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DoD Deputy Chief Information Officer

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The DoDAF Architecture Framework Version 2.0

Welcome to the DoDAF web site! This website is the online documentation for the Department of Defense Architecture Framework.

The Promulgation Memo was signed on 28 May 2009 and is the prescribed framework for all Department architectures. 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.

DoDAF Conformance criteria is listed here.

Version 2.0

This documentation release is Version 2.0. This numbering aligns the documentation with the DoDAF Meta Model (DM2) version 2.0. This is the current release of DoDAF as of May 2009.

A PDF is produced periodically and can be downloaded here: DoDAF 2.0.pdf

Please note that this site is intended to be a living document. As such, minor editorial and style changes will occur.

Contact Information

For any general enquiries, please contact us via the general enquiry mailbox.

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Introduction

The Department of Defense Architecture Framework (DoDAF), Version 2.0 is 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. DoDAF is prescribed for the use and development of Architectural Descriptions in the Department. It also 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 within their areas of authority and responsibility. They select an architect and an architecture development team to create the architecture in accordance with the requirements they define.

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

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.

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.

DoDAF V2.0 provides a Data Capture Method for each data group of the DM2 to guide architects in collecting and organizing the necessary architectural data.

The DoDAF enables architectural content that is "Fit-for-Purpose" as an architectural description consistent with specific project or mission objectives. Because the techniques of 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 can be documents, spreadsheets, dashboards, or other graphical representations and serve as a template for organizing and displaying data in a more easily understood format. When data is collected and presented as a "filled-in" model, 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. 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. This enables organizations to use their own established presentation preferences in their deliberations.

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

Specific DoDAF-described Models for a particular purpose are prescribed by process-owners. All the DoDAF-described Models do not have to be created. 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.

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, 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 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. **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.**

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

Framework (C4ISR AF) or DoDAF, in that architects now have the freedom to create enterprise architectures to meet the demands of their customers. The 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 to make 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 they 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. It 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.

The DoDAF Journal is the electronic interface for DoDAF support. The DoDAF Journal provides a place for submitting future change requests to DoDAF or the DM2; provides examples, and includes descriptions of other best practices, lessons learned, and reference documents including:

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

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What is New in DoDAF V2.0

The major changes for DoDAF V2.0 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.
- Products have been replaced by views that represent specific types of presentation for architectural data and derived information. With the focus on data, DoDAF V2.0 does not have products but has DoDAF-described Models. Rather than the Operational Viewpoint-5 (OV-5) Operational Activity Model Product, there is the Activity Model with the same supporting data. This is shifting the focus of the architecture effort onto the data early in the Architecture Development Process.
- 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 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:
    - 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.

- System has changed from DoDAF V1.5. System is not just computer hardware and computer software. System is now defined in the general sense of an assemblage of components - machine, human - that perform activities (since they are subtypes of Performer) and are interacting or interdependent. This could be anything, i.e., anything from small pieces of equipment that have interacting or interdependent elements, to Family of Systems (FoS) and System of Systems (SoS). Note that Systems are made up of Materiel (e.g., equipment, aircraft, and vessels) and Personnel Types.
- 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 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 DoDAF Meta-model (DM2), containing a Conceptual Data Model (CDM), a Logical Data Model (LDM), and a Physical Exchange Specification (PES) has been created.
- Approaches to SOA development are described and discussed.
- For the architect, DoDAF V2.0 changes the focus of the Architecture Development Process are described in "What Does the Architect Need to Do"? The basis of the Architecture Development Process is now the Data Meta-model Groups, described in the LDM.
- To align with ISO Standards, where appropriate, the terminology has changed from Views to Viewpoint (e.g., the Operational View is now the Operational Viewpoint).
- DoDAF can capture the security markings and is described in the PES. In addition, a discussion of the security characteristics mapped to the DoDAF Concepts has been added.
- In DoDAF V1.5 and previous versions, Nodes are logical concepts that caused issues in the exchange and discussion of architectures. In one architecture that was reviewed, Operational Nodes mapped to System, Organization, Person Type, Facility, Materiel, and Installation. Within the same architecture, System Node maps to System, Materiel, Organization, and Location. The overlap Organizational and System nodes (System, Organization, Material) illustrates the complexity of trying to define Nodes. The concrete concepts of Node (including Activities, System, Organization, Person Type, Facility, Location, Materiel, and Installation) were incorporated into the DoDAF Meta-model. Since Nodes are logical concepts that could be used to represent the more concrete concepts of activities, systems, organizations, personnel types, facilities, locations, materiels, and installations or combinations of those things, DoDAF V2.0 focuses on those concrete concepts. There will not be a mapping of Node to the DoDAF V2.0 Meta-model Groups, concepts, classes, or associations. For the architect, there are some changes in architecture development:
    - When appropriate, DoDAF V1.0 and V1.5 architectures that use the Node concept will need to update the architecture to express the concrete concepts in place of the abstract concept that Node represents. When pre-DoDAF V2.0 architecture is compared with DoDAF V2.0 architecture, the concrete concepts that Node represents must be defined for the newer architecture.
    - DoDAF V2.0 architectures will need to express the concrete concepts (activities, systems, organizations, personnel types, facilities, locations, materiels, and installations, etc.).

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DoDAF V2.0 Vision

Provide an overarching set of architecture concepts, guidance, best practices, and methods to enable and facilitate architecture development in support of major decision processes across all major Departmental programs, Military components, and Capability areas:

- Be 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.

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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 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). It is the foundation for long-term administration and management of architectural data and its accompanying models (templates), views, and consolidated viewpoints.

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

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 thing, such as an activity). It enables the federation of all pertinent architecture information, and provides full referential integrity. Logical consistency of the data thus becomes a critical ‘property’ of architectures of all types.

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:

- **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. Instances of Enterprise Architectures include Capability, Segment, Mission Thread, and Strategic

Architectures.

- **Solution Architectures**: A framework or structure that portrays the relationships among all the elements of something that answers a problem. This architecture type 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 another architecture. A Solution Architecture is the most common type of architecture developed in the Department.

Version 1.0 and 1.5 of the DoDAF used the term ‘product’ or ‘products’ to describe visualizations of architecture data. In DoDAF V2.0, 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. 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. The architectural data described in DoDAF V2.0 can support many model and view requirements; the regulations and instructions should be consulted for specific model and view requirements.

Maintaining and Managing Architectures

Embedding architecture development process in routine planning and decision-making institutionalizes the architecture and makes the maintenance of architectural data, views, and viewpoints more automatic. Architectures are maintained and managed within the Department through a process of *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.

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.

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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. 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:

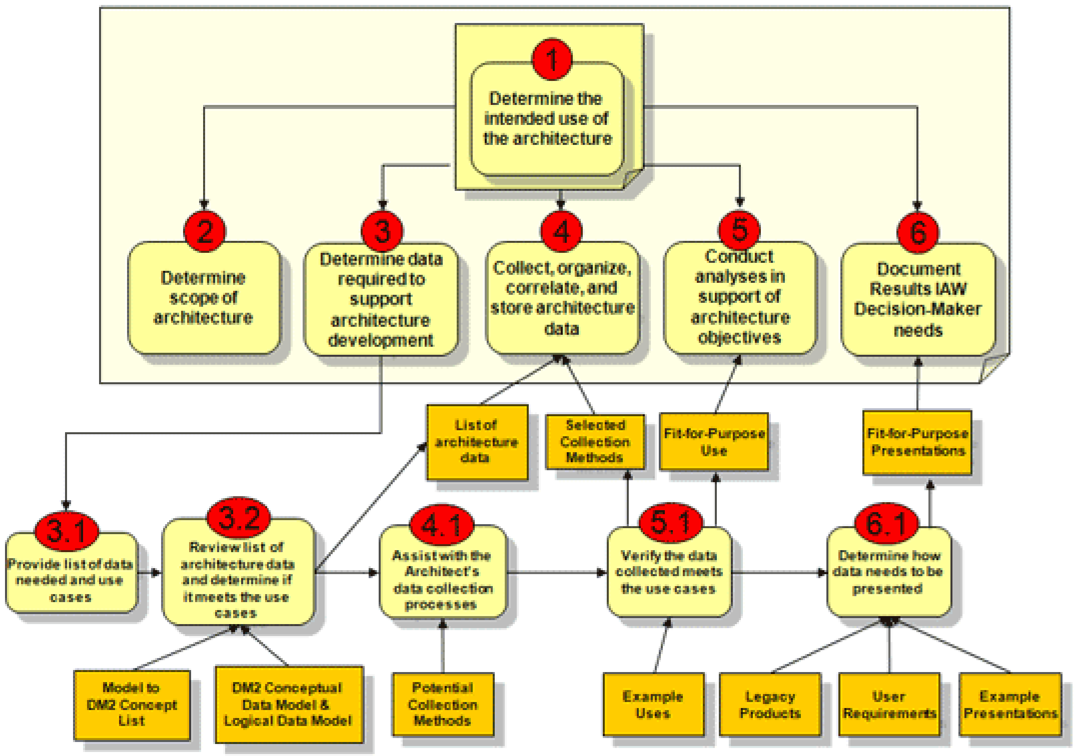
- Identifies the Purpose and Scope for the Architecture. The 6-Step Architecture Development Process provides a structure for development of scope and purpose.
- Transmits to the architect and development team the scope and purpose of the architecture effort, along with those goals and objectives that 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.

The **figure below** shows 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. In each step, the 'Meta-model Groups' referred to by the step is that data in the Meta-model Groups in DM2.

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.

- 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). In that step, the architect determines the appropriate collection methods for the "Fit-for-Purpose" needs. The LDM 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. The LDM 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). The DoDAF described Models describes each of the DoDAF-described Models. This step results in presentation creation in Step 6 of the 6-Step Architecture Development Process.



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.

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Guidelines

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 for which they are produced. 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. It also offers flexibility in approach, toolset utilization, and techniques (e.g., structured analysis, object-oriented, and service-oriented).

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:

- **Focus:** Architectural Descriptions should clearly support the stated objectives, i.e., be “Fit-for-Purpose.” While DoDAF V2.0 describes a number of models, diligent scoping of a project and any guiding regulations, instructions, or standard procedures will determine the specific visualization requirements appropriate to a particular architectural effort.
- **Efficiency:** Architectural Descriptions should be as simple and straightforward as possible, while still achieving their stated purpose. Architectural descriptions should reflect the level of complexity defined by the purpose for their creation. Rigorous scoping of a project will ensure that the resulting architectural data, derived information, and the views created are consistent with their original purpose. 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.
- **Clarity:** 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 technology in the enterprise. It supports the decision-making process and provides a record to explain critical choices to technical and non-technical managerial staff.
- **Comparability:** 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.
- **Integration of data:** 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

Physical Exchange Specification, as a resource to achieve 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.

- **Data-Centricity:** Architectural Descriptions should be data centric. 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.
- **Tool-Agnostic:** Multiple toolsets, with varying internal rules, techniques, notations, and methods may be used, consistent with the PES. 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, and is capable of producing data that can be shared in a federated environment. 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 Physical Exchange Specification to collect, organize, and share architectural data.
    - Capable of eXtensible Markup Language (XML) data transfer to/from architectural tools and other resources, such as the DoD Architecture Registry System (DARS) for registering architectural data.

- **Reusability:** Architectural data should be organized, reusable, and decomposed sufficiently for use by architectural development teams and decision support analysis teams. Whenever possible, data common to other Architectural Descriptions should be used. New data should be created so that it becomes discoverable to others with similar requirements.
- **Net-Centricity:** 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 they 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.
- **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 and is capable of producing data that can be shared in a federated environment. Eessential toolset attributes desirable for creation of Architectural Descriptions utilizing DoDAF are listed below.
- **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 to collect, organize, and share architectural data.
    - Capable of eXtensible Markup Language (XML) data transfer to/from the DMR, and other resources for registering architectural data.

Tailoring Architecture to Customers' Needs

- 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.

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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 use architectural data to influence management decision making.

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 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.

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.

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. JCIDS implements an integrated, collaborative process to guide development of new capabilities through changes in joint DOTMLPF and policy.

JCIDS process owners have written 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.

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. The DAS uses Joint Concepts, integrated architectures, and DOTMLPF analysis in an integrated, collaborative process to ensure that desired capabilities are supported by affordable systems and other resources.

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). The Defense Acquisition Management Framework 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 for aligning resources and as an input to the Defense Planning Guidance (DPG), Program Objective Memorandum (POM) development, and Program and Budget Reviews.

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.

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

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.

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 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.

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.

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.

Net-centric Integration

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

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 in the area of terrorist-related information. Since that time, new Federal legislation 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, 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. When published, that ISE document should be used in coordination with DoDAF to ensure that these specific types of data meet established Federal standards.

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DM2 Support for Viewpoints and DoD Key Processes

The DoDAF V2.0 Meta-model Groups support the viewpoints and DoD Key Processes of JCIDS, DAS, PPBE, System Engineering, Operations, and Portfolio Management (IT and Capability). The table below indicates a non-inclusive mapping of DoDAF Meta-model Groups to the DoDAF Viewpoints and DoD Key Processes. The support for the Key Processes is for the information requirements that were presented at the workshops for the key processes and, as such, do not reflect all of the information requirements that a key process could need.

DoDAF Meta-model Groups Mapping to Viewpoints and DoD Key Processes

Metamodel Data Groups	View Points	**DoD Key Processes**
	AV, CV, DIV,OV,PV,StdV, SvcV, SV	JCIDS, DAS, PPBE, System Engineering, Operations, Portfolio Management (IT and Capability)
Performer	CV, OV, PV,StdV, SvcV, SV	J, D, P, S, O, C
Activity	OV	J, O, C
Resource Flow	AV, CV, DIV,OV,PV,StdV	J, S, O
Data and Information	AV, DIV	J, D, P, S, O, C
Capability	CV, PV, SV, SvcV	J, D, P, S, O, C
Services	CV, StdV, SV	P, S, C
Project	AV, CV, PV, SvcV, SV	D, P, S, C
Training/Skill/Education	OV, SV, SvcV, StdV	J, S, O
Goals	CV, PV	J, D, P, O, C
Rules	OV, StdV, SvcV, SV	J, D, S, O
Measures	SvcV, SV	J, D, S, O, C
Location	SvcV, SV	P, S, O

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Architectural 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 listed below, 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.

