that architects now have the freedom to create enterprise architectures to meet the demands of their customer requirements. The central core of DoDAF V2.0 is a data-centric approach where the creation of architectures to support decision-making is secondary to the collection, storage, and maintenance of data needed for efficient and effective decisions. The architect and stakeholders select views to ensure that architectures will explain current and future states of the process or activity under review. Selecting architectural views carefully ensures that the views adequately explain the requirement and proposed solution in ways that will enhance audience understanding.

DoDAF V2.0 also provides, but does not require, a particular methodology in architecture development. Volume 1 contains numerous examples of how to utilize the DoDAF methodology either alone, or in conjunction with other methods. Volume 1 provides guidance and suggestions on how to ensure that other proposed methods can be adapted as needed to meet the DoD requirements for data collection and storage. Similarly, the views presented in DoDAF are examples, intended to serve as a possible visualization of a particular view. DoDAF V2.0 also continues providing support for views (i.e., 'products' developed in previous versions of the Framework). These views do not require any particular graphical design by toolset vendors.

DoDAF V2.0 is composed of three volumes, along with an electronic DoDAF Journal currently hosted on Defense Knowledge Online, *https://www.us.army.mil/suite/page/454707*. Together, these volumes and the DoDAF Journal provide a resource enabling users to access the DoD's entire body of knowledge associated with architecture.

- **Volume 1** provides general guidance for development, use, and management of DoD architectures. This volume is designed to help non-technical users understand the role of architecture in support of major decision support processes. Volume 1 provides a 6-step methodology (Section 7) that can be used to develop architectures at all levels of the Department, and a Conceptual Data Model (CDM) (Section 9) for organizing data collected by an architecture effort.
- **Volume 2** describes the construct of architectures, data descriptions, data exchange requirements, and examples of their use in developing architectural views in technical detail, to include the development and use of service-oriented architecture (SOAs) in support of Net-centric operations. Volume 2 provides a Logical Data Model (LDM), based on the CDM, which describes and defines architectural data; further describes the methods used to populate architectural views, and describes how to use the architectural data in DoDAF-described Models, or in developing Fit-for-Purpose Views that support decision-making.
- **Volume 3** relates the CDM structure with the LDM relationships and associations, along with business rules described in Volume 2 to introduce a PES, which provides the constructs needed to enable exchange of data among users and COIs. ***NOTE: DoDAF V2.0 does NOT prescribe a Physical Data Model (PDM), leaving that task to software developers who will implement the principles and practices of DoDAF in their own software offerings.***
- **The DoDAF Journal**, *https://www.us.army.mil/suite/page/454707*, is the electronic interface for DoDAF support. The DoDAF Journal provides a place for submitting future change requests to DoDAF or the DM2 (Section 9); provides examples referenced in the various DoDAF volumes, and includes descriptions of other best practices, lessons learned, and

reference documents that supplement the information contained in the three volumes of DoDAF V2.0, including:

- DoDAF Architecture Development Process for the Models
- DoDAF Product Development Questionnaire & Analysis Report
- DoDAF V2.0 Meta-model Data Dictionary

In DoDAF V2.0, data leans heavily on the major areas of change within the Department, including the Joint Capabilities Integration and Development System (JCIDS), the Defense Acquisition System (DAS), Systems Engineering (SE), the Planning, Programming, Budgeting, and Execution (PPBE) Process, and Portfolio Management (PfM). These major processes produce far-reaching change across all Military Departments, Agencies, the Joint Staff, and other Departmental functions. Architectures developed utilizing the guidance in DoDAF demonstrate how change is documented and executed through an architecturally based approach that:

- Establishes and documents scope and boundaries.
- Documents best practices.
- Defines and describes generic performance measures (metrics).
- Documents and describes potential solutions for management review and approval.

DoDAF V2.0 is organized to facilitate the organization, and maintenance of data collected in an architectural development effort. The data centric approach facilitates both the production of multiple custom views of the architecture and continuing requirements to produce integrated architectures made up of traditional DoDAF views. This approach supports Departmental programs, such as Business Transformation Agency (BTA), JCIDS, and other major functions with significant impact throughout the Department that have developed requirements for multiple, custom views beyond the customary operational, systems, and technical views contained in previous versions of DoDAF and is also consistent with DoDI 4630.8 requirements for integrated architectures. These customized views, and the models that utilize the data, enable the architecture information to be communicated to, and understood by, stakeholders in diverse functional organizations. Products developed under previous versions of DoDAF continue to be supported, as described in Volume 2.

DoDAF data can be collected, organized, and stored by a wide range of architecture tools developed by commercial sources. Visualization of views in DoDAF V2.0 is for illustration purposes only. There may be multiple techniques that can be employed creating architectural models in differing views.

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1. INTRODUCTION

DoDAF V2.0 is the overarching, comprehensive framework and conceptual model enabling the development of architectures to facilitate DoD managers at all levels to make key decisions more effectively through organized information sharing across Department, Joint Capability Areas (JCAs), Component, and Program boundaries. DoDAF V2.0 focuses on architectural data as information required by key DoD decision makers, rather than on developing individual products. The DoDAF-described Models described in this volume and Volume 2 are used to obtain and visualize data requirements. The framework also enables architecture content to be built that is "Fit-for-Purpose", as defined and described in Section 1.4. DoDAF is one of the principal pillars supporting the responsibilities Department of Defense Chief Information Officer (DoD CIO) in exercise of his responsibilities for development and maintenance of architectures required under the Clinger-Cohen Act. DoDAF also explains guidance from OMB Circular A-130 and other appropriate DoD directives and instructions; this version of the Framework also provides guidance on the development of architectures supporting the development of Net-centric services within the Department.

DoDAF also serves as the principal guide for development of integrated architectures, as defined in DoD Instruction 4630.8[2], which states: *"An architecture consisting of multiple views or perspectives facilitating integration and promoting interoperability across capabilities and among integrated architectures"*. The term integrated means that data utilized in more than one instance in the architectural views is commonly understood across those views.

The OMB annually evaluates agency efforts to improve performance in strengthening the quality and usefulness of information technology investments requested by agencies through well-organized strategic decisions relating to investments and PfM. This process evaluates the use of enterprise and segment architectures, discussed in Section 3 of this document, as a principal means of ensuring mission requirements are met, while achieving savings and cost avoidance goals. Each agency is required to adopt an architecture framework—either existing or created within the agency for that purpose. DoDAF is the designated architecture framework with the DoD for architecture development.

The DM2 is a data model that provides information needed to collect, organize, and store data or derived information in a way easily understood. The descriptions of DoDAF-described Models in Volumes 1 and 2 provide guidance on how to develop graphical representations of that data and derived information that will be useful in defining acquisition requirements under the DoD Instruction 5000 series.

DoD managers, as process owners and/or decision-makers, specify the requirements, and control the development of architectures, as described in this volume, within their areas of authority and responsibility. In that role, they select an architect, and an architecture development team to create the architecture in accordance with the requirements defined by the manager (process

[2] Department of Defense Instruction 4630.8, Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS) 30 June 2004. Office of the Assistant Secretary of Defense (Networks & Information Integration) (NII)/ DoD Chief Information Officer (DoD CIO). The current version is found at: www.dtic.mil/whs/directives/corres/pdf/463008p.pdf

owner). As described in Volume 1, the architecture concentrates on those data that correspond to architecture requirements.

The duties of the architect and the architecture team that create the architecture are supported by Volume 2 of DoDAF. The architect supervises development of the architecture, and ensures that the requirements and visual representations of the architecture meet process owner requirements.

1.1 Vision for DoDAF V2.0

The vision for utilization of DoDAF is to:

- Provide an overarching set of architecture concepts, guidance, best practices, and methods to enable and facilitate architecture development in support of major decision support processes across all major Departmental programs, Military components, and Capability areas that is consistent and complementary to Federal Enterprise Architecture Guidance, as provided by OMB.
- Support the DoD CIO in defining and institutionalizing the Net-Centric Data Strategy (NCDS) and Net-Centric Services Strategy (NCSS) of the Department, to include the definition, description, development, and execution of services and through introduction of SOA Development.
- Focus on architectural data as information required for making critical decisions rather than emphasizing individual architecture products. Enable architects to provide visualizations of the derived information through combinations of DoDAF-described Models, and Fit-for-Purpose Views commonly used by decision-makers, enabling flexibility to develop those views consistent with the culture and preferences of the organization.
- Provide methods and suggest techniques through which information architects and other developers can create architectures responsive to and supporting Departmental management practices.

1.2 DoDAF V2.0 Organization and Intended Audience

DoDAF V2.0 is presented in three volumes, along with an electronic DoDAF Journal. Together, these volumes provide a resource enabling users to understand and access DoD's entire body of knowledge associated with architecture.

DoDAF Volume 1 – Introduction, Overview, and Concepts. **(Primary audience: Executives, Project Directors, & Managers)** Volume 1 introduces DoD architecture concepts and provides general guidance for development, use, and management of DoD architectures. This volume is intended to help non-technical users understand the role of architecture in support of major decision support processes. Volume 1 provides a 6-step methodology (Section 7) that can be used to develop architectures at all levels of the Department, and a CDM (Section 9) for organizing data and derived information collected by an architecture effort.

Volume 1 contains the following resources:

- An overview and vision for DoDAF in Section 1.
- Defining "Fit-for-Purpose" Architectures in Section 2.
- An overview of the Framework, DoDAF-based architecture development guidelines, and the historical background for DoDAF in Section 3.
- An Introduction to Enterprise Architecture, Federated Architecting, and Architecture Enterprise Services, and an introduction to the Federal Enterprise Architecture published by the OMB in Section 4.
- An overview for architecture planning in Section 5.
- Addressing customer requirements in architecture development in Section 6.
- Methodology for architecture development in Section 7.
- Presentation methods and graphical views in Section 8.
- The DM2 Conceptual View in Section 9.
- Analytics in support of architecture-based management analysis section 10.
- Guidance on configuration management (CM) of architectures, and the CM process for DoDAF in Section 11.
- Inter-relationships among DoDAF and other architecture frameworks in Section 12.

DoDAF Volume 2 – Architectural Data and Models. (Primary Audience: architects, program managers, portfolio managers, and other technically oriented architecture users) Volume 2 describes the Meta-model data groups, and their associated models, introduced in Volume 1, from a technical viewpoint.

Volume 2 is organized as follows:

- Introduction in Section 1.
- Meta-model Data Groups in Section 2. Twelve data groups are described in Volume 2, and each is defined by the following attributes:
  - Associated Data
  - Data Collection Method
  - Use
- DoDAF Viewpoints and Models in Section 3.

Appendices contain acronyms, DoDAF Model Support, and references. Volume 2 references the DoDAF Journal for the DoDAF V2.0 Meta-model Data Dictionary which describes the DoDAF LDM, and the DoDAF Architecture Development Process for the Models. The LDM provided introduces the relationships and associations needed by data modelers and technical designers.

Within DoDAF, the reference to data refers to the architectural data that an Architectural Description needs to capture. As an exception, in Volume 2, Section 2.3, Information and Data and Volume 2, Section 3.1.3, Data and Information Viewpoint, the discussions describes the architectural data and the data that is being captured to populate the models for the solution. The architectural data may be the resource flows, but the solution data is the specific attributes of an instance of a resource flow for a given solution, e.g., the information that needs to capture the Latitude within a Cursor on Target message.

DoDAF Volume 3 – DM2 PES. Volume 3 introduce a PES that relates the CDM structure, LDM relationships, associations, and business rules as described in Volume 2, The PES provides the constructs needed to enable exchange of data and derived information among users and COIs.

NOTE: DoDAF V2.0 does NOT prescribe a PDM, leaving that task to the software developers who will implement the principles and practices of DoDAF in their own software offerings.

DoDAF Journal. The DoDAF Journal, *https://www.us.army.mil/suite/page/454707*, the electronic interface for DoDAF support, provides a place for submitting future change requests to DoDAF or the DM2, and provides the examples referenced in the various DoDAF volumes. The Journal is a community of interest based discussion board. The Journal also includes descriptions of other best practices, lessons learned, and reference documents that supplement the information contained in the three volumes of DoDAF V2.0. The Journal has two parts:

- The first part describes the DoDAF CM Process, and provides the means to submit, review, and comment on the adjudication of formal changes to DoDAF. This part is intended to apply to all audiences who would like to propose changes to and keep up to date with the details of the DoDAF.
- The second part is a Community of Interest reference of best practices, examples, and templates, which can be used in projects where DoDAF is used to develop and execute process change through architecture development. This part is geared to architects, developers, program managers, and portfolio managers. Part 2 is organized in the same structure as the volumes of DoDAF.

A quick reference guide and tutorial on the use of DoDAF and the DoDAF Journal is also under development. Definitions of terms, acronyms, and other useful data, to include a bibliography are found in the appendices of this volume.

1.3 Purpose and Scope

The DoDAF provides the guidance needed to establish a common vocabulary for architecture development, for the exchange of architecture information, and for facilitating interoperability between Architectural Descriptions. Architectures are created for a number of reasons.

From a compliance perspective, DoD development of architectures is compelled by law and policy (i.e., Clinger-Cohen Act, Office of Management, and Budget (OMB) Circular A-130). From a practical perspective, the management of large organizations employing sophisticated systems, technologies, and services in pursuit of often complex joint missions demands a structured, repeatable method for evaluating investments and investment alternatives, as well as the ability to implement organizational change effectively, create new systems, deploy new technologies, and offer services which add value to decisions and management practices.

Guidance provided by DoDAF V2.0 applies to all architectures developed, maintained, and used within the DoD. The DoDAF also provides the foundational constructs to support the concept of *architecture federation* at each tier, enabling the sharing of all pertinent architecture information, and facilitates creation of the federated version of the DoD Enterprise Architecture.

DoDAF V2.0 provides guidance in all areas of the architecture lifecycle, consistent with both DoD and OMB Guidance (i.e., Development, Maintenance, and Use of Architectures)[3]. It is the foundation for long-term administration and management of architectural data, and its accompanying models (templates), views, and consolidated viewpoints that compose the presentation capability of an architecture.

DoDAF V2.0 also supports the concept of SOA development. Volume 1 provides management guidance on development of architectural views and viewpoints, based on service requirements. Volume 2 provides the technical information needed, data views, and other supporting resources for development of services-based architectures.

1.3.1 Developing Architectures

Careful scoping and organization by managers of the architecture development effort focuses on areas of change indicated by policy or contract in support of the stated goals and objectives. A data-centric, rather than product-centric, architecture framework ensures concordance across architectural views (i.e., that data in one view is the same in another view when talking about the same exact thing , such as an activity), enables the federation of all pertinent architecture information, and provides full referential integrity (that data in one view is the same in another view when talking about the same exact thing , such as an activity) through the underlying data to support a wide variety of analysis tasks. Logical consistency of the data thus becomes a critical 'property' of architectures of all types as described more fully below. The objective of achieving concordance across the architectural view must be included in architecture planning and development actions.

DoDAF V2.0 describes two major types of architectures that contribute to the DoD Enterprise Architecture, the **Enterprise-level architecture** and the **Solution Architecture**. Each of these architectures serves a specific purpose, as described briefly below, and in more detail in Section 4 of Volume 1:

[3] *Office of Management and Budget (OMB) Circular-A-130, Management of Federal Information Resources*, February 8, 1996. Executive Office of the President, Office of Management and Budget. The current version can be found at: http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html#2

- Enterprise Architectures: A strategic information asset base, which defines the mission, the information necessary to perform the mission, the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to changing mission needs. EA includes a baseline architecture, a target architecture, and a sequencing plan.[4]
- Solution Architectures: A framework or structure that portrays the relationships among all the elements of something that answers a problem.[5] This architecture type is not a part of the DoD Enterprise Architecture, but is used to define a particular project to create, update, revise, or delete established activities in the Department. Solution architecture may be developed to update or extend one or more of the other architecture types. A Solution Architecture is the most common type of architecture developed in the Department. Solution architectures include, but are not limited to, those SOA-based architectures developed in support of specific data and other services solutions.

Instances of Enterprise Architectures include Capability, Segment, Mission Thread, and Strategic Architectures. They are not types of Architecture.

Version 1.0 and 1.5 of the DoDAF used the term 'product' or 'products' to describe the visualizations of architecture data. In this volume, the term 'DoDAF-described Model' is generally used, unless there is a specific reference to the products of earlier versions. For DoDAF-described Models that have been populated or created with architectural data, the term 'Views' is used. The term "Fit-for-Purpose Views" is used when DoDAF described models are customized or combined for the decision-maker's need.

The Models described in DoDAF, including those that are legacy views from previous versions of the Framework, are provided as pre-defined examples that can be used when developing presentations of architecture data. DoDAF does not prescribe any particular models, but instead concentrates on data as the necessary ingredient for architecture development. If an activity model is created, a necessary set of data for the activity model is required. Key process owners will decide what architectural data is required, generally through DoDAF-described Models or Fit-for-Purpose Views. However, other regulations and instructions from both DoD and CJCS have particular presentation view requirements. These views are supported by DoDAF V2.0, and should be consulted for specific view requirements. The architectural data described in DoDAF V2.0 can support many model and view requirements and the regulations and instructions should be consulted for specific model and view requirements.

In general, architecture data and derived information can be collected, organized, and stored by a wide range of tools developed by commercial sources. Creation of various views using these

[4] *Office of Management and Budget (OMB) Circular-A-130, Management of Federal Information Resources*, February 8, 1996. Executive Office of the President, Office of Management and Budget. The current version can be found at: http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html#2

[5] Derived from Joint Pub 1-02 and Merriam-Webster.com.

architecture tools is the typical way an enterprise architect initially captures and represents important architectural data.

Both DoDAF-described Models and Fit-for-Purpose Views (e.g., dashboards, composite, or fusion presentations) created as a part of the architecture development process, which visually render the underlying architectural data, act to facilitate decisions.

1.3.2 Maintaining and Managing Architectures

Embedding architecture development process in routine planning and decision-making institutionalizes the practice and makes the maintenance of architectural data, views, and viewpoints more automatic. Architectures are maintained and managed within the Department through *tiered accountability*. Tiered accountability is the distribution of authority and responsibility for development, maintenance, CM, and reporting of architectures, architecture policy, tools, and related architecture artifacts to all four distinct tiers within the DoD. DoDAF V2.0 supports four tiers: Department, JCA, Component, and Solution (i.e., program or project-level solutions development). These tiers support the federated approach for architecture development and maintenance.

1.3.3 Using Architectures

Architectures are used to support major DoD decision-making processes, including JCIDS, DAS, PPBE, SE, and PfM processes. Other major Departmental processes supported are business process reengineering, organizational development, research and development, operations support, and service-oriented solutions. Architectural data and other derived information, based on process-owner or stakeholder input and review, provides decision makers with the information necessary to support specific decisions in those processes.

1.3.4 DoDAF Conformance

DoD Components are expected to conform to DoDAF to the maximum extent possible in development of architectures within the Department. Conformance ensures that reuse of information, architecture artifacts, models, and viewpoints can be shared with common understanding. Conformance is expected in both the classified and unclassified communities, and further guidance will be forthcoming on specific processes and procedures for the classified architecture development efforts in the Department.

DoDAF conformance is achieved when:

- The data in a described architecture is defined according to the DM2 concepts, associations, and attributes.
- The architectural data is capable of transfer in accordance with the PES.

1.4 What is New in DoDAF V2.0

The major changes for DoDAF V2.0 Volume 1 are:

- The major emphasis on architecture development has changed from a product-centric process to a data-centric process designed to provide decision-making data organized as information for the manager.
- The three major viewpoints of architecture described in previous version (e.g., Operational, Technical, and System) have been changed to more specific viewpoints that relate to the collection of architecture-related data which can be organized as useful information for the manager in decision-making. To support customer requirement and re-organization needs, in Section 3:
  - All the models of data—conceptual, logical, or physical—have been placed into the Data and Information Viewpoint.
  - The Technical Standards Viewpoint has been updated to the Standards Viewpoint and can describe business, commercial, and doctrinal standards, in addition to technical standards.
  - The Operational Viewpoint now can describe rules and constraints for any function (business, intelligence, warfighting, etc.) rather that just those derived from data relationships.
  - Due to the emphasis within the Department on Capability PfM and feedback from the Acquisition community, the Capability Viewpoint and Project Viewpoint have been added.
- Products have been replaced by views that represent specific types of presentation for architectural data and derived information.
- Architecture views are, in turn, organized into viewpoints, which provide a broad understanding of the purpose, objectives, component parts, and capabilities represented by the individual architectural views.
- The Department initiatives for Architecture Federation and Tiered Responsibility have been incorporated into Version 2.0.
- Requirements for sharing of data and derived information in a Federated environment are described.
- Specific types of architecture within the Department have been identified and described (e.g., Department-level [which includes Department, Capability & Component architectures] and Solution Architectures).
- The DoD Enterprise Architecture is defined and described.
- Linkages to the Federal Enterprise Architecture are defined and described.
- Architecture constructs originally described in the UK Ministry of Defence Architecture Framework (MODAF), the NATO Architecture Framework (NAF), and the Open Group Architecture Framework (TOGAF) are adopted for use within DoDAF.
- A DM2, containing a CDM, a LDM, and a PES has been created.
- Approaches to SOA development are described and discussed.

1.5 What DoD Managers and Executives Need to Know About DoDAF

Architecture development is a management tool that supports the decision-making process. A Process owner (an executive responsible for a specific process or program) has the direct responsibility for ensuring that a particular process or program works efficiently, in compliance with legal and departmental requirements, and serves the purpose for which it was created. Periodically a review and evaluation of the efficiency of the program or process is required.

Those requirements for review, to include those detailed in legislation such as the Clinger-Cohen Act and OMB Directive A-130, include the need to create or update an information architecture supporting any budget requests for funding of those projects and processes.

A manager or executive may delegate the responsibility for creation of the architecture to an architect with the professional qualifications needed, along with an architecture development team. However, that delegation of authority does not alter the continuing responsibility of the executive or manager. As described throughout this volume, the decision-maker needs to be actively involved in the architecture development process and support Architectural Description development. Active involvement means that the decision-maker:

- Identifies the Purpose and Scope for the Architecture. The 6-Step Architecture Development Process (depicted in Section 7.1.1 6-Step Architecture Development Process) provides a structure for development of scope and purpose.
- Transmits to the architect and development team the scope and purpose of the architecture effort, along with those goals and objectives that support the need.
- In conjunction with the architect, identifies the general data categories needed for architecture development; assists in data collection and validation.
- Determines desired views and presentation methods for the completed architecture.
- Meets frequently with the architect and development team to ensure that the development effort is on target (i.e., is "Fit-for-Purpose") and provides new direction, as required to ensure that the development effort meets established requirements.

Figure 1.5-1 is a more detailed view of the 6-Step Architecture Process, and depicts the sub-steps that the decision-maker needs to perform in coordination with the architect within the 6-Step Architecture Development Process described in Section 7. In each step, the 'Meta-model Groups' referred to by the step is that data in the Meta-model Groups in DM2 described in this volume, and more technically in volume 2.

The decision-maker generally performs the following functions:

- Reviews the Purpose (Step 1 of the DoDAF Methodology) and Scope (Step 2) with the Architect. In order for the architecture to be "Fit-for-Purpose," the decision-maker needs to provide the list of the categories of data needed and a description of how the data will be used to the Architect. The decision-maker, not the Architect, is the subject matter expert for the problem to be solved, the decision to be made, or the information to be captured and analyzed. The architect is the technical expert who translates the decision-maker's requirements into a set of data that can be used by engineers and analysts to design possible solutions. Determining the data needed and the requirements (Step 3.1) to be applied is an important responsibility for the decision-maker and cannot be delegated to the Architect.
- Reviews the Views, Concepts, Associations, and Attributes that the architect has determined meets the data needs and requirements (Step 3.2). The Models, Concepts, Associations, and Attributes required are determined in the Architect's detailed process (Step 4.1 and 4.2) described in Section 1.6 of Volume 2.

- Assists with data collection, or provides the data needed (Step 4.1) using the architecture collection method described in the Architect's detailed process (Step 4.3) found in section 1.6 of Volume 2. In that step, the architect determines the appropriate collection methods for the "Fit-for-Purpose" needs. Section 2 of Volume 2 contains a Method subsection for each of the Meta-model groups, which provides potential collection methods. Step 3 includes those actions taken to ensure that data integration occurs across all views created as a part of the architecture development effort.
- Verifies with the architect that the data collected meets the need (Step 5.1) described in use-cases to support the analysis that will be performed in Step 5 of the 6-Step Architecture Development Process. The architect has collected the architectural data that will meet the decision-maker's purpose ("Fit-for-Purpose") and support the decision review processes. Section 2 of Volume 2 contains a Use subsection for each of the Meta-model groups, which provides example uses.
- Determines the appropriate views for the "Fit-for-Purpose" needs and support to decision deliberations (Step 6.1). Volume 2, Section 3 contains a DoDAF Viewpoints & Models subsection which describes each of the DoDAF-described Models. This step results in presentation creation in Step 6 of the 6-Step Architecture Development Process.

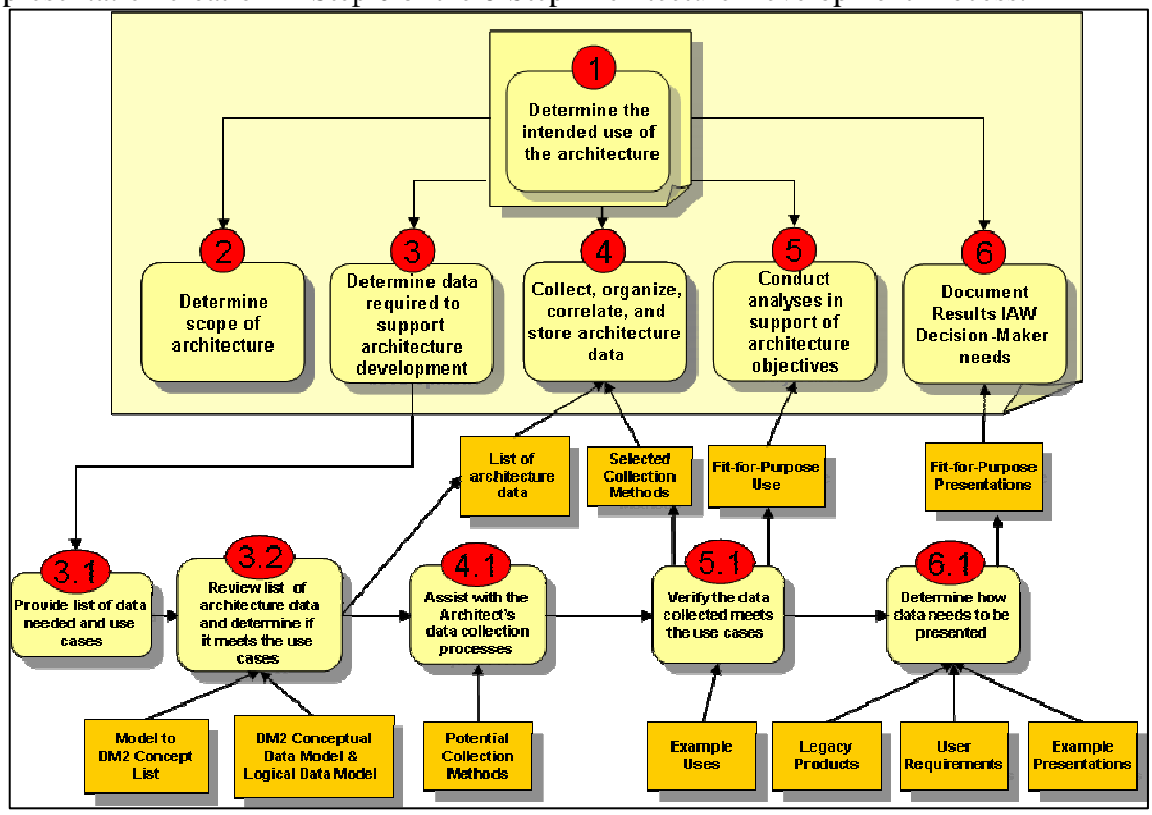

Figure 1.5-1: What the Decision-Maker Needs to Do

Working with the architect and team, the decision-maker has a critical role in ensuring that the architecture not only supports the creation of executable requirements that will achieve the desired outcome, but also that senior executives and managers can view the desired solution in an understandable and logical manner.

2. SCOPING ARCHITECTURES TO BE "FIT-FOR-PURPOSE"

Establishing the scope of an architecture is critical to ensuring that its purpose and use are consistent with specific project goals and objectives. The term "Fit-for-Purpose" is used in DoDAF to describe an architecture (and its views) that is appropriately focused (i.e., responds to the stated goals and objectives of process owner, is useful in the decision-making process, and responds to internal and external stakeholder concerns. Meeting intended objectives means those actions that either directly support customer needs or improve the overall process undergoing change.

The architect is the technical expert who translates the decision-maker's requirements into a set of data that can be used by engineers to design possible solutions.

At each tier of the DoD, goals and objectives, along with corresponding issues that may exist should be addressed according to the established scope and purpose, (e.g., Departmental, Capability, SE, and Operational), as shown in the notional diagram in **Figure 2-1**.