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://cio-nii.defense.gov/ cio/diea/
DoD Architecture Registry System (DARS)	DARS is the DoD registry 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	The Systems metadata from the Architecture can be used to populate DITPR with new or updated information. DITPR can also populate the	https://www.dadms.navy.mil/

	inventory of MC/ME/MS systems, and the registry for systems under DoDI 5000.2.	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.	
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 (SIPRNet)
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	Use the taxonomy to align or extend system functions within the architecture being developed	https://us.ar.y.mil/suite/page/419489

	development.		
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 (SIPRNet)
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
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,	https://stalwart .spawar .navy.mil/ naerg/

		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.	
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.	http://metadata.dod.mil, Select the “NCES Service Discovery” button
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

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DoDAF V1.5 Support

The architectures for DoDAF V1.0 and DoDAF V1.5 may continue to be used. When appropriate (usually indicated by policy or by the decision-maker), DoDAF V1.0 and V1.5 architectures will need to update their architecture. When pre-DoDAF V2.0 architecture is compared with DoDAF V2.0 architecture, concept differences (such as Node) must be defined or explained for the newer architecture.

In regard to DoDAF V1.5 products, they have been transformed into parts of the DoDAF V2.0 models. In most cases, the DoDAF V2.0 Meta-model supports the DoDAF V1.5 data concepts, with one notable exception: Node. Node is a complex, logical concept that is represented with more concrete concepts. The table below indicates the mapping of DoDAF V1.5 products to DoDAF V2.0 models.

Mapping of DoDAF V1.5 Products to DoDAF V2.0 Models

DoDAF V2.0 / DoDAF V1.5	Operational Viewpoint	Systems Viewpoint	Services Viewpoint	All Viewpoint	Standards Viewpoint	Data & Information Viewpoint
AV-1				AV-1		
AV-2				AV-2		
OV-1	OV-1					
OV-2	OV-2					
OV-3	OV-3					
OV-4	OV-4					
OV-5	OV-5a, OV-5b					
OV-6a	OV-6a					
OV-6b	OV-6b					
OV-6c	OV-6c					
OV-7						DIV-2
SV-1		SV-1	SvcV-1			
SV-2		SV-2	SvcV-2			
SV-3		SV-3	SvcV-3a, SvcV-3b			
SV-4a		SV-4				
SV-4b			SvcV-4			
SV-5a		SV-5a				
SV-5b		SV-5b				
SV-5c			SvcV-5			
SV-6		SV-6	SvcV-6			
SV-7		SV-7	SvcV-7			
SV-8		SV-8	SvcV-8			
SV-9		SV-9	SvcV-9			
SV-10a		SV-10a	SvcV-10a			
SV-10b		SV-10b	SvcV-10b			
SV-10c		SV-10c	SvcV-10c			
SV-11						DIV-3
TV-1					StdV-1	
TV-2					StdV-2	

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Relationships to Other Architecture Frameworks/Reference Documents

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.

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.

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 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 Open Group Architecture Framework

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 Ministry of Defence Architecture Framework

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.

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.

Reference Architectures

The Architectures described below have a particular impact on the development of Architectural Descriptions in the Department:

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.

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.

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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DoDAF Background

Authority: Law, Policy, and Historic Perspective

Federal law and policies have expressed the need for architectures in support of business decisions.

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" 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. Alignment with the reference models ensures that important elements of the FEA are described in a common and consistent way. 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.

Historical Evolution of DoDAF

Historical Evolution of DoDAF The Command, Control, Communications, Computers, and Intelligence, Surveillance, and Reconnaissance Architecture Framework (C4ISR AF) 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 Core Architecture Data Model which provided for data organization and sharing.

DoDAF V1.5, dated 23 April 2007, 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 better 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 required. Updates 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.

DoDAF V2.0 – The Need for Change

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 **Solutions ("Program Level") Architecture**. This architecture has been required, defined, and supported by major Departmental processes for solution evaluation, interoperability, and resource allocation. **Enterprise Architecture** provides a roadmap for change as well as a context and reference for how and where programs fit within a larger 'enterprise' picture. DoDAF V2.0 supports the development and use of both solution architectures and enterprise-wide architectures. 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.

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. When it is used to work 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 can provide better harmonization of architecture content and process requirements. Additionally, such a tailored architecture can be shared and provide insight into best practices that benefits programs, architects, and process owners well beyond its original scope. Architectural content include data defining generic performance measures (metrics), capabilities, and relevant PfM data, all of which are analytically useful to process owners and systems engineers.

Product-Centric to Data-Centric. Prior versions of DoDAF and 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 new emphasis on utilizing architectural data to support analysis and decision-making, and greatly expands the graphical representations of that data. It is possible to present architectural data in a meaningful, useful, and understandable manner using the techniques and templates contained in DoDAF V2.0 and the DoDAF Journal.

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Methodologies

The 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 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.

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:

- **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), 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

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customization of the generic method for use in major departmental functions and operations.

NOTE: The methodology described is also 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. The Service Viewpoint 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 Architectural Data and Models and the DM2 PES, provide the information needed for use in developing an Architectural Description. When utilizing another method, reference to this 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.

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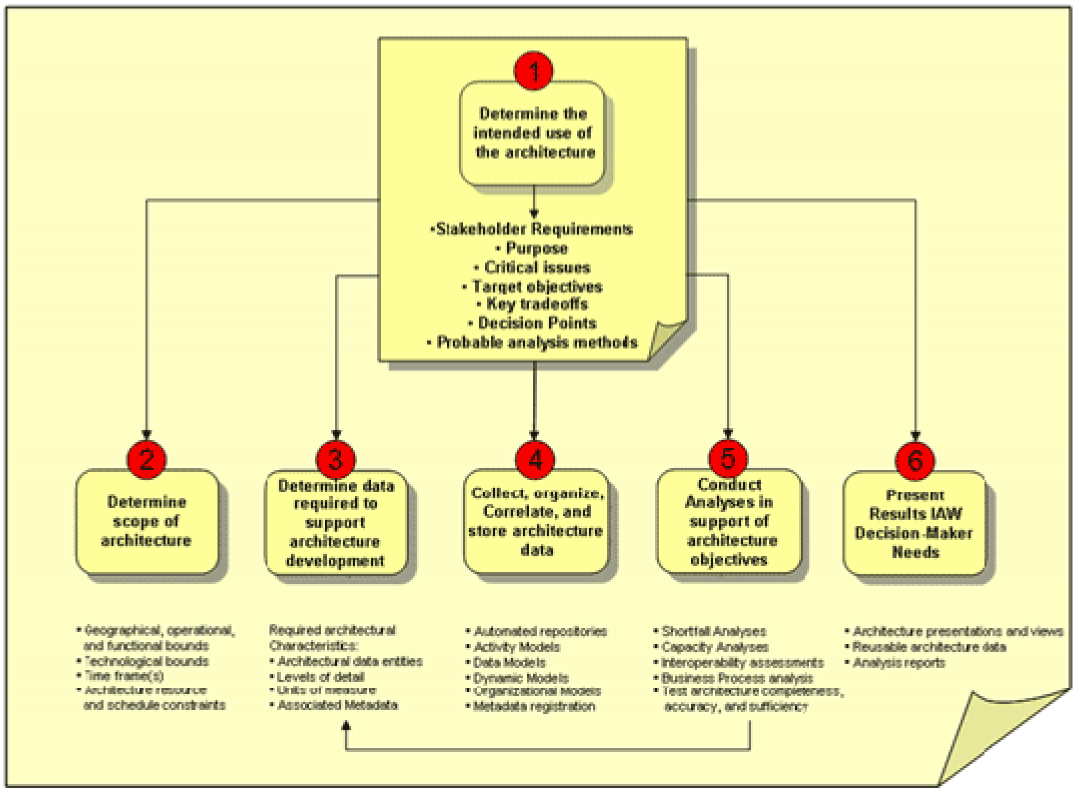
6-Step Architecture Development Process



Architecture Development 6-Step Process

[Step 1: Determine Intended Use of Architecture](#)
[Step 2: Determine Scope of Architecture](#)
[Step 3: Determine Data Required to Support Architecture Development](#)
[Step 4: Collect, Organize, Correlate, and Store Architectural Data](#)
[Step 5: Conduct Analyses in Support of Architecture Objectives](#)
[Step 6: Document Results in Accordance with Decision-Maker Needs](#)

The high-level, 6-step architecture development process provides guidance to the architect and Architectural Description development team and emphasizes the guiding principles. 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. The figure above depicts this 6-step process.

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NOTE: It is important to note 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.

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.

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.

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.

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.

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 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.

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, 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 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.

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).

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

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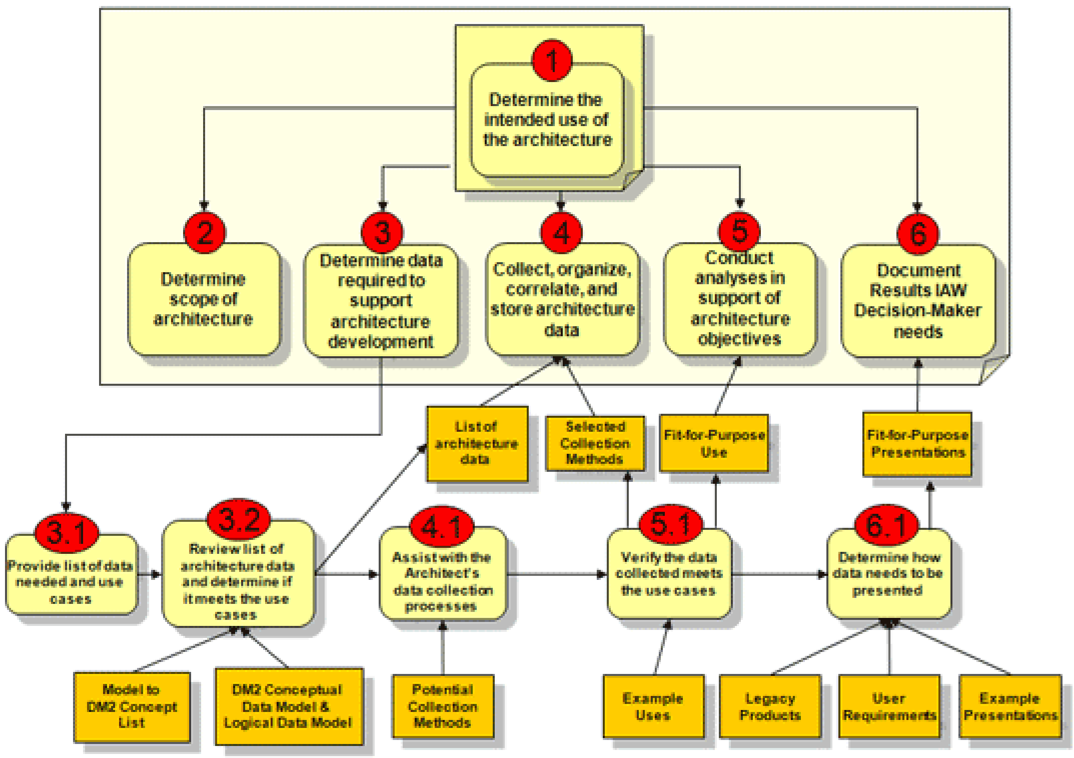
What Does the DoD Manager (Decision-maker, Process-Owners, Executive, or Stakeholder) Need to Do?

The DoD Manager identifies the Purpose and Scope for the Architectural Description and gains agreement with the architect. Through the 6-Step Architecture Development Process described below, the DoD Manager needs to remain involved from end-to-end to support the Architectural Description development.

What Does the Decision-Maker Need To Do?



The manager's responsibilities in each step are as follows:

- Step 3.1: After the DoD Manager has determined the Purpose and Scope (Steps 1 and 2), they needs to review the Purpose and Scope with the architect. In order for the architecture to be "Fit-for-Purpose", the DoD Manager needs to provide the architect with the list of data needed and the usage of that data (use-cases). The DoD Manager, ***not the architect***, is the subject matter expert. The DoD Manager, in concert with the architect, will determine the problem to be solved, the decisions to be made, and the corresponding data and information to be captured and analyzed. These key responsibilities can not be delegated to the architect.
- Step 3.2: The DoD Manager reviews the DoDAF-described Models and Fit-for-Purpose Views, Concepts, Associations, and Attributes that, according to the architect, meet the data requirements and use-cases.
- Step 4.1: The DoD Manager must assist or provide the data needed to enable the

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architecture collection method to work.

- Step 5.1: The DoD Manager needs to verify that the data collected meets their needs (use-cases) and is sufficient to support the analysis that will be performed in Step 5.
- Step 6.1: Based on data collected in Step 4 and the use-cases, the DoD Manager determines the appropriate methods of presentation of the “Fit-for-Purpose” views and to support their decision processes.

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What Does the Architect Need to Do?

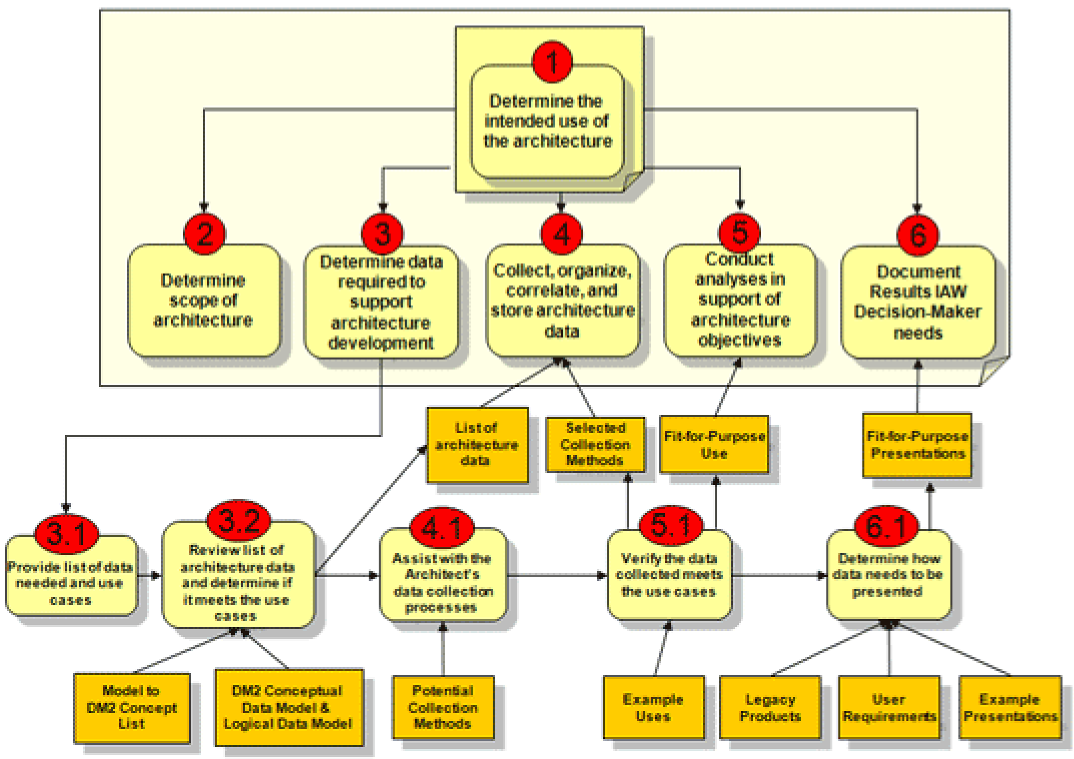
Using DoDAF V2.0 and the DoDAF Journal, the architect needs to perform two key activities:

- Develop the Architectural Description. (see below)
- Enable use of the Architectural Description in the solution implementation.

Develop the Architectural Description

Once the Architectural Description Purpose and Scope are identified, what does the architect need to do? Within the 6-Step Architecture Development Process, in Step 3 the architect determines the data needed to support the Architectural Description development.

In each step, the Meta-model Groups referred to by the step is that data in the Meta-model Groups in the DoDAF Meta-model. The figure below depicts the sub steps that the architect needs to perform within the 6-Step Architecture Development Process. Some of these sub steps are performed in concert with the decision-maker, but the architect has more steps than the decision-maker.



What Does the Architect Need to Do?

The architect's detailed steps, as part of the 6-Step Architecture Development Process are as follows:

- Step 3.1: Using the DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models in Mappings to DM2 Concepts, the architect determines the DoDAF-

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described Models needed, based on the concepts required to satisfy the architecture's purpose and scope (from Step 1 and 2 of the 6-Step Architecture Development Process). The architect also determines the Fit-for-Purpose Views needed, also based on the concepts required to satisfy the architecture's purpose and scope.

- Step 3.2: After determining the DoDAF-described Models and Fit-for-Purpose Views required, the architect reviews the:
  - DM2 Conceptual Data Model
  - DM2 Logical Data Model
  - DM2 Concepts, Associations, and Attributes
  - DoDAF Meta-model Data Dictionary

- Step 4.1: With the concepts identified in the Architectural Description's Purpose and Scope (from Step 1 and 2 of the 6-Step Architecture Development Process), the required DoDAF-described Models and Fit-for-Purpose Views, the available DM2 metadata, the architect determines the specific architecture DM2 Meta-model Groups, concepts, associations, and attributes that need to be collected for the Architecture Development Process. The tables in the Method subsections of Section 2, Meta-model Data Groups, identify the specific data.
- Step 4.2: The architect assembles the list of required DoDAF-described Models and Fit-for-Purpose Views, DM2 Meta-model Groups, Concepts, Associations, and Attributes. This provides the list of architectural data that needs to be collected, organized, correlated, and stored as part of Step 4 of the 6-Step Architecture Development Process.
- Step 4.3: Using the identified Meta-model Groups in the DM2, the architect determines the method to collect the data. With the specific list of required DoDAF-described Models, Fit-for-Purpose Views, DM2 Meta-model Groups, Concepts, Associations, and Attributes, the architect determines the appropriate collection methods for the "Fit-for-Purpose" needs. The results of this sub-step should guide the collection methods that will be performed in Step 4 of the 6-Step Architecture Development Process.
- Step 5.1: Using the identified Meta-model Groups in the DM2, the architect determines the usage of the data. With the specific list of required DoDAF-described Models, Fit-for-Purpose Views, DM2 Meta-model Groups, Concepts, Associations, and Attributes, the architect determines the appropriate usage to satisfy the identified "Fit-for-Purpose" needs. The architect needs to determine the "Fit-for-Purpose" use of the architectural data that will meet the decision-maker's purpose and support the decision processes, including the analysis that will need to be performed in Step 5 of the 6-Step Architecture Development Process. The results of this sub step should support the analysis that will be performed in Step 5 of the 6-Step Architecture Development Process. Architectural Description analysis is key to proper use of an architecture by its stakeholders. Such analysis should be the joint responsibility of the stakeholders and the architect to ensure it answers the stakeholders' questions.
- Step 6.1: Using the identified Meta-model Groups in the DM2, the architect and decision-maker determines the presentations of the data.

With the specific list of required:
- DoDAF-described Models
- Fit-for-Purpose Views
- DM2 Meta-model Groups
- Concepts, Associations, and Attributes along with the:

- Legacy Products
- User Requirements
- Example Presentations

The architect and decision-maker determines the appropriate presentations (Fit-for-Purpose Views) and data for the identified “Fit-for-Purpose” needs that will meet the decision-maker’s purpose and support their decision processes.

The results of this sub-step should support the presentations (Fit-for-Purpose Views) that will be created in Step 6 of the 6-Step Architecture Development Process. The DoDAF V2.0 Architecture Development Process for the DoDAF-described Models in the DoDAF Journal presents a non-prescriptive set of tasks to develop DoDAF-described Models in a Microsoft Project Plan.

Using Architectural Metadata >>

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What Does the Architect Need to Do?

Using the DoDAF V2.0 and the DoDAF Journal, the architect needs to perform two key activities:

- Develop the Architectural Description.
- Enable use of the Architectural Description in the solution implementation. (below)

Using Architectural Metadata

In addition, as the architecture is being developed, architecture metadata can be used (and updated) to support various processes and to populate architecture resources for implementation. One of the Net-Centric Data Strategy goals supported is to enable the architecture to be Discoverable as a reusable Architecture Resource. The figure below illustrates the potential uses of architecture metadata for the processes they can support and the architecture resources that can be populated from the metadata captured in an architecture repository. It is important to note that architecture metadata can be used throughout the development process, not just at the end of the architecture effort.

The architecture metadata can support:

- Defense Acquisition System process with Project metadata.
- Planning, Programming, Budgeting, and Execution (PPBE) process with Cost metadata
- Information Support Plan (ISP) process with Capability metadata.
- Systems Design and Systems Engineering processes with various metadata, e.g., capability, activity, processes, systems, services, cost, project, data, and taxonomies.
- Service description, service port, and service Resource Flow metadata is used to populate a Service Registry.
- AV-2 metadata is used to create DDMS data catalog entries for authoritative sources.
- Resource Flow and Physical Schema metadata is used to populate the Metadata Registry.
- DoD Information Technology Portfolio Repository (DITPR) population with System data.

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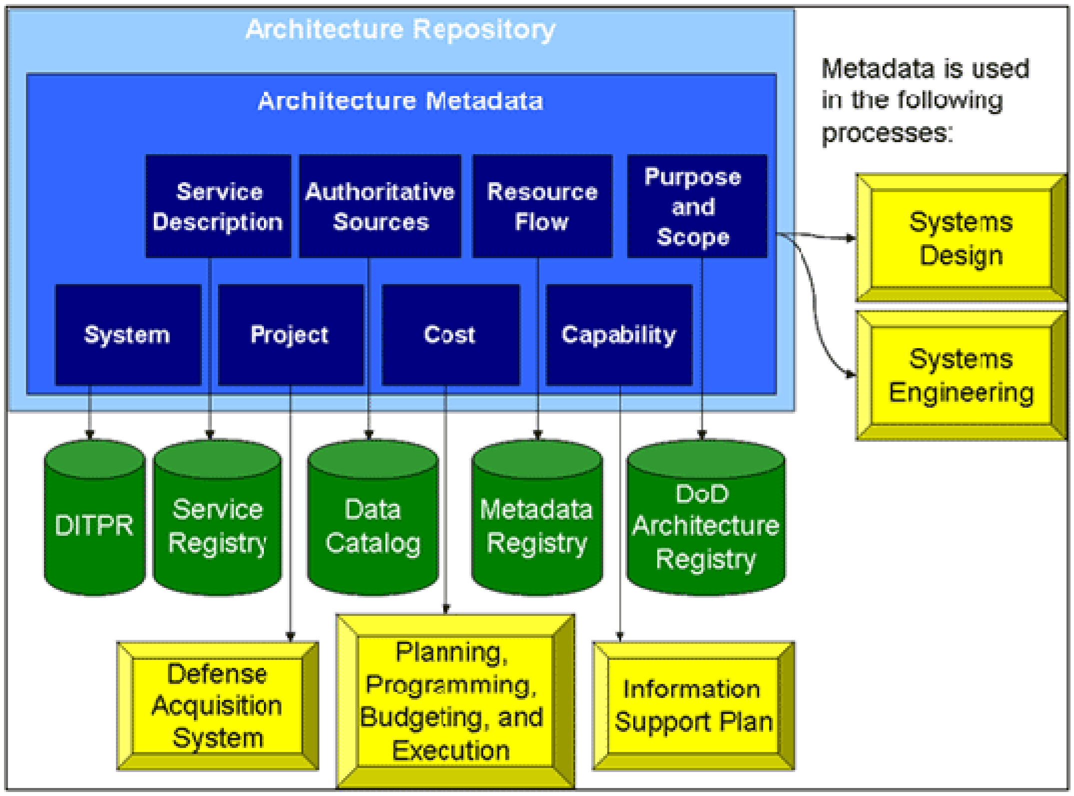

Architectural Metadata Supports Implementation

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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."*

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.

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 below. 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

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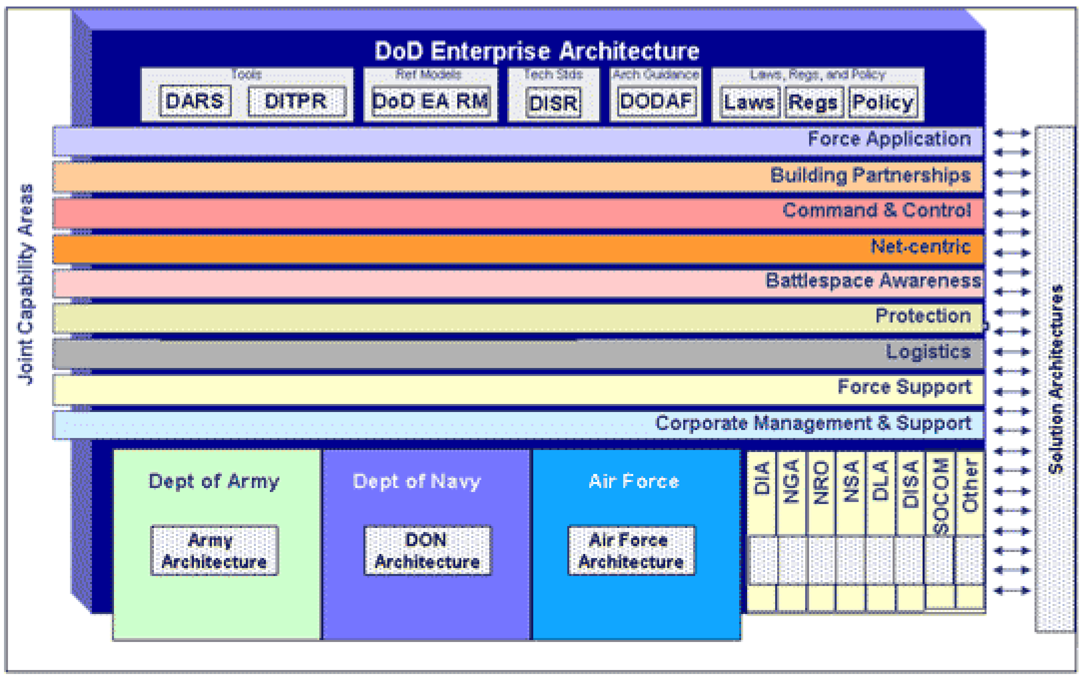
to Segment architecture information, to establish and enforce standards, guide security and information assurance requirements across the Department of Defense, and provide a sound basis for transition from the existing DoD environment to the future. The DoD EA is a federation of Architectural Descriptions 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.



Components of the DoD EA

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.

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.

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.

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.”

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.

DoD Architecture Enterprise Services

The next generation of DoD Enterprise Architectures will be constructed by employing a set of DoD Architecture Enterprise Services (DAES) 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. 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 , 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.

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 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, 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.