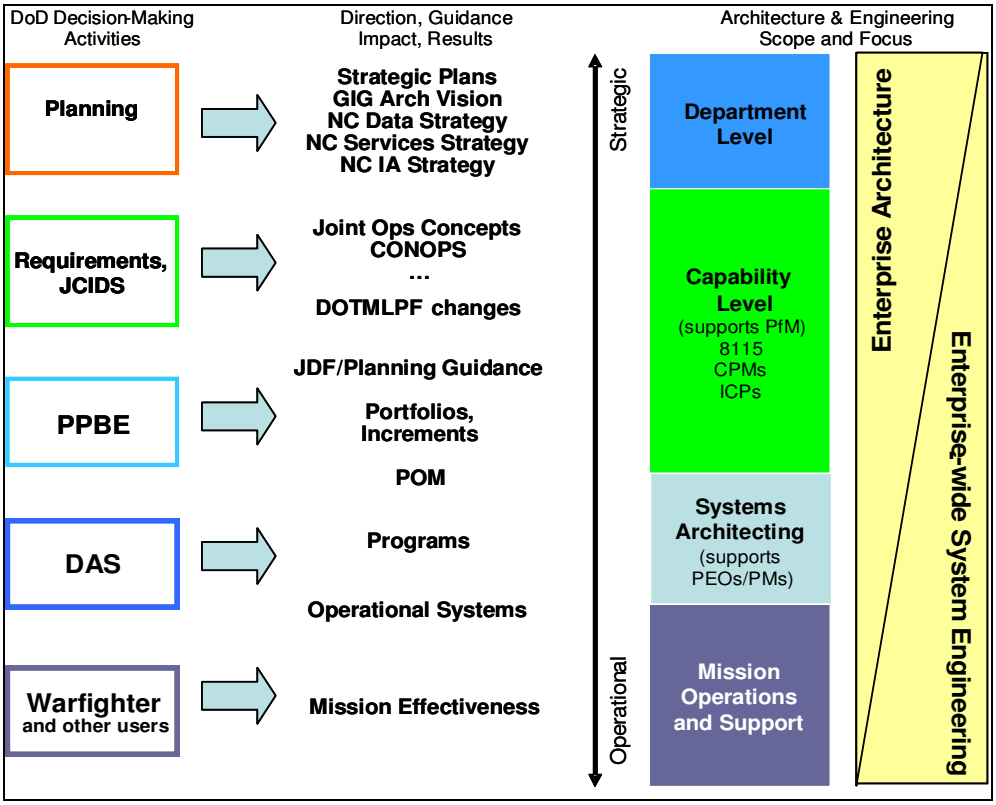

Figure 2-1: Establishing the Scope for Architecture Development

Establishing a scope for an architecture effort at any tier is similarly critical in determining the architecture boundaries (Purpose and Use expected), along with establishing the data categories needed for analysis and management decision-making. Scope also defines the key players whose input, advice, and consensus is needed to successfully architect and implement change (i.e., Stakeholders, both internal and external). Importantly, scope also determines the goals and objectives of the effort, consistent with both boundaries and stakeholders; since goals and

objectives define both the purpose for architecture creation and the level of the architecture. Establishing the scope of an effort also determines the level of complexity for data collection and information presentation.

Architecture development also requires an understanding of external requirements that may influence architecture creation. An architecture developed for an internal agency purpose still needs to be mappable, and consistent with, higher level architectures, and mappable to the DoD EA. For some architecture developments, consideration must be given in data collection and graphical presentation to satisfaction of other external requirements, such as upward reporting and submission of architectural data and models for program review, funding approval, or budget review due to the sensitivity or dollar value of the proposed solution. Volume 2 contains guidance on data collection for specific views required by instruction, regulation, or other regulatory guidance (i.e., Exhibit 53, or Exhibit 300 submissions; OMB Segment architecture reviews, or interoperability requirements).

Architecture scoping must facilitate alignment with, and support the decision-making process and ultimately mission outcomes and objectives as shown in **Figure 2-2**. Architectural data and supporting views, created from organizing raw data into useful information, and collected into a useful viewpoint, should enable domain experts, program managers, and decision makers to utilize the architecture to locate, identify, and resolve definitions, properties, facts, constraints, inferences, and issues, both within and across architectural boundaries that are redundant, conflicting, missing, and/or obsolete. DoDAF V2.0 provides the flexibility to develop both Fit-for-Purpose Views (User-developed Views) and views from DoDAF-described Models to maximize the capability for decision-making at all levels. Figure 2-2 below shows how the development of architectures supports the management decision process. In this case, the example shows how an architecture and the use of it in analysis can facilitate the ability to determine and/or validate mission outcome.

Analysis also uncovers the effect and impact of change (“what if”) when something is redefined, redeployed, deleted, moved, delayed, accelerated, or no longer funded. Having a disciplined process for architecture development in support of analytics will produce quality results, not be prone to misinterpretations, and therefore, be of high value to decision makers and mission outcomes.

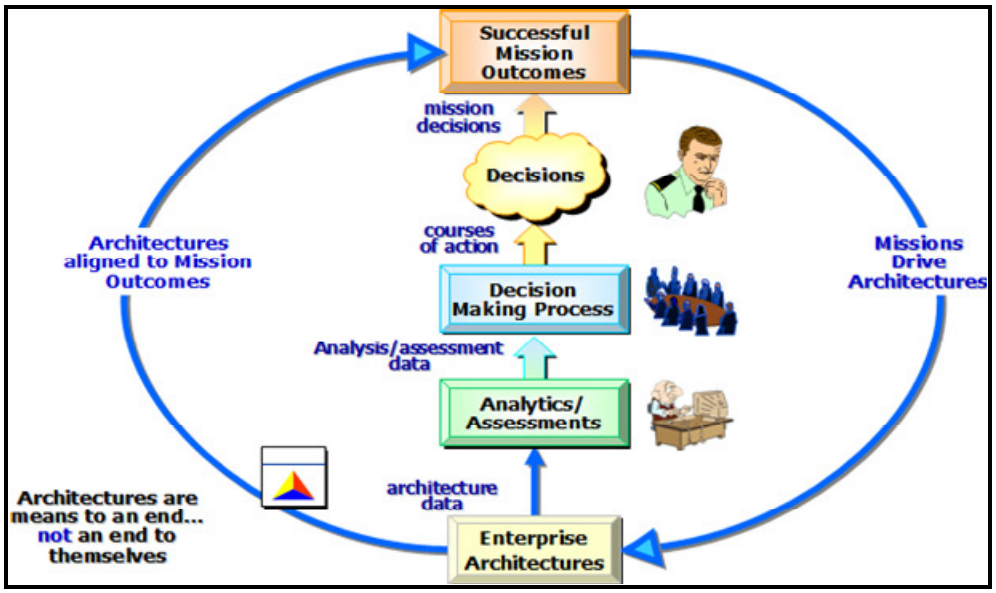

Figure 2-2: Mission Outcomes Supported by Architectures

3. DODAF VOLUMES AND JOURNAL OVERVIEW

Section 3 provides an overview of DoDAF V2.0, both the volumes, and the electronic Journal, and describes the primary reasons for developing and publishing a new version. This section also addresses fundamental principles and guidelines that should be followed when an architecture development effort is initiated. A graphical representation of the breadth and depth of information, users, concepts, and artifacts that can assist in describing an architecture for executives, managers, and other non-technical reviewers and users is also provided.

3.1 DoDAF Overview

DoDAF is the structure for organizing architecture concepts, principles, assumptions, and terminology about operations and solutions into meaningful patterns to satisfy specific DoD purposes. DoDAF offers guidance, principles and direction on communicating business, mission needs and capabilities to managers, architects, analysts, and developers who are responsible for developing and building the necessary services, applications and infrastructure to meet stakeholder needs and to manage their expectations.

Architecture frameworks support change in organizations through building and utilization of architectures that:

- Enhance decision making processes by leveraging knowledge and opportunities for reusing existing information assets.
- Respond to stakeholder, customer, and client needs for effective and efficient processes, systems, services, and resource allocation.
- Provide mechanisms to manage configuration of the current state of the enterprise and maintain validity of the expected performance.
- Facilitate the design of future states of the enterprise.
- Establish a baseline architecture for solutions under development.

In DoDAF V2.0, examples provided lean heavily on the major areas of change within the Department, including the Joint Capabilities Integration and Development System (JCIDS), the Defense Acquisition System (DAS), Systems Engineering (SE), the Planning, Programming, Budgeting, and Execution (PPBE) Process, and Portfolio Management (PfM). These key processes produce far-reaching change across all Military Departments, Agencies, the Joint Staff, and other Departmental functions. Architectures developed utilizing the guidance in DoDAF demonstrates how change is documented, and executed through an architecturally based approach that:

- Establishes and documents scope and boundaries.
- Documents best practices.
- Defines and describes generic performance measures (metrics).
- Documents and describes potential solutions for management review and approval.

Data, organized as information, is the critical element of architecture development. DoDAF V2.0 provides a CDM and LDM, along with a PES in the DM2 for use by data managers, tool vendors, and others to facilitate:

- Establishment of areas of discourse and a shared vocabulary.
- Support for data overlap analysis.
- Define and encourage the use of shared information.
- Provide a target for architectural data integration.

The framework is consistent with, and supports DoD policy directives that require programs and components to (a) ensure that their architectures meet stated objectives and Departmental requirements, and, (b) provide the information necessary to support defined decisions at higher tiers. These policies also require consistency across horizontal architecture boundaries within a tier. The guidance and information contained in these volumes also ensures that, when followed, architecture development is consistent with OMB Enterprise Architecture Guidance.

This version of the DoDAF is written to support the Departmental preference for *federated architecture development in a tiered environment* (Section 4.3). To enable federation and facilitate tiered responsibility and accountability, the framework provides data structures to ensure appropriate touch-points can be compared for consistency across architecture boundaries. Utilization of these data structures ensures that higher tiers have access to data from lower tiers in a form that supports their decision needs. The Framework also includes aids to architects in supporting net-centricity in their architectures and structures that define the management of net-centric architectures (Volume 2).

DoDAF V2.0 also facilitates creation of SOA-based architectures that define solutions specifically in terms of services that can be discovered, subscribed to, and utilized, as appropriate, in executing departmental or joint functions and requirements.

3.2 DoDAF Background

3.2.1 Authority: Law, Policy, and Historic Perspective

The Federal Government has established the importance of using architecture in law, policy, and guidance. Federal law and policies (**Table 3.2.1-1**), have expressed the need for architectures in support of business decisions.

Table 3.2.1-1: Federal Law and Policy

Policy/Guidance	Description
Clinger-Cohen Act of 1996	Recognizes the need for Federal Agencies to improve the way they select and manage IT resources and states, "information technology architecture, with respect to an executive agency, means an integrated framework for evolving or maintaining IT and acquiring new IT to achieve the agency's strategic goals and information resources management goals." Chief Information Officers are assigned the responsibility for "developing, maintaining, and facilitating the implementation of a sound and integrated IT architecture for the executive agency".
E-Government Act of 2002	Calls for the development of Enterprise Architecture to aid in enhancing the management and promotion of electronic government services and processes.
Office of Management and Budget Circular A-130	"Establishes policy for the management of Federal information resources"[6] and calls for the use of Enterprise Architectures to support capital planning and investment control processes. Includes implementation principles and guidelines for creating and maintaining Enterprise Architectures.
OMB Federal Enterprise Architecture Reference Models (FEA RM)	Facilitates cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across Federal Agencies.[7] Alignment with the reference models ensures that important elements of the FEA are described in a common and consistent way.[8] The DoD Enterprise Architecture Reference Models are aligned with the FEA RM.
OMB Enterprise Architecture Assessment Framework (EAAF)	Serves as the basis for enterprise architecture maturity assessments. Compliance with the EAAF ensures that enterprise architectures are advanced and appropriately developed to improve the performance of information resource management and IT investment decision making.
General Accounting Office Enterprise Architecture Management Maturity Framework (EAMMF)	"Outlines the steps toward achieving a stable and mature process for managing the development, maintenance, and implementation of enterprise architecture." Using the EAMMF allows managers to determine what steps are needed for improving architecture management.

[6] *Office of Management and Budget (OMB) Circular-A-130, Management of Federal Information Resources*, February 8, 1996. Executive Office of the President, Office of Management and Budget. The current version can be found at: http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html#2

[7] *Federal Enterprise Architecture (FEA).* Executive Office of the President, Office of Management and Budget E-Gov Initiative. The current version of the FEA, and its associated reference models can be found at: http://www.whitehouse.gov/omb/egov/a-2-EAModelsNEW2.html

[8] *Federal Enterprise Architecture Consolidated Reference Model Version 2.3*. Executive office of the President, Office of Management and Budget (OMB). A current version can be found at: http://www.whitehouse.gov/omb/assets/fea_docs/FEA_CRM_v23_Final_Oct_2007_Revised.pdf

3.2.2 Historical Evolution of DoDAF

The Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture Framework v1.0, dated 7 June 1996, was created in response to the passage of the Clinger-Cohen Act. It replaced the Technical Architecture for Information Management (TAFIM). Version 2.0 of the C4ISR Framework was published on 18 December 1997.

The DoDAF V1.0, dated 30 August 2003 restructured the C4ISR Framework V2.0 and broadened the applicability of architecture tenets and practices to all JCAs rather than just the C4ISR community. DoDAF V1.0 addressed usage, integrated architectures, DoD and Federal policies, value of architectures, architecture measures (metrics), DoD decision support processes, development techniques, analytical techniques, and moved towards a repository-based approach by placing emphasis on architectural data elements that comprise architecture products. DoDAF V1.0 was supported by a CADM which provided for data organization and sharing.

DoDAF V1.5, dated 23 April 2007, was a transitional evolution of the DoDAF V1.0, provided additional guidance on how to reflect net-centric concepts within Architectural Descriptions, included information on architectural data management and federating architectures through the Department, and incorporated the pre-release CADM V1.5, a simplified model of previous CADM. DoDAF V1.5 provided support for net-centricity concepts within the context of the existing set of architectural views and architecture products.

DoDAF V2.0 expands previous framework development efforts to capture architecture information about net-centricity, support Departmental net-centric strategies, and describe service-oriented solutions that facilitate the creation and maintenance of a net-centric environment. DoDAF V2.0 will continue to be updated in the future as it improves its support for the increasing uses of architectural data and its derived information to meet the growing needs of decision makers in a Net-Centric Environment (NCE).

3.2.3 DoDAF V2.0 – The Need for Change

Over time, and as experience with architecture has grown within the Department, it has become obvious that there are two types of architectures. The first and most traditional type is the ***Program Level or Solutions Architecture***. This architecture has been required, defined, and supported by major Departmental processes for solution evaluation, interoperability, and resource allocation. ***Enterprise Architecture,*** the second type of architecture, provides a roadmap for change as well as a context and reference for how and where programs fit within a larger ‘enterprise’ picture. Because of the complex structure and function of the DoD, an enterprise can be defined at the Department level, the JCA level, and the Component level. These ‘tiers’ need architecture content at their level to guide and direct their lower level mission requirements. The JCA and Component tiers are critical to address the high-level capabilities and semantics of a specific JCA or Component within the enterprise so that federation of individual architectural data is possible.

An architecture can represent either a current (i.e., “As-Is” or baseline) viewpoint, or a future, desired (i.e., “To-Be”) viewpoint. When the architecture is a baseline viewpoint, it should

illustrate the enterprise, or a portion of it, as it exists at some point in time. The future state architecture depicts the changes that are desired (whether operational, system/service-centric, or technology-driven) at some future point in time, and the strategies, programs and projects that are employed to achieve the desired transformation[9]. The future view extends beyond details or summaries of operational and systems solutions, and includes program plans, programmatic status reporting, financial and budget relationships, and risk management assessments, along with a transition plan.

DoDAF V2.0 supports the development and use of both solution architectures and enterprise-wide architectures to illustrate the context for change at the capability and component level, and/or the interdependencies among the components or capabilities. Future updates and revisions to DoDAF will extend beyond the solution space to provide standard mechanisms for communicating program plans, financial information, and project status. These future updates will more fully support the ability of managers and executives to evaluate and direct their programs. Without such standards, interdependent programs and projects will continue to be evaluated separately, and managed as individual budgets and consequently as stovepipe solutions. Such an advance in enterprise architecture would facilitate PfM as a whole, help ensure that program direction is coordinated and accountable, and address impact and alternative analysis across programmatic boundaries.

3.2.3.1 Architecture Focus. DoDAF V2.0 focuses on the use of architecture throughout the various tiers of the department as they relate to operational and transformational decision-making processes. Working directly with process owners, through a set of comprehensive workshops, to validate and extend architectural data content, and provide meaningful and useful architectural views for their decision-making, DoDAF V2.0 provides better harmonization of architecture content and process requirements. Additionally, these tailored architectures can be shared and provide insight into best practices that benefit programs, architects, and process owners. Architectural data content also includes data defining generic performance measures (metrics), capabilities, and the relevant PfM data, all of which are analytically useful to process owners and systems engineers.

3.2.3.2 Shifting from Product-Centric to Data-Centric Focus. Both the prior versions of DoDAF and earlier C4ISR versions of the Architecture Framework have emphasized reusable and interoperable data organized into 'products' (e.g., graphical representations or documents). DoDAF V2.0 places its emphasis on utilizing architectural data to support analysis and decision-making, and greatly expands the types of graphical representations that can be used to support decision-making activities. With appropriate architectural data, it is possible to support innovative and flexible presentation of the architectural data in a meaningful, useful, and understandable manner through the views described in Volumes 1 and 2.

3.3 Assumptions

Development of DoDAF V2.0 is guided by several assumptions. These are:

- The DoDAF will continue to evolve to meet the growing needs of decision makers in a NCE.

[9] Derived from OMB Circular A-130 that an enterprise architecture consists of a baseline architecture, a target architecture, and a transition strategy.

- As capability development continues, and Infrastructure continues to mature, architectures will increasingly be a factor in evaluating investments, development, and performance at the various portfolio levels.
- As the DoD increases its use of architectural data and its derived information for decision-making processes, architects will need to understand how to aggregate the data as useful information for presentation purposes at the enterprise level.
- The DoDAF plays a critical role in the development and federation of architectures. It will continue to improve its support for the increasing uses of semantically linked and aligned architectural data.
- Architectural data described in DoDAF is not all-inclusive. Architectures may require additional data, and it is expected that architecture developers at all levels will extend the set of architectural data as necessary.
- Prescription of required architect data sets or views to be included in an architecture is a decision made by process owners based on the purpose of the architecture, not by DoDAF. Some specific minimum architectural data will be described in DoDAF for the exchange of architectural data in the federated environment, and will be included in the architect data set supporting products required by the process owners.

3.4 DoDAF Structure

DoDAF V2.0 is organized around data, models, and views. This approach responds to Departmental programs, such as Business Transformation (BT), JCIDS, and other major functions with significant impact throughout the Department that have developed requirements for multiple, custom views. These views use information based on authoritative data, beyond the operational, systems, and technical views of previous versions of DoDAF, and is consistent with DoD Instruction (DoDI) 4630.8 requirements for integrated architectures. The views are based on models that are templates for collecting specific data within the data categories found in Volume 2, and also those views that may be user-defined to more clearly explain specific data. Models that are populated with architectural data are called views. These customized views enable the information, contained in an architecture, to be communicated to, and understood by, stakeholders in diverse functional organizations. The products developed under previous versions of DoDAF, utilized as views, can continue to be used, and continue to be supported in DoDAF V2.0, as described in Volume 2.

*A **model** is a template for collecting data.*

*A **view** is a representation of a related set of information using formats or models. A View, as described in DoDAF 2.0, is a representation of data in any understandable format. Formats can include any of the presentation styles (such as dashboards, spreadsheets, diagrams, data models, etc.) that convey the meaning of data.*

*A **viewpoint** describes data drawn from one or more perspectives and organized in a particular way useful to management decision-making. More specifically, a **viewpoint definition** includes the information that should appear in individual views; how to construct and use the views (by means of an appropriate schema or template); the modeling techniques for expressing and analyzing the information; and a rationale for these choices (e.g., by describing the purpose and intended audience of the view).*

ISO 42010, 15 July 2007, defines an Architectural Description as "A collection of products to document an architecture." For DoDAF V2.0, the definition of an Architectural Description is "a collection of views to document an architecture."

The definitions above are derived from International Standards[10] on Architectural Description and definition. While DoDAF is not completely conformant with those documents, due primarily to the broad perspective of Architectural Description development within the Department, it is the aim of DoDAF development to pursue and achieve conformance over time.

3.4.1 Architectural Data

Architectural data provides for more efficient and flexible use and reuse of the Architectural Description, enabling broader utility for decision makers and process owners. This version of DoDAF emphasizes the collection, organization, and maintenance of architectural data and derived information, as opposed to development of products in previous versions. A technical description of the underlying data can be found in DoDAF Volume 2.

[10] International Standards Organization (ISO) Standard 15407:200x, *Industrial Automation Systems – Reference base for enterprise architecture and models*, dated 10 January 2009; International Standards Organization (ISO) Standard 42010, *Systems and Software Engineering – Architecture Description*, dated 16 January 2009.

NOTE: DoDAF data can be collected, organized and stored by a wide range of architecture tools developed by commercial sources. Visualization of views, as shown in DoDAF V2.0 is for example purposes only. It should be understood, however, that the creation of a limited set of models, using a range of architecture tools developed by commercial sources, is the typical way an enterprise architect initially captures and collects important architectural data. These models are commonly produced by architects. Development of architectural views is accomplished by collecting and organizing architectural data that must be clearly mapped to the underlying DoDAF Conceptual and Logical Data Models in a standard and consistent way, to capture interoperable architectural data, and to achieve the goal of a federated approach to architecture management.

There is no single, correct way to visualize any view, although the examples present those that are commonly used in the DoD communities. The critical factor in 'conforming' to DoDAF practice is that the data represented by the graphical representation is consistent with or mappable to the DoDAF Conceptual and Logical Data models, and the PES described in these volumes.

3.4.2 Architecture Viewpoints and DoDAF-described Models

An architecture viewpoint is a selected set of architectural data that has been organized to facilitate visualization in an understandable way. An Architectural Description can be visualized in a number of formats, such as dashboard, fusion, textual, composite, or graphics, which present data and derived information collected in the course of the development of an Architectural Description. A view is only a presentation of a portion of the architectural data, in the sense that a photograph provides only one view of the object within the picture, not the entire representation of that object. **Figure 3.4.2-1** provides a graphical representation of the architecture viewpoints in DoDAF V2.0.

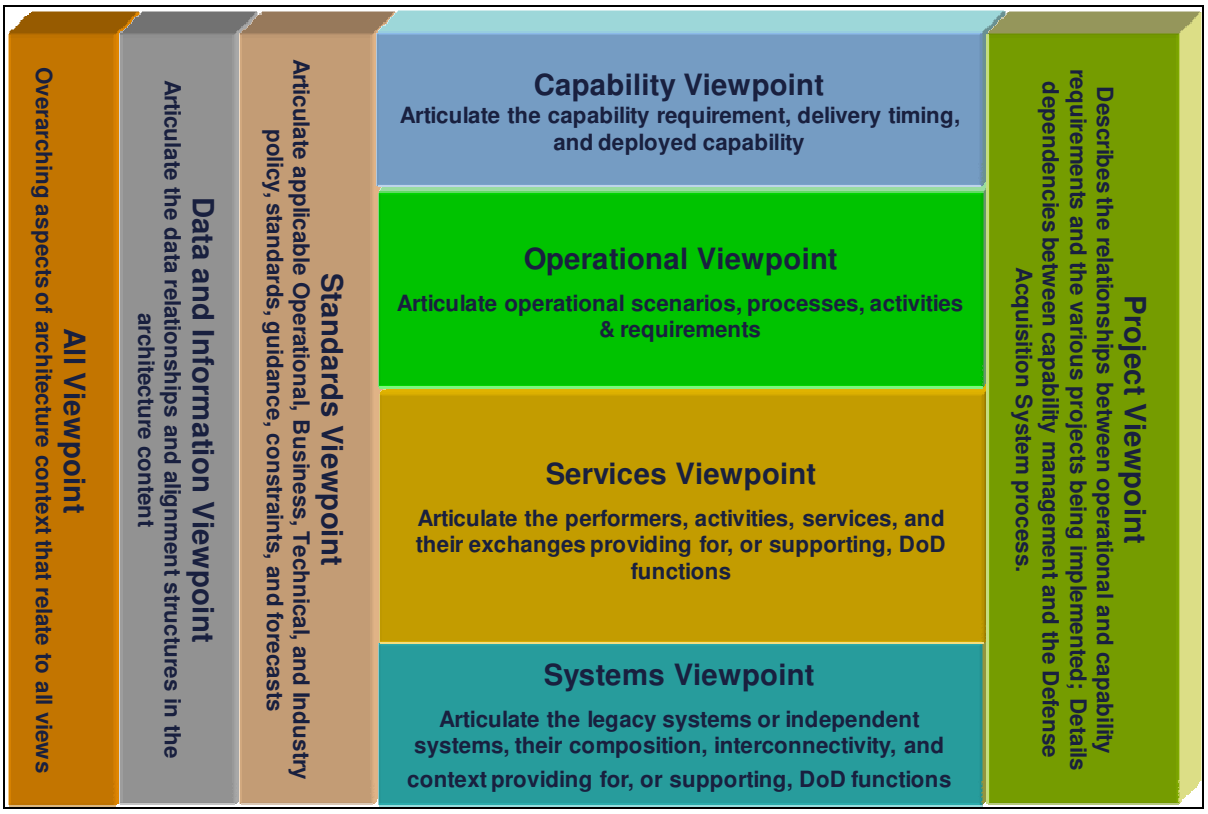

Figure 3.4.2-1: Architecture Viewpoints in DoDAF V2.0

3.4.2.1 All Viewpoint. Some overarching aspects of an Architectural Description relate to all the views. The All Viewpoint (AV) models provide information pertinent to the entire Architectural Description, such as the scope and context of the Architectural Description. The scope includes the subject area and time frame for the Architectural Description. The setting in which the Architectural Description exists comprises the interrelated conditions that compose the context for the Architectural Description. These conditions include doctrine; tactics, techniques, and procedures; relevant goals and vision statements; concepts of operations (CONOPS); scenarios; and environmental conditions.

3.4.2.2 The Capability Viewpoint. The Capability Viewpoint (CV) captures the enterprise goals associated with the overall vision for executing a specified course of action, or the ability to achieve a desired effect under specific standards and conditions through combinations of means and ways to perform a set of tasks. It provides a strategic context for the capabilities described in an Architectural Description, and an accompanying high-level scope, more general than the scenario-based scope defined in an operational concept diagram. The models are high-level and describe capabilities using terminology, which is easily understood by decision makers and used for communicating a strategic vision regarding capability evolution.

3.4.2.3 The Data and Information Viewpoint. The Data and Information Viewpoint (DIV) captures the business information requirements and structural business process rules for the Architectural Description. It describes the information that is associated with the information exchanges in the Architectural Description, such as attributes, characteristics, and inter-

relationships. Data is described fully in Volume 2. Where appropriate, the data captured in the models of this Viewpoint needs to be considered by COIs.

3.4.2.4 The Operational Viewpoint. The Operational Viewpoint (OV) captures the organizations, tasks, or activities performed, and information that must be exchanged between them to accomplish DoD missions. It conveys the types of information exchanged, the frequency of exchange, which tasks and activities are supported by the information exchanges, and the nature of information exchanges.

3.4.2.5 The Project Viewpoint. The Project Viewpoint (PV) captures how programs are grouped in organizational terms as a coherent portfolio of acquisition programs. It provides a way of describing the organizational relationships between multiple acquisition programs, each of which are responsible for delivering individual systems or capabilities.

3.4.2.6 The Services Viewpoint. The Services Viewpoint (SvcV) captures system, service, and interconnection functionality providing for, or supporting, operational activities. DoD processes include warfighting, business, intelligence, and infrastructure functions. The SvcV functions and service resources and components may be linked to the architectural data in the OV. These system functions and service resources support the operational activities and facilitate the exchange of information.

3.4.2.7 The Standards Viewpoint. The Standards Viewpoint (StdV) is the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements. Its purpose is to ensure that a system satisfies a specified set of operational requirements. The StdV provides the technical systems implementation guidelines upon which engineering specifications are based, common building blocks established, and product lines developed. It includes a collection of the technical standards, implementation conventions, standards options, rules, and criteria that can be organized into profile(s) that govern systems and system or service elements in a given Architectural Description.

3.4.2.8 The Systems Viewpoint. Systems Viewpoint (SV) captures the information on supporting automated systems, interconnectivity, and other systems functionality in support of operating activities**. Over time, the Department's emphasis on Service Oriented Environment and Cloud Computing may result in the elimination of the Systems Viewpoint.**

3.4.2.9 DoDAF-described Models. The DoDAF-described Models that are available in DoDAF V2.0 are listed in **Table 3.4.2.9-1**. The list provides the possible models and is not prescriptive. The Decision-maker and process owners will determine the DoDAF-described Models that are required for their purposes.

Table 3.4.2.9-1: DoDAF V2.0 Models

Models	Descriptions
AV-1: Overview and Summary Information	Describes a Project's Visions, Goals, Objectives, Plans, Activities, Events, Conditions, Measures, Effects (Outcomes), and produced objects.
AV-2: Integrated Dictionary	An architectural data repository with definitions of all terms used throughout the architectural data and presentations.
CV-1: Vision	The overall vision for transformational endeavors, which provides a strategic context for the capabilities described and a high-level scope.
CV-2: Capability Taxonomy	A hierarchy of capabilities which specifies all the capabilities that are referenced throughout one or more Architectural Descriptions.
CV-3: Capability Phasing	The planned achievement of capability at different points in time or during specific periods of time. The CV-3 shows the capability phasing in terms of the activities, conditions, desired effects, rules complied with, resource consumption and production, and measures, without regard to the performer and location solutions.
CV-4: Capability Dependencies	The dependencies between planned capabilities and the definition of logical groupings of capabilities.
CV-5: Capability to Organizational Development Mapping	The fulfillment of capability requirements shows the planned capability deployment and interconnection for a particular capability phase. The CV-5 shows the planned solution for the phase in terms of performers and locations and their associated concepts.
CV-6: Capability to Operational Activities Mapping	A mapping between the capabilities required and the operational activities that those capabilities support.
CV-7: Capability to Services Mapping	A mapping between the capabilities and the services that these capabilities enable.
DIV-1:Conceptual Data Model	The required high level data concepts and their relationships.
DIV-2: Logical Data Model	The documentation of the data requirements and structural business process (activity) rules. In DoDAF V1.5, this was the OV-7.
DIV-3: Physical Data Model	The physical implementation format of the Logical Data Model entities, e.g., message formats, file structures, physical schema. In DoDAF V1.5, this was the SV-11.
OV-1: High Level Operational Concept Graphic	The high-level graphical/textual description of the operational concept.
OV-2: Operational Resource Flow Description	A description of the resource flows exchanged between operational activities.
OV-3: Operational Resource Flow Matrix	A description of the resources exchanged and the relevant attributes of the exchanges.
OV-4: Organizational Relationships Chart	The organizational context, role or other relationships among organizations.