References to Architectural Description Development

Resource	Description	Architecture Use
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

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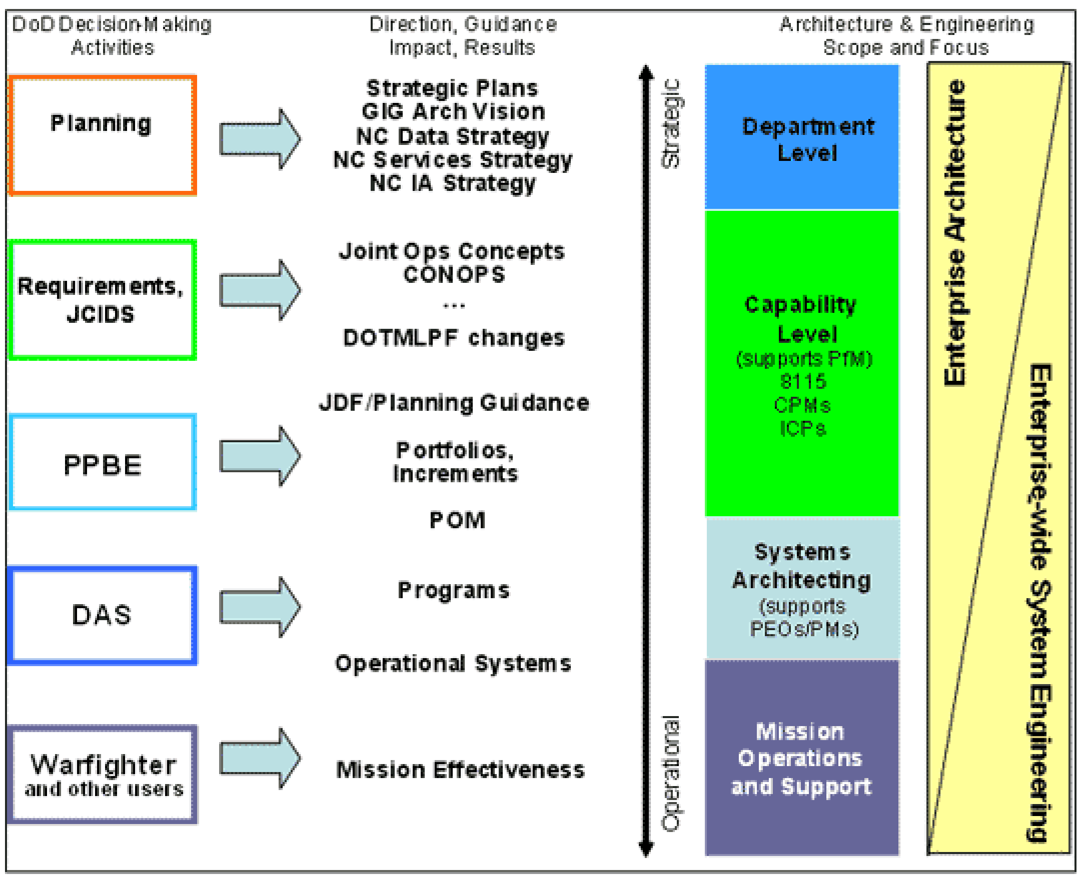
Scoping Architectures to be "Fit-for-Purpose"

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 the figure below.



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

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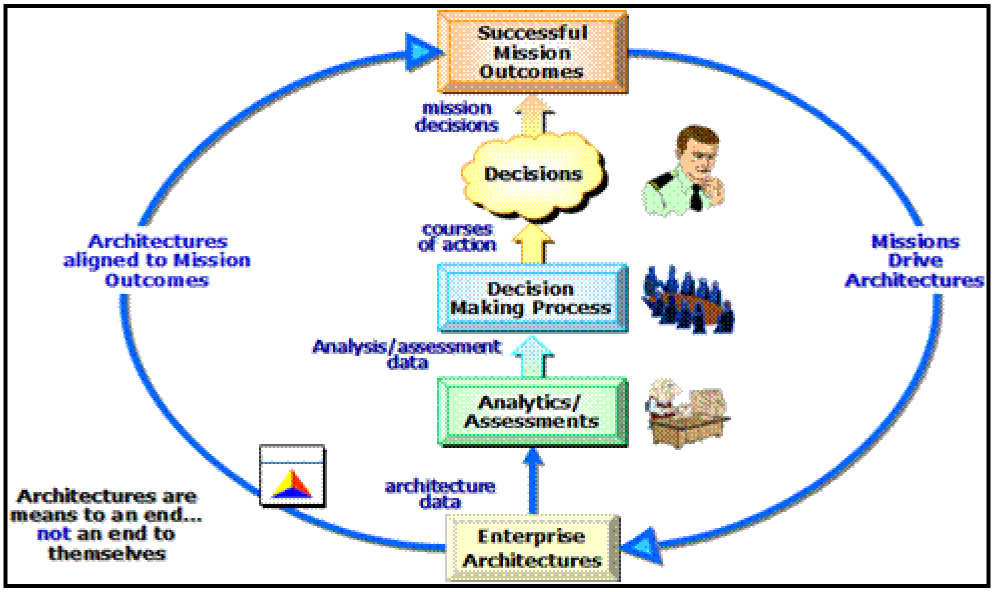
implement change (i.e., Stakeholders, both internal and external). Importantly, scope also determines the goals and objectives of the effort, consistent with both boundaries and stakeholders; since goals and objectives define both the purpose for architecture creation and the level of the architecture. 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. This site 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 the figure below. 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. The figure 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.



Mission Outcomes Supported by Architectures

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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. 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.

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.

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.

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 describes the lifecycle as:

- Develop.

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- Use.
- Maintain.

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.

Architecture Development

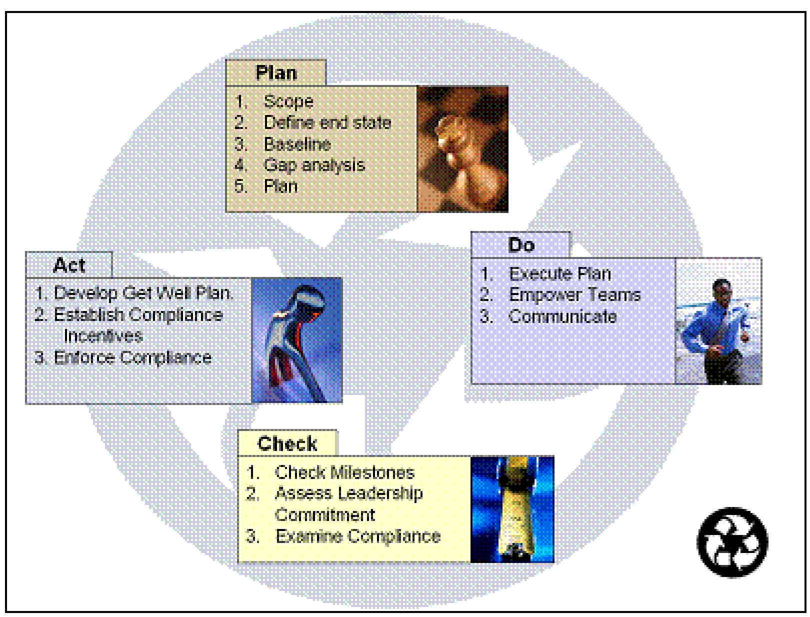
Architectural Descriptions are developed to represent either the state of an activity at a specified time (i.e., baseline architecture) or the results of change in an activity that will occur over some future time (i.e., "To-Be" or future architecture). Enterprise architectures (usually with Departmental, 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 the Logical data Model.

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 the figure below, is described in detail in the DoDAF Journal. This lifecycle relies on the commonly used Plan-Do-Check-Act (PDCA) governance method.



Plan, Do, Check, and Act (PDCA) Cycle

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).

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.

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.

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.

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. Specifics of the DoD/OMB architecture self-assessment are described in the DoDAF Journal.

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. 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 page. Specifics of the DoD/GAO architecture self-assessment are described in the DoDAF Journal. The Enterprise Architecture Management Maturity Framework (EAMMF) can also be used for this purpose.

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.

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.

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.

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.

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.

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Detailed Planning

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.

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.

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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, along with the PES, 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 this site. 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.

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).

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.

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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.

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.

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.

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.

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.

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.

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 discussion 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.

Deployment/Operational Model

The Operational Model, another potential Systems Engineering Fit-for-Purpose View, describes the operation of the IT system, as illustrated below. 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.

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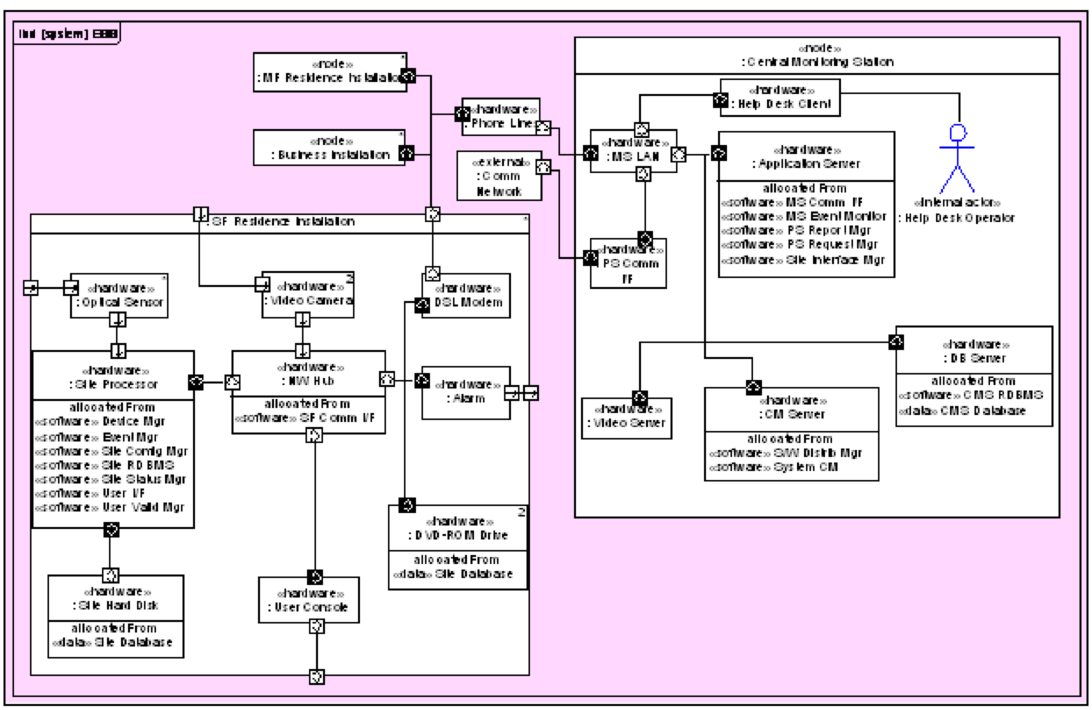

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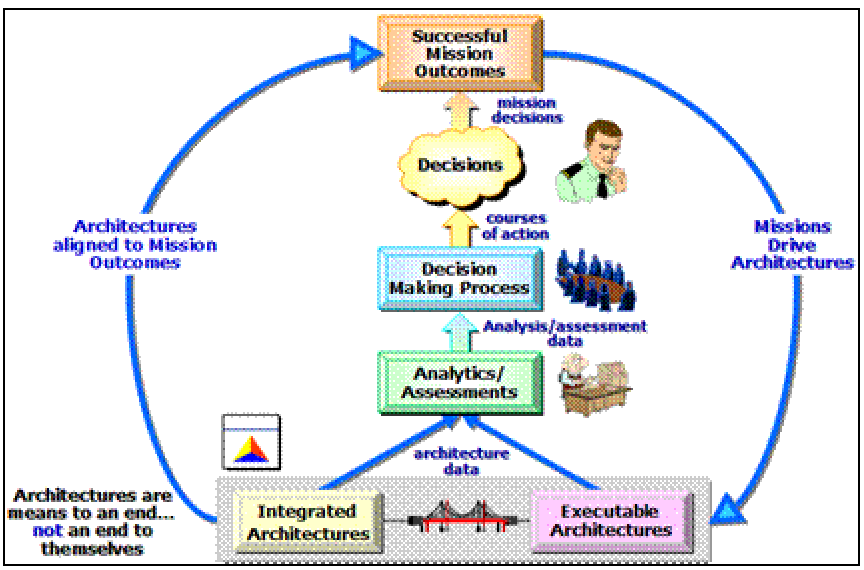
Architecture-Based Analytics

Architecture-based analytics the process of doing analysis with and on architectural data. It 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, provided they represent the most current and accurate information about a program or mission requirement.

Analytics Context

DoDAF V2.0 has been designed to facilitate the collection of relevant data employing quantitative, repeatable, analytical processes to support decisions at all levels of an enterprise. Architectural views (formerly "products") are no longer the end goal, but are described solely to facilitate useful to the underlying information. All views are tailorable. Data completeness of the data schema are more critical than the view chosen by a particular user. Analytics, properly conducted, represent a powerful tool for the decision-maker, ensuring that the most appropriate, current, and valid data is used to support decisions.

Analytics are central to successful decision-making. Analysis defines and describes potential courses of action (i.e., alternatives) that can be considered when making a mission or program decision.



The Analytics Process

Architecture development is an iterative process. Analyses developed on the basis of significant 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 assumptions is updated, previous analyses should be reviewed to determine if the previous analysis needs to be redone. Such examination needs to be recognized as natural in an environment where

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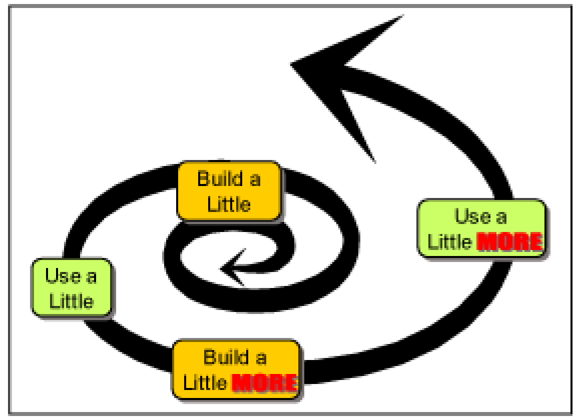
program direction and priorities are constantly in flux.

The need for iterative analyses 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 they are automated. The iterative approach enables Architectural Descriptions to achieve incremental goals early, and throughout the architecture lifecycle.



Iterative Approach

Types of Architecture Analysis

There are two categories of analytical activity. These are:

- Static Analyses: Those analyses, which are based on making a value judgments, based on data extracted from the Architectural Description. Analysis of weather patterns and measurements for the last 50 years to determine trends and correlations is an example of 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. The construction and execution of weather prediction model to determine possible future weather trends is an example of dynamic analysis.

Examples of Analytics

Analytic methods can be applied to the many aspects of the architecting process. Examples of analytical support can be found within DOTMLPF, as shown below. DOTMLPF analysis leads to better definition of a warfighting capability by being able to anticipate its effects and assess the impact of change on the domains within which the change will be deployed.

DOTMLPF domains map to DM2 CDM concepts with the following analytical support activities:

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,	Examine leadership issues

	Assets	
Personnel	Performers	Examine personnel solutions – new personnel or personnel with better qualifications
Facilities	Locations	Examine fixing, building, or modifying facilities

The list above is potentially analytical activities that relate to DM2 CDM concepts potentially applicable to DOTMLPF domains. As more demands are placed on architecture, the flexibility inherent in DoDAF will encourage further innovation from architects and from tool vendors alike.

Principles of Architecture Analytics

The five key foundational principles of architecture analytics are described below:

Information Consistency

Information consistency means that data (and the information derived from it) within an Architectural Description is consistent with an overarching metadata structure (called a 'schema'). In addition to adhering to the explicit syntax (naming rules) of the schema, data also needs to be consistent with any additional rules specified by the project. Information consistency is usually checked to some degree by commercial architecture tools; additional checking should be conducted to help assure a consistent architectural view.

Information consistency also refers to whether the data in one area of the Architectural Description agrees with the data in another area. 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.

Data Completeness

Data completeness refers to the requirement that all necessary attributes of each data element be 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 generation, and/or simulations or executable architectures.

Transformation

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

Iteration

Analysis needs to support an iterative architecture refinement and decision process. Analysis that takes too long in any iteration will quickly become irrelevant. Rather, small iterative steps or modules should be created that will produce reliable, trusted results.

Lack of Ambiguity

An architectural dataset must make clear the meaning of each element defined within it. If there are semantically variable architectural constructs, they cannot be accurately analyzed. This limits the scope and effectiveness of analytics and the usefulness of the architecture itself. Semantic specificity is essential to gain the full benefits of analyses.

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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, representation of data needed is a logical extension of the overall process. This section describes these representations (architects call them models or views).

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 the figure below illustrates, presentation techniques pull from the architectural information store and display the data in a variety of meaningful ways to stakeholders.

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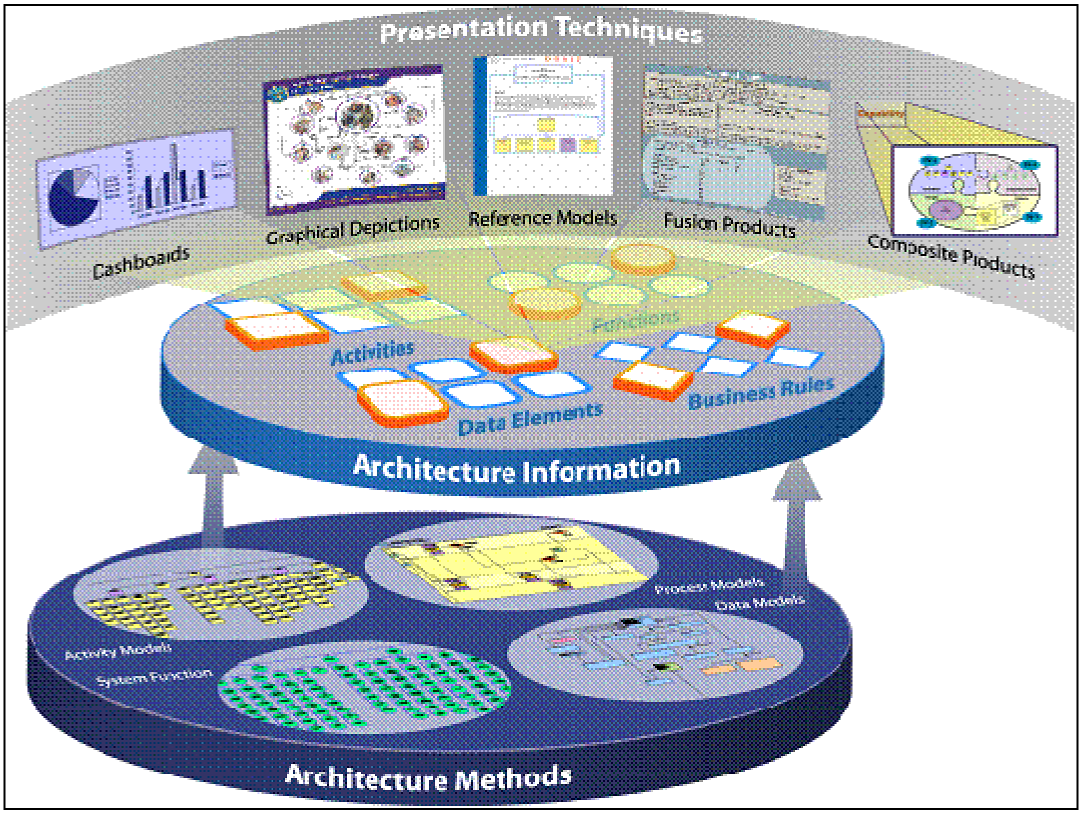
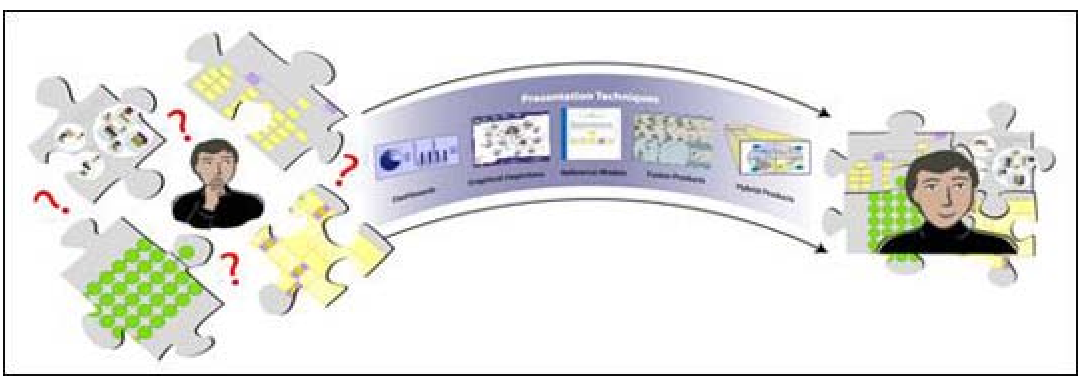


Presentation Techniques

The presentation techniques and best practices described here 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 the figure below, 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.



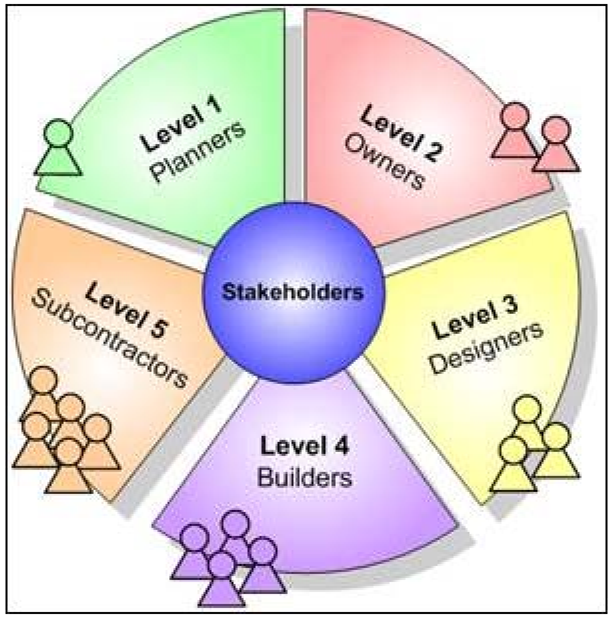
The Information Bridge

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.

Choosing an Appropriate Presentation Technique

In any given business process, decisions must be made at multiple levels of the organization.

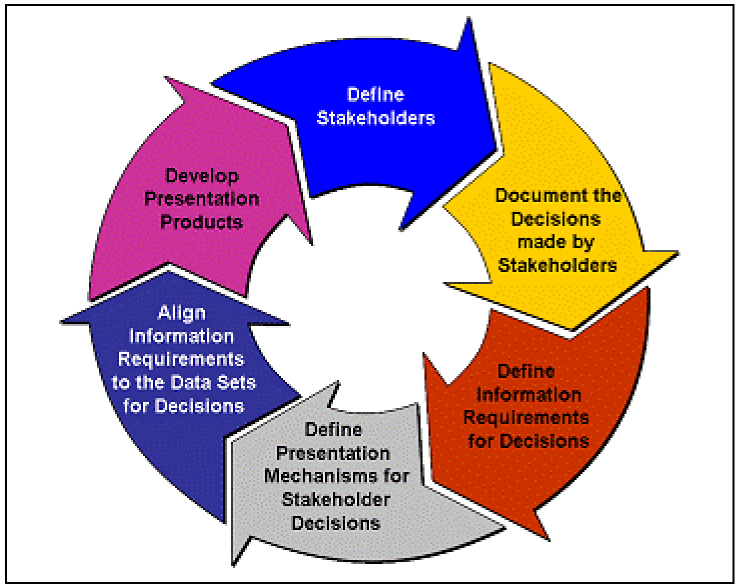
Whether one is a senior level executive, a process owner, or a system developer, he or she will need to make judgment calls based upon the available data. Each level of decision making, in turn, has both a unique purpose and understanding of Architectural Description, making it important to tailor the 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. The figure below, based on the Zachman Framework, summarizes the multiple levels of decision makers within a typical organization that make up an audience.



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.

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. The "Level of Decision-Makers" figure is a simplified representation of the presentation development process.



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 Meta-model Groups is provided in the LDM, 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.
- Dashboards: Integrate abstracted architectural information for a given business context.
- Fusion Views: Display multiple pieces of architectural data and incorporate disparate pieces of information that are not captured within the Architectural Description.
- Graphics: Visually represent manipulated data.
- Reference Models: Capture the elements of the architectural data and translate those elements into text.

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.

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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.

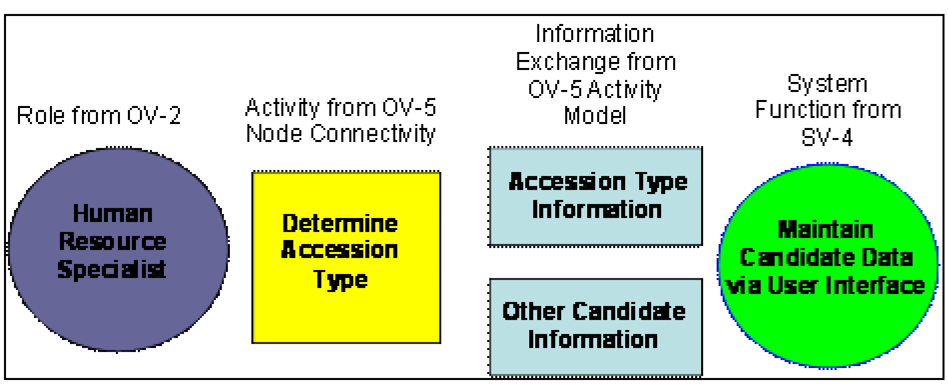
Purpose and Audience

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.

Examples

The example composite view figure 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".



Example Composite View

The figure below 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

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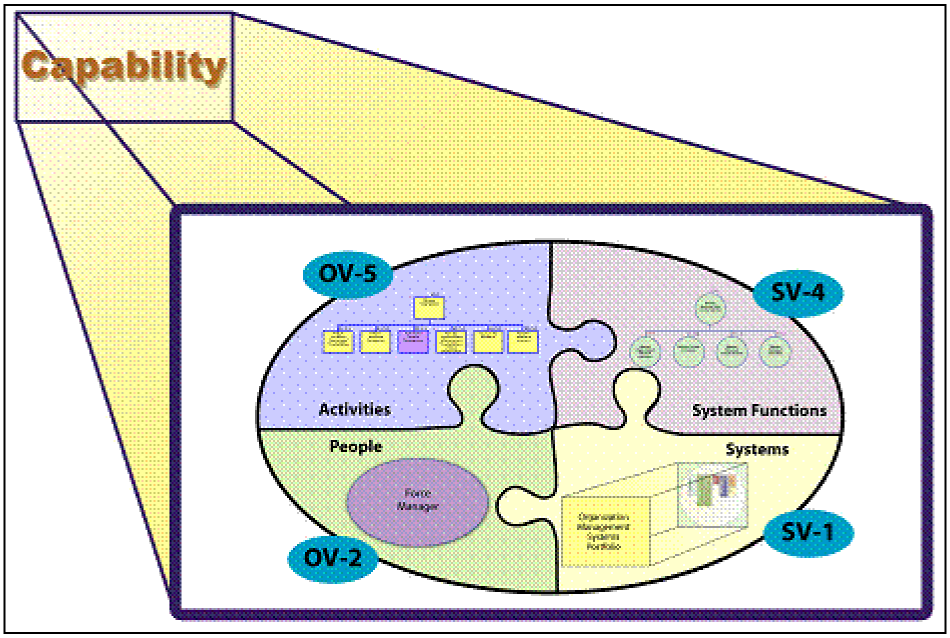
common tie.