Table 3.4.2.9-1: DoDAF V2.0 Models

Models	Descriptions
OV-5a: Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in an hierarchal structure.
OV-5b: Operational Activity Model	The context of capabilities and activities (operational activities) and their relationships among activities, inputs, and outputs; Additional data can show cost, performers or other pertinent information.
OV-6a: Operational Rules Model	One of three models used to describe activity (operational activity). It identifies business rules that constrain operations.
OV-6b: State Transition Description	One of three models used to describe operational activity (activity). It identifies business process (activity) responses to events (usually, very short activities).
OV-6c: Event-Trace Description	One of three models used to describe operational activity (activity). It traces actions in a scenario or sequence of events.
PV-1: Project Portfolio Relationships	Describes the dependency relationships between the organizations and projects and the organizational structures needed to manage a portfolio of projects.
PV-2: Project Timelines	A timeline perspective on programs or projects, with the key milestones and interdependencies.
PV-3: Project to Capability Mapping	A mapping of programs and projects to capabilities to show how the specific projects and program elements help to achieve a capability.
SvcV-1 Services Context Description	The identification of services, service items, and their interconnections.
SvcV-2 Services Resource Flow Description	A description of resource flows exchanged between services.
SvcV-3a Systems-Services Matrix	The relationships among or between systems and services in a given Architectural Description.
SvcV-3b Services-Services Matrix	The relationships among services in a given Architectural Description. It can be designed to show relationships of interest, (e.g., service-type interfaces, planned vs. existing interfaces).
SvcV-4 Services Functionality Description	The functions performed by services and the service data flows among service functions (activities)
SvcV-5 Operational Activity to Services Traceability Matrix	A mapping of services (activities) back to operational activities (activities).
SvcV-6 Services Resource Flow Matrix	It provides details of service resource flow elements being exchanged between services and the attributes of that exchange.
SvcV-7 Services Measures Matrix	The measures (metrics) of Services Model elements for the appropriate time frame(s).
SvcV-8 Services Evolution Description	The planned incremental steps toward migrating a suite of services to a more efficient suite or toward evolving current services to a future implementation.

Table 3.4.2.9-1: DoDAF V2.0 Models

Models	Descriptions
SvcV-9 Services Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future service development.
SvcV-10a Services Rules Model	One of three models used to describe service functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.
SvcV-10b Services State Transition Description	One of three models used to describe service functionality. It identifies responses of services to events.
SvcV-10c Services Event-Trace Description	One of three models used to describe service functionality. It identifies service-specific refinements of critical sequences of events described in the Operational Viewpoint.
StdV-1 Standards Profile	The listing of standards that apply to solution elements.
StdV-2 Standards Forecast	The description of emerging standards and potential impact on current solution elements, within a set of time frames.
SV-1 Systems Interface Description	The identification of systems, system items, and their interconnections.
SV-2 Systems Resource Flow Description	A description of resource flows exchanged between systems.
SV-3 Systems-Systems Matrix	The relationships among systems in a given Architectural Description. It can be designed to show relationships of interest, (e.g., system-type interfaces, planned vs. existing interfaces).
SV-4 Systems Functionality Description	The functions (activities) performed by systems and the system data flows among system functions (activities).
SV-5a Operational Activity to Systems Function Traceability Matrix	A mapping of system functions (activities) back to operational activities (activities).
SV-5b Operational Activity to Systems Traceability Matrix	A mapping of systems back to capabilities or operational activities (activities).
SV-6 Systems Resource Flow Matrix	Provides details of system resource flow elements being exchanged between systems and the attributes of that exchange.
SV-7 Systems Measures Matrix	The measures (metrics) of Systems Model elements for the appropriate timeframe(s).
SV-8 Systems Evolution Description	The planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation.
SV-9 Systems Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future system development.
SV-10a Systems Rules Model	One of three models used to describe system functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.

Table 3.4.2.9-1: DoDAF V2.0 Models

Models	Descriptions
SV-10b Systems State Transition Description	One of three models used to describe system functionality. It identifies responses of systems to events.
SV-10c Systems Event-Trace Description	One of three models used to describe system functionality. It identifies system-specific refinements of critical sequences of events described in the Operational Viewpoint.

3.5 DoDAF Development Guidelines

DoDAF V2.0 provides comprehensive and practical guidance for the creation of Architectural Descriptions that provide added value for decision-making at the level of the DoD they are produced. To this end, the framework offers guiding principles in the development of Architectural Descriptions that transcend the tier, level, or purpose of the architecture development, and a logical method for executing the development of Architectural Descriptions for supporting critical decisions within key DoD management and change management processes. The Framework also offers flexibility in approach, toolset utilization, and techniques such as structured analysis, object-oriented, and service-oriented.

3.5.1 Guiding Principles

Guiding principles are high-level concepts, which provide a general roadmap for success in developing Architectural Descriptions under DoDAF V2.0. The principles are:

- **Architectural Descriptions should clearly support the stated objective(s) ("Fit-for-Purpose")**. The framework offers general direction in the development of Architectural Descriptions so that they can support critical decisions within key DoD management and change management processes. While DoDAF V2.0 describes a number of models, based on collected data, diligent scoping of a project and any guiding regulations, instructions, or standard procedures will determine the specific visualization requirements for a particular architectural effort.
- **Architectural Descriptions should be simple and straightforward, but still achieve their stated purpose**. Architectural descriptions should reflect the level of complexity defined by the purpose for their creation. Scoping of a project, as described in Section 7.0 Methodologies, will ensure that the resulting architectural data and derived information, and the views created are consistent with their original purpose.
- **Architectural Descriptions should facilitate, not impede, communications in decision processes and execution**. Creation of Architectural Descriptions is meant to support decision processes and facilitate improvement of procedures and/or technology in the enterprise. Collection of architectural data and creation of views supports the decision-making process, and provides a record to explain critical choices to technical and non-technical managerial staff.
- **Architectural Descriptions should be relatable, comparable, and capable of facilitating cross-architecture analysis**. Most Architectural Descriptions, except perhaps those at the highest levels of DoD or an organization, relate on their boundaries to other external processes and operations. When several processes and/or operations are evaluated, compared,

or cross-referenced, it should be clear how, where, and why data passes among them in similar form.

- **Architectural Descriptions should articulate how data interoperability is achieved among federated Architectural Descriptions**. To enable federation, the framework will provide structures to ensure that horizontal touch-points can be compared for consistency across Architectural Description boundaries. Other mechanisms will ensure that higher tiers have access to data from lower tiers in a form that supports their decision needs. DoDAF utilizes the DM2, and particularly the PES described in Volume 3, as a resource for interoperability. A key element in ensuring interoperability is the effort taken to plan for integration of data across views, Architectural Description boundaries, and is consistent between tiers.
- **Architectural Descriptions should be data centric and tool-agnostic**. The framework assists in the design of structures that meet specific needs depending on the priorities of individual organizations. In particular, the framework calls for the development of integrated, searchable, structured architectural data sets that support analysis targeted to critical decisions. To that end, multiple toolsets, with varying internal rules, techniques, notations, and methods may be used, consistent with the PES.
- **Architectural data should be organized, reusable, and decomposed sufficiently for use by architectural development teams and decision support analysis teams**. Collecting and organizing architectural data for use in decision processes should not be 'over done', that is the depth and breadth of data collected should be sufficient to capture the major processes actions, and not be so broad that the original intent of the architecture project becomes clouded. Whenever possible, data common to other Architectural Descriptions should be used. New data should be created utilizing the structures described in Volumes 2 and 3 so that, when stored in the DoD Metadata Registry (DMR), it becomes discoverable to others with similar requirements.
- **Development of Architectural Descriptions should be guided by the principles and practices of net-centricity to facilitate and support the Net-Centric Strategy of the Department.** Development of Architectural Descriptions should ensure that Architectural Descriptions are developed adhere to net-centric principles, as outlined in the Net-Centric Strategy, and clearly delineate data that must be shared across and between systems or services described in the Architectural Description.

NOTE: It is recognized that not all Architectural Descriptions or architectural data developed by DoD are related to net-centric operations or net-centricity; however, for the majority of Architectural Descriptions developed under the DoDAF, net-centricity is a critical design consideration.

Architectural guiding principles enable and facilitate validation and verification activities that will determine the success of the project, and the ability of the resulting Architectural Descriptions to serve the purpose for which it was created. Guiding principles support the more specific goals and objectives of a project as a roadmap.

3.5.2 Multiple Techniques and Toolsets, Including Structured and Object Oriented Analysis

The framework allows architects to select techniques and toolsets to meet specific needs. While the framework provides examples of the application of both Structured Analysis and Design (SADT) and Object-Oriented Analysis & Design (OOAD) techniques, it mandates neither. The framework explicitly permits any technique that meets the needs of the organization, provides the appropriate architectural data, adheres to the architectural data requirements of parent tiers described further in Section 3, and is capable of producing data that can be shared in a federated environment. A brief section on essential toolset attributes desirable for creation of Architectural Descriptions utilizing DoDAF are contained below in Section 3.5.3.

3.5.3 Essential Toolset Attributes

While DoDAF is toolset agnostic, allowing architects, and Architectural Description development teams to utilize any toolset they desire to create Architectural Descriptions, there are some basic attributes of a toolset needed to ensure that Architectural Descriptions, once registered, are discoverable, sharable, and their data useful to others with similar or derived needs in their own Architectural Description development. These attributes are:

- Capable of utilizing the PES described in Volume 3 to collect, organize, store, and share architectural data.
- Capable of eXtensible Markup Language (XML) data transfer to/from the DMR, and other resources, such as the DoD Architecture Registry System (DARS) for registering architectural data.

3.6 Architecture Resources

A number of architecture resources exist which serve as sources for guidelines that should be consulted while building architectural views. Some of these architecture resources are briefly described in **Table 3.6-1**, with their architectural uses, and their URLs. Additional information is contained in the individual URLs. Some architecture resources require Secret Internet Protocol Router Network (SIPRNET) access.

Table 3.6-1: Architecture Resources

Resource	Description	Architecture Use	URL
Department of Defense Information Enterprise Architecture (DoD IEA)	Defines the key principles, rules, constraints and best practices to which applicable DoD programs, regardless of Component or portfolio, must adhere in order to enable agile, collaborative net-centric operations.	The DoD IEA provides the guidelines and rules that the architect must keep in mind in the architecture development effort.	*http://www.defenselink.mil/cio-nii/cio/diea/*

Resource	Description	Architecture Use	URL
DoD Architecture Registry System (DARS)	DARS is the DoD registry and repository of segment and solution architectures comprising the federated DoD enterprise architecture.	To discover architectures that exist, or may be in development. Depending on the purpose and scope, an architect may search and discover Architectures that overlap the scope and purpose of the architecture effort. To register metadata about architectures that are being developed, or currently exist.	*https://dars1.army.mil*
DoD Information Technology Portfolio Repository (DITPR)	The official unclassified DoD data source for Federal Information Security Management Act (FISMA), E-Authentication, Portfolio Management, Privacy Impact Assessments, the inventory of MC/ME/MS systems, and the registry for systems under DoDI 5000.2.	The Systems metadata from the Architecture can be used to populate DITPR with new or updated information. DITPR can also populate the architecture's Systems metadata, particularly on systems that interface with systems described in the architecture, but are not part of the scope of the architecture.	*https://www.dadms.navy.mil/*
DoD Information Technology Standards and Profile Registry (DISR)	Online repository for a minimal set of primarily commercial IT standards.	The DISR can be used to populate the Standards models (StdV-1 and StdV-2) of the Architecture. Conversely, the Standards Models can identify additional or new standards that need to be added to DISR.	*https://disronline.disa.mil*
Joint C4I Program Assessment Tool (JCPAT)	Formally assess systems and capabilities documents (Initial Capabilities Document, Capability Development Document, and Capability Production Document) for Joint Staff interoperability requirements certification and is the ITS/NSS Lifecycle Repository and the archives.	The ICD, CDD, and CPD contain architecture information. As the architecture development progresses, the collected architecture information can be extracted and reported in the ICD, CDD, and the CPD. In addition, the architecture information can be within with the Enhanced-Information Support Plan (E-ISP) tool, a part of the JCPAT toolset.	*http://jcpat.ncr.disa.smil.mil/JECOweb.nsf*

Resource	Description	Architecture Use	URL
Joint Common System Function List (JCSFL)	A common lexicon of systems/service functionality supporting joint capability. The JCSFL is provided for mapping functions to supported activities and the systems or services that host them. Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 6212.01E prescribes the JCSFL for use in developing a common vocabulary for architecture development.	Use the taxonomy to align or extend system functions within the architecture being developed	*https://us.ar.y.mil/suite/page/419489*
Knowledge Management/ Decision Support (KM/DS)	The KM/DS tool will be used by DoD components to submit documents and comments for O-6 and flag reviews, search for historical information, and track the status of documents.	Supporting the JCIDS approval process, the documents that are necessary for Milestone Decisions have architecture information. As the architecture development progresses, the collected architecture information can be extracted and reported in the required documents.	*https://jrockmds1.js.smil.mil/guestjrcz/gbase.guesthom.*
Metadata Registry	The DoD Metadata Registry and Clearinghouse provides software developers access to data technologies to support DoD mission applications. Through the Metadata Registry and Clearinghouse, software developers can access registered XML data and metadata components, database segments, and reference data tables and related metadata information	The Resource Flows and Physical Schemas from the Architecture can be used to populate the Metadata Registry.	*http://metadata.dod.mil*

Resource	Description	Architecture Use	URL
Naval Architecture Elements Reference Guide (NAERG)	A standard terms of reference for the Navy and Marine Corps. The Architecture Elements represent the critical taxonomies requiring concurrence and standardization for an integrated architecture. They comprise the lexicon for the three views of the architecture framework, the operational (OV), system (SV) and technical standards (TV) views.	The use of the critical taxonomies is a step to ensuring integration of systems within a system of systems and alignment of information technology (IT) functionality to mission and operational needs. The data contained in each element of the Architecture list shall be used for overall architecture framework development, programmatic research, development, and acquisition activities, and related integration and interoperability and capability assessments. It will be updated through review periods to support DoN Program Objective Memorandum (POM) efforts and to reflect changes mandated by DoD, technology improvements, and other factors.	*https://stalwart.spawar.navy.mil/naerg/*
Knowledge Management/ Decision Support (KM/DS)	The KM/DS tool will be used by DoD components to submit documents and comments for O-6 and flag reviews, search for historical information, and track the status of documents.	Supporting the JCIDS approval process, the documents that are necessary for Milestone Decisions have architecture information. As the architecture development progresses, the collected architecture information can be extracted and reported in the required documents.	*https://jrockmds1.js.smil.mil/guestjrcz/gbase.guesthom.*
Metadata Registry	The DoD Metadata Registry and Clearinghouse provides software developers access to data technologies to support DoD mission applications. Through the Metadata Registry and Clearinghouse, software developers can access registered XML data and metadata components, database segments, and reference data tables and related metadata information	The Resource Flows and Physical Schemas from the Architecture can be used to populate the Metadata Registry.	*http://metadata.dod.mil*

Resource	Description	Architecture Use	URL
Naval Architecture Elements Reference Guide (NAERG)	A standard terms of reference for the Navy and Marine Corps. The Architecture Elements represent the critical taxonomies requiring concurrence and standardization for an integrated architecture. They comprise the lexicon for the three views of the architecture framework, the operational (OV), system (SV) and technical standards (TV) views.	The use of the critical taxonomies is a step to ensuring integration of systems within a system of systems and alignment of information technology (IT) functionality to mission and operational needs. The data contained in each element of the Architecture list shall be used for overall architecture framework development, programmatic research, development, and acquisition activities, and related integration and interoperability and capability assessments. It will be updated through review periods to support DoN Program Objective Memorandum (POM) efforts and to reflect changes mandated by DoD, technology improvements, and other factors.	*https://stalwart.spawar.navy.mil/naerg/*
Service Registry	The Service Registry provides enterprise-wide insight, control and leverage of an organization's services. It captures service descriptions and makes them discoverable from a centrally managed, reliable, and searchable location.	The Services metadata from the Architecture effort can be used to populate the Service Registry in the process of developing the solution.	*TBD*
Universal Joint Task List (UJTL)	The Universal Joint Task List from the Chairman of the Joint Chiefs of Staff Manual 3500.04C (CJCSM) serves as a common language and common reference system for joint force commanders, combat support agencies, operational planners, combat developers, and trainers to communicate mission requirements. It is the basic language for development of a joint mission essential task list (JMETL) or agency mission essential task list (AMETL) that identifies required capabilities for mission success.	Use the taxonomy to align or extend operational activities within the architecture being developed.	*http://www.dtic.mil/doctrine/jel/cjcsd/cjcsm/m350004c.pdf*

4. ENTERPRISE ARCHITECTURE

"Today, the encouraging coalescence among leaders is that many enterprise systems have the same architectural approach—although not all express it in the same way. A similar convergence addresses the kinds of techniques, pattern, and designs that are independent of specific application domains, and that enable effective production of responsive, scalable, flexible, and unifiable enterprise applications."[11]

Within DoD, Enterprise Architecture (EA) has been seen for many years as providing product-oriented insight into a wide range of data, programs, and activities, organized through Communities of Interest (COI). The data-centric approach to DoDAF V2.0 is designed to facilitate the reuse and sharing of COI data. Since DoDAF provides the conceptual, logical, and PES but does not otherwise prescribe the configuration of the product composition, architects and stakeholders are free to create their views of data that best serve their needs.

4.1 Introduction and Overview

An Architectural Description is a strategic information asset that describes the current and/or desired relationships between an organization's business, mission and management processes, and the supporting infrastructure. Architectural Descriptions define a strategy for managing change, along with transitional processes needed to evolve the state of a business or mission to one that is more efficient, effective, current, and capable of providing those actions needed to fulfill its goals and objectives. Architectural Descriptions may illustrate an organization, or a part of it, as it presently exists; any changes desired (whether operational or technology-driven); and the strategies and projects employed to achieve the desired transformation. An Architectural Description also defines principles and goals and sets direction on issues, such as the promotion of interoperability, intra-, and interagency information sharing, and improved processes, that facilitate key DoD program decisions.

Such support extends beyond details or summaries of operational and systems solutions, and includes program plans, programmatic status reporting, financial and budget relationships, and risk management. In addition to detailed views of individual solutions, the framework supports the communication of enterprise-wide views and goals that illustrate the context for those solutions, and the interdependencies among the components. Beyond the solution space, standard mechanisms for communicating program plans, financial information, and project status are established so that executives and managers can evaluate and direct their programs.

The DoD EA is an Architectural Description that is an enterprise asset used to assess alignment with the missions of the DoD enterprise, to strengthen customer support, to support capability portfolio management (PfM), and to ensure that operational goals and strategies are met. The DoD EA is shown in **Figure 4.1-1**. It is comprised of DoD architecture policy, tools, and standards, DoD-level Architectural Descriptions like the DoD Information Enterprise Architecture (DoD IEA), DoD-level Capability Architectural Descriptions, and Component Architectural Descriptions. Its purposes are to guide investment portfolio strategies and decisions, define capability and interoperability requirements, provide access to Segment

[11] McGovern, James, Ambler, Scott, Stevens, Michael E., Linn, James, Sharan, Vikas & Jo, Elias K. (2004) A Practical Guide to Enterprise Architecture. New Jersey: Prentice-Hall. 306pp.

architecture information, to establish and enforce standards, guide security and information assurance requirements across the Department of Defense, and provide a sound basis for transition from the existing DoD environment to the future. The DoD EA is a federation of Architectural Descriptions with which Solution Architectural Descriptions must conform. . Its content includes but is not limited to rules, standards, services and systems lifecycle information needed to optimize and maintain a process, or part of a process that a self-sufficient organization wants to create and maintain by managing its IT portfolio. The DoD EA provides a strategy that enables the organization to support its current operations while serving as the roadmap for transitioning to its target environment. Transition processes include an organization's PfM, PPBE, and EA planning processes, along with services and systems lifecycle methodologies.

The JCA portfolios describe future, required operational, warfighting, business, and Defense intelligence capabilities, together with the systems and services required. They provide the organizing construct for aligning and federating DoD EA content to support the Department portfolio management structure. The description of the future DoD operating environment and associated capability requirements represent the target architecture of the DoD EA. These are time-phased as determined by functional owners and JCA developers.

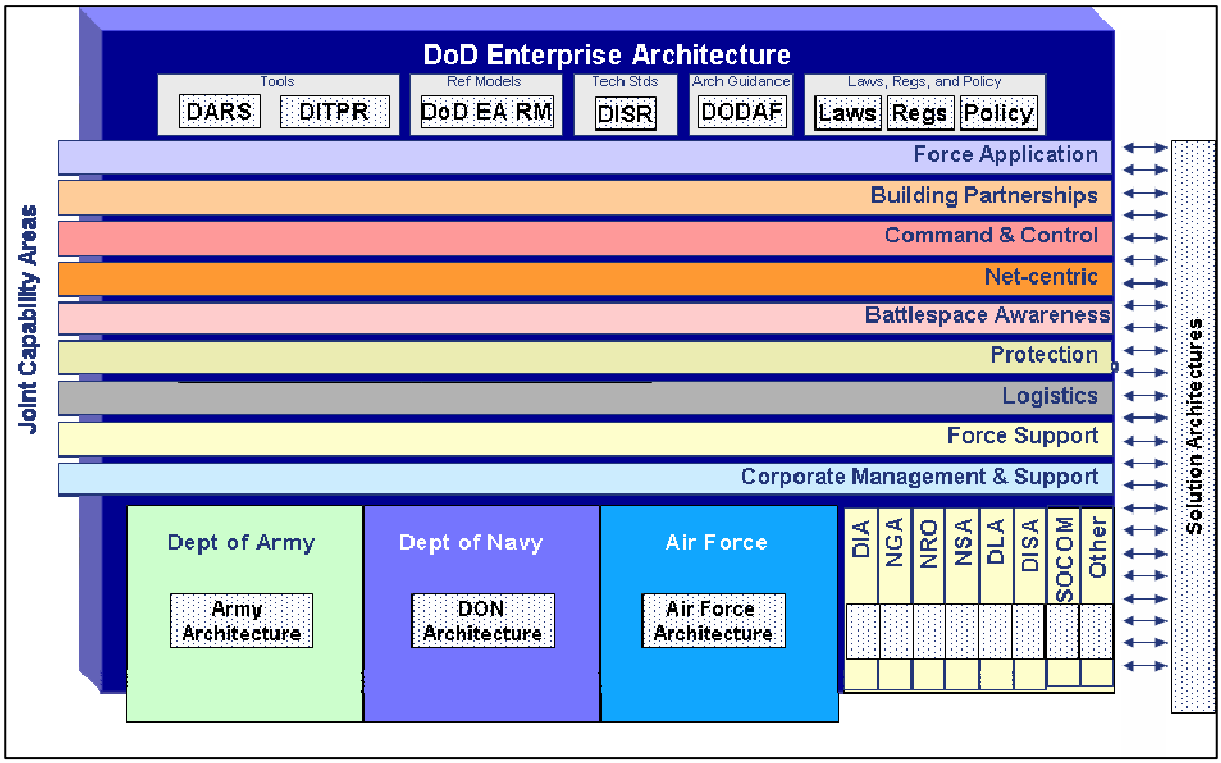

Figure 4.1-1: Components of the DoD EA

Migration in a net-centric operating environment from the "As-Is" to the "To-Be" requires that the DoD Information Environment Architecture (DoD IEA) and the Net-Centric strategies act as uniform references for, and guide the transition sequence to ensure that both operational/business capabilities and IT capabilities, as required, are properly described. Policy is being developed by the DoD CIO to describe how federation will be used to mature the DoD EA as well as its relationship to federated, solution Architectural Descriptions.

4.2 Transition Planning

As discussed above, one major impetus for creating and using Architectural Descriptions is to guide acquisition and development of new enterprises, capabilities and systems or improvements to existing ones. Earlier versions of DoDAF addressed this need exclusively using "As-Is" and "To-Be" Architectural Descriptions, along with a Systems and/or Services Technology Forecast. The "As-Is" and "To-Be" concepts are time-specific snapshots of DoDAF views that initially served as the endpoints of a transition process. However, this transition strategy has several potential pitfalls, to include the difficulty in accurately representing the "As-Is" starting point where legacy systems are sometimes poorly documented, and processes are largely undefined. There is also the consideration that long-term goals are often very flexible, resulting in flux in the "To-Be" version.

Since the "As-Is" and "To-Be" Architectural Descriptions are time-specific versions of similar sets of data with similar viewpoints, transition planning is able to chart an evolutionary path from the "As-Is" to its corresponding "To-Be" architectural vision given a clear understanding of the expected outcomes or objectives through some future (perhaps undefined) future point. It is expected that the To-Be Architectural Descriptions will change over time as Departmental priorities shift and realign. More comprehensive discussions of the "As-Is" and "To-Be" Architectural Descriptions, including transition requirements, are contained in Volume 2, and the DoDAF Journal.

4.3 Federated Approach to DoD Architecture Management

The Department has adopted a federated approach to distributed architectural data collection, organization, and management among the Services, Agencies and COIs as its means of developing the DoD Enterprise Architecture, with a virtual rather than physical data set described through supporting documentation and architectural views. This approach provides increased flexibility while retaining significant oversight and quality management services at the Departmental level. Detailed guidance on the DoD federation approach will be contained in DoDD 8210, "Architecting the DoD Enterprise."

4.4 Tiered Accountability

Tiered Accountability (TA) is the distribution of authority and responsibility to a DoD organization for an element of the DoD EA. Under TA, DoD is defining and building enterprise-wide capabilities that include data standards, business rules, enabling systems, and an associated layer of interfaces for Department, specified segments of the enterprise (e.g., JCA, DoD Components), and Programmatic solutions. Each tier has specific goals, as well as responsibilities to the tiers above or below them.

Architectural Descriptions are categorized when developed to facilitate alignment (mapping and linking), cataloging, navigating, and searching disparate architecture information in a DoD registry of holdings. All Architectural Descriptions developed by the tiers should be federated, as described in the DoD Federation Strategy.

Alignment in the tiers is required for the DoD EA to be discoverable, shareable, and interoperable. Architectural Descriptions can also support many goals within the tiers, each of

which may imply specific requirements for structure, content, or level of detail. Alignment decisions should balance the interdependence of Architectural Descriptions with the need for local flexibility to address local issues. Alignment describes the minimum constraints needed to ensure consistency across architecture levels. Architectural Descriptions often relate at some 'touch point' to other Architectural Descriptions on the same level, level(s) above, or level(s) below, and should be discovered and utilized in the development of Architectural Descriptions to ensure that appropriate linkages are created and maintained. The need to plan for them implies that each Architectural Description sharing a touch-point should be available to architects on both sides. The DMR for data and the DARS for architecture registration facilitate the ability to discover and utilize architectural data, with the caveat that any touch-points within the purview of an established COI adhere to COI guidance[12].

4.5 DoD Architecture Enterprise Services

The next generation of DoD Enterprise Architectures will be constructed by employing a set of DoD Architecture Enterprise Services (DAES)[13] for registering, discovering, aligning, translating, and utilizing architectural data, and derived information to support key DoD decision processes through implementing the concepts of the DoD Net-Centric Strategies. [14] DAES will be implemented using Web Services, in which specific content and/or functionality is provided by one user for others, many of whom may be unknown to the provider. An Operational Resource Flow Description (A redesigned Operational Viewpoint 2 (OV-2) DoDAF-described Model) has been retained in DoDAF V2.0 to describe those services that can be discovered and subscribed from one or more specific sources and delivered to one or more known or unknown subscribers.

Registration of architectures, one of the goals of the NCDS[15], is the first step toward enabling discovery of architecture metadata. DAES includes a registration service to register the metadata (through the DMR), and a method to describe the purpose and scope of an Architectural Description (through DARS). The registration service will enable cataloging of Architectural Descriptions in federated repositories, and, once complete, Architectural Descriptions are 'available' for discovery. When an Architectural Description is discoverable, it can be aligned to, linked to, or re-used by other Architectural Descriptions. The discovery service enables users to execute a federated search for architecture holdings meeting specified search parameters.

4.6 Alignment to the Federal Enterprise Architecture

The OMB established the Federal Enterprise Architecture (FEA) program in 2003 to build a comprehensive business-driven blueprint of the entire Federal Government. OMB's Circular A-11 requires that Cabinet-level agencies, including the DoD, link their budget submissions to the

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[12] *Department of Defense Net-Centric Data Strategy*, 9 May, 2003. Office of the Assistant Secretary of Defense (Networks & Information Integration) (NII)/DoD Chief Information Officer (DoD CIO).
[13] Formerly called the GIG Architecture Enterprise Services (GAES).
[14] For additional details about the services, please review Section 11, "GIG Architecture Enterprise Services (GAES) — Making the GIG Architecture Visible, Accessible, and Understandable" of the "Global Information Grid (GIG) Architecture Federation Strategy," Version 1.2, 1 August 2007.
[15] *Department of Defense Net-Centric Data Strategy*, 9 May, 2003. Office of the Assistant Secretary of Defense (Networks & Information Integration) (NII)/DoD Chief Information Officer (DoD CIO).

FEA, and annually evaluates those submissions through the Enterprise Architecture Assessment Program, which establishes an evaluation score for overall agency progress.

The core principles of the FEA program are:

- Business-driven approach.
- Promote collaboration of effort and reuse.
- Improve efficiency and effectiveness of business operations through the use of enterprise architecture for the capital investment process.
- Demonstrate cost savings and cost avoidance through improved core processes, and cross-agency sharing and mutual investment.

DoD leverages the FEA construct and core principles to provide the Department with the enterprise management information it needs to achieve its own strategic transformation goals and respond to upward reporting requirements of OMB. The primary objective is to improve DoD performance, using EA, by providing a framework for cross-mission analysis and identification of gaps and redundancies; and by developing transition plans and target architectures that will help move DoD to the net-centric environment.

Several Federal and DoD-specific EA artifacts exist that describe enterprise-level management information. These include:

- The President's Management Agenda.
- OMB A-11 Exhibit 300 submissions.
- OMB FEA Practice Guidance.
- OMB EA Assessment Guide.
- OMB FEA Reference Models.
- DoD EA Reference Model (RM) Taxonomy.
- DoD EA Consolidated RM.
- DoD EA Transition Strategy.
- DoD Segment Architectures.
- DoD EA Self-Assessment.
- DoD Architecture Federation Strategy.

These artifacts facilitate the alignment with the FEA, contribute to a broader understanding of architecture alignment, provide a basis for federated Architectural Descriptions, promote a more efficient and effective use of assets, and ultimately lead to better decision-making.

When developing architectures, particularly at the Departmental and Component levels, alignment with the FEA is accomplished by utilizing the Federal Enterprise Architecture-Consolidated Reference Model (FEA-CRM) documents together with DoD documents and references as a basis for defining processes, data, services, and technical standards. As an example, when a process owner determines that an Architectural Description is needed for some specific purpose, the first references to use are as shown below in **Table 4.6-1**, as well as other Architectural Descriptions above and below the level of the Architectural Description under development. The DoD-level information is contained in the DoD EA Reference Models, along

with the implementing guidance, standards, and descriptions of Department-wide information that is mapped to the FEA-CRM in accordance with the FEA construct.