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.

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.

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.

Examples

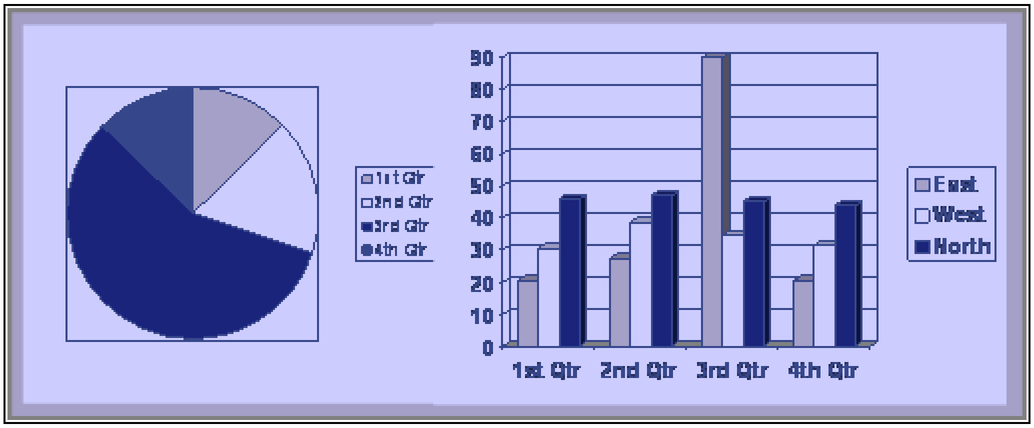
The visualization techniques table illustrates various visualization techniques that can be used to create a dashboard.

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.
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	Area charts are good for simple comparisons with multiple series of data. By setting contrasting color

	shaded or colored.	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.

An illustration of the use of these techniques to create a dashboard.



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.

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DoD Deputy Chief Information Officer

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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.

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.

Examples

The financial data fusion view figure 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.

Click image for larger view

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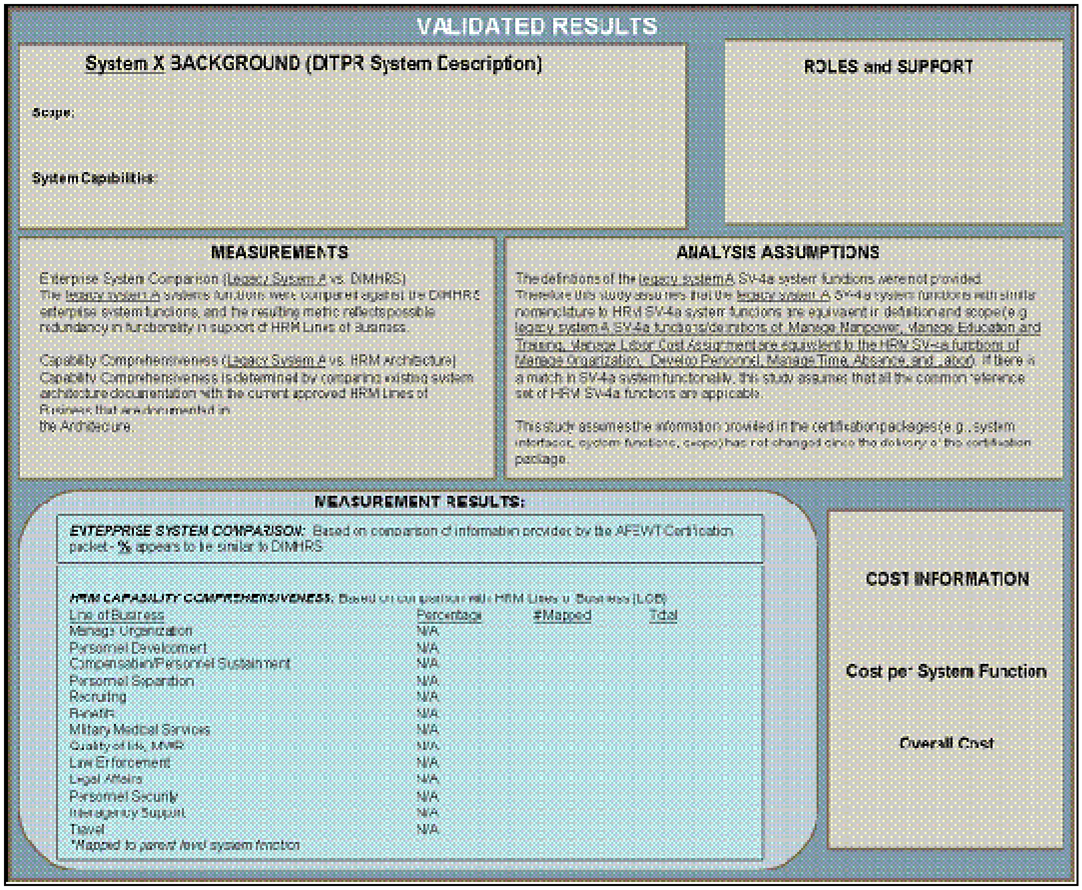


Financial Data Fusion View

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.

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.

Purpose and Audience

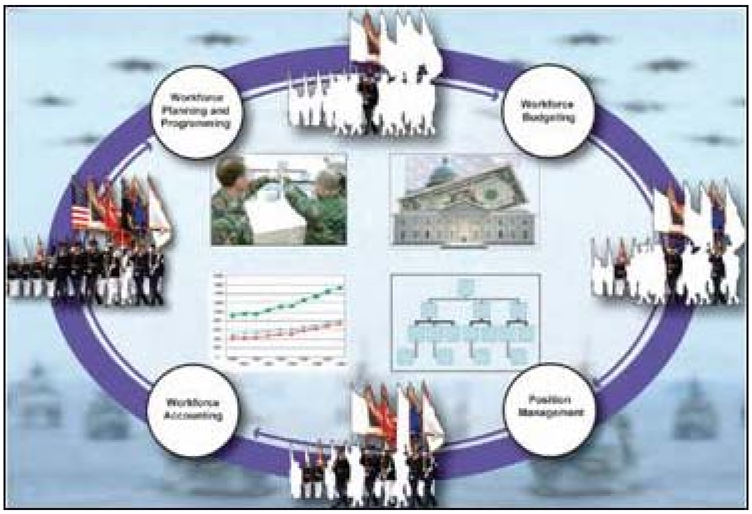
Graphical views provide a visual depiction of the information and are therefore targeted at visually oriented learners. When properly executed, a graphical view allows the intended audience to view the information in an uncluttered, easy to understand, and precise design. Additionally, graphical views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

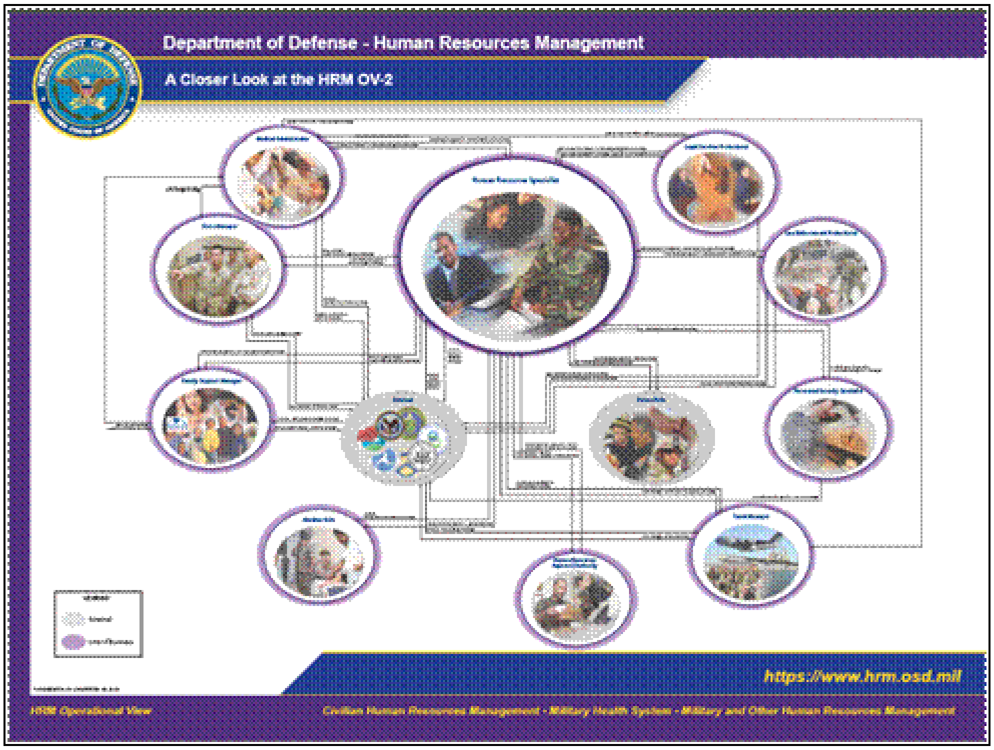
Examples

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.

The following figures 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.



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



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.

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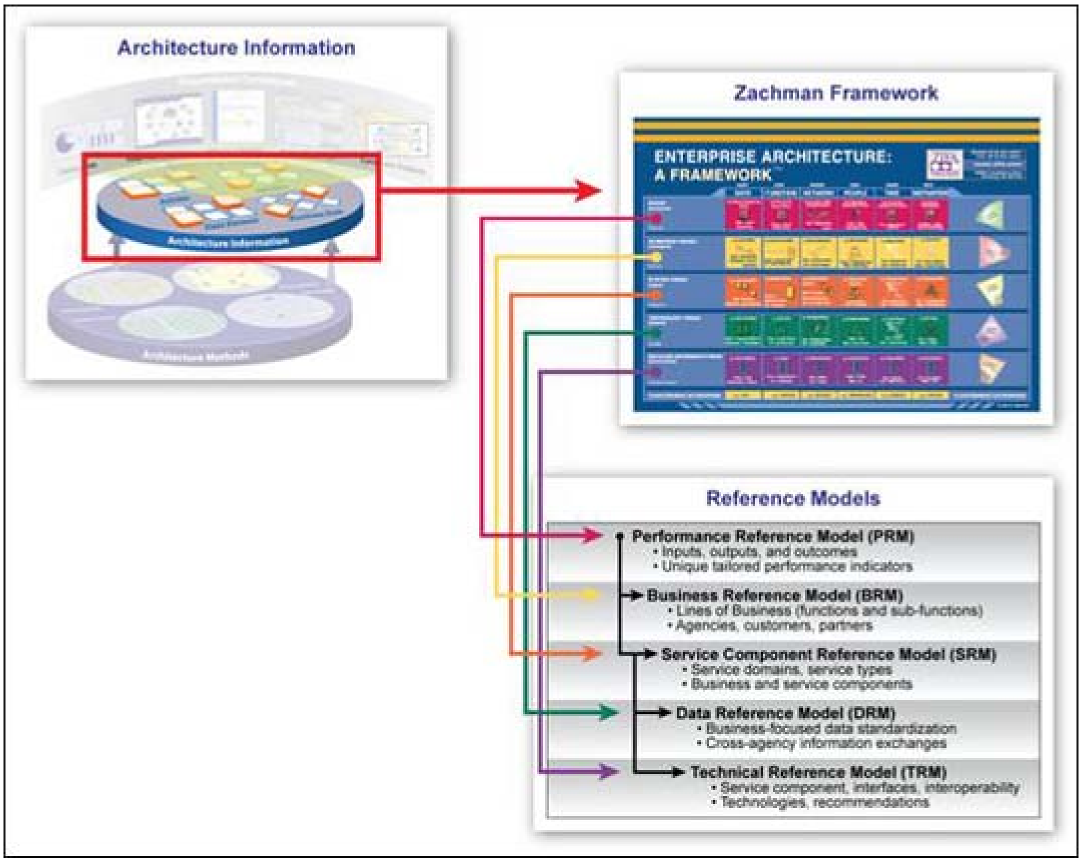
Reference Models

Reference models provide textual extractions of underlying architectural data. As the notional reference model figure below 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.



A Notional Reference Model

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

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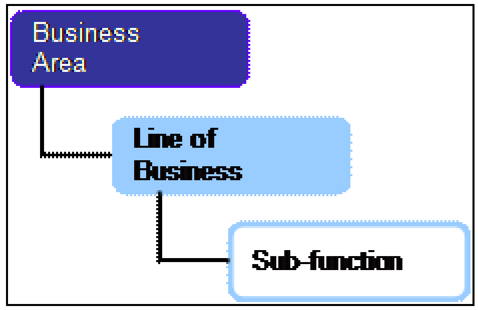
leveraged across the Federal Government.