4.7 Addressing Security Issues in DoDAF-Conformant Architecture Development

Security continues to be a critical concern within the DoD, and Architectural Description development efforts at any level need to ensure that appropriate security concerns are addressed clearly, so that any decisions made that rely on the Architectural Descriptions are valid and useful. Security concerns are routinely addressed through the risk assessment process described in Section 10 of Volume 1, and Appendix C of Volume 2.

Table 4.6-1: References to Architectural Description Development

Action	Reference(s)	Usage
Determine Processes Involved	DoDAF FEA Business Reference Model (BRM)	(DoDAF) Determine techniques and notation to be used (FEA BRM) Determine FEA business processes to align to; use taxonomies in BRM to name processes
Identify and Define data	DM2 (DM2) FEA Data Reference Model (DRM)	(DM2) Data Group and metadata structures (DRM) Existing Government-wide metadata for linkage to architecture
Document Architectural Description and Ensure Compliance	DoDAF DoD Metadata Registry (DMR) DoD Architecture Registry System (DARS) Toolset OMB EA Guidance Federated Enterprise Architecture-Consolidated Reference Model (FEA-CRM) OMB EA Assessment Guide	(DoDAF) provides described models, and guidance on creating Fit-for-Purpose Views for presentation purposes (DMR) Provides existing metadata to use in conjunction with DMR to create data required (DARS) provides registration services for architecture discovery (Toolset) provides automated notation method for creating views (OMB EA Guidance) provides information on required format and content of EA for OMB 53/300 process (OMB EA Assess. Guide) provides guidance on evaluation of architectures submitted to OMB for review
Publish Architecture	DoD Architecture Federation Strategy Agency Repository DARS	(DoD Fed. Strategy) provides guidance on architectural data discovery (Agency Repository) stores EA Data (DARS) Providers EA contact information

Each of the individual models described in detail in Volume 2 provides the architect and development team with a set of data for collecting, documenting, and maintaining security data. These data support physical, procedural, communications security (COMSEC), Transient Electromagnetic Pulse Emanation Standard (TEMPEST), and Information Security (INFOSEC) concerns. DM2 incorporates the Intelligence Community Information Security Marking (IC ISM) standard for classification markings of architecture information.

5. ARCHITECTURE PLANNING

5.1 Defining the Enterprise

In a generic sense, an enterprise is any collection of organizations that has a common set of goals and/or a single bottom line. An enterprise, by that definition, can encompass a Military Department, DoD as a whole, a division within an organization, an organization in a single location, or a chain of geographically distant organizations linked by a common management or purpose. An enterprise today is often thought of as an *extended enterprise* where partners, suppliers, customers, along with their activities and supporting systems, are included in the Architectural Description.

Government agencies may comprise multiple enterprises, and there may be separate enterprise architecture, or Architectural Description projects. However, the projects often have much in common about the execution of process activities and their supporting information systems, and they are all linked an enterprise architecture. The DoD Enterprise Architecture is described in Section 3.1. Architectural description development in conjunction with the use of a common architecture framework, which describes the common elements of Architectural Descriptions, lends additional value to the effort, and provides a basis for the development of an architecture repository for the integration and reuse of models, designs, and baseline data.

5.2 The Enterprise-level Architecture

Enterprise-level Architectural Descriptions in DoD are generally created under the responsibility and authority of a senior-level official within the Department, Component, Organization, Agency, or the program office responsible for development of JCAs. As an enterprise-level effort, it is expected that all of the major processes are documented and described, even if a specific project involves only a more limited subset of processes or activities. That way, subsequent Architectural Description efforts can build on previous efforts to ensure the integration and extension of the enterprise is not compromised.

Enterprise-level Architectural Descriptions usually exhibit breadth rather than depth. Since this Architectural Description is the ‘capstone’, or highest level of an Architectural Description, on which others will build, it is especially important that processes, which relate to each other, either through interaction of activities, or the use of data by internal and external stakeholders, are identified or documented.

5.3 Solution Architectures

The solution-architecture is scoped to include all major activities that are associated with an identified solution for a capability gap in response to a specific requirement. This solution may contain links to one or programs which require the data and/or outputs produced by the specified the solution identified to fill a specified gap.

5.4 Architecture Management

Architectural Descriptions are designed to describe the data on an organization or program/capability that will support continuing managing decision-making over time. Creation

of Architectural Descriptions and their management follow an established lifecycle that is similar to those other resources that have well-described lifecycles. OMB Circular A-130[16] describes the lifecycle as:

- Develop.
- Use.
- Maintain.

For consistency, that structure is followed in this volume as well. These phases recognize discreet actions that occur at various times, all designed to ensure that architectural data can be collected and later reused for management decision-making and reporting.

5.4.1 Architecture Development

Architectural Descriptions are developed to represent either the state of an activity at a specified time (i.e., baseline architecture) or the results of change in an activity that will occur over some future time (i.e., "To-Be" or future architecture). Enterprise architectures (usually with Departmental, Capability, Segment, or Component content) are initially created to create a common context needed to understand the organization and operations of high-level processes under their control.

Solution Architectural Descriptions collect data that is specific to their program or capability, and data necessary to link to both the higher-level Architectural Descriptions with which they share common parentage, and any lower-level Architectural Descriptions, which describe in more detail particular aspects of the program or JCA.

Visualization of data provides a unique perspective of data from the viewpoint needed for decision-making. That may be a commander/director, action officer, system developer, data administrator, user, or anyone else executing some part of the architected process. More discussion of data collection and visualization is contained in DoDAF Volume 2.

5.4.2 Architecture Utilization

The ultimate success of an Architectural Description effort lies in the ability to use architectural-related data to support decisions for change within the organization. While Architectural Description development is generally accomplished as a project, accomplished through a team trained for that purpose, the results of the Architectural Description development, to be effective over the longer term, need to be adopted as the common, normal mode of performing the organization's business.

The enterprise architecture, as a corporate asset, should be managed like any other asset, and reinforced by management as a key part of the formal program that results in decision-making. Achieving that level of acceptance occurs only when Architectural Descriptions are created that reflect reality (e.g., baseline), or planned change/growth (e.g., "To-Be", or target).

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[16] *Office of Management and Budget (OMB) Circular-A-130, Management of Federal Information Resources*, February 8, 1996. Executive Office of the President, Office of Management and Budget. The current version can be found at: http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html#2

Successful execution of the EA development process in an agency-wide endeavor requires management direction and support, allocation of resources, continuity, and coordination. Creating an EA program calls for sustained leadership and strong commitment, buy-in by the agency head, senior leadership, and early designation of a lead architect. These leaders and the supporting EA Team are the first level of support for institutionalizing the results of the effort.

When architectural data and views are constructed and organized in a way that they are understood, accepted, and utilized in daily activities, they facilitate decision-making. To achieve optimal success, architectural views and data must meet standards that facilitate reuse by others whose activities border on, or replicate activities, services and systems already documented by architectural data and products. To that end, data collection must adhere to the standards set by the COI, or other recognized authority so that the data can be registered for, and used by others.

5.4.3 Architecture Maintenance

Changes in an organization supported by Architectural Description development will achieve institutionalization only when the senior leadership agrees with, supports, encourages, reinforces, and adopts the results of the Architectural Description effort. Ideally, a member of the Senior Leadership Team should be designated as the 'champion' of the change effort, and should work with the process owner to ensure that institutionalization occurs Employees, who actually perform the daily activities described in the Architectural Description, must be represented in the Architecture Development Team and contribute to the overall data collection and view creation.

5.4.4 Architecture Compliance Reviews

Architectural description compliance reviews are a key part of the validation and verification (V&V) process ongoing throughout the Architectural Description development effort. A *compliance review* is a type of review that analyzes whether Architectural Description developers are progressing according to the specifications and requirements developed for the Architectural Description effort by the process owner. The goals of an architecture compliance review include:

- Identifying errors in the Architectural Description early to reduce the cost and risk of changes required later in the project. These error-catching actions will reduce cost and schedule slips, and will quickly realize business objectives.
- Ensuring the application of best practices to Architectural Descriptions work (Development, use, and maintenance).
- Providing an overview of the compliance of architecture to mandated enterprise standards.
- Identifying and communicating significant architectural gaps to supplier and service providers.
- Communicating to management the status of technical readiness of the project.

Utilization of architecture compliance reviews as an integral part of the development process ensures that utilization of architectural data and views later will be in conformance with applicable requirements. A more in-depth discussion of the compliance review process is contained in the DoDAF Journal.

5.4.4.1 OMB Architecture Assessment. The OMB requires departments and independent agencies to submit a self-assessment of their enterprise architecture programs in February of each year. For DoD, this applies at the Department level. The self-assessment is performed in three EA capability areas: completion of the EA, use of the EA and results, and utilization of the OMB Federal Enterprise Architecture program EA Assessment Framework.[17] Specifics of the DoD/OMB architecture self-assessment are described in the DoDAF Journal.

5.4.4.2 GAO Architecture Assessment. The Government Accountability Office (GAO) periodically requires all departments and independent agencies to submit a self-assessment of the maturity of the management of their EA programs. In addition, GAO may perform their own review and assessment of architecture efforts associated with large-scale programs.[18] In certain cases, GAO expects an agency to establish an independent quality assurance process for a large-scale architecture to determine whether it meets quality criteria such as those identified earlier in this section.[19] Specifics of the DoD/GAO architecture self-assessment are described in the DoDAF Journal. The Enterprise Architecture Management Maturity Framework (EAMMF) (Table 3.2.1.1) can also be used for this purpose.

5.4.5 User Support

User support is the service that each enterprise unit provides its users, both internally and externally to the enterprise, as described in the architectural data and views.

5.4.6 Training

It is the responsibility of agency executive management to institutionalize the control structures for the EA process, as well as for the agency Capital Planning & Investment (CPIC) and Shelf Life Code (SLC) processes. For each decision-making body, all members should be trained, as appropriate, in the EA, the EA process, the relationship of the EA to the Agency's mission, DoDAF, and the FEA. Specific training, at various levels of detail, should be tailored to the architecture role of the personnel.

Architecture development training for team members is often provided by the team leader and Chief Architect during the course of team operations. Training for team members includes sessions on group interactions, toolset operations, data collection, and creation of models and views.

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[17] *Federal Enterprise Architecture Program: Enterprise Architecture Assessment Framework, version 2.2*, October 2007. Executive Office of the President, Office of Management and Budget. The current version can be found at: http://www.whitehouse.gov/omb/egov/a-2-EAAssessment.html.

[18] *United States Government Accountability Office (GAO) Report: DoD Business Systems Modernization: Long-standing Weaknesses in Enterprise Architecture Development Need to Be Addressed*, July 2005, GAO-05-702. A copy of the report is available at: http://www.gao.gov/new.items/d05702.pdf

[19] *United States Government Accountability Office (GAO) Report: Framework for Assessing and Improving Enterprise Architecture Management, version 1.1*, April 2003, GAO-03-584G. A copy of the report is available at: www.gao.gov/new.items/d03584g.pdf

5.4.7 Communications Planning

Communication management is the formal and informal process of conducting or supervising the exchange of information to all stakeholders of enterprise architecture. Communication planning is the process of ensuring that the dissemination, management, and control of critical stakeholder information is planned and executed in an efficient and effective manner.

The purpose of communications planning is to (1) keep senior executives and business units continually informed, and (2) to disseminate EA information to management teams. The Chief Architect and support staff defines a marketing and communications plan consisting of:

- Constituencies.
- Level of detail.
- Means of communication.
- Participant feedback.
- Schedule for marketing efforts.
- Method of evaluating progress and buy-in.

The CIO's role is to interpret the Agency Head's vision, and recognize innovative ideas (e.g., the creation of a digital government) that can become key drivers in the EA strategy and plan. In turn, the Chief Architect is the primary technical communicator with the communities of interest involved in an Architectural Description effort.

At the Process Owner level, the communications plan is similar to that described above for the CIO. As with the CIO at the enterprise, the process owner is the manager of Architectural Description efforts, supported by an architect and development team. The process owner must clearly define the purpose and scope of an Architectural Description effort (i.e., "Fit-for-Purpose") and communicate those goals and objectives for the Architectural Description effort to the architect and team. In turn, as development of the Architectural Description progresses, the architect provides feedback to the process owner, participates in validation and verification activities, and provides revisions, as required to the original development plan.

5.4.8 Quality Planning

Quality management is the process of organizing activities involving the determination of quality requirements, establishing quality policies, objectives, performance measures (metrics), and responsibilities, and ensuring that these policies, objectives, and measures (metrics) will satisfy the needs within the enterprise. The quality management system executes policies, procedures, and quality planning processes, along with quality assurance, quality control processes, and continuous process improvement activities to improve the overall health and capability of the enterprise. The primary input into the quality management process is quality planning.

Quality planning for Architectural Description development identifies which quality standards are relevant to creation of the Architectural Description and determines how to satisfy them. Quality requirements are stated in the Project Scope Statement, further defined in the Program Management Plan and other guidance, such as that provided by the methodology being applied to the development effort. Guidance also includes other enterprise environmental factors, such as

Governmental agency regulations, rules, standards, and guidelines specific to the application area. Information needed during quality planning is generally collected during Architectural Description development, and represented in architectural data and views as controls, resources, inputs, and outputs, as appropriate. A more comprehensive discussion of quality planning is provided online in the DoDAF Journal.

5.4.9 Risk Management

Risk management is the act or practice of dealing with risk. It includes planning for risk, assessing risk issues, developing risk handling strategies, and monitoring risk to determine how they have changed. Risk management planning is the process of deciding how to approach and conduct the risk management activities for the enterprise, program, and projects.

Architectural-based risk assessment is a risk management process that identifies flaws in Architectural Description and determines risks to business information assets that result from those flaws. Through the process of architectural risk assessment, risks are identified and prioritized based on their impact to the business; mitigations for those risks are developed and implemented; and the Architectural Description is reassessed to determine the efficacy of the mitigations.

Risk management planning should be initiated early during development of the scope for the Architectural Description effort. Mitigation of risk is crucial to success of the overall effort. Inputs to the risk management planning process include a review of existing enterprise environmental factors, organizational process assets, the proposed scope statement, and the program management plan. *Enterprise environmental factors* are the attitudes toward risk and the risk tolerance of the organizations and people involved in the organization that exert influence over change. Risk attitudes and tolerances may be expressed in policy statements or revealed in actions. *Organizational process assets* are tools and techniques, which normally predefine organizational approaches to risk management such as established risk categories, common definitions of concepts and terms, standard templates, roles and responsibilities, and authority levels for decision-making.

A comprehensive discussion of Risk management can be found online in the DoDAF Journal.

6. CUSTOMER REQUIREMENTS

In a large organization such as DoD, there are myriad decisions made each day. These decisions require facts (i.e., valid information) for successful execution. Two things affect the ability to make decisions. First, information must be available; second, a decision support process must exist to frame how the decision, once made, can be executed. Decision support can be as simple as an established procedure or rule for execution, or a more complex, integrated set of actions to ensure that a decision is executed properly.

Within DoD are a number of very complex, overarching, decision support services that provide a framework for execution on DoD's most critical program activities. These key DoD change management decision support processes include JCIDS, DAS, SE, PPBE, and PfM. The following paragraphs discuss how these key decision support processes impact management decision making in DoD using architectural data.

6.1 Tailoring Architecture to Customers' Needs

Architectural Descriptions are collections of information about an organization that is relevant to a requirement. This information frequently includes processes, supporting systems, needed or desired services, interfaces, business rules, and other details that can be organized to facilitate a decision. From this perspective, Architecture applies a method for tailoring information collection to a specific local need with a clear understanding of the decisions the Architectural Description needs to support, how those decisions should be made, and what information they require. Responding to the organization's requirements generally requires the following information to apply the methodology described in Section 7, or another selected by the architect:

- Detail on specific implementations of the basic processes, including explicit identification of critical decisions mandated or implied.
- Identification of performance measures that can be used to judge the effectiveness of each process (including any mandated by the authoritative documents), taking special note of those that sample the effectiveness of Architectural Description support (the DoDAF Journal includes a tutorial on a relatively painless method for performance engineering).
- For each critical decision, identification of at least one method (and optionally several alternatives) for making that decision, identifying analyses to perform and questions to answer.
- For each analysis or question, identification of needed information.
- Creation of additional business objects/elements and attributes as needed to capture information in the architecture repository.
- Process and information definitions for utilization in Architectural Description development.

The architect simplifies the architectural design by eliminating unneeded objects and attributes through a 'best sense of opportunity' approach, whereby interaction with the customer provides normal and expected needs that generally satisfies the majority of information needs for Architectural Description development. Architectural views should be created to reflect, as closely as possible, the normal 'culture', and preferred presentation design of the agency.

6.2 Key Decision Support Processes

Organizations within the DoD may define local change management processes, supportable by Architectural Descriptions, while adhering to defined decision support processes mandated by the Department, including JCIDS, the DAS, SE, PPBE, Net-centric Integration, and PfM. These key support processes are designed to provide uniform, mandated, processes in critical decision-making areas, supplemented by individual agency operations, defined by Architectural Descriptions tailored to support those decisions-making requirements.

6.2.1 Joint Capability Integration and Development System

The primary objective of the JCIDS process is to ensure warfighters receive the capabilities required to execute their assigned missions successfully. JCIDS defines a collaborative process

that utilizes joint concepts and integrated Architectural Descriptions to identify prioritized capability gaps and integrated joint Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) and policy approaches (materiel and non-materiel) to resolve those gaps.[20] JCIDS implements an integrated, collaborative process to guide development of new capabilities through changes in joint DOTMLPF and policy.

The JCIDS process owners recognized the need for architecture and wrote policy to support architecture requirements (i.e., specific product sets required in specific documents, such as the Information Support Plan, Capability Development Document, and Capability Production Document) that permits components and lower echelon commands to invoke the JCIDS process for requirements at all levels. A more comprehensive discussion of JCIDS is contained in the DoDAF Journal.

6.2.2 Defense Acquisition System

The DAS exists to manage the nation's investments in technologies, programs, and product support necessary to achieve the National Security Strategy and support employment and maintenance of the United States Armed Forces.[21] The DAS uses Joint Concepts, integrated architectures, and DOTMLPF analysis in an integrated, collaborative processes to ensure that desired capabilities are supported by affordable systems and other resources.[22]

DoD Directive 5000.1 provides the policies and principles that govern the DAS. In turn, DoD Instruction 5000.2, Operation of the DAS establishes the management framework for translating mission needs and technology opportunities, based on approved mission needs and requirements, into stable, affordable, and well-managed acquisition programs that include weapon systems and automated information systems (AISs).[23] The Defense Acquisition Management Framework[24] provides an event-based process where acquisition programs advance through a series of milestones associated with significant program phases.

The USD (AT&L) leads the development of integrated plans or roadmaps using integrated architectures as its base. DoD organizations use these roadmaps to conduct capability assessments, guide systems development, and define the associated investment plans as the basis

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[20] *Chairman of the Joint Chiefs of Staff (CJCS) Instruction 3170.01F, Joint Capabilities Integration and Development System (JCIDS)*, 1 May 2007. A copy of the current version of the instruction can be found at: http://www.dtic.mil/cjcs_directives/cdata/unlimit/3170_01.pdf.

[21] *Department of Defense Directive (DoDD) 5000.1, The Defense Acquisition System*, 12 May 2003 (certified current as of November 20, 2007). A current copy of the directive can be found at: https://akss.dau.mil/dag/DoD5000.asp?view=document&doc=2)

[22] *Department of Defense Instruction (DoDI) 5000.2., Operation of the Defense Acquisition System.* (2003) Under-Secretary of Defense (Acquisition, technology & Logistics) (OUSD AT&L). A current copy of this document can be found at: https://akss.dau.mil/dag/DoD5000.asp?view=document&doc=2

[23] *Department of Defense Instruction (DoDI) 5000.2., Operation of the Defense Acquisition System.* (2003) Under-Secretary of Defense (Acquisition, technology & Logistics) (OUSD AT&L). A current copy of this document can be found at: https://akss.dau.mil/dag/DoD5000.asp?view=document&doc=2

[24] *Integrated Defense Acquisition, Technology, & Logistics Life Cycle Management Framework* (2005). Defense Acquisition University, Ft. Belvoir, VA. A current copy of the chart is found at: http://www.dau.mil/pubs/IDA/IDA_04.aspx

for aligning resources and as an input to the Defense Planning Guidance (DPG), Program Objective Memorandum (POM) development, and Program and Budget Reviews.[25]

6.2.3 Systems Engineering

DoD Acquisition policy directs all programs responding to a capabilities or requirements document, regardless of acquisition category, to apply a robust SE approach that balances total system performance and total cost with the family-of-systems, and system-of-systems context. Programs develop a Systems Engineering Plan (SEP) for Milestone Decision Authority (MDA) that describes the program's overall technical approach, including activities, resources, measures (metrics), and applicable performance incentives.

SE processes are applied to allow an orderly progression from one level of development to the next detailed level using controlled baselines. These processes are used for the system, subsystems, and system components as well as for the supporting or enabling systems used for the production, operation, training, support, and disposal of that system. Execution of technical management processes and activities, such as trade studies or risk management activities may point to specific requirements, interfaces, or design solutions as non-optimal and suggest change to increase system-wide performance, achieve cost savings, or meet scheduling deadlines[26].

Architecture supports SE by providing a structured approach to document design and development decisions based on established requirements.

6.2.4 Planning, Programming, Budgeting, and Execution

The PPBE process allocates resources within the DoD and establishes a framework and process for decision-making on future programs. PPBE is a systematic process that guides DoD's strategy development, identification of needs for military capabilities, program planning, resource estimation, and allocation, acquisition, and other decision processes. JCIDS is a key supporting process for PPBE, providing prioritization and affordability advice.

DoDAF V2.0 supports the PPBE process by identifying the touch points between architecture and the PPBE process, identifying the data to be captured within an Architectural Description, facilitating informed decision-making, and identifying ways of presenting data to various stakeholders/roles in the PPBE decision process.

6.2.5 Portfolio Management

DoD policy requires that IT investments be managed as portfolios to ensure IT investments support the Department's vision, mission, and goals; ensure efficient and effective delivery of capabilities to the Warfighter; and maximize return on investment within the enterprise. Each portfolio may be managed using the architectural plans, risk management techniques, capability

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[25] *Department of Defense Instruction (DoDI) 5000.2., Operation of the Defense Acquisition System*. (2003) Under-Secretary of Defense (Acquisition, technology & Logistics) (OUSD AT&L). A current copy of this document can be found at: https://akss.dau.mil/dag/DoD5000.asp?view=document&doc=2

[26] *DoD Acquisition Guidebook*. Office of the Under-Secretary for Acquisition, Technology & Logistics (AT&L). A current copy of the Guidebook can be found at: https://akss.dau.mil/dag/DoD5000.asp?view=document&doc=2

goals and objectives, and performance measures. Capability architecting is done primarily to support the definition of capability requirements. PfM uses the Architectural Description to analyze decisions on fielding or analysis of a needed capability.[27]

Architectural support to PfM tends to focus on the investment decision itself (although not exclusively), and assists in justifying investments, evaluating the risk, and providing a capability gap analysis.

6.2.6 Operations

In most cases, an enterprise will capture its routine or repeatable business and mission operations as architectural content. However, when the basic structure of an activity is very stable and the activity repeated often, such as military operations planning or project definition and management, the enterprise may choose to include that structure as part of the Architectural Description itself. In this case, the architecture repository may be enhanced to include templates, checklists, and other artifacts commonly used to support the activity.

The JCIDS, PPBE, and DAS processes establish a knowledge-based approach, which requires program managers to attain the right knowledge at critical junctures to make informed program decisions throughout the acquisition process. The DoD IT PfM process continues to evolve that approach with emphasis on individual systems and/or services designed to improve overall mission capability. Consistent with OMB Capital Planning and Investment Control (CPIC) guidance, the DoD uses four continuous integrated activities to manage its portfolios – analysis, selection, control, and evaluation. The overall process is iterative, with results being fed back into the system to guide future decisions.[28]

6.2.7 Net-centric Integration.

Net-centric Integration and interoperability requirements, to include supporting architectural views, are required by CJCSI 6212.01E[29]. DoDAF V2.0 provides views that support interoperability requirements, both in DoDAF-described Models (including those from previous versions of DoDAF), and new viewpoints, described in Section 3. The DM2 provides data support to interoperability requirements and facilitates creation of user-defined views that meet specific, “Fit-for-Purpose” requirements.

6.3 Information Sharing

Information sharing across the Department has existed for many years in various forms. The sharing of information took on new urgency following the events of September 2001, especially

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[27] *Department of Defense Directive (DoDD) 8115.01, Information Technology Portfolio Management*, October 10, 2005. Office of the Assistant Secretary of Defense (Networks & Information Integration) (NII)/DoD Chief Information Officer (DoD CIO). The latest copy of this directive can be found at: http://www.dtic.mil/whs/directives/corres/rtf/811501x.rtf

[28] DoDD 8115.01, 10.

[29] Chairman of the Joint Chiefs of Staff (CJCS) Instruction 6212.01E, Interoperability and Supportability of Information Technology and National Security Systems, 15 Dec 2008. A copy of the current version of the instruction can be found at: http://www.dtic.mil/cjcs_directives/cdata/unlimit/6212_01.pdf.

in the area of terrorist-related information. Since that time, new Federal legislation[30] and presidential orders require that agencies develop a common framework for the sharing of information, and define common standards for how information is acquired, accessed, shared, and used within a newly created *Information Sharing Environment (ISE).* While initial efforts relate to terrorism-related data, the standards being set could apply, in the future, more broadly across the Department.

Importantly, an Information Sharing Environment Enterprise Architecture Framework (ISE-EAF) is under development[31], which will provide guidance for information collection and dissemination within the Information Sharing Environment (ISE). This Framework is consistent with the DoDAF, and is essential data structures will be mappable to the DM2 described in DoDAF Volumes 2 and 3. When published, that ISE document should be used in coordination with DoDAF to ensure that these specific types of data meet established Federal standards.

7. METHODOLOGIES

This section introduces a methodology-based approach to Architectural Description development in DoD, draws on the methodology originally introduced in DoDAF V1.5, and expands on that methodology to highlight its use in a data-driven, net-centric architecture development environment. The methodology contained in this section is notional, represents best practices that have evolved over time, and can be utilized in conjunction with, or as a replacement for other methodologies, as described below.

7.1 Methodology Based Approach to Architecture

The Webster's II New College Dictionary 2001 defines methodology as (1) the system of principles, procedures, and practices applied to a particular branch of knowledge, and, (2) the branch of logic dealing with the general principles of the formation of knowledge. Generally speaking, knowledge is gained through the acquisition of, and effective use of information organized from data for a particular purpose.

An architecture development methodology specifies how to derive relevant information about an enterprise's processes and business or operational requirements, and how to organize and model that information. Architecture methods describe consistent and efficient ways to collect data, organize the data in a particular grouping or structure, and store collected data for later presentation and use in decision-making processes. A methodology also provides a means for replicating the steps taken to create an Architectural Description for a specific purpose later, by another person or team with the expectation of achieving similar results.

In turn, through utilization of a method, it is possible to compare Architectural Descriptions created under the same, or similar methods, evaluate how disparate Architectural Descriptions can be linked to provide a higher-level picture of a process or capability, and to analyze the impact of future change. These analyses can include:

[30] Intelligence Reform and Terrorism Prevention Act of 2004 (IRTPA), PL 108-458 (December 17, 2004).
[31] *Information Sharing Environment Enterprise Architecture Framework (DRAFT)* June, 2008. Office of the Program Manager, Information Sharing Environment.

- **Static Analyses –** which could include capability audit, interoperability analysis, or functional analysis. These analyses are often performed using simple analysis tools such as paper-based comparisons and database queries.
- **Dynamic Analyses –** sometimes referred to as executable models, these analyses typically examine the temporal, spatial, or other performance aspects of a system through dynamic simulations. For example, these analyses might be used to assess the latency of time sensitive targeting systems or conduct traffic analyses on deployed tactical networks under a variety of loading scenarios.
- **Experimentation –** the use of tactical capability requirements, such as the Coalition Warrior Interoperability Demonstration (CWID), sponsored annually by the JCS, and various battle labs to provide the ability to conduct human-in-the-loop simulations of operational activities. Differing degrees of live versus simulated systems can be deployed during these experiments and there is a high degree of control over the experiment variables. These can be used for a variety of purposes.

The 6-step architecture development process described below is a generic, time-tested method, which can be utilized, in a wide range of architectural requirements through relatively simple adaptation. The examples described within the steps provide information on customization of the generic method for use in major departmental functions and operations.

NOTE: The methodology described in this section is applicable to development of SOA-based architectures. The steps described in the methodology, together with the requirements of the toolset, techniques and notation desired, should be considered together when defining a SOA. Volume 2 provides specific models that are useful for services-specific data collection, and presentation models and documents that describe services.

If another method is desired, then utilization of the information contained in this Volume, Volume 2, Architectural Data and Models, and Volume 3, the DM2 PES, provide the information needed for use in developing an Architectural Description. When utilizing another method, reference to the notional methodology can ensure adherence to the principles described in DoDAF V2.0, to maximize the potential for reuse of essential data, and also to ensure conformance with DoDAF V2.0.

7.1.1 6-Step Architecture Development Process

The high-level, 6-step architecture development process provides guidance to the architect and Architectural Description development team and emphasizes the guiding principles described in Section 3.5.1. The process is data-centric rather than product-centric (e.g., it emphasizes focus on data, and relationships among and between data, rather than DoDAF V1.0 or V1.5 products). This data-centric approach ensures concordance between views in the Architectural Description while ensuring that all essential data relationships are captured to support a wide variety of analysis tasks. The views created as a result of the architecture development process provide visual renderings of the underlying architectural data and convey information of interest from the Architectural Description needed by specific user communities or decision makers. **Figure 7.1.1-1** depicts this 6-step process.

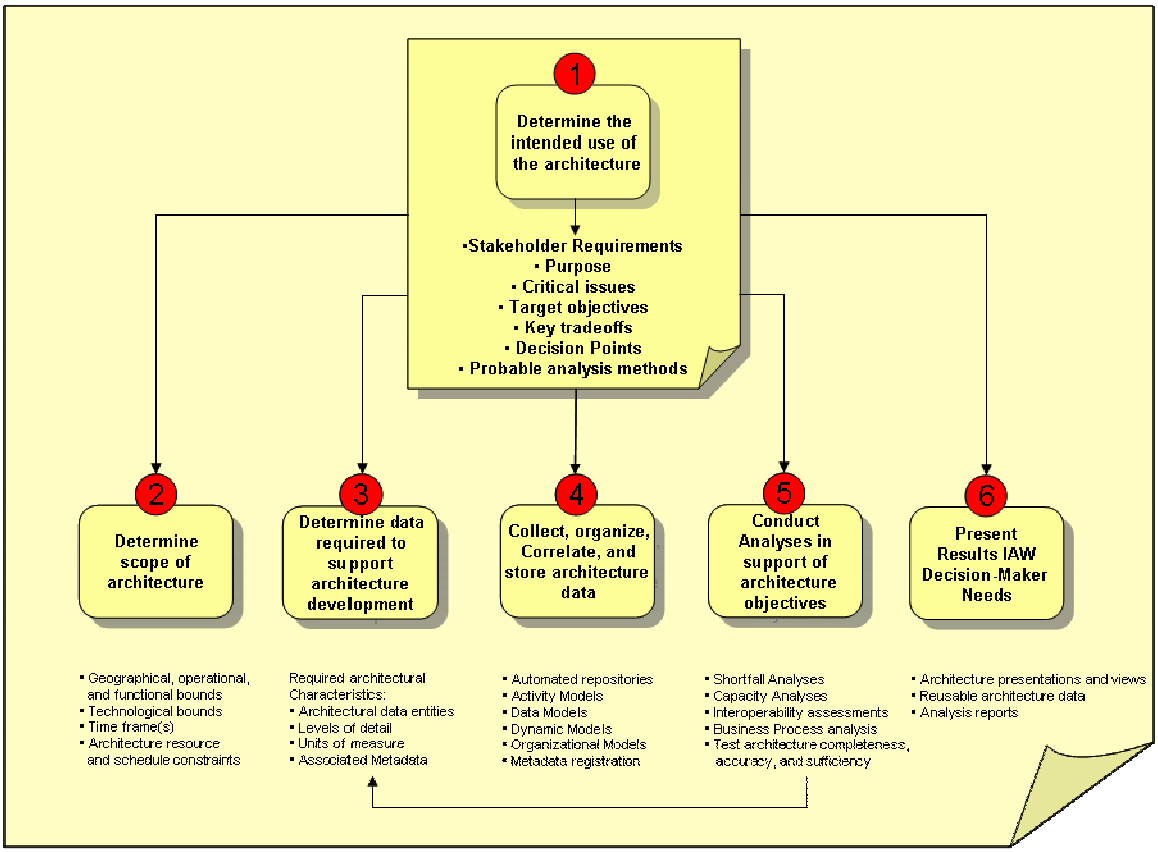

Figure 7.1.1-1: Architecture Development 6-Step Process

NOTE: It is important to note in this section that the development of Architectural Description is an iterative process and a unique one, in that every Architectural Description is:

- Different in that architecture creation serves a specific purpose, and is created from a particular viewpoint.
- Serving differing requirements, necessitating different types of views to represent the collected data.
- Representative of a 'snapshot in time' (e.g., the Architectural Description may represent the current view or baseline, or it may represent a desired view in some future time).
- Changeable over time as requirements become more focused or additional knowledge about a process or requirement becomes known.

The methodology described below is designed to cover the broadest possible set of circumstances, and also to focus on the most commonly used steps by the architecture community.

7.1.1.1 Step 1: Determine Intended Use of Architecture. Defines the purpose and intended use of the architecture ("Fit-for-Purpose"); how the Architectural Description effort will be conducted; the methods to be used in architecture development; the data categories needed; the potential impact on others; and the process by which success of the effort will be measured in terms of performance and customer satisfaction. This information is generally provided by the

process owner to support architecture development describing some aspect of their area of responsibility (process, activity, etc.).

A template for collection of high-level information relating to the purpose and scope of the Architectural Description, its glossary, and other information, has been developed for registration of that data in DARS. An electronic copy is found on the public page of DARS.

7.1.1.2 Step 2: Determine Scope of Architecture. The scope defines the boundaries that establish the depth and breadth of the Architectural Description and establish the architecture's problem set, helps define its context and defines the level of detail required for the architectural content. While many architecture development efforts are similar in their approach, each effort is also unique in that the desired results or effect may be quite different. As an example, system development efforts generally focus first on process change, and then concentrate on those automated functions supporting work processes or activities. In addition to understanding the process, discovery of these 'system functions' is important in deciding how to proceed with development or purchase of automation support.

Information collected for Architectural Descriptions describing services is similar to information collected for Architectural Descriptions describing systems. For describing services, Architectural Description will collect additional information concerning subscriptions, directory services, distribution channels within the organization, and supporting systems/communications web requirements.

Similar situations occur with Architectural Description development for joint operations. Joint capabilities are defined processes with expected results, and expected execution capability dates. The Architectural Descriptions supporting the development of these types of capabilities usually require the reuse of data already established by the military services and agencies, analyzed, and configured into a new or updated process that provides the desired capability. Included are the processes needed for military service and/or agency response, needed automation support, and a clear definition of both desired result and supporting performance measures (metrics). These types of data are presented in models further described in Volume 2.

The important concept for this step is the clarity of scope of effort defined for the project that enables an expected result. Broad scoping or unclear definition of the problem can delay or prevent success. The process owner has the primary responsibility for ensuring that the scoping is correct, and that the project can be successfully completed.

Clarity of scope can better be determined by defining and describing the data to be used in the proposed Architectural Description in advance of the creation of views that present desired data in a format useful to managers. Early identification of needed data, particularly data about the Architectural Description itself, the subject-matter of the proposed Architectural Description, and a review of existing data from COIs, can provide a rich source for ensuring that Architectural Descriptions, when developed, are consistent with other existing Architectural Descriptions. It also ensures conformance with any data-sharing requirements within the Department or individual COIs, and conformant with the DM2 described in Section 9.

An important consideration beginning with this and each subsequent step of the architecture development process is the continual collection and recording of a consistent, harmonized, and common vocabulary. The collection of terms should continue throughout the architecture development process. As architectural data is identified to help clarify the appropriate scope of the architecture effort, vocabulary terms and definitions should be disambiguated, harmonized, and recorded in a consistent AV-2 process documented in the "DoDAF V2.0 Architecture Development Process for the DoDAF-described Models" Microsoft Project Plan.

Analysis of vocabularies across different Architectural Descriptions with similar scope may help to clarify and determine appropriate Architectural Description scope. Specific examples of data identification utilizing the AV-2 Data Dictionary construct are found in the DoDAF Journal.

7.1.1.3 Step 3: Determine Data Required to Support Architecture Development. The required level of detail to be captured for each of the data entities and attributes is determined through the analysis of the process undergoing review conducted during the scoping in Step 2. This includes the data identified as needed for execution of the process, and other data required to effect change in the current process, (e.g., administrative data required by the organization to document the Architectural Description effort). These considerations establish the type of data collected in Step 4, which relate to the architectural structure, and the depth of detail required.

The initial type of architectural data content to be collected is determined by the established scope of the Architectural Description, and recorded as attributes, associations, and concepts as described in the DM2. A mapping from DM2 concepts, associations, and attributes to architecture models is provided that suggests relevant architectural views the architect may develop (using associated architecture techniques) during the more comprehensive and coherent data collection of Step 4. This step is normally completed in conjunction with Step 4, a bottom-up approach to organized data collection, and Architectural Description development typically iterates over these two steps. As initial data content is scoped, additional data scope may be suggested by the more comprehensive content of Architectural Views desired for presentation or decision-making purposes.

This step can often be simplified through reuse of data previously collected by others, but relevant to the current effort. Access to appropriate COI data and other architecture information, discoverable via DARS and the DMR, can provide information on data and other architectural views that may provide useful in a current effort.

Work is presently underway within the Department to ensure uniform representation for the same semantic content within architecture modeling, called Architecture Modeling Primitives . The Architecture Modeling Primitives, hereafter referred to as Primitives, will be a standard set of modeling elements, and associated symbols mapped to DM2 concepts and applied to modeling techniques. Using the Primitives to support the collection of architecture content and, in concert with the PES, will aid in generating common understanding and communication among architects in regard to architectural views. As the Primitives concepts are applied to more modeling techniques, they will be updated in the DoDAF Journal and details provided in subsequent releases of DoDAF. When creating an OV-6c in Business Process Modeling Notation (BPMN), the Primitives notation may be used. DoD has created the notation and it is in the

DoDAF Journal. The full range of Primitives for views, as with the current BPMN Primitives, will be coordinated for adoption by architecture tool vendors.

7.1.1.4 Step 4: Collect, Organize, Correlate, and Store Architectural Data. Architects typically collect and organize data through the use of architecture techniques designed to use views (e.g., activity, process, organization, and data models as views) for presentation and decision-making purposes. The architectural data should be stored in a recognized commercial or government architecture tool. Terms and definitions recorded are related to elements of the (DM2).

Designation of a data structure for the Architectural Description effort involves creation of a taxonomy to organize the collected data. This effort can be made considerably simpler by leveraging existing, registered artifacts registered in DARS of the DM2, to include data taxonomies and data sets. Each COI maintains its registered data on DARS, either directly or through a federated approach. In addition, some organizations, such as U.S. Joint Forces Command (JFCOM), have developed templates, which provide the basis of a customizable solution to common problems, or requirements, which includes datasets already described and registered in the DMR. Examples of this template-based approach are in the DoDAF Journal.

DARS provides more information that is specific, and guidance on retrieving needed data through a discovery process. Once registered data is discovered, the data can be cataloged and organized within a focused taxonomy, facilitating a means to determine what new data is required. New data is defined, registered in DARS, and incorporated into the taxonomy structure to create a complete defined list of required data. The data is arranged for upload to an automated repository, such as DARS, to permit subsequent analysis and reuse. Discovery metadata (i.e., the metadata that identifies a specific Architectural Description, its data, views, and usage) should be registered in DARS as soon as it is available to support discovery and enable federation. Architects and data managers should use the DoD EA Business Reference Model (DoD EA BRM) taxonomy elements as the starting point for their registration efforts. Additional discovery metadata, such as processes and services may be required later, and should follow the same registration process.

7.1.1.5 Step 5: Conduct Analyses in Support of Architecture Objectives. Architectural data analysis determines the level of adherence to process owner requirements. This step may also identify additional process steps and data collection requirements needed to complete the Architectural Description and better facilitate its intended use. Validation applies the guiding principles, goals, and objectives to the process requirement, as defined by the process owner, along with the published performance measures (metrics), to determine the achieved level of success in the Architectural Description effort. Completion of this step prepares the Architectural Description for approval by the process owner. Changes required from the validation process, result in iteration of the architecture process (repeat steps 3 through 5 as necessary).

7.1.1.6 Step 6: Document Results in Accordance with Decision-Maker Needs. The final step in the architecture development process involves creation of architectural views based on queries of the underlying data. Presenting the architectural data to varied audiences requires transforming the architectural data into meaningful presentations for decision-makers. This is

facilitated by the data requirements determined in Step 3, and the data collection methods employed during Step 4.

DoDAF V2.0 provides for models and views. DoDAF-described Models are those models described in Volume 2 that enable an architect and development team whose data has already been defined and described consistent with the DM2. The models become views when they are populated with architectural data. These models include those previously described in earlier versions of DoDAF, along with new models incorporated from the MODAF, the NATO NAF, and TOGAF that have relevance to DoD architecture development efforts.

Fit-for-Purpose Views are user-defined views that an architect and development team can create to provide information necessary for decision-making in a format customarily used in an agency. These views should be developed consistent with the DM2, but can be in formats (e.g., dashboards, charts, graphical representations) that are normally used in an agency for briefing and decision purposes. An Architectural Description development effort can result in an Architectural Description that is a combination of DoDAF-described Models and Fit-for-Purpose Views.

DoDAF does not require specific models or views, but suggests that local organizational presentation types that can utilize DoDAF-created data are preferred for management presentation. A number of available architecture tools support the creation of views described in this step. The PES provides the format for data sharing.

NOTE: While DoDAF does not require specific models or views in an architecture, several JCS and DoD publications do require specific views in response to their stated requirements. Managers and architects, in deciding what views are created in an architecture development effort, must consider those specific requirements to ensure that the architecture developed is useful in satisfying those requirements.

7.1.2 Accommodating Multiple Methods for Implementation

DoDAF V2.0 is designed to be flexible in development of Architectural Descriptions supporting all tiers, capabilities, component-level views, and specific functional or operational requirements. The method described within the Framework is generic, and can be used in conjunction with other frameworks, tools, or techniques to achieve the desired result. Specifically, the conceptual model supporting DoDAF V2.0 can be used to develop both relational and object-oriented (OO) databases in a wide variety of formats; supports both the structured analysis and Object-oriented analysis and design modeling techniques and their specific notations; and continues to support previous versions of this framework.

Many Architectural Descriptions are created utilizing data from Architectural Descriptions developed previously under another framework (i.e., MODAF, NAF, TOGAF). It is also possible, through data mapping, to link that data to the DoDAF V2.0 conceptual and LDMs, since the data models supporting these frameworks are based on either the predecessor C4ISR Framework or DoDAF V1.0.

7.1.3 Architecture Lifecycle and Architecture Governance

Architectural Description development is only one phase of an overall architecture lifecycle, similar to other process maturity and change lifecycles. One such lifecycle, the Architecture Governance, Implementation, and Maturity Cycle, shown in **Figure 7.1.3-1** below, is described in detail in the DoDAF Journal. This lifecycle relies on the commonly used Plan-Do-Check-Act (PDCA) governance method.

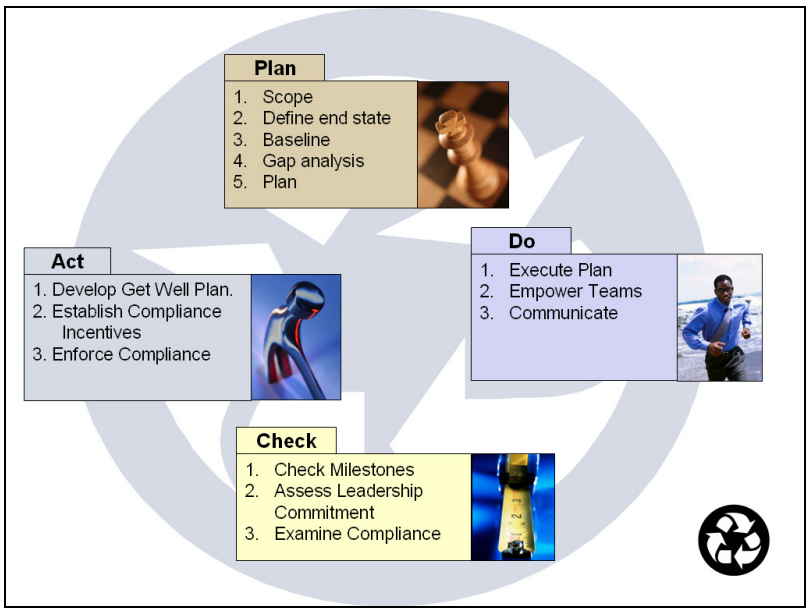

Figure 7.1.3-1: Plan, Do, Check, and Act (PDCA) Cycle

7.1.4 Planning for Architecture Development

Planning an Architectural Description effort involves more than selection of a method for development. The Architectural Description effort starts with the identification of a requirement, problem, or desired change by the process owner – the senior official responsible for the overall operation of the functional, tactical, component or JCA. The process owner selects a team leader and team members who will actively participate in the Architectural Description effort. That team may have a varying membership, generally including an enterprise architect, and subject matter experts in the process area undergoing analysis and potential change, and will refine the process owner's vision and/or initial requirement into a project through development of an appropriate Architectural Description, as shown in the steps in Section 6.1.1, and in Section 10, Architecture Planning.

Managers and decision-makers are generally not technicians or information architects. They do, however, have a vital part in the decisions that need to be made early in the planning process to define the types of views they need to support their involvement in the decision-making process. Organizations differ in the type of presentation materials they prefer (i.e., dashboards, charts, tables) and these preferences need to be accommodated during Architectural Description development. Toolsets should be selected that have the capability to provide these management views and products, along with the ability to collect and organize data consistent with the DM2

to facilitate reuse. A detailed discussion of toolset requirements and capabilities is contained in the DoDAF Journal.

7.1.5 Approaches to Architecture Development

Several methodologies, with supporting tools, techniques, and notations (i.e., a set of written symbols used to represent something such as activity, decisions, systems, applications, interfaces) exist for developing Architectural Descriptions. While DoDAF does not promote a specific approach, the DoDAF provides the rules, standard entities, and relationships for developing Architectural Descriptions in a semantically consistent and interoperable fashion. The DoDAF V2.0 CDM and LDM, described in Volumes 1 and 2, along with the PES in Volume 3, have been designed to facilitate adoption of DoDAF by a wide range of toolsets and techniques. The DM2 should be used as the principal reference for creating the data structures in toolsets to ensure both interoperability and reuse capabilities. An achievable level of commonality among the notations is possible when basing architecture development on the DoDAF V2.0 CDM and LDM.

NOTE: Several commercial toolsets that are commonly used to develop architecture views still use the terms ‘model’ of ‘diagram’ to describe those views. Within this chapter, we continue to use the terms ‘model’ and ‘diagram’, as they are used by toolset vendors, to avoid confusion. However, a model or diagram created by a toolset, using an appropriate notation, and included in a set of views in a DoD architecture should be understood as a ‘view’ within DoDAF.

The two most common techniques—the SADT Approach and the OOAD Approach—are discussed briefly below. Examples of the notation supporting these techniques are presented in examples contained within Volume 2. Either of these techniques can be used with the methodology described above, or by others, such as MODAF, NAF, TOGAF, or other Government or commercial offerings.

7.1.5.1 Structured Technique Overview. Architectural Descriptions developed under a structured analysis-driven approach are process-oriented and characterized by hierarchical process decomposition. Historically, structured models generally used in DoD originated from the Integration Definition Language developed by the U.S. Air Force, and later used to develop the Integration Definition for Activity Modeling (IDEF0) [IDEF0 1993] Standards and the Federal Information Processing Standard (FIPS) published by the National Institutes for Standards & Technology (NIST). This technique evolved from an earlier, also process-driven approach, SADT, developed for the U.S. Air Force Materiel Command. More recently, architecture development using structured methods has also included those utilizing the BPMN, developed by the Business Process Management Initiative, and currently managed by the Object Management Group (OMG).

7.1.5.1.1 Process Data Flow. A process flow diagram (PFD) is a graphical representation of the flow of data through a process. With a process flow diagram, users are able to visualize how the process will operate, what the process will accomplish, and how the process is executed normally. Process flow diagrams can be used to provide the end user with a physical idea of the resulting actions that occur on data input, and how their actions ultimately have an effect upon

the structure of the whole process. Process flow diagrams also define desired or required system-level functions—the level and type of automation desired to improve the time, efficiency, and results of executing a process.

7.1.5.1.2 Process Task-Dependency Diagram. Process Task Dependency (PTD) Diagrams lay out clearly the step-by-step flow of a process by tracking the flow of material, information or a service through all its steps in a logical or required order. The PTD diagram assists an unfamiliar audience to picture the steps of a process and clarifies misconceptions about how the process actually operates, while providing a reference for the handling of corrective action or process improvement. Task-sequence notations work especially well for uninterruptible processes, meaning a set of steps that exhibits clear dependencies, doesn't execute until explicitly triggered, and normally continues until it achieves a clear exit criterion. Such processes are generally low-level and detailed, and useful for:

- Defining detailed performance measures (metrics) and measures capture.
- Establishing an information base for executable architecture/process simulation.
- Defining automation functional requirements.

7.1.5.1.3 Entity-Relation Model. The Entity-Relation Model describes the structure of an architecture domain's system data types and the business process rules that govern the system data. It provides a definition of architectural domain data types, their attributes or characteristics, and their interrelationships.

7.1.5.2 Object-Oriented Technique Overview. Object-oriented architectural views are created utilizing the Unified Modeling Language (UML) architecture technique and notation, together with the DoDAF logical and PES data structures. This technique describes the operational need, places data (objects, or 'performers' in the DoDAF data structure) in the context of its use, and provides a traceable foundation for system and software design. It is based on the concepts of data abstraction and inheritance from a service-oriented view. The object-oriented technique provides an orderly arrangement of the parts of the business organization and includes a style and method of design through its highly developed notation style.

7.1.5.2.1 Process – Activity Diagram, Object-Sequence Diagram. An *activity diagram* is frequently used in conjunction with a process flow diagram that describes the sequence and other attributes (i.e., timing) of the activities. A *process flow* diagram further captures the precedence and causality relations between situations and events. In object modeling, *activity* diagrams address the dynamic view of the system. They are especially important in modeling the function of a system and emphasize the flow of control among objects. An *object diagram* shows a set of objects (i.e., performers) and their relationships. Object diagrams represent static snapshots of instances of things found in class diagrams.

7.1.5.2.2 Data – Object Class Diagram. *Class diagrams* offer all the UML elements needed to produce entity-relationship diagrams. Class diagrams consist of classes, interfaces, collaborations, dependency, generalization, association, and realization relationships. The attributes of these classes can be expanded to include associations and cardinality [Booch, 1999]. In terms of support to DoDAF V1.5, classes that appear in an OV-7 (The DIV-3 in DoDAF V2.0) class diagram correlate to OV-3 information elements and OV-5 inputs and outputs. The

OV-7 class diagram is a separate diagram from the class diagrams that may be developed for other products.

7.2 System (Component, Package, Deployment) Diagram

DoDAF V2.0 provides extensive architectural support for the SE process. As the process of developing the system architecture moves from the high-level concept (e.g., system interface description, system overview diagram) to more detailed views, it becomes useful to create multiple models so that specialized views ("Fit-for-Purpose") of the Architectural Description can be depicted. Three important diagrams (Fit-for-Purpose Views) are 1) the Component Model, which focuses on functional features of the system; 2) the Package Diagram, which focuses on grouping of components for specific purposes; and 3) the Deployment/Operational Model, which focuses on the physical runtime infrastructure on which functional components will be deployed.

The value of using multiple models arises from the fact that each of these models begins to call upon different skills and knowledge sets as the level of detail increases. Since these diagrams/ models are dependent upon each other, they cannot be created in complete isolation. The architecting process thus becomes an iterative process, defining the data for each portion, then evaluating how the data portion fits with other data portions, and making revisions that optimize the data. This can enable the generation of dependent diagrams which are accurate.

7.2.1 Component Model and Package Diagram

A Component Model, which can be a Systems Engineering Fit-for-Purpose View, describes the hierarchy of functional components, their responsibilities, static relationships, and the way components collaborate to deliver required functionality. For Section 7.2 only, a *component* is a relatively independent part of an IT System and is characterized by its responsibilities, and the interfaces it offers. Components can be decomposed into smaller components or aggregated into larger components. Some components already exist, but it may be necessary to build or buy others. A component can be a collection of classes, a program (e.g., one that performs event notification), a part of a product, or a hardware device with embedded functional characteristics (e.g., a Personal Digital Assistant [PDA]). Some are primarily concerned with data storage. A more comprehensive treatment of Component Models is found in the DoDAF Journal.

7.2.2 Deployment/Operational Model

The Operational Model, another potential Systems Engineering Fit-for-Purpose View, describes the operation of the IT system, as illustrated below in **Figure 7.2.2-1**. The Operational Model is derived primarily from the operational requirements placed on the e-business application. Like the Component Model, the Operational Model is typically developed through a series of progressively more detailed elaborations (i.e., Conceptual, Specified, and Physical). Also like the Component model, at each level of elaboration there may be a need to create more than one view of the Operational Model so that no single view becomes overloaded by attempting to convey too much information. A more comprehensive treatment of the Deployment/Operational Model is contained in the DoDAF Journal.

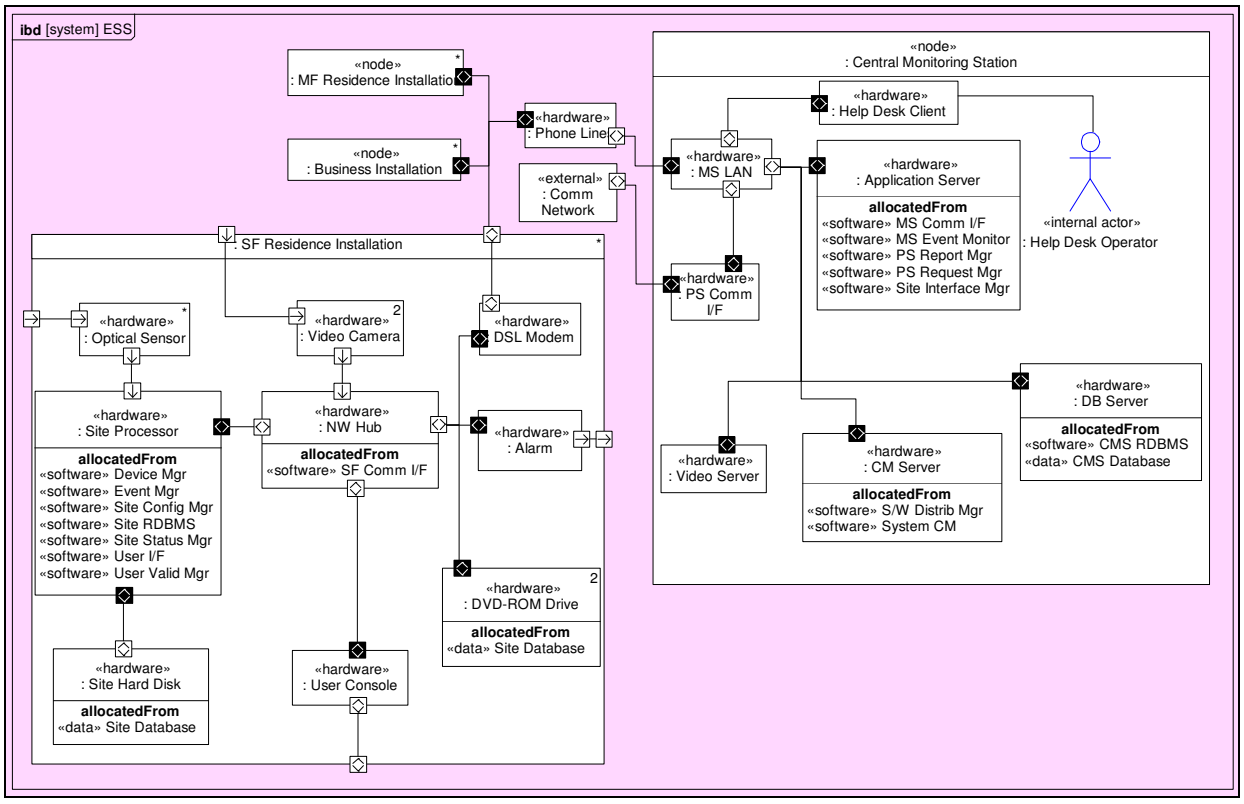

Figure 7.2.2-1: Deployment/Operational Model

8. ARCHITECTURE PRESENTATION TECHNIQUES

While information is the lifeblood of enterprise architecture, it can be overwhelming to decision makers when presented in a raw format. Likewise, the structured methodology of modeling enterprise architecture information is both necessary and useful for creating Architectural Descriptions that can be shared between organizations. However, many of the 'traditional' architecture products are unwieldy because of their format and are useful only to trained architects. Many organizations develop a mandated architecture but make it expensive shelf-ware instead of using it to communicate important, accurate, and relevant information to the stakeholders who need it. Architects must be able to communicate architectural information in a meaningful way to process owners and other stakeholders, or the discipline of enterprise architecture will soon meet an untimely demise.

The results of architectural-related data collection need to be presentable to non-technical senior executives and managers at all levels. Many managers are skilled decision-makers, but have not had technical training in Architectural Description development. Since Architectural Description development efforts are designed to provide input to the decision-making process, graphical representation of data needed is a logical extension of the overall process. This section describes these graphical representations (architects call them models or views).

8.1 Overview

Effective presentation of business information is necessary for architects to tell the story of the architectural data with stakeholders. Since the purpose of the architecture discipline is to collect and store all relevant information about an enterprise, or some specific part of the enterprise, it can reasonably be assumed that the majority of information needed by an organization's decision makers is contained somewhere in the architectural data. Many of the existing architecture methods are valuable for organizing architectural information, but less valuable for communicating that information to stakeholders. Presentation views are always dependent on the quality of the architectural information that is collected through the rigor of architecture methods. As **Figure 8.1-1** illustrates, presentation techniques pull from the architectural information store and display the data in a variety of meaningful ways to stakeholders.

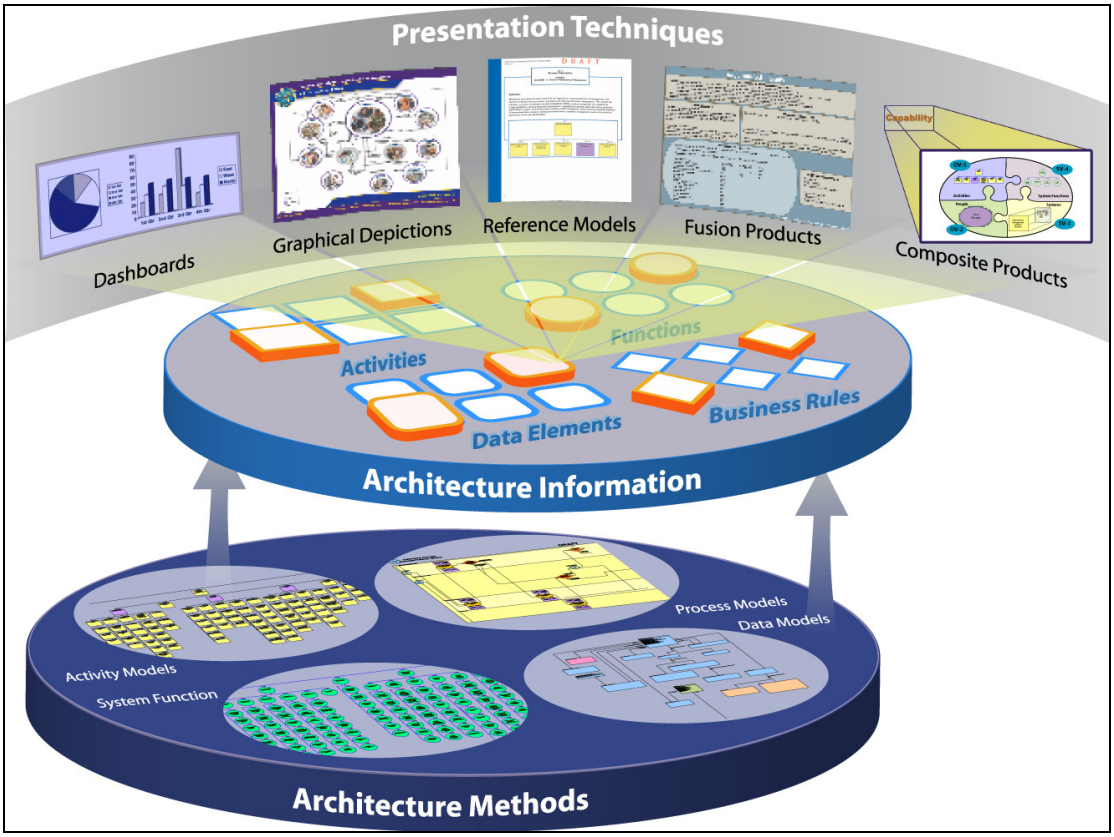

Figure 8.1-1: Presentation Techniques

The presentation techniques and best practices described here, and documented more fully in Volume 2, were developed based on the idea that business information, captured both internally and externally to an organization's architecture in support of common user requirements, can be displayed in a way that enhances clarity and understanding, and facilitates decision-making. That often means complex technical information has to be 'translated' into a form for presentation that is useful to management. An 'Information Bridge', as shown in **Figure 8.1-2** is the link between the architect and management. The bridge provides the means to take technical information, and recast that information in graphical or textual terms that consistent with the culture of the organization.