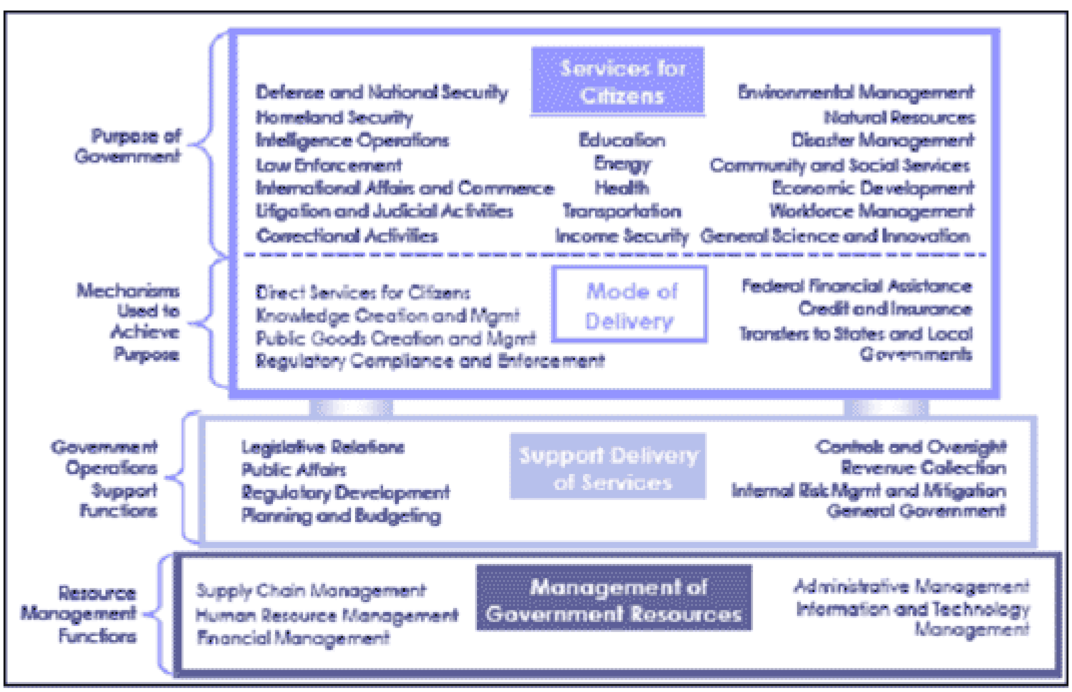
Examples

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, 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:



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:



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Architecture Development

Security

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.

Each of the individual models 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.

How Does DoDAF Represent Security?

Capabilities are subject to a variety of threats to the integrity, availability, and confidentiality of their operation. These threats range from failures of equipment, attempts to gain unauthorized access to their services and data, to sabotage of their functions. Security engineering is concerned with identifying the potential threats to a capability, and then, using a risk management approach, devising a set of measures which reduce the known and potential vulnerabilities to an acceptable level. In general, the measures that can be applied fall into the following categories:

- Physical – measures such as guards, guard dogs, fences, locks, sensors, including Closed Circuit Television, strong rooms, armor, weapons systems, etc.
- Procedural – the specification of procedures, including vetting (which tests that personnel have a sufficient level of integrity and trust to be given responsibility to access and use a capability's services and data) that will reduce the likelihood of vulnerabilities being exploited.
- Communication Security (COMSEC) – using encryption and other techniques to ensure that data transmission is available at sufficient bandwidth, that the traffic pattern and content of data in transit are indecipherable to a third party who might intercept the data, and that its integrity is protected.
- Transient Electromagnetic Pulse Emanation Standard (TEMPEST) – measures to ensure that the electromagnetic transmissions from equipment can't be intercepted to derive information about the equipment's operation and the data it processes.
- Information Security (INFOSEC) – ensuring the integrity, availability and confidentiality of data and IT-based services.

In general, the measures employed to protect a capability will have undesirable impacts on all of the capability's lines of development, and in particular on it's deploy ability, usability and procurement and maintenance costs. It is therefore desirable to minimize the strength of the measures to be employed in a fashion commensurate with the value of the assets being protected. This requires a risk-managed approach based on the assessment of the likely threats posed to the asset. A risk assessment approach considers the following

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characteristics:

- Environment – The level of hostility of the environment the asset is being deployed to.
- Asset Value – this is denoted by a protective marking which indicates the impact of the loss or disclosure of the asset would have on the effective operation of the government and its departments of state.
- Criticality – an assessment of the criticality of the asset to enabling the government to undertake its activities.
- Personnel Clearance – a measure of the degree of trust that the government is willing to put in the personnel that will have (direct or indirect) access to the asset.

The aim of this guidance for representing security considerations is to enable sufficient information to be recorded for interested parties (accreditors, security advisors, users, system managers) to understand the potential security exposure of capabilities so that security can be managed effectively throughout the life of a capability.

The table below shows the DoDAF scheme for assigning security characteristics and protective measures to elements of DoDAF. There is not a specific security viewpoint in DoDAF; security information can be shown on models using annotations and call–outs. The DoDAF Meta-Model contains the concepts, associations, and attributes for capturing and representing security characteristics in a consistent way between models.

DoDAF Viewpoints and Concept Mapped to Security Characteristics and Protective Measures

Viewpoint	Concept	Security Characteristics	Protective Measures	Notes
Capability	Capability requirement	Security Marking Criticality Environment User Security Profile		The security characteristics of capability requirements provide the security envelope for the capability for a particular timeframe.
Operational	Location	User Security Profile Environment		The User Security Profile is the lowest clearance of the users within a location, facility, or organization. The environment identifies the most hostile conditions for the location, facility, or organization.
	Activity	Security Marking Criticality		The security marking identifies the highest security marking of information that will be processed by a Operational Activity and the Criticality measures the impact on government operations with the disruption of the operational activity.

	Resource Flow	Security Marking		The security marking identifies the highest security marking that will be exchanged in a Resource Flow.
	Organization	User Security Profile Environment		The minimum clearances of members of the organization, post, base, fort.
System	Capability Taxonomy	Security Marking Criticality Environment User Security Profile		The security characteristics of a capability taxonomy are to be derived from the constituent systems.
	System	Security Marking Criticality Environment User Security Profile	Physical TEMPEST COMSEC	The environment of a system is derived from the Physical Asset to which is deployed. The User Security Profile is derived from the Organization which uses the system, its Criticality and Security Marking from its Functions.
	Physical Asset	Environment	Physical TEMPEST	The environment identifies the worst environment to which the Physical Asset will be deployed.
	Function	Security Marking Criticality	INFOSEC Procedural	The Security Marking identifies the maximum security marking of the data the Function will process and the criticality represents the degree of harm to government operations if disrupted.
	Resource Flow	Security Marking	COMSEC	The Security Marking represents the maximum security marking of the Resource Flow.
	Performer and Activity	User Security Profile	Procedural	The User Security Profile is the lowest clearance of the user performing the function. This should be derived from Organizations who perform the Function, if the information exists.
Service	Capability Taxonomy	Security Marking Criticality Environment User Security Profile		The security characteristics of a capability taxonomy are to be derived from the constituent services.
	Service	Security Marking Criticality Environment User Security Profile	Physical TEMPEST COMSEC	The environment of a service is derived from the Physical Asset to which is deployed. The User Security Profile is derived from the Organization which uses the service, its Criticality and Security Marking from its Functions.

	Physical Asset	Environment	Physical TEMPEST	The environment identifies the worst environment to which the Physical Asset will be deployed.
	Activity	Security Marking Criticality	INFOSEC Procedural	The Security Marking identifies the maximum security marking of the data the Function will process and the criticality represents the degree of harm to government operations if disrupted.
	Resource Flow	Security Marking	COMSEC	The Security Marking represents the maximum security marking of the Resource Flow.
	Performer and Activity	User Security Profile	Procedural	The User Security Profile is the lowest clearance of the user performing the function. This should be derived from Organizations who perform the Function, if the information exists.
Standards	Performer	Security Marking	INFOSEC Procedural	The Security Marking identifies the security standard for the data the Function will process and the criticality represents the degree of harm to government operations if there is unauthorized access.

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DoDAF Viewpoints and Models

DoDAF has been designed to meet the specific business and operational needs of the DoD. It defines a way of representing an enterprise architecture that enables stakeholders to focus on specific areas of interests in the enterprise, while retaining sight of the big picture. To assist decision-makers, DoDAF provides the means of abstracting essential information from the underlying complexity and presenting it in a way that maintains coherence and consistency. One of the principal objectives is to present this information in a way that is understandable to the many stakeholder communities involved in developing, delivering, and sustaining capabilities in support of the stakeholder's mission. It does so by dividing the problem space into manageable pieces, according to the stakeholder's viewpoint, further defined as DoDAF-described Models.

Each viewpoint has a particular purpose, and usually presents one or combinations of the following:

- Broad summary information about the whole enterprise (e.g., high-level operational concepts).
- Narrowly focused information for a specialist purpose (e.g., system interface definitions).
- Information about how aspects of the enterprise are connected (e.g., how business or operational activities are supported by a system, or how program management brings together the different aspects of network enabled capability).

However, it should be emphasized that DoDAF is fundamentally about creating a coherent model of the enterprise to enable effective decision-making. The presentational aspects should not overemphasize the pictorial presentation at the expense of the underlying data.

DoDAF organizes the DoDAF-described Models into the following viewpoints:

- The All Viewpoint describes the overarching aspects of architecture context that relate to all viewpoints.
- The Capability Viewpoint articulates the capability requirements, the delivery timing, and the deployed capability.
- The Data and Information Viewpoint articulates the data relationships and alignment structures in the architecture content for the capability and operational requirements, system engineering processes, and systems and services.
- The Operational Viewpoint includes the operational scenarios, activities, and requirements that support capabilities.
- The Project Viewpoint describes the relationships between operational and capability requirements and the various projects being implemented. The Project Viewpoint also details dependencies among capability and operational requirements, system engineering processes, systems design, and services design within the Defense Acquisition System process. An example is the Vcharts in Chapter 4 of the Defense Acquisition Guide.
- The Services Viewpoint is the design for solutions articulating the Performers, Activities, Services, and their Exchanges, providing for or supporting operational and capability functions.
- The Standards Viewpoint articulates the applicable operational, business, technical, and industry policies, standards, guidance, constraints, and forecasts that apply to capability and operational requirements, system engineering processes, and systems

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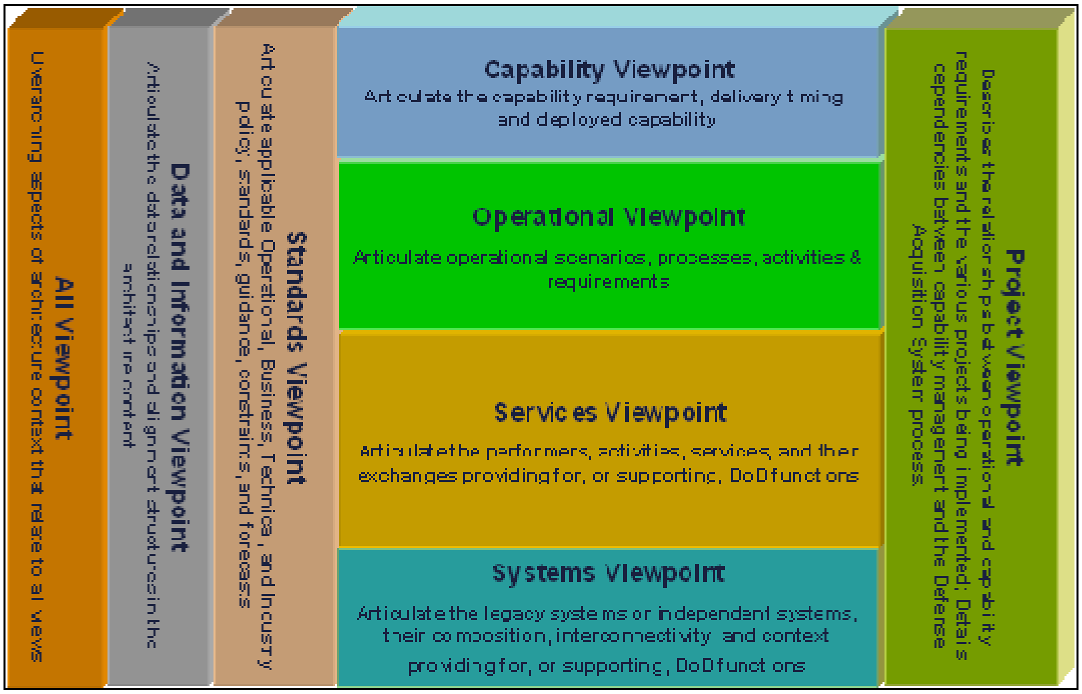
and services.

- The Systems Viewpoint, for Legacy support, is the design for solutions articulating the systems, their composition, interconnectivity, and context providing for or supporting operational and capability functions.

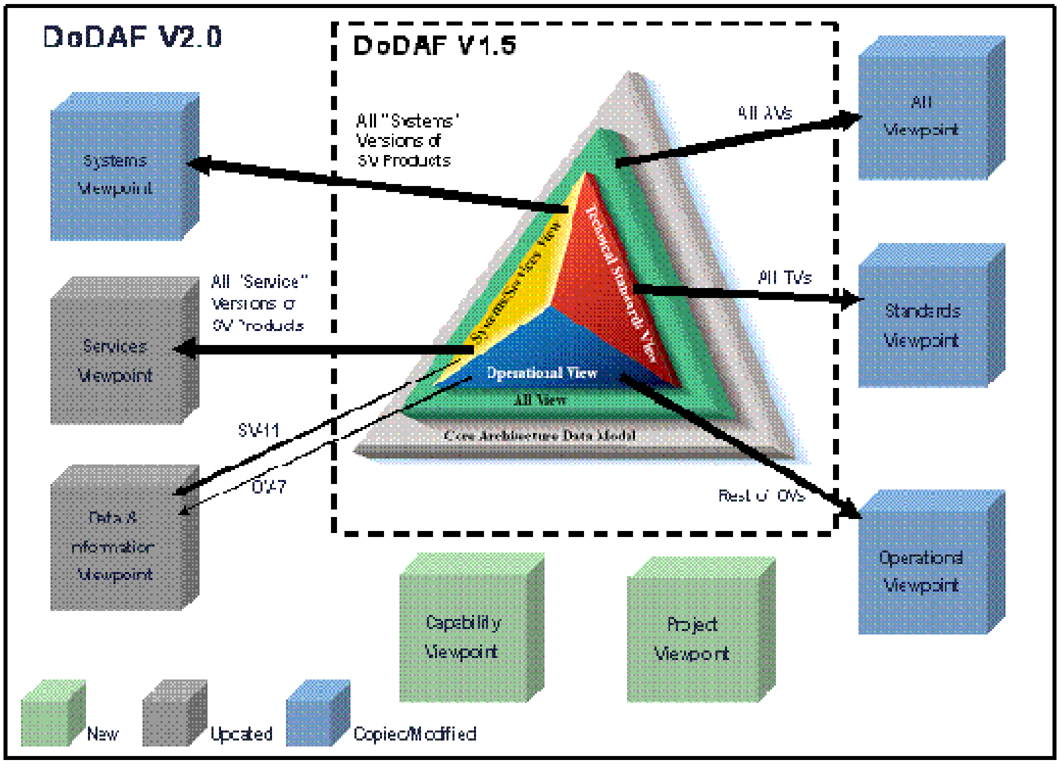
A presentation of these viewpoints is portrayed in graphic format below:



DoDAF Viewpoints

DoDAF V2.0 is a more focused approach to supporting decision-makers than prior versions. In the past, decision-makers would look at DoDAF offerings and decide which were appropriate to their decision process. An example is the JCIDS process architecture requirements inside the JCIDS documentation (ICD, CDD, CPD, etc.). Additionally, older version Architectural Description products were hard-coded in regard to content and how they were visualized. Many times, these design products were not understandable or useful to their intended audience. DoDAF V2.0, based on process owner input, has increased focus on architectural data, and a new approach for presenting architecture information has addressed the issues. The viewpoints categorize the models as follows:

- As illustrated below, the original viewpoints (Operational Viewpoint, Systems and Services Viewpoint, Technical Standards Viewpoint, and the All Viewpoint) have had their Models reorganized to better address their purposes. The Services portion of the older Systems and Services Viewpoint is now a Services Viewpoint that addresses in more detail our net-centric or services-oriented implementations.