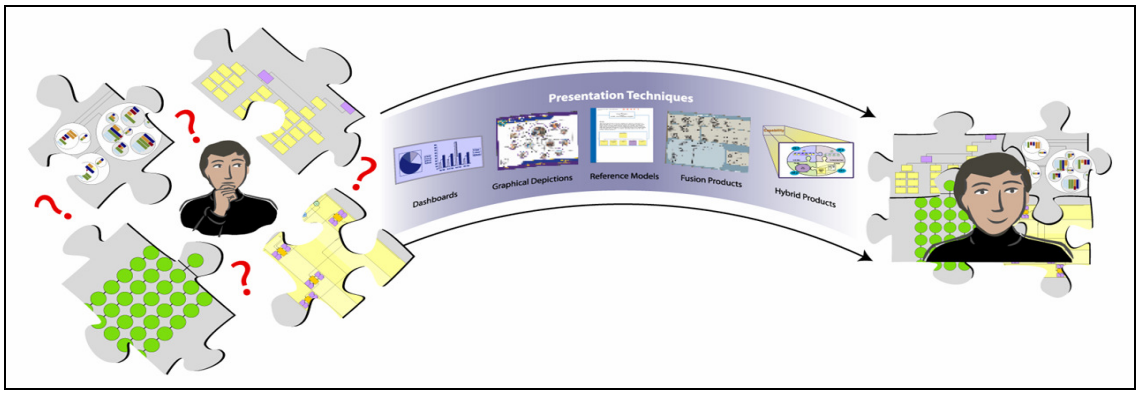

Figure 8.1-2: The Information Bridge

DoDAF V1.0 and V1.5 defined a set of products for visualizing, understanding, and assimilating the broad scope and complexities of an Architectural Description through graphic, tabular, or textual means. These products can still be produced, and are supported by the sets of DoDAF-described Models described in Volume 2.

8.2 Choosing an Appropriate Presentation Technique

In any given business process, decisions must be made at multiple levels of the organization. Whether one is a senior level executive, a process owner, or a system developer, he or she will need to make judgment calls based upon the available data. Each level of decision making, in turn, has both a unique purpose and understanding of Architectural Description, making it important to tailor the data to maximize its effectiveness. The presenter, with the help of an experienced architect, must determine the audience of a presentation before choosing the type of presentation technique to use. **Figure 8.2-1**, based on the Zachman Framework,[32] summarizes the multiple levels of decision makers within a typical organization that make up an audience.

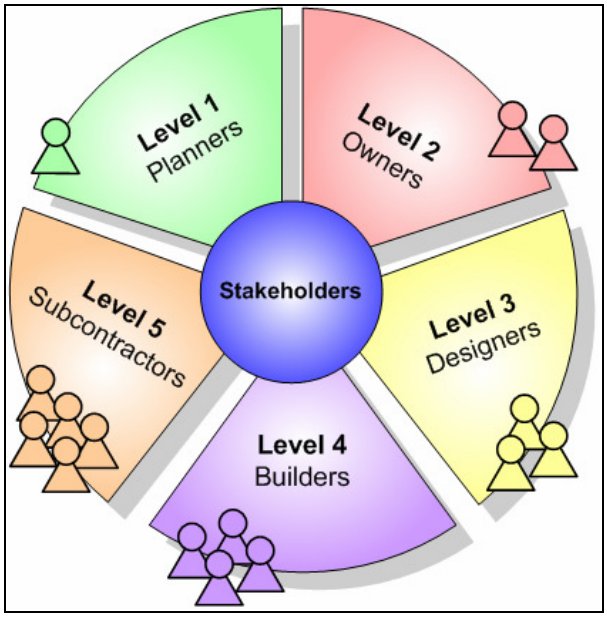

Figure 8.2-1: Levels of Decision-Makers

Each level has differing requirements for presentation of data. Level 1 Planners may find a graphical wall chart more useful in making decisions, whereas a Level 4 Builder will most likely require a more technical presentation, one relating more directly to the Architectural Description. Level 5 sub-contractors are the workers who will perform the work required, and generally required varying levels of technical data and other information to accomplish their task.

[32] Zachman, John. Zachman Framework. © Zachman International. The Zachman Framework can be found at the Zachman International Website: http://zachmaninternational.com/index.php/the-zachman-framework/26-articles/13-the-zachman-framework-a-concise-definition.

Narrowing down the type of presentation required is done by asking the following question: *What information does the decision maker need to make a data-supported decision*? For each decision level there is a data set that can be manipulated using a presentation technique. After analyzing the audience and type of information, the presenter should consider the various types of techniques discussed in this section. **Figure 8.2-2** is a simplified representation of the presentation development process.

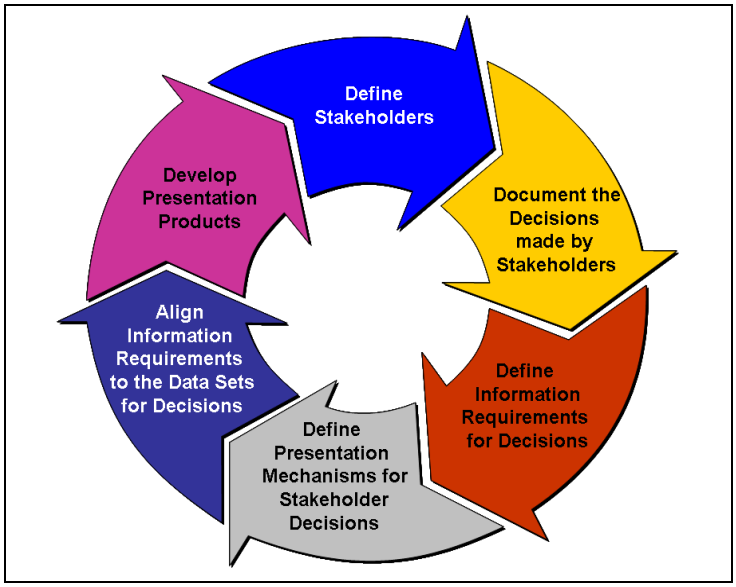

Figure 8.2-2: Presentation Development Process

It is imperative to realize that when choosing how to present data sets, there is no limit on what views to use. There are countless ways to display information to decision makers, and it is up to the presentation developer to determine the most effective way to accomplish this task.

This section describes a base of view development techniques to start from, each created to serve its own unique purpose. Details are provided on five different presentation techniques that have proven to be useful in engaging various audiences.

A more detailed discussion of DM2 Groups is provided in Volume 2, Section 2, including a description and purpose for each group, the data capture method, and the use of each group. There are the ***DoDAF-described Models*** that derive from and conform to the DM2.

Alternatively, Fit-for-Purpose Views can be created, utilizing DoDAF-conformant data that provide other forms of graphical presentation. These use presentation that are more common to briefings and decision analysis. The five techniques commonly used are:

- Composite Views: Display multiple pieces of architectural data in formats that are relevant to a specific decision maker (Section 8.3).
- Dashboards: Integrate abstracted architectural information for a given business context (Section 8.4).
- Fusion Views: Display multiple pieces of architectural data and incorporate disparate pieces of information that are not captured within the Architectural Description (Section 8.5).
- Graphics: Visually represent manipulated data (Section 8.6).
- Reference Models: Capture the elements of the architectural data and translate those elements into text (Section 8.7).

Fit-for-Purpose Views provide wide flexibility for the architect and process owner to create architectural views easily understood and useful to management for decision-making purposes. Each of these types of views is described below.

8.3 Composite Views

A composite view displays multiple pieces of architectural data in formats that are relevant to a specific decision maker. By drawing information from numerous sources, this presentation technique provides a holistic view for the audience. Contrasting two or more snapshots next to each other allow for an easy comparison of composite views. These views will be comprised of related architectural views that directly support each other (i.e., system functions in an SV-4 that support activities in an OV-5). The view can be graphically displayed in three dimensions to tie the pieces of architectural data together.

8.3.1 Purpose and Audience

Composite views allow decision makers to view important relationships in data without reading through large pieces of architectural data. Most business owners are interested only in their particular business area and its immediate interconnections. By placing relevant parts of architectural data directly in front of the audience, it is easier to gain a comprehensive understanding of the data in an efficient manner. The audience that will find these views most useful are:

- Process Owners who have direct staff oversight or technical systems expertise and require high level conceptual briefings.
- Designers—implementers of the initiative, who require information detailing specifics of implementation.
- Builders—System architects who require details on how to implement and use products.

8.3.2 Examples

Figure 8.3.2-1 illustrates a simplified example of a Composite View. The activity Determine Accession Type is supported by the system function Maintain Candidate Data via User Interface. The information to support this system function includes Accession Type Information and Other Candidate Information. The activity is carried out by a Human Resource Specialist.

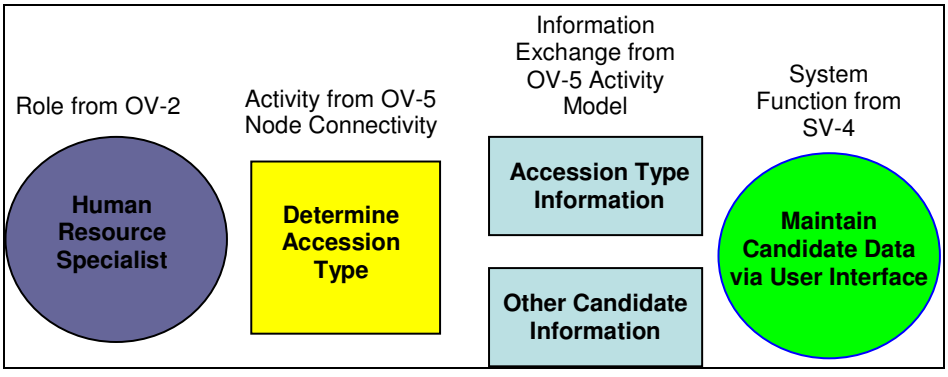

Figure 8.3.2-1: Example Composite View

Figure 8.3.2-2 illustrates a final version of a different Composite View. Four architectural samples are displayed, and a three-dimensional Capability label lets the audience know the common tie.

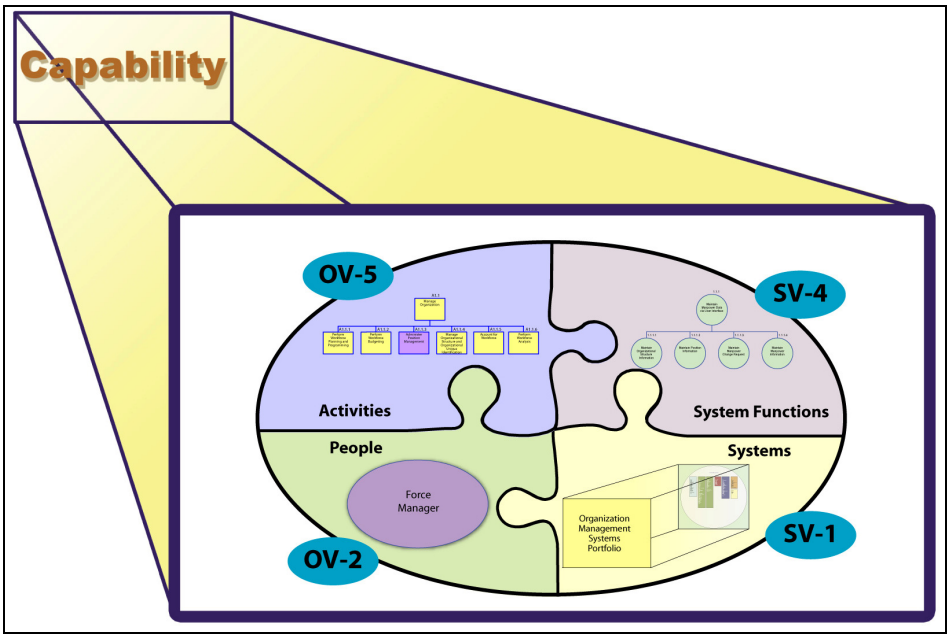

Figure 8.3.2-2: Another Composite View

Composite views are ideal for explaining interconnections between Architectural Descriptions. The audience will more easily understand relationships in data by viewing manageable slices of mappings all at once. The developer of these views can interchange Architectural Descriptions easily, highlighting the most important parts for the audience. Composite views are neither wordy, nor oversimplified. Additionally, they can be used by a wide range audience.

8.4 Dashboard Views

Dashboards integrate abstracted architectural information for a given business context and are generally geared to displaying information required by a specific stakeholder. A well-constructed dashboard consists of a status, trend, or a variance to a plan, forecast, or budget (or combination thereof). Dashboards are generally user friendly, providing easy access to enterprise data to enable organizations to track performance and optimize decision-making. High-level decision makers generally like dashboards because dashboards are frequently used in other business contexts besides enterprise architecture, and decision makers have a familiarity with this presentation tool. In addition, the dashboard is formatted so key stakeholders can review valuable, insightful information at a glance to manage their organization's performance goals effectively.

8.4.1 Purpose and Audience

The visual qualities of a dashboard allow executives and managers to identify which of their business areas are successful and which are problem areas needing immediate attention. Like all enterprise architecture presentation techniques, the dashboard must be designed with the stakeholder audience in mind and should be geared towards the audience's specific goals. One of the most important goals in creating a dashboard is to deliver a highly intuitive tool that yields greater business insight for decision makers.

Since dashboards display highly aggregated and abstracted information, they are typically targeted to senior decision makers. However, they are also a great tool to share with junior architects to ensure they understand key business drivers and concepts as they take a deeper dive into their respective areas.

8.4.2 Examples

Table 8.4.2-1 illustrates various visualization techniques that can be used to create a dashboard.

Table 8.4.2-1: Visualization Techniques

Visualization Technique	Description	When to Use
Pie Chart	Pie charts can be used for representing small sets of information. However, they are generally considered poor data visualization for any data set with more than half a dozen elements. The problem with pie charts is that it is very difficult to discern proportional differences with a radically divided circle, except in the case of a small data set that has large value differences within it. Pie charts also pose a problem for labeling, as they are either dependent on a color or pattern to describe the different data elements, or the labels need to be arranged around the perimeter of the pie, creating a visual distraction.	Pie charts should be used to represent very small data sets that are geared to high-level relationships between data elements. Pie charts present summary level relationships, and should be used carefully for detailed analysis.
Bar Chart	Bar charts are an ideal visualization for showing the relationship of data elements within a series or multiple series. Bar charts allow for easy comparison of values, share a common measure, and are easily compared to one another.	Bar charts are best suited for categorical analysis but can also be used for short duration series analysis (e.g., the months of a year). A presenter needs to be aware of the risks in using bar charts if there is a data set that has one element with a large outlier value; this will render the visualization for the remaining data elements unusable. This chart scale is linear, and will not clearly represent the relationships between the remaining data elements.

Visualization Technique	Description	When to Use
Line Charts	Time series line charts are most commonly used with the time dimension along the X-axis and the data being measured along the Y-axis.	Use line charts when you would like to see trends over time in a measure, versus a side-by-side, detailed comparison of data points. Line charts are ideal for time series analysis where you want to see the progress of one or more measures over time. Line charts also allow for comparative trend analysis as you can stack multiple series of data into one chart.
Area Charts	Area charts can be considered a subset of the line chart, where the area under or above the line is shaded or colored.	Area charts are good for simple comparisons with multiple series of data. By setting contrasting color hues you can easily compare the trends over time between two or more series.
Tables and Lists	Tables and lists contain large amounts of data that can be categorized into a list or divided into a table but cannot be easily compiled into a visual or numerical analysis tool.	Tables and lists are best used for information that either contains large lists of non-numeric data, or data that has relationships not easily visualized or does not lend itself to easy numeric analysis.

Figure 8.4.2-1 illustrates the use of these techniques to create a dashboard.

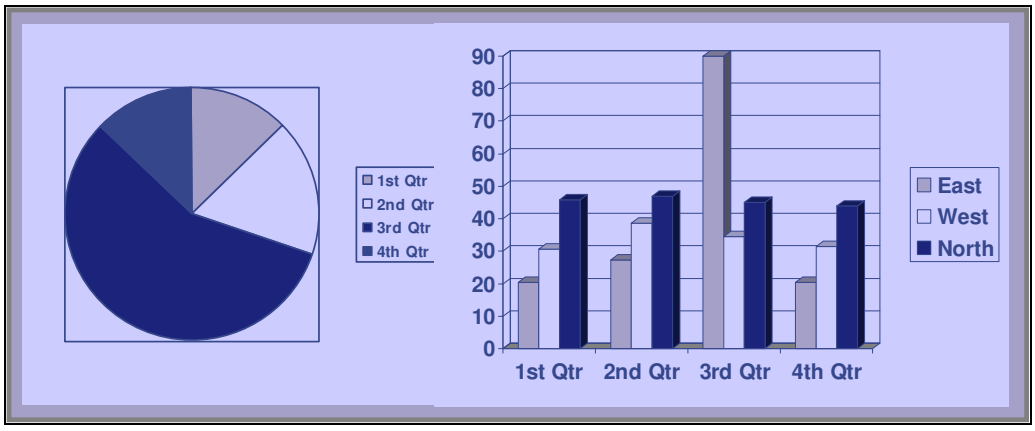

Figure 8.4.2.-1: Notional Dashboard

A dashboard is effective in demonstrating the number of systems supporting an activity or modifying a data element. It can provide data from a variety of sources to create a multi-disciplined and multi-dimensional performance feedback. It combines standard components and building blocks to create an executive dashboard that meets particular needs.

8.5 Fusion Views

A fusion view is very similar to a composite view in that it displays multiple pieces of architectural data in formats that are relevant to a specific decision maker. However, a fusion view also incorporates disparate pieces of information that are not captured within the Architectural Description. Fusion views are frequently used to display information that is sensitive in nature and that is viewed only by certain stakeholders making specific decisions. For example, fusion views could be used to display funding information regarding a program or system.

8.5.1 Purpose and Audience

Fusion views serve as a single location for viewing disparate pieces of information from within and outside of the context of the Architectural Description. A fusion view can be used to bridge the gap between an enterprise architecture analysis, other analysis, and transformation processes. It is frequently used when making a decision that incorporates information that has been deliberately omitted from the Architectural Description.

Fusion views can be used by all members of the Development Team (i.e., Planners, Owners, Designers, Builders, and Subcontractors). Planners use them to review portfolio choices within the context of the Architectural Description and to determine how choices compare to the portfolio as a whole, as well as against an individual system or group of systems. Owners use fusion views to review current progress against planned goals, which may include cost and schedule data or to address capability gaps within the Architectural Description. Designers, Builders, and Subcontractors can use a more detailed fusion view to review implementation impacts associated with the development of a particular system and to show the complexity of the information involved.

8.5.2 Examples

Figure 8.5.2-1 incorporates financial data and support information into an analysis. The outside information commonly consists of financial data gathered from authorized sources or scheduling information and constraints gathered from a Work Breakdown Structure (WBS) or similar reporting mechanism. This can be tailored so that the user can use any data that is relevant to their needs.

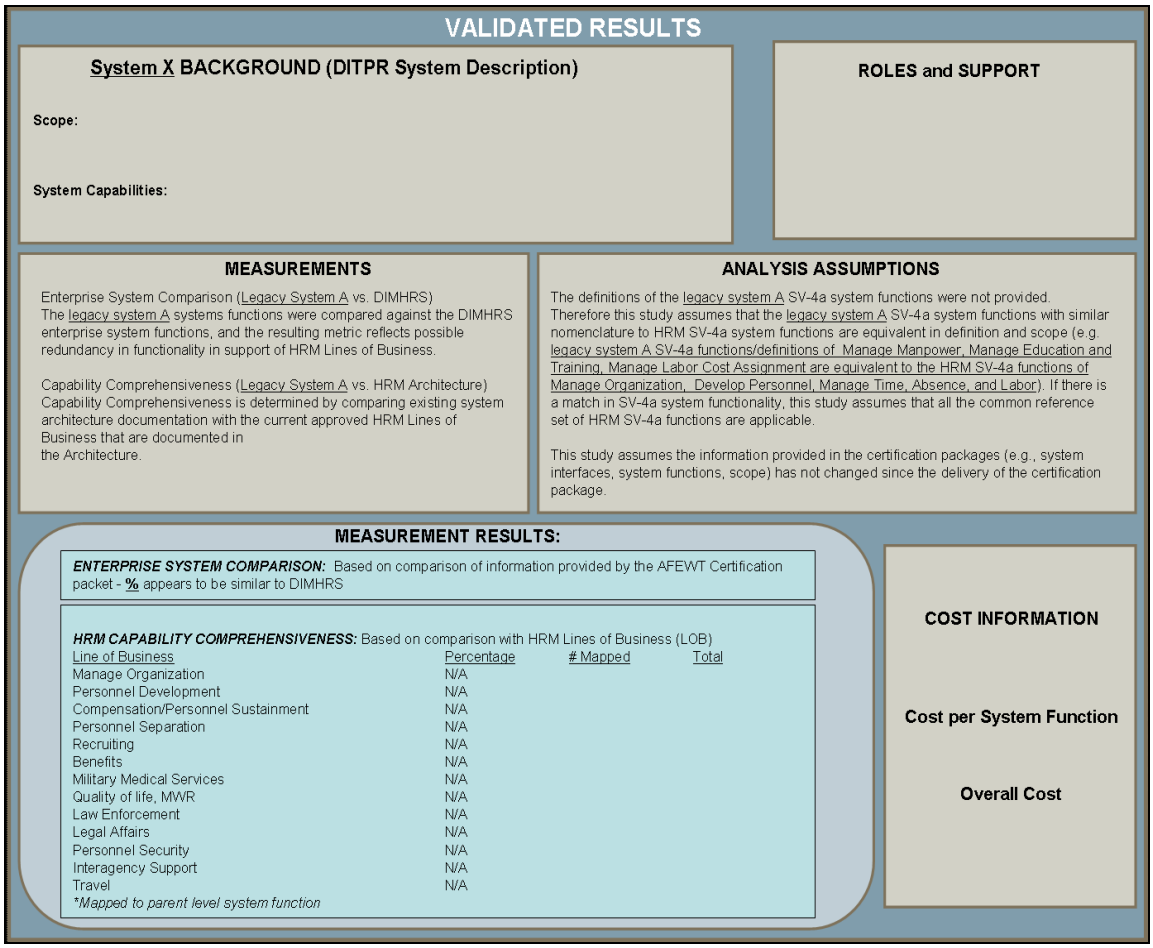

Figure 8.5.2-1: Financial Data Fusion View

A similar Fusion view is shown in Figure 8.5.2-2 that does not include the financial data.

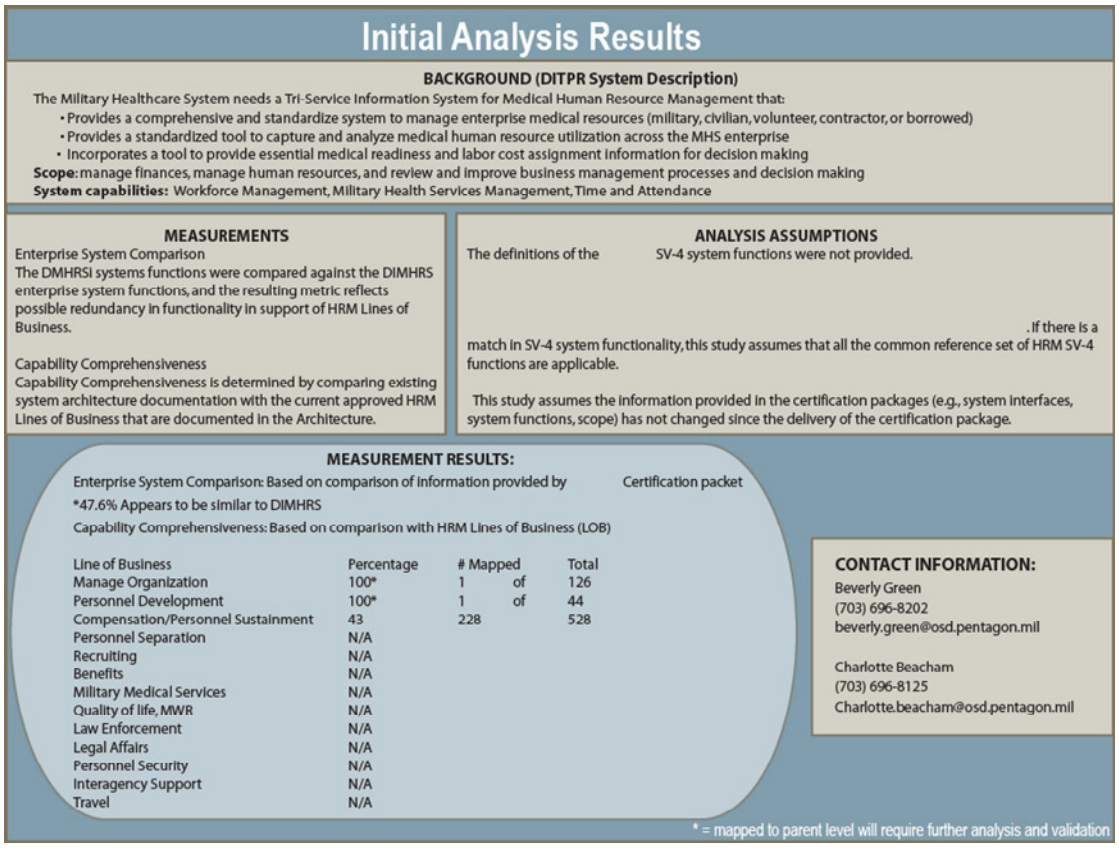

Figure 8.5.2-2: Fusion View without External Financial Data

A fusion view is a powerful tool with the ability to portray accurately the relationships between different types of information. A fusion view can be used to provide a 360-degree view of a system, validate systems against Architectural Descriptions, show availability of services, or provide a perspective of a current environment (e.g., a viewpoint) that can be used in decision-making discussions.

8.6 Graphics Views

A graphic is a representation (as a picture, map, or graph) used especially for illustration of concepts. In the case of enterprise architecture, graphics views are used for the pictorial representation and manipulation of data. In other words graphics provide a visual representation of business information and processes. Graphical views can be of tremendous benefit in representing multiple concepts in a clean, simple design.

8.6.1 Purpose and Audience

Graphical views provide a visual depiction of the information and are therefore targeted at visually oriented learners. When properly executed, a graphical view allows the intended audience to view the information in an uncluttered, easy to understand, and precise design. Additionally, graphical views can attract attention and cause interest. Most people understand

pictures faster and easier than they do text or model-based documents. Graphical views provide the presenter with unlimited options for displaying their business concepts and for tailoring their product to the targeted audience.

Because of the lack of underlying complexity, a graphical view tends to be more abstract and is usually presented to high-level audiences. The identification of the target stakeholder level and the intended message is the first step in determining whether a graphical view is the appropriate tool for information delivery. The appropriateness of graphical views can only be determined once the message and stakeholder level have been identified. Graphical depictions of data and business processes can be tailored to any stakeholder level as long as the intended message and information can be represented in a logical, reader-friendly form. All levels of decision makers will find graphical views useful for high-level analysis.

8.6.2 Examples

The use of graphical views is a common practice in DoD and non-DoD organizations. Because graphical views do not usually show the underlying complexity, it is important to remember that they are tied to details within the Architectural Description. As with dashboard views, if a stakeholder does not understand where the information came from, or if they lack faith in the detailed architectural information, then the graphical view will essentially be meaningless to them. It is also critical to emphasize the underlying architectural information when briefing the graphic to senior decision makers. An OV-1, for example, provides a high-level concept description of a business, and is usually the first, and can be the only architectural view a senior decision maker sees. In order for an OV-1 to have an impact, a decision maker must be able to see a direct correlation from the graphic view to the detailed aspects of the business. Figure 8.6.2-1 and Figure 8.6.2-2 illustrate this concept. Each part of the graphic view corresponds to a detailed area of the overall business, which will be represented and composed of a complex set of architectural views. The graphical views are also used to show the relationships between the business areas which come together to form a complete picture.

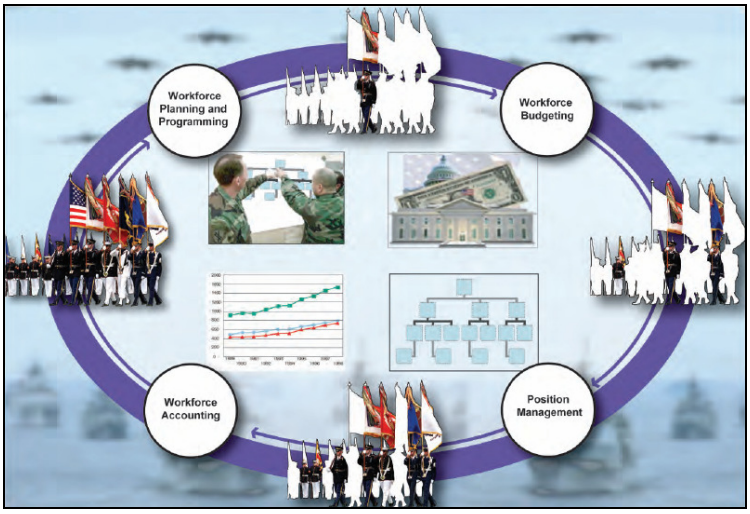

Figure 8.6.2-1: Non-prescriptive, Illustrative High-level Concept Description (OV-1)

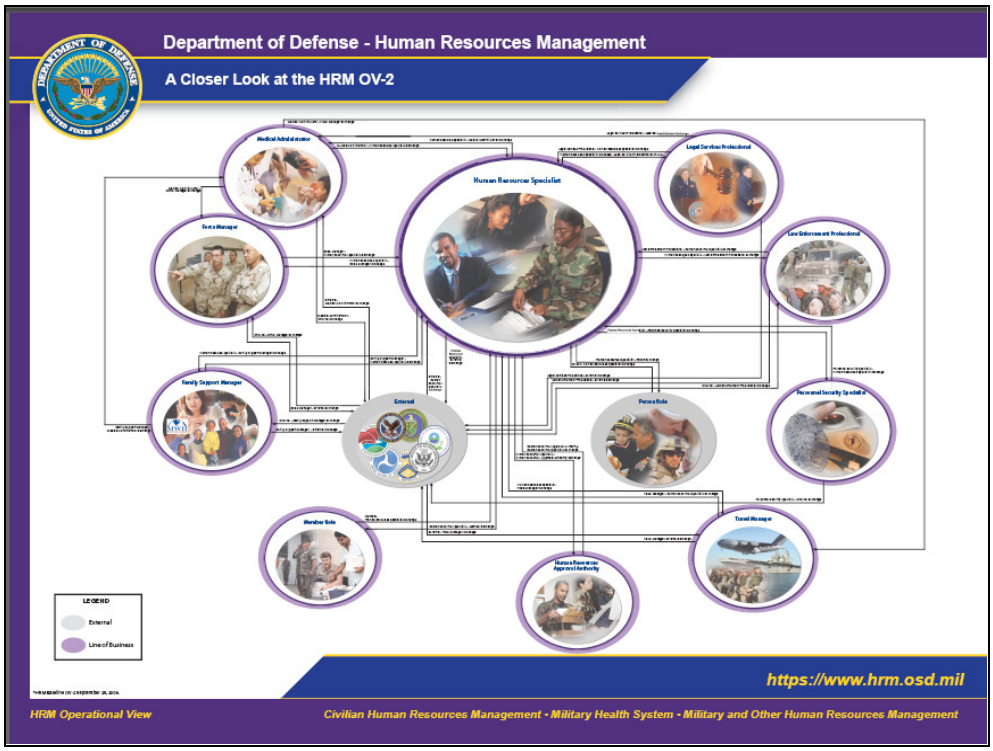

Figure 8.6.2-2: Non-prescriptive, Illustrative High-level Operational Connectivity Description (OV-2)

Graphical views enable the efficient communication of complex quantitative ideas. In a society that is fascinated with visual stimulation, the use of graphical views provides an attractive and efficient communications tool. When effectively designed, graphical views can facilitate understanding and recognition; promote analysis; and support learning and sharing of ideas.

8.7 Reference Models

Reference models provide textual extractions of underlying architectural data. As Figure 8.7-1 illustrates, reference models capture the elements of the architectural views, and translate those elements into text. This reference model provides a framework for describing important elements of the FEA in a common and consistent way. The FEA consists of five reference models: Performance Reference Model (PRM), Business Reference Model (BRM), Service Component Reference Model (SRM), Data Reference Model (DRM), and the Technical Reference Model (TRM). Through the use of this common framework and vocabulary, IT portfolios can be better managed and leveraged across the Federal Government[33].

[33] *Federal Enterprise Architecture Consolidated Reference Model Version 2.3*. Executive office of the President, Office of Management and Budget (OMB). A current version can be found at: http://www.whitehouse.gov/omb/assets/fea_docs/FEA_CRM_v23_Final_Oct_2007_Revised.pdf

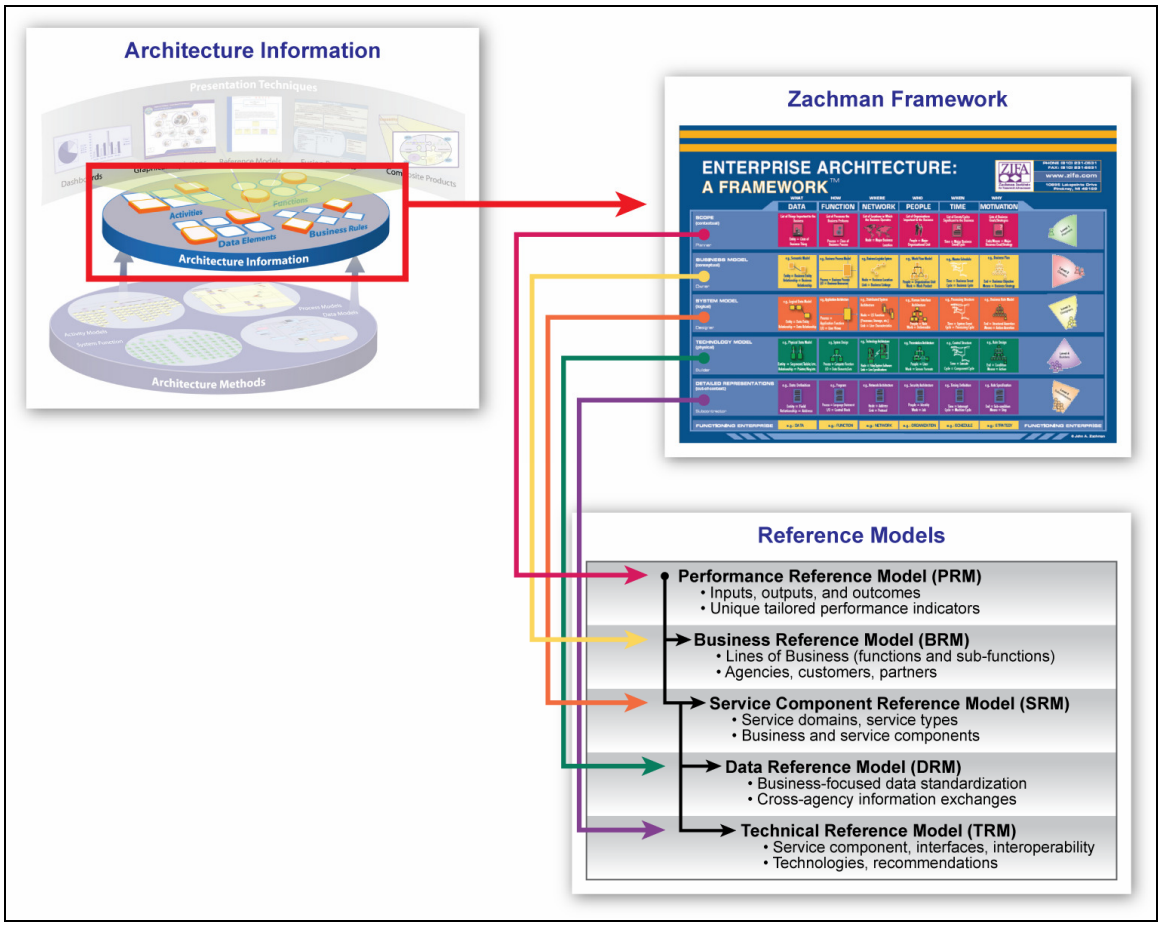

Figure 8.7-1: A Notional Reference Model

8.7.1 Purpose and Audience

Reference models are designed to facilitate cross-agency analysis, through the development of a common taxonomy and ontology for describing the business operations of Federal agencies, independent of any specific agency. Cross-agency analysis is used by planners and process owners to identify duplicate investments, gaps, and opportunities for collaboration within and across agencies. Collectively, the reference models comprise a framework for describing important elements of the FEA in a common and consistent way. Through the use of this common framework and vocabulary, IT portfolios can be better managed and leveraged across the Federal Government.[34]

8.7.2 Examples

One example of a reference model is the FEA BRM. The BRM provides an organized, hierarchical construct for describing the day-to-day business operations of the Federal Government. While many models exist for describing organizations, (organization charts,

[34] *Federal Enterprise Architecture Consolidated Reference Model Version 2.0.* Executive office of the President, Office of Management and Budget (OMB). A current version can be found at: http://www.whitehouse.gov/omb/assets/fea_docs/FEA_CRM_v23_Final_Oct_2007_Revised.pdf

location maps, etc.) this model presents the business using a functionally driven approach. The Lines of Business and Sub-functions that comprise the BRM represent a departure from previous models of the Federal Government that use antiquated, stove-piped, agency-oriented frameworks. The BRM is the first layer of the Federal Enterprise Architecture, and it is the main viewpoint for the analysis of data, service components, and technology (See **Figure 8.7.2-1**).[35]

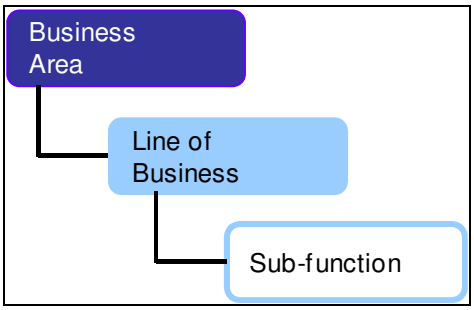

Figure 8.7.2-1: BRM Structure

The BRM is broken into four areas: Services for Citizens, Mode of Delivery, Support Delivery of Services, and Management of Government Resources. The model's four Business Areas are decomposed into 39 Lines of Business. Each business line includes a collection of Sub-functions that represent the lowest level of granularity in the BRM. For example, the Environmental Management Line of Business encompasses three Sub-functions: (1) Environmental Monitoring and Forecasting; (2) Environmental Remediation; and (3) Pollution Prevention and Control. Within each Sub-function are the agency-specific business functions, processes, and activities (see **Figure 8.7.2-2**).[36]

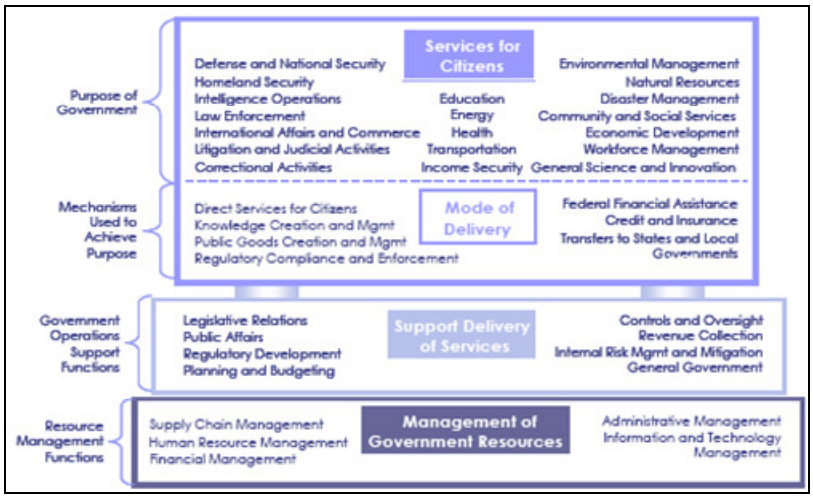

Figure 8.7.2-2: BRM Areas

[35] *Federal Enterprise Architecture Consolidated Reference Model Version 2.0*. Executive office of the President, Office of Management and Budget (OMB). A current version can be found at: http://www.whitehouse.gov/omb/assets/fea_docs/FEA_CRM_v23_Final_Oct_2007_Revised.pdf

[36] *Federal Enterprise Architecture Records Management Profile, Version 1.0,* December 15, 2005. Executive Office of the President. Office of Management and Budget. A current version of the profile can be found here: http://www.cio.gov/documents/RM_Profile_v1.pdf

Federal agencies are currently using the FEA reference models to plan and develop their annual budgets and set strategic goals. Agencies' annual budget submissions to OMB for IT must describe how these investments align to the business, performance, service component, and technical reference models. In practical terms, this means that agencies must describe their IT investments in terms of the business operations they will support, the functional capabilities they intend to deliver, the supporting technologies used to build or deliver the capabilities, and performance impacts.[37]

By providing a common language to describe the relationship between Federal business operations, technology, and information, the FEA enables the Government to identify opportunities to leverage technology which:

- Reduce unnecessary redundancy.
- Facilitate intergovernmental information sharing.
- Establish a direct relationship between IT and agency performance to support citizen centered, customer-focused Government.
- Maximize IT investments to better achieve mission outcomes.[38]

9. DODAF META-MODEL

Note: This section describes the DM2, which replaces the Core Architecture Data Model referenced in previous versions of DoDAF.

The DM2 provides a high-level view of the data normally collected, organized, and maintained in an Architectural Description effort. It also serves as a roadmap for the reuse of data under the federated approach to architecture development and management. Reuse of data among communities of interest provides a way for managers in any level or area of the Department to understand what has been done by others, and also what information is already available for use in their Architectural Description, and management decision-making efforts.

The DM2 has several levels, each of which is important to a particular viewer of Departmental processes. A conceptual level or ***CDM*** is described in this volume and defines the high-level data constructs from which Architectural Descriptions are created in non-technical terms, so that executives and managers at all levels can understand the data basis of Architectural Description.

The ***LDM*** adds technical information, such as attributes to the CDM and, when necessary, clarifies relationships into an unambiguous usage definition. The LDM is described further in Volume 2.

A ***PES*** is described in Volume 3, and consists of the LDM with general data types specified and implementation attributes (e.g., source, date) added, and then generated as a set of XSD's, one schema per DoDAF-described Model.

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[37] *Federal Enterprise Architecture Records Management Profile, Version 1.0,* December 15, 2005. Executive Office of the President. Office of Management and Budget. A current version of the profile can be found here: http://www.cio.gov/documents/RM_Profile_v1.pdf

[38] Federal Enterprise Architecture Records Management Profile

The 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 JCAs, Components, and Federal and Coalition partners, thus facilitating the understanding and implementation of interoperability of processes and systems. As the DM2 matures to meet the ongoing data requirements of process owners, decision makers, architects, and new technologies, it will to a resource that more completely supports the requirements for architectural data, published in a consistently understandable way, and will enable greater ease for discovering, sharing, and reusing architectural data across organizational boundaries.

To facilitate the use of information at the data layer, the DoDAF describes a set of models for visualizing data through graphic, tabular, or textual means. These views relate to stakeholder requirements for producing an Architectural Description.

9.1 The DoDAF Conceptual Data Model

The CDM defines concepts involving high-level data constructs from which Architectural Descriptions are created, enabling executives and managers at all levels to understand the data basis of Architectural Description. The key concepts are as follows:

- Activity: Work, not specific to a single organization, weapon system or individual that transforms inputs (Resources) into outputs (Resources) or changes their state.
- Agreement: A consent among parties regarding the terms and conditions of activities that said parties participate in.
- Architectural Description: Information describing an architecture such as an OV-5b Operational Activity Model.
- Capability: The ability to achieve a Desired Effect under specified (performance) standards and conditions through combinations of ways and means (activities and resources) to perform a set of activities.
- Condition: The state of an environment or situation in which a Performer performs.
- Constraint: The range of permissible states for an object.
- Data: Representation of information in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. Examples could be whole models, packages, entities, attributes, classes, domain values, enumeration values, records, tables, rows, columns, and fields.
- Desired Effect: The result, outcome, or consequence of an action (activity).
- Guidance: An authoritative statement intended to lead or steer the execution of actions.
- Information: The state of a something of interest that is materialized -- in any medium or form -- and communicated or received.
- Location: A point or extent in space that may be referred to physically or logically.

- Materiel: Equipment, apparatus or supplies that are of interest, without distinction as to its application for administrative or combat purposes.
- Measure: The magnitude of some attribute of an individual.
- Measure Type: A category of Measures.
- Organization: A specific real-world assemblage of people and other resources organized for an on-going purpose.
- Performer: Any entity - human, automated, or any aggregation of human and/or automated - that performs an activity and provides a capability.
- Person Type: A category of persons defined by the role or roles they share that are relevant to an architecture.
- Project: A temporary endeavor undertaken to create Resources or Desired Effects.
- Resource: Data, Information, Performers, Materiel, or Personnel Types that are produced or consumed.
- Rule: A principle or condition that governs behavior; a prescribed guide for conduct or action.
- Service: A mechanism to enable access to a set of one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description. The mechanism is a Performer. The capabilities accessed are Resources -- Information, Data, Materiel, Performers, and Geo-political Extents.
- Skill: The ability, coming from one's knowledge, practice, aptitude, etc., to do something well.
- Standard: A formal agreement documenting generally accepted specifications or criteria for products, processes, procedures, policies, systems, and/or personnel.
- System: A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements.
- Vision: An end that describes the future state of the enterprise, without regard to how it is to be achieved; a mental image of what the future will or could be like.

Additional CDM concepts are identified and defined in Appendix B.

The CDM also describes the relationships among data constructs in relatively non-technically and easily understood terms. **Figure 9.1-1** is a graphical representation of the CDM. The blue triangle-headed lines are read, “type-of” from bottom to top, (e.g., a System is a type-of Performer).

The associations between the concepts, are as follows, keyed to the footnote numbers from top to bottom and left to right:

1) Measurements are done in accordance with Rules, (e.g., Rules that specify how test measurement equipment must be calibrated before a test).
2) Certain types of Measures apply to an Activity, (e.g., how long it takes. This feature was part of the IDEF0 specification).
3) A Project consists of several or many Activities (e.g., Tasks).
4) Measures can be categorized into Measure Types.
5) There are Measures associated with a Project (e.g., time, cost).
6) Activities are performed in accordance with Rules (e.g., Controls in IDEF0).
7) A Project has Desired Effects (e.g., goals).
8) Desired Effects (e.g., goals) guide/drive Activities
9) Visions are realized by Desired Effects (e.g., objectives).
10) Desired Effects are Measureable; otherwise there wouldn't be any way to know they were achieved. This statement implies a measure can be constructed for all Desired Effects.
11) A Rule applies to an Activity under certain Conditions, (e.g., Rules of Engagement may vary dependent on threat Conditions).
12) An Activity is performable under certain Conditions, (e.g., the Conditions applicable to Tasks in the UJTL).
13) The performance of Activities under certain Conditions has Measures, (e.g., the Measure Types applicable to Tasks [Activities] in the UJTL).
14) Capabilities have Desired Effects, as so stated in the CJCSI 3170.
15) A Capability entails performance of Activities (Tasks), as so stated in the CJCSI 3170.
16) The performance of Activities as part of a Capability is done under certain Conditions, as so stated in the CJCSI 3170.
17) The performance of those Activities as part of a Capability has Measures (metrics) for their performance, as so stated in the CJCSI 3170.
18) A Condition has metrics (Measures).
19) An Activity is performed by a Performer under certain Conditions.
20) Performers perform Activities. This characteristic distinguishes Performers from their superclass, Resources.
21) The performance of Activities by Performers is subject to Rules. Even though Rules constrain Activities, there may be tailoring for the performance of those Activities by specific Performers.
22) The performance of Activities by Performers is subject to Measures. Activities can have Measures in and of themselves; however there can be additional or tailored Measures associated with the performance of those Activities by specific Performers.
23) An Activity consumes or produces Resources. Those Resources can be Materiel, Information, Data, Geo-Political, or other Performers. When the production and

consumption is of Information or Data, the DoDAF V1.5 OV-3, OV-5, SV-4, SV-6, and others are partially represented.

24) The consumption or production of Resources by Activities is subject to Rules, (e.g., the Information Assurance Rules that are part of the OV-3).

25) The consumption and production of Resources by Activities is measureable, (e.g., the Timeliness and Size measures that are part of the OV-3).

26) Activities result in effects on Effect Objects (Resources), i.e., a cause-effect chain.

27) The effect on Effect Objects by Activities is measureable.

28) A Capability is realized by one or more Performers (including configurations of Performer)

29) A Resource has Measures, (e.g., mass, size).

30) Performers perform at Locations.

31) The Skills of a Person Type are measureable, (e.g., Skill level of a Person Type.

32) Person Types have Skills).

33) Information describes a thing.

34) Information Pedigree is a type of Information that describes the production of Information (resources) by Activities, their Performers, and the Rules, Conditions, and Measures that apply to that information production.

35) A Person Type can be part of a System, (e.g., a radar operator or, more generally, in a cybernetic sense).

36) A Service provides access to Performers. This results from the DoD definition of Service which is verbatim from Organization for the Advancement of Structured Information Standards (OASIS).

37) Materiel can be part of a System, the parts and equipment that are part of a System.

These associations are formalized and made explicit (reified) in the LDM presented in Volume 2.

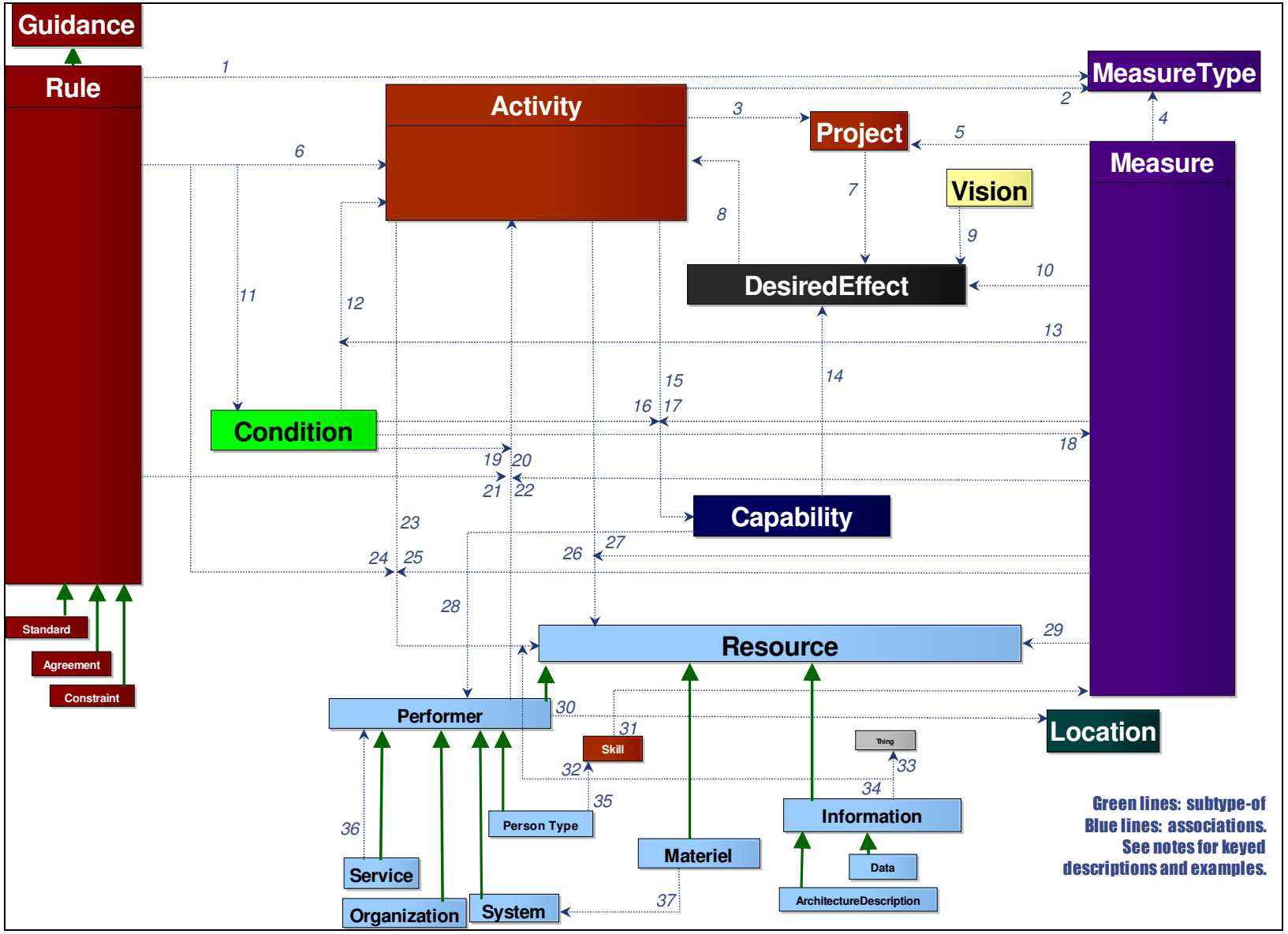

Figure 9.1-1: DoDAF Conceptual Data Model

Underlying the CDM is a foundation that utilizes common data modeling constructs that facilitate the reuse of common data patterns, an overview of which is shown in **Figure 9.1-2.**

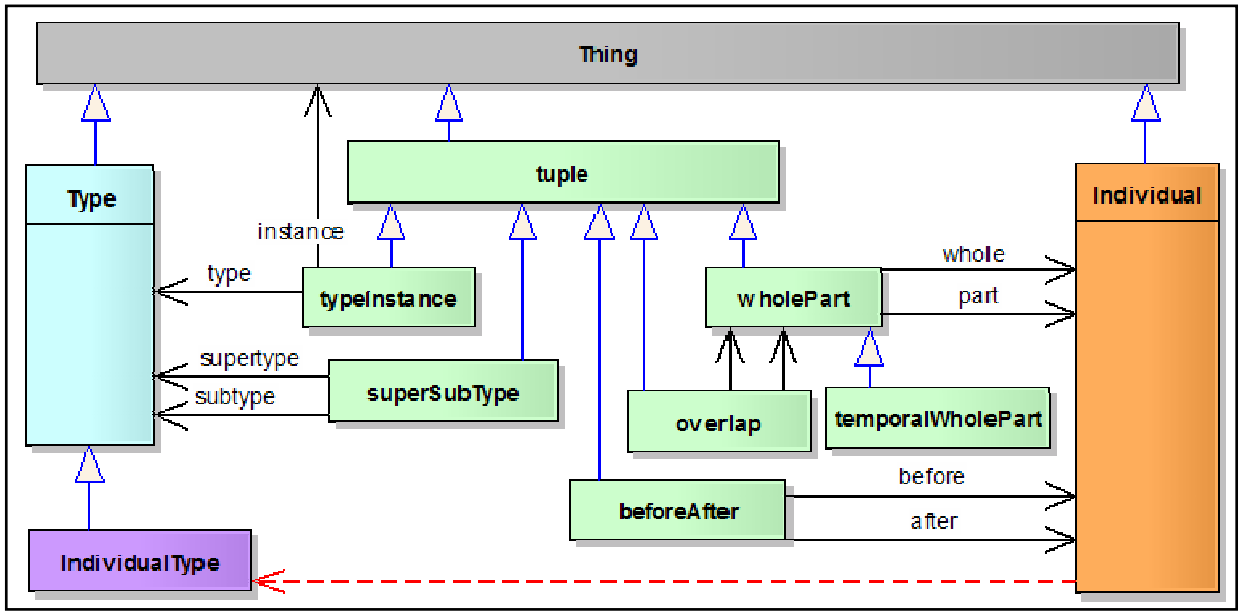

Figure 9.1-2: Overview of DM2 Foundation

The top-level foundation elements are:

a. ***Thing***, similar to other model's *object*.

b. ***Individual***, a *thing* that exists as an indivisible whole, or as a single member of a category.

c. ***Type***, a set of individuals or classes of other sets or classes.

d. ***Tuple***, ordered places of *things* (e.g., a block in a spreadsheet or a table).

These foundation elements are similar to many other foundation high-level data constructs that exist in the industry. The common patterns that are reused are:

a. ***Composition*** (or whole-part).

b. ***Super/Sub Type*** (or generalization/specialization, e.g., tank or main battle tank).

c. ***Before /After***, for *things* that have time-related relationships in their Type.

d. ***Overlap***, e.g., for *things* that can exchange other things that are parts of themselves, things that occur at overlapping times and overlapping places.

Composition and Super/Sub Type apply to almost all architecture concepts. Before/After is frequently used to model before/after situations, while Interface applies to few concepts, limited at this time to the pattern describing Activity.

The DM2 LDM presented in Volume 2 includes all the foundation elements, common patterns, and their linkage to DoDAF concepts. The DM2 LDM also introduces attributes, including some common core attributes for information pedigree, security classification marking, and identifiers.

10. ARCHITECTURE-BASED ANALYTICS

Architecture-based analytics includes all of the processes that transform architectural data into useful information in support of the decision making process. Various types of analysis are described below (static vs. dynamic), along with descriptions of desirable characteristics for the overall architectural data set needed for successful and accurate analysis capability. Architectural Descriptions are an ideal construct to use in decision-making since they represent the most current, and accurate information about a program or mission requirement.

10.1 Analytics Context

DoDAF V2.0 has been designed to facilitate collection of data usable through quantitative, repeatable, analytical processes to support decisions at all levels of enterprise and/or system engineering. Architectural views (formerly products) are no longer the end goal, but are described solely to facilitate useful access to information. All views are tailorable. The requirements for data completeness and self-consistency within the data schema are more critical than the view chosen at any particular time by a particular user. Analytics, properly conducted, represent a powerful tool for the decision-maker, ensuring that the most appropriate and current, as well as valid data is used for decision-making.

Figure 10.1-1 below, an adaptation of Figure 2-2, from Section 2, illustrates the overall architecting process. More specifically, it illustrates that analytics, the process of doing analysis with and on architectural data, is central to successful decision-making. Analysis defines and describes potential courses of action (i.e., alternatives) that can be considered when considering a mission or program decision.

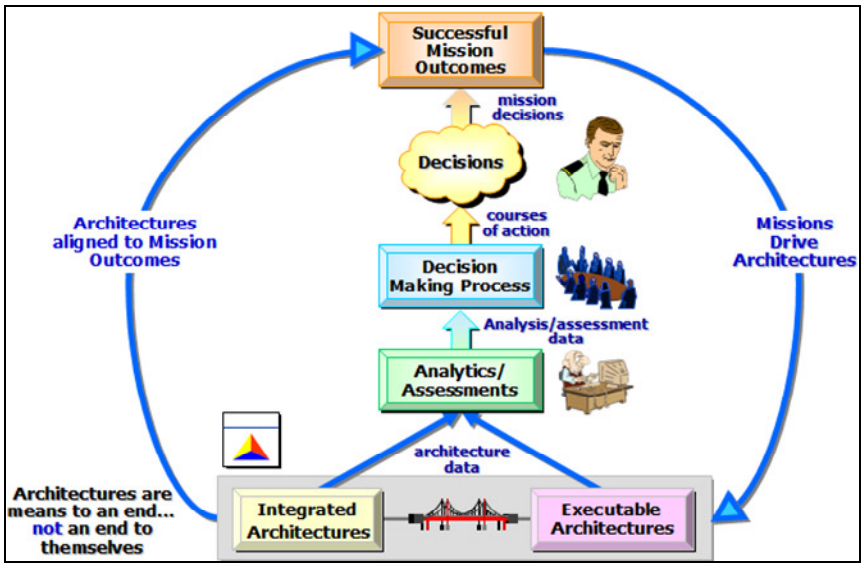

Figure 10.1-1: Analytics Process, Central to Transforming Architectural Data into Usable Forms to Support Decision-Makers

Architecture development is an iterative process, evolved over time. Analyses developed from architectural data remain valid only as long as the processes and information do not change, and management decision-making remains focused on the same problem for which the architectural

data was collected. When any of these variables (i.e., architecture purpose, process steps, information, or management direction) change, previous analyses should be reviewed to determine if the previous analysis needs to be redone, based on the newly provided information. Constant feedback and examination needs to be understood as natural in an environment where program direction and priorities are constantly in flux.