DoDAF V1.5 Evolution to DoDAF V2.0

- All the models of data (conceptual, logical, or physical) have been placed into the Data and Information Viewpoint rather than spread throughout the Operational Viewpoint and Systems and Services Viewpoints.
- The Systems Viewpoint accommodates the legacy system descriptions.
- The new Standards Viewpoint can now describe business, commercial, and doctrinal standards, as well as the technical standards applicable to our solutions, which may include systems and services.
- 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 Portfolio Management and feedback from the Acquisition community, the Capability Viewpoint and Project Viewpoint have been added through a best-of-breed analysis of the MODAF and NAF constructs.

Workshops have brought the Systems Engineering community and the architecture community closer together in defining the DoDAF architecture content that would be useful to the Systems Engineering process, and this has resulted in an understanding which the entire set of viewpoints and the underlying architectural data can be used in the System Engineering processes. There is not a set of separate System Engineering viewpoint or DoDAF-described Models as the system engineer and system engineering decision-makers can use the existing DoDAF-described Models and their own defined Fit-for-Purpose Views.

The approach to the presentation of Architectural Description moves away from static and rigid one-size-fits-all templates of architecture portrayals for architects. The term we have coined is "Fit-for-Purpose" presentation. Through various techniques and applications, the presentation of Architectural data increases customer understanding and architecture's usefulness to decision-making by putting the data underlying the architectural models into the context of the problem space for each decision-maker.

Viewpoint and DoDAF-described Model Descriptions

The following DoDAF Viewpoints and DoDAF-described Models are discussed below with some details, such as model uses and model descriptions:

- All Viewpoint
- Capability Viewpoint
- Data and Information Viewpoint
- Operational Viewpoint
- Project Viewpoint
- Services Viewpoint
- Standards Viewpoint
- Systems Viewpoint

For the DoDAF-described Model descriptions, a major source of material was adapted from MODAF. In addition, a note on system engineering is included.

The Views 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 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 does not prescribe any particular Views, but instead concentrates on data as the necessary ingredient for architecture development. However, other regulations and instructions from both DoD and CJCS may have particular presentation view requirements. These Views are supported by DoDAF 2.0, and should be consulted for specific view requirements.

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DoDAF Viewpoints and Models

All Viewpoint

There are some overarching aspects of an Architectural Description that are captured in the AV DoDAF-described Models. The AV DoDAF-described Models provide information pertinent to the entire Architectural Description rather than representing a distinct viewpoint. AV DoDAF-described Models provide an overview of the architecturectural effort including such things as the scope, context, rules, constraints, assumptions, and the derived vocabulary that pertains to the Architectural Description. It captures the intent of the Architectural Description to help ensure its continuity in the face of leadership, organizational, and other changes that can occur over a long development effort.

All Viewpoint Model Descriptions

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.

Uses of All Viewpoint DoDAF-described Models. The AV DoDAF-described Models captures the scope of the architecture and where the architecture fits in relationship to other architectures. Another use of the All Viewpoint is for the registration of the architecture to support the net-centric goals of making Architectural Descriptions visible (Discoverable).

Mappings of the All Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

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DoDAF Viewpoints and Models

All Viewpoint

AV-1 Overview and Summary Information. The overview and summary information contained within the AV-1 provides executive-level summary information in a consistent form that allows quick reference and comparison between Architectural Descriptions. The written content of the AV-1 content describes the concepts contained in the pictorial representation of the OV-1.

The AV-1 frames the context for the Architectural Description. The AV-1 includes assumptions, constraints, and limitations that may affect high-level decisions relating to an architecture-based work program. It should contain sufficient information to enable a reader to select a single Architectural Description from among many to read in more detail. The AV-1 serves two additional purposes:

- In the initial phases of architecture development, it serves as a planning guide.
- When the architecture is built, the AV-1 provides summary information concerning *who*, *what, when, why,* and *how* of the plan as well as a navigation aid to the models that have been created.

The usage of the AV-1 is to:

- Scope the architecture effort.
- Provide context to the architecture effort.
- Define the architecture effort.
- Summarize the findings from the architecture effort.
- Assist search within an architecture repository.

Detailed Description:

An enterprise has an architecture, which is manifested through an Architectural Description (in this case, a DoDAF described Architectural Description). That Architectural Description consists of a number of populated views each of which is an instance of a specific model or a combination of model. DoDAF consists of a set of viewpoints and these are organized in terms of models. Each model is associated with a specific set of concerns that certain stakeholders have, and which the models constructed are intended to address. The stakeholder groupings tend to align with the model definitions within a viewpoint (so the DoDAF Operational Viewpoint relates to operational stakeholders, i.e., end users). Finally each Architectural Description has a rationale that governs the selection of Models that will be used and the scope of the underlying models. The AV-1 is intended to describe this.

The AV-1 is usually a structured text product. An architecting organization may create a template for the AV-1 that can then be used to create a consistent set of information across different architecture-based projects. While the AV-1 is often dispensed with or "retrofitted" to a finished architecture package, it's desirable to do it up-front because the AV-1 provides a summary of a given Architectural Description and it documents the following descriptions:

- Architectural Description Identification - Identifies the Architectural Description effort name, the architect, and the organization developing the Architectural Description. It also includes assumptions and constraints, identifies the approving authority and the

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completion date, and records the level of effort required to develop the Architectural Description.

- Scope - Identifies the Viewpoints, DoDAF-described Models, and Fit-for-Purpose Views that have been selected and developed. The AV-1 should address the temporal nature of the Architectural Description, such as the time frame covered, whether by specific years or by designations such as "current", "target", or transitional. Scope also identifies the organizational entities and timelines that fall within the scope of the Architectural Description.
- Purpose and perspective - Explains the need for the Architectural Description, what it will demonstrate, the types of analyses that will be applied to it, who is expected to perform the analysis, what decisions are expected to be made based of each form of analysis, who is expected to make those decisions, and what actions are expected to result. The perspective from which the Architectural Description is developed is identified.
- Context - Describes the setting in which an Architectural Description exists. Context includes such things as: mission, doctrine, relevant goals and vision statements, concepts of operation, scenarios, information assurance context (e.g., types of system or service data to be protected, such as classified or sensitive but unclassified, and expected information threat environment), other threats and environmental conditions, and geographical areas addressed, where applicable. Context also identifies authoritative sources for the standards, rules, criteria, and conventions that are used in the architecture. Any linkages to parallel architecture efforts should be identified.
- Status - Describes the status of the architecture at the time of publication or development of the AV-1 (which might precede the architectural development itself). Status refers to creation, validation and assurance activities.
- Tools and File Formats Used - Identifies the tool suite used to develop the Architectural Description and file names and formats for the Architectural Models if appropriate.
- Assumptions and Constraints.
- Archtecture development schedule including start date, development milestones, date completed, and other key dates. Further details can be reflected in the Project Viewpoint.

If the architecture is used to support an analysis, the AV-1 may be extended to include:

- Findings - States the findings and recommendations that have been developed based on the architectural effort. Examples of findings include: identification of shortfalls, recommended system implementations, and opportunities for technology insertion.
- Costs - the architecture budget, cost projections, or actual costs that have been incurred in developing the architecture and/or undertaking the analysis. This might include integration costs, equipment costs and other costs.

During the course of developing an Architectural Description, several versions of the AV-1 may be produced. An initial version may focus the effort and document its scope, the organizations involved, and so forth. After other Models within an Architectural Description's scope have been developed and verified, another version may be produced to document adjustments to the scope and to other aspects of the Architectural Description that may have been identified. After an Architectural Description has been used for its intended purpose, and the appropriate analysis has been completed, a final version should be produced to summarize these findings for high-level decision-makers. In this version, the AV-1 and a corresponding graphic in the form of an OV-1 serve as an executive summary of the Architectural Description. The AV-1 can be particularly useful as a means of communicating the methods that have been applied to create models and the rationale for grouping these models. Viewing assumptions that have shaped individual models may also be included. In this form, the AV-1 needs to list each individual model and provide a brief commentary.

This could take several forms:

- It could refer to one or more DoDAF-described Models.
- It could refer to the DoDAF Community of Practice.
- It could refer to a focus for the work, e.g., integration or security.
- It could refer to a combination of these.

Finally, each Architectural Description has a rationale that governs the selection of the Models used and the scope of the underlying models as a result of employing the 6-Step Architecture Development Process. The AV-1 DoDAF-described Model is intended to describe the decisions made throughout that process.

AV-2: Integrated Dictionary >>

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AV-2: Integrated Dictionary. The AV-2 presents all the metadata used in an architecture. An AV-2 presents all the data as a hierarchy, provides a text definition for each one and references the source of the element (e.g., DoDAF Meta-model, IDEAS, a published document or policy).

An AV-2 shows elements from the DoDAF Meta-model that have been described in the Architectural Description and new elements (i.e., not in the DM2) that have been introduced by the Architectural Description.

It is essential that organizations within the DoD use the same terms to refer to a thing. Because of the interrelationship among models and across architecture efforts, it is useful to define common terminology with common definitions (referred to as taxonomies) in the development of the models within the Architectural Description. These taxonomies can be used as building blocks for DoDAF-described Models and Fit-for-Purpose Views within the Architectural Description. The need for standard taxonomies derives from lessons learned from early DoD Architectural Description development issues as well as from federation pilots conducted within the Department. Federation of Architectural Descriptions were made much more difficult because of the use of different terminology to represent the same architectural data. Use of taxonomies to build models for the architecture has the following benefits over free-text labeling:

- Provides consistency across populated views, based on DoDAF-described Models.
- Provides consistency across Architectural Descriptions.
- Facilitates Architectural Description development, validation, maintenance, and re-use.
- Traces architectural data to authoritative data sources.

This is facilitated by the DM2. Architectural Descriptions can often introduce new terms - possibly because the architecture is covering new technology or business activities. The purpose of the AV-2 is to provide a means to explain the terms and abbreviations used in building the architecture and, as necessary, submit them for review and inclusion into authoritative vocabularies developed by COIs that are pertinent to the Architectural Description content.

In the creation of any Architectural Description, reuse of authoritative external taxonomy content, e.g., the FEA Reference Models, or the Joint Common System Function List, are important to aligning the architectural content across many descriptions to increase their understandability, interoperability, Architecture Federation, and compliance. A discussion on the use of taxonomies in the development of the AV-2 and the architecture effort is below.

Detailed Description:

The AV-2 content can be organized by the following areas within the DM2 that can be used to expedite architecture development:

- Capabilities: The taxonomy should minimally consist of names, descriptions, and conditions that may be applicable to performance measures.
- Resource Flow. The taxonomy should minimally consist of names of information elements exchanged, descriptions, decomposition into constituent parts and subtypes,

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and mapping to system data elements exchanged.
- Activities (Operational Activities or Tasks). The taxonomy should minimally consist of names, descriptions, and decomposition into the constituent parts that comprise an activity.
- Activities (System or Service Functions). The taxonomy should minimally consist of names, descriptions, and decomposition into the constituent parts that comprise a system function.
- Performance Parameters. The taxonomy should minimally consist of names, descriptions, units of measure, and conditions that may be applicable to performance parameters.
- Performers: Performers can be persons, services, systems or organizations. The taxonomy should minimally consist of names, descriptions, breakdowns into constituent parts (e.g., a services comprising other services), and applicable categorizations. Each of the above types of performers is a candidate for a being a taxonomy.
- Skills: The taxonomy should minimally consist of names, descriptions, units of measure, and conditions that may be applicable to performance parameters.
- Standards: The taxonomy should minimally consist of categories of standards (e.g., DoD Information Technology Standards and Profile Registry [DISR]'s Service Areas).
- Triggers/Events: The taxonomy minimally consists of names, descriptions, and breakdown into constituent parts of the event or trigger and categorization of types of events or triggers.

Not all architectural data in a given taxonomy is useful in every case of architectural development. However, given the ongoing evolutionary change in organizations, services, systems, and activities, the value of using established, validated taxonomic structures that can be expanded or contracted as needed becomes obvious. Moreover, the development of new models over time is greatly simplified as understanding of the taxonomies is increased. Standard taxonomies, like DISR Service Categories, become building blocks for more comprehensive, quality architectural DoDAF-described Models and Fit-for-Purpose Views. The