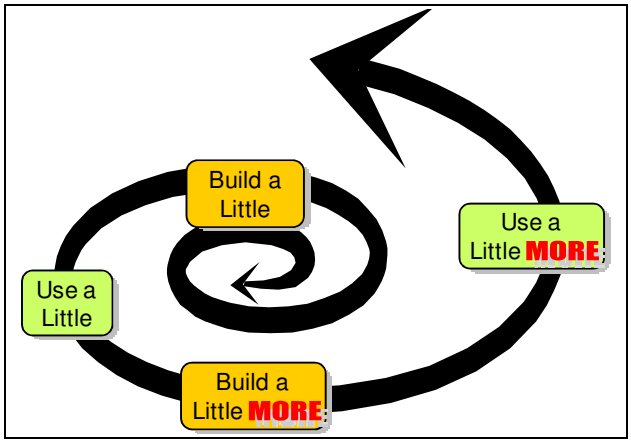

Figure 10.1-2: Iterative Approach

The need for an iterative analytical capability points towards tool-assisted and tool-supported analyses whenever possible. Process steps, such as re-running analyses, that are difficult or time consuming to perform will not likely be performed unless automated. The iterative approach, shown in Figure 10.1-2 of build a little, use a little, build a little, enables Architectural Descriptions to achieve incremental, reachable goals early and throughout the entire architecture lifecycle process.

10.2 Architecture Analytic

This is a process that uses architectural data to support decision-making through automated extraction of data from a structured dataset. Automated extraction may be nothing more than results from a query into a database. Architectural Descriptions that are well designed, and consistent with the purpose for which they were created, are also well suited to the analytics process.

10.3 Types of Architecture Analysis

There are two categories of analytical activity. These are:

- Static Analyses: Those analyses, which are based on making a value judgment, based on data extracted from the Architectural Description. For example, analysis of the weather patterns and measurements for the last 50 years to determine trends and correlations would be static analyses.
- Dynamic Analyses: Those analyses, which are based on running an executable version of the architectural data to observe the overall behavior of the model. For example, the construction and execution of a dynamic weather prediction model to determine the possible future weather trends is an example of dynamic analysis.

10.4 Examples of Analytics

Analytics can be used in conjunction with many aspects of the architecting process. Examples of analytical support can be found within DOTMLPF, as shown in Table 10.4-1, below. DOTMLPF is the analysis of who (people, organization, leadership) perform what operations (doctrine) at which locations (facilities) using (training) which system resources (material) to

produce and consume information and data. DOTMLPF analysis leads to better definitions of warfighting capabilities by being able to anticipate effects and assess impact of change on domains and by examining usage (who/what affects something) and references (who/what is affected by something). DOTMLPF domains map to DoDAF CDM concepts with the following analytical support activities.

Table 10.4-1: DOTMLPF

DOTMLPF Domains	DoDAF Conceptual Data Model concepts	Analytical Support Activities
Doctrine	Functions, Performers, Assets, Locations	Examine Tactics, Techniques, and Procedures
Organization	Performers, Org Units	Examine organizational structure
Training	Functions, Performers, Assets	Train personnel on their activities and the systems they use
Materiel	Functions, Material, Data, Information, Location, Assets, Performers	Examine materiel solutions – a new system?
Leadership	Org Units, Performers, Assets	Examine leadership issues
Personnel	Performers	Examine personnel solutions – new personnel or personnel with better qualifications
Facilities	Locations	Examine fixing, building, or modifying facilities

It is not the intent for DoDAF to prescribe all possible analytical activities. The list above is only a partial listing of potential activities that relate to DoDAF CDM concepts useful to the DOTMLPF domains. As more demands are placed on architecture, and as industry spawns more automation, the flexibility described in DoDAF will encourage further innovation from architects and from tool vendors.

10.5 Principles of Architecture Analytics

The five key foundational principles of architecture analytics are described below. These principles help in maintaining quality Architectural Description and foster further innovation for spawning new analytical activities in the future.

10.5.1 Information Consistency

Information consistency means that data (and its derived information) within an Architectural Descriptions is consistent with an overarching metadata structure (called a 'schema'). In addition to adhering to the explicit syntax rules of the schema, data also needs to be consistent with any additional rules specified for the project. Information consistency is often checked to some degree by commercial architecture tools, and additional checking capabilities can be implemented to help assure a more reliable architectural view.

Information consistency also refers to whether the data in one section of the Architectural Description agrees with the data in another section. For instance, if a specific Activity is assigned to a role in one place, yet in another portion of the Architectural Description, that role is shown as not having responsibility for that activity, this would be an information inconsistency. This is normal because the underlying architectural data is found in two or more places. In this case, the

tool itself or some configurable process should perform rule-based checks for redundancy to ensure the data in multiple places is consistent. Consistency also involves architecture integration where the underling architectural data is stated only once—one fact, one place—and the architectural views are projections of a single, inherently consistent model.

10.5.2 Data Completeness

Data completeness refers to the requirement that all required attributes of data elements are specified. For example, a set of system functions where only some of the functions have associated textual descriptions would not be data complete. Data completeness also refers to the property of having all necessary data to perform certain analyses, view (product/artifact) generation, and/or simulations or executable architectures.

Analytics demands that the architectural data be understandable. Not every analytical procedure will need to examine every part of the Architectural Description. However, no analytical procedure can analyze an Architectural Description that it cannot sufficiently understand, so the Architectural Description's structured dataset needs to be complete enough to support required analytics, thus making it essential that the structured dataset support and define all aspects of the Architectural Description. The architectural model, the projections of the model, and the transformations of the model should, to the extent possible, be based upon open standards. Open standards allow analytics choices

10.5.3 Transformation

Many decisions require the use of data contained in datasets created by different toolsets. Utilizing the data for analysis may require a transformation of the data into an alternative structure, which in turn may be accessed by another tool. Transformation allows the intellectual capital invested in the Architectural Description to reach beyond the set of tools used in creating it.

10.5.4 Iteration

Analysis needs to support an iterative architecture refinement and decision process (refer to Figure 10.1-1). Analysis that takes too long in any iteration will quickly become irrelevant to the overall process. Rather, small iterative steps or modules should be created that will produce reliable, trustable results.

10.5.5 Lack of Ambiguity

An architecturally structured dataset must make clear the meaning of each defined element. If there are semantically variable architectural constructs, they cannot be accurately analyzed by multiple analysis tools. This limits the scope and effectiveness of analytics and therefore limits the usefulness of the architecture itself. Semantic specificity is essential to gain the full benefit of analytics.

11. CONFIGURATION MANAGEMENT OF THE DODAF ARCHITECTURE FRAMEWORK

CM provides an orderly way to facilitate change, based on a documented requirements baseline, and utilizing best practices in the change management process. This is intended to ensure that expectations are fully understood and realized in an efficient manner, including proper consideration of all potential impacts on customers and resources. CM is a necessary and critical process to assure an orderly and stable evolution of any Architectural Description and also to ensure that the DoDAF remains current in the face of evolving methods and techniques of Architectural Description creation and management.

This section provides a summary overview of the two primary aspects of CM of DoD enterprise architecture efforts:

- CM guidance to developers of specific instance Architectural Descriptions prepared within DoD in accordance with the DoDAF.
- CM of the DoD Framework document content itself.

These CM activities are complementary with existing DoD CM processes for the DARS, the DoD Information Technology Standards Registry (DISR), and the Metadata Registry (MDR). A more comprehensive description of the overall CM Process is found online in the DoDAF Journal.

11.1 Configuration Management Authority

The CM Authority for the contents of the DoDAF document is the DoD CIO, Office of the Assistant Secretary of Defense (OASD) Enterprise Architecture & Standards Directorate.

11.2 Configuration Management Guidance for Program Managers

There are many benefits to the Department gained by adhering to a CM Program in the production of architectural data, thus providing consistency to the creation and utilization of presentation views, while still allowing flexibility in graphical presentation. These include:

- **Utilization of the DM2** (Conceptual, Logical and PES) in architectural data collection, organization, storage, and documentation.
- **Utilization of DoDAF technical guidance (Contained in Volume 2, and the DoDAF Journal)** in the creation and graphical representation of views, based on architectural data and a desired viewpoint. This is accomplished by:
  - DoDAF definition of attributes for common architectural views. Thus, there is a known basis for making change to architectural views, and a means for evaluating the effectiveness of that change according to the chosen viewpoint.
  - DoDAF representation of a common vocabulary and grammar for documenting Architectural Descriptions thus facilitating common understanding among DoD components, ensuring interoperability in exchanging architectural data and federation of individual Architectural Descriptions within a higher tier enterprise view.

- **Traceability of Requirements**. Architectural data can more easily be associated with baseline requirements, and, as requirements change, the associated impacts on present and future actions can more easily be evaluated, and more accurately reflect the change requirement.
- **Configuration Identification**. Utilization of DoDAF data elements allows a consistent identification of Configuration Items (CIs), which are currently defined as:
  - **The Vocabulary** – The Elements (e.g., process, system function, Capability) and Views (AV, OV, SV, StdV, etc.) that describe the behavioral, tabular, mapping, ontological, and structural representations of an Architectural Description. The metadata (e.g., Information about data in the Architectural Description).
  - **The Grammar–** The formal conceptual and logical relationships between elements and products of the Vocabulary – The Conceptual and LDM.
  - **The Presentation Guidelines** – "Fit-for-Purpose" viewpoints, dashboards, decision views, etc.
  - **Methods and Process Guidelines.**
  - **The DoDAF Document** – The narrative volumes comprising the DoDAF.
- **Organized Process**. Change activity is controlled through a known, documented, and organized process.
- **Improved Change Management**. Architectural data can be better managed to produce stable and consistent requirements to guide the development of interoperable systems, processes, and procedures.
- **Improved Analysis and Trades**. Analyses that better reflect customer need through common understanding and explicit documentation of architecture baselines and change evolution.

11.2.1 Configuration Management Implementation

Each Architectural Description effort must establish a CM process and document it in a CM Plan. This plan is submitted when each version or update to the Architectural Description is submitted to DARS for registration and discovery. In developing CM processes for Architectural Descriptions it is recommended that best practices be adopted such as those outlined in Electronic Industries Alliance (EIA) Standard EA-649[39]. This a flexible, but well-defined standard employed most often at the enterprise level. Its flexibility lies in the ability to provide CM practices that can be selectively applied to the degree necessary for each of the areas to be covered under this plan.

[39] *ANSI/GEIA Standard EIA 649-A National Consensus Standard for Configuration Management* American National Standards Institute. This standard is available at: http://www.techstreet.com/cgi-bin/detail?product_id=1160265

11.2.2 Evaluating Architecture Changes

Appropriate evaluation criteria should be developed in the CM Plan and applied according to the scope and tier of the Architectural Description effort. The evaluation criteria must include factors that test compliance with the Net-Centric Reference Architectures and the DoD IE as outlined in Section 3.0 of the DoDAF and the Net-Centric Guidance contained in Volume 2. The results of architecture evaluations should be used to guide decisions for approving proposed changes, as well as in planning future extensions or updates to the Architectural Description.

11.2.3 The DARS Registration Process

Consistent with the federated architecture approach described in Section 3, essential architectural information must be registered with DARS so that discovery of reusable architectural data can be accomplished throughout the Department. Generally, and as further described in the instructions on registration contained online in the DARS, this consists of the Overview and Summary Information (AV-1) which can be completed online, and the Configuration Control Plan (CCP) that describes how the organization intends to manage and periodically update its information. Individual data entities and other artifacts are similarly registered in the DMR.

11.3 Configuration Control Board

The DoDAF Configuration Control Board (CCB) provides an organized management review process to ensure validity, currency, and timeliness of architectural data described over time. The board provides CM and control carefully scoped and administered to reduce the burden and complexity of architecture sharing and maintenance, as well as update, while providing flexibility to the DoD community in the continued management of their architectural views and associated data. The CCB consists of members appointed by the Deputy DoD CIO, and includes representatives of the Joint Staff, the Office of the Secretary of Defense (OSD), the Military Services, Combatant Commands, and Defense Agencies.

11.4 Technical Working Groups

The CCB may, from time to time, establish technical working groups (TWG), as required, to oversee, review, and make recommendations to the board on specific technical aspects of the CM Program, or configuration items. TWGs provide the subject-matter expertise necessary to ensure that documents, the DM2, and other products under configuration control of the CCB are maintained in a responsible manner. TWGs, when tasked by the CCB, provide detailed and comprehensive technical review of proposed changes and recommendations to the CCB on action(s) to be taken that result from recommended changes.

In addition, there is a standing TWG for the DM2. DM2 change requests (action items) can be raised by any of the working group members or flow down from the CCB. A working copy of the DM2 is maintained, along with all reference and research materials and the current action item tracker. DM2 issues impacting the foundation are forwarded to the International Defense Enterprise Architecture Specification (IDEAS) Group for consideration. When a number of changes have accumulated, the TWG recommends a new DM2 baseline version be established and released. Upon, approval by the CCB, the new DM2 is published along with a record of changes from last baseline and a new working copy is setup.

Both permanent members of the CCB and members of all technical working groups are notified about all CCB meetings and all scheduled TWG sessions, as are the Combatant Commands and Defense Agencies.

12. RELATIONSHIPS TO OTHER ARCHITECTURE FRAMEWORKS/REFERENCE DOCUMENTS

DoDAF is designed to align, map, and socialize with industry, allies with their own national frameworks, and other reference documents required for interoperability, reuse, and operational purposes. The DoDAF approach to alignment is to incorporate relevant concepts into DoDAF from other frameworks and reference documents and understand, integrate and describe the differences.

12.1 Frameworks

Frameworks are documents that describe useful methods, practices, and procedures for developing Architectural Descriptions. Frameworks can be prescriptive (e.g., their use is required) or descriptive (i.e., their use is recommended). DoDAF has both prescriptive and descriptive elements that organizations within the Department require its use in developing Architectural Descriptions that respond to their mandates.

12.1.1 Federal Enterprise Architecture Program

The FEA promotes shared development for common Federal processes, interoperability, and sharing of information among the Agencies of the Federal Government and other Governmental entities through the use of a set of reference models and practices that apply to all Federal agencies in the Executive branch. The FEA Practice Guidance uses a ***segment architecture*** approach that allows critical parts of the overall Federal Enterprise, called architectural segments, to be developed individually, while integrating these segments into the larger Enterprise Architecture. The DoDAF leverages the FEA construct and core principles to provide the Department with the enterprise management information it needs to achieve its strategic transformation goals, while ensuring that upward reporting and review can be accomplished against the FEA.

The current version of the FEA can be found at the E-Gov Website: *http://www.whitehouse.gov/omb/e-gov/fea/*.

12.1.2 The Zachman Framework

The Zachman Framework provides a formal and highly structured way of defining an enterprise. It is based on a two-dimensional classification model, displayed as a matrix, which utilizes six basic communication interrogatives (What, How, Where, Who, When, and Why) and intersecting six distinct model types which relate to stakeholder groups (Strategists, Executive Leaders, Architects, Engineers, Technicians, and Workers) to give a holistic view of the enterprise. Decomposition of the matrix allows for several diagrams of the same data sets to be developed for the same architecture, where each diagram shows an increasing level of detail.

DoDAF V2.0 supports the needs of various stakeholders' perspective by supporting various levels of abstraction and granularity.

The Zachman Framework can be found at the Zachman International Website:
http://zachmaninternational.com/manages/stories/The%20Zachman%20Framework.pdf

12.1.3 The Open Group Architecture Framework

TOGAF is a comprehensive architecture framework and methodology, which enables practitioners to design, evaluate, and build an appropriate architecture for the organization. The TOGAF Architecture Development Method (ADM) supports the TOGAF architecture development approach for architectures that meet business needs. TOGAF's ADM prescribes methodology, not products, or modeling notation, and should be used with other architecture frameworks as appropriate. TOGAF evolved from the DoD Technical Architecture Framework for Information Management (TAFIM). DoDAF V2.0 and TOGAF both provide a practical, design agnostic method for creating enterprise architectures. The DoDAF V2.0 "Fit-for-Purpose" approach for developing views, presentations, or generated reports are based on TOGAF's business, data, application, and technology views.

The latest version of TOGAF can be found at the Open Group Website:
http://www.opengroup.org/architecture/togaf/

12.1.4 The Ministry of Defence Architecture Framework

MODAF is based on the DoDAF V1.0 baseline, which it represents through the MODAF Meta Model (M3). MODAF retains compatibility with United States modeling initiatives, but is specifically designed to support architecture modeling for the UK Ministry of Defense (MOD) business. MODAF uses aspects of the existing DoDAF with additional viewpoints (acquisition, capability) that are required to support MOD processes, procedures, and organizational structures. The additional viewpoints provide a rigorous method for understanding, analyzing, and specifying capabilities, systems, System of Systems (SoS), business processes, and organizational structures. DoDAF V2.0 incorporates the data elements from MODAF required to support an acquisition and capability views in DoDAF V2.0.

The latest version of the MODAF can be found at the MODAF Website:
http://www.modaf.org.uk/

12.1.5 NATO Architecture Framework

The NAF provides the rules, guidance, and product descriptions for developing, presenting, and communicating architectures across NATO and other national boundaries. Earlier versions of NAF were tightly coupled to the DoDAF. NAF's new features include a capability, service-oriented, and program view. DoDAF V2.0 has adopted the capability and program views described in NAF as defined by NAF.

The NATO Architecture Framework can be found at the NATO Website. (Requires User Registration).

12.2 Other Reference Documents

Several other documents, described below, have a particular impact on the development of Architectural Descriptions in the Department and are included in this section for that purpose.

12.2.1 DoD Information Enterprise Architecture

The DoD Information Enterprise Architecture (IEA) provides a common foundation to support accelerated DoD transformation to net-centric operations and establishes priorities to address critical barriers to its realization. The DoD IEA comprises the information, information resources, assets, and processes required to achieve an information advantage and share information across the Department, and with other mission partners.

12.2.2 DoD Business Enterprise Architecture

The DoD Business Enterprise Architecture (BEA) Architectural Description provides a comprehensive description of the major business areas of the Department, and serves the departure point for integrating DoD business services across the Departmental programs and the JCAs.

12.2.3 DoD Global Information Grid Enterprise Architecture

The GIG facilitates mission accomplishment by providing tactical services from the edge in support of the warfighter. The GIG Architectural Description maps operational outcomes in critical strategic and tactical areas to the DoD JCAs. Currently, the GIG contains an Operational Reference Model which provides a functional decomposition of activities associated with the five key areas defined as GIG 2.0 attributes.

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APPENDIX A
ACRONYMS

This is the integrated DoDAF V2.0 acronyms and their definitions. Some have more than one definition depending on their usage; they could have a specific meaning in Architecture as well as generic English language usage.

Acronym	Definition
ADM	Architecture Development Method
AMETL	Agency Mission Essential Task List
ASD	Assistant Secretary of Defense
AT&L	Acquisition Technology and Logistics
AV	All Viewpoint
BEA	Business Enterprise Architecture
BMM	Business Motivation Model
BPMN	Business Process Modeling Notation
BPR	Business Process Reengineering
BRM	Business Reference Model
BT	Business Transformation
BTA	Business Transformation Agency
C4I	Command, Control, Communications, Computers and Intelligence
C4ISRAF	Command, Control, Communications, Computers, and Intelligence Surveillance Reconnaissance Architecture Framework
CADM	Core Architecture Data Model
CCB	Configuration Control Board
CCP	Configuration Control Plan
CDD	Capability Development Document
CDM	Conceptual Data Model
CIO	Chief Information Officer
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Manual
CM	Configuration Management
COI	Community Of Interest
COMSEC	Communications Security
CONOPS	Concepts of Operations
CPD	Capability Production Document
CPIC	Capital Planning and Investment Control
CPM	Capability Portfolio Management
CRM	Consolidated Reference Model
CV	Capability Viewpoint
CWID	Coalition Warrior Interoperability Demonstration
DAES	DoD Architecture Enterprise Services
DARS	DoD Architecture Registry System
DAS	Defense Acquisition System

Acronym	Definition
DDMS	DoD Discovery Metadata Specification
DIEA	DoD Information Enterprise Architecture
DISR	DoD Information Technology Standards and Profile Registry
DITPR	DoD Information Technology Portfolio Repository
DIV	Data and Information Viewpoint
DM2	DoDAF Meta-model
DMR	DoD Metadata Registry
DoDAF	DoD Architecture Framework
DoDI	Department of Defense Instruction
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
DPG	Defense Planning Guidance
DRM	Data Reference Model
EA	Enterprise Architecture
EAAF	Enterprise Architecture Assessment Framework
EAMMF	Enterprise Architecture Management Maturity Framework
EIA	Electronic Industries Alliance
E-ISP	Enhanced-Information Support Plan
FEA	Federal Enterprise Architecture
FEA-CRM	Federated Enterprise Architecture-Consolidated Reference Model
FEA-RM	Federal Enterprise Architecture Reference Model
FIPS	Federal Information Processing Standard
FISMA	Federal Information Security Management Act
GAO	Government Accountability Office
GIG	Global Information Grid
IC	Intelligence Community
ICD	Initial Capabilities Document
IDEAS	International Defence Enterprise Architecture Specification
IDEF0	Integration Definition for Activity Modeling
IE	Information Environment
IEA	Information Enterprise Architecture
INFOSEC	Information Security
IP	Internet Protocol
IRTPA	Intelligence Reform and Terrorism Prevention Act of 2004
ISE	Information Sharing Environment
ISE-EAF	Information Sharing Environment Enterprise Architecture Framework
ISM	Information Security Marking
ISO	International Standards Organization
IT	Information Technology
ITS/NSS	Information Technology/National Security Systems
JCA	Joint Capability Area
JCIDS	Joint Capability Integration and Development System
JCPAT	Joint C4I Program Assessment Tool
JCS	Joint Chiefs of Staff

Acronym	Definition
JCSFL	Joint Common System Function List
JFCOM	Joint Forces Command
JMETL	Joint Mission Essential Task List
KM/DS	Knowledge Management/Decision Support
LDM	Logical Data Model
M3	MODAF Meta Model
MDA	Milestone Decision Authority
MDR	Metadata Registry
MOD	Ministry of Defence
MODAF	Ministry of Defence Architecture Framework
NAERG	Naval Architecture Elements Reference Guide
NATO	North Atlantic Treaty Organization
NCDS	Net Centric Data Strategy
NCE	Net-Centric Environment
NCSS	Net-Centric Services Strategy
NII	Networks and Information Integration
NIST	National Institutes for Standards & Technology
NSS	National Security Systems
OASD	Office of the Assistant Secretary of Defense
OASIS	Organization for the Advancement of Structured Information Standards
OMB	Office of Management and Budget
OMG	Object Management Group
OO	Object-Oriented
OOAD	Object-Oriented Analysis & Design
OSD	Office of the Secretary of Defense
OUSD	Office of the Undersecretary of Defense
OV	Operational Viewpoint
PDA	Personal Digital Assistant
PDCA	Plan, Do, Check, and Act
PDM	Physical Data Model
PES	Physical Exchange Specification
PFD	Process Flow Diagram
PL	Public Law
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting, and Execution
PRM	Performance Reference Model
PTD	Process Task Dependency
PV	Project Viewpoint
RA	References Architecture
RM	Reference Model
SADT	Structured Analysis and Design Technique
SE	Systems Engineering
SEP	Systems Engineering Plan
SIPRNET	Secret IP Router Network

Acronym	Definition
SLC	Shelf Life Code
SOA	Service-Oriented Architecture
SRM	Service Component Reference Model
SV	Systems Viewpoint
TA	Tiered Accountability
TAFIM	Technical Architecture for Information Management
TEMPEST	Transient Electromagnetic Pulse Emanation Standard
TOGAF	The Open Group Architecture Framework
TRM	Technical Reference Model
TV	Technical Standards View
TWG	Technical Working Groups
U.S.	United States
UJTL	Universal Joint Task List
UK	United Kingdom
UML	Unified Modeling Language
UPDM	Unified Profile for DoDAF and MODAF
URL	Uniform Resource Locator
USD	Under Secretary of Defense
V&V	Validation & Verification
WBS	Work Breakdown Structure
XML	eXtensible Markup Language
XSD	XML Schema Definition

APPENDIX B
CONCEPTUAL DATA MODEL DEFINITIONS

Table B-1: Conceptual Data Model Definitions

Technical Term	Composite Definition	Potentially Related Terms or Aliases
Activity	Work, not specific to a single organization, weapon system or individual that transforms inputs (Resources) into outputs (Resources) or changes their state.	Action, Process Operational Activity, Processes, Function, System Function, Operation, Task, Plan, Project
Adaptability Measure	A measure of the ease with which Performers satisfy differing Constraints and Capability and Service needs.	
Address	The name of a location along with the location-finding scheme that allows a location to be found from the name. Examples include postal address, email address, URL, datalink address.	
Agreement	A consent among parties regarding the terms and conditions of activities that said parties participate in.	
Capability	The ability to achieve a Desired Effect under specified [performance] standards and conditions through combinations of ways and means [activities and resources] to perform a set of activities.	
Condition	The state of an environment or situation in which a Performer performs.	
Constraint	The range of permissible states for an object.	Business Rule, Rule, Restraint, Operational Limitation, Guidance
Country	A political state or nation or its territory.	
Data	Representation of information in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. Examples could be whole models, packages, entities, attributes, classes, domain values, enumeration values, records, tables, rows, columns, and fields.	
Desired Effect	The result, outcome, or consequence of an action [activity].	DesiredEffectType IndividualDesiredEffect
Domain Information	Types of information within the scope or domain of the architecture.	
Effects Measure	Category of measures on Effect Objects	

Table B-1: Conceptual Data Model Definitions

Technical Term	Composite Definition	Potentially Related Terms or Aliases
Facility	A real property entity consisting of underlying land and one or more of the following: a building, a structure (including linear structures), a utility system, or pavement.	
Functional Standard	Functional standards set forth rules, conditions, guidelines, and characteristics.	
GeoFeature	An object that encompasses meteorological, geographic, and control features mission significance	
GeoPolitical Extent	A geospatial extent whose boundaries are by declaration or agreement by political parties.	
Guidance	An authoritative statement intended to lead or steer the execution of actions.	
Information	Information is the state of a something of interest that is materialized -- in any medium or form -- and communicated or received.	
Installation	A base, camp, post, station, yard, center, or other activity, including leased facilities, without regard to the duration of operational control. An installation may include one or more sites.	
Location	A point or extent in space that may be referred to physically or logically.	
Maintainability Measure	A category of measures of the amount of time a Performer is able to conduct Activities over some time interval.	
Materiel	Equipment, apparatus or supplies that are of interest, without distinction as to its application for administrative or combat purposes.	
Measure	The magnitude of some attribute of an individual.	
Measure Type	A category of Measures	
Needs Satisfaction Measure	A category of quality measures that address how well a system meets the user's needs and requirements.	
Organization	A specific real-world assemblage of people and other resources organized for an on-going purpose.	Department, Agency, Enterprise
Organizational Measure	A category of quality measures that address how costly a Performer is to operate and maintain.	
Performance Measure	A category of quality measures that address how well a Performer meets Capability needs.	

Table B-1: Conceptual Data Model Definitions

Technical Term	Composite Definition	Potentially Related Terms or Aliases
Performer	Any entity - human, automated, or any aggregation of human and/or automated - that performs an activity and provides a capability.	Actor, Agent, Capability Configuration (MODAF)
Person Type	A category of persons defined by the role or roles they share that are relevant to an architecture.	Role
Physical Measure	A category of measures of spatio-temporal extent of an Individual such as length, mass, energy, velocity	
Port	An interface (logical or physical) provided by a System.	
Project	A temporary endeavor undertaken to create Resources or Desired Effects.	Plan, Tactic, Strategy, Activity
Real Property	Land and improvements to land (i.e., facilities).	
Region Of Country	A large, usually continuous segment of a political state or nation or its territory.	
Region Of World	A large, usually continuous segment of a surface or space; area.	
Resource	Data, Information, Performers, Materiel, or Personnel Types that are produced or consumed.	
Rule	A principle or condition that governs behavior; a prescribed guide for conduct or action	
Service	A mechanism to enable access to a set of one or more capabilities , where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description. The mechanism is a Performer. The “capabilities” accessed are Resources -- Information, Data, Materiel, Performers, and Geo-political Extents.	
Service Channel	A logical or physical communication path between requisitions and services.	
Service Description	Information necessary to interact with the service in such terms as the service inputs, outputs, and associated semantics. The service description also conveys what is accomplished when the service is invoked and the conditions for using the service.	Service Interface Description (UPDM)
Service Level	A measurement of the performance of a system or service.	
Service Port	A part of a Performer that specifics a distinct interaction point through which the Performer interacts with other Performers. This isolates dependencies between performers to particular interaction points rather than to the performer as a whole.	Mediator (OASIS SOA RA), Service Interface (UPDM)

Table B-1: Conceptual Data Model Definitions

Technical Term	Composite Definition	Potentially Related Terms or Aliases
Site	Physical (geographic) location that is or was owned by, leased to, or otherwise possessed. Each site is assigned to a single installation. A site may exist in one of three forms: (1) Land only, where there are no facilities present and where the land consists of either a single land parcel or two or more contiguous land parcels. (2) Facility or facilities only, where the underlying land is neither owned nor controlled by the government. A stand-alone facility can be a site. If a facility is not a stand-alone facility, it must be assigned to a site. (3). Land and all the facilities thereon, where the land consists of either a single land parcel or two or more contiguous land parcels.	
Skill	The ability, coming from one's knowledge, practice, aptitude, etc., to do something well.	Training, Knowledge, Ability
Spatial Measure	A category of measures of the spatio-temporal location of an Individual.	
Standard	A formal agreement documenting generally accepted specifications or criteria for products, processes, procedures, policies, systems, and/or personnel.	
System	A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements.	
Technical Standard	Technical standards document specific technical methodologies and practices to design and implement.	
Temporal Measure	A type of measure of time	
Vision	An end that describes the future state of the enterprise, without regard to how it is to be achieved; a mental image of what the future will or could be like	

APPENDIX C
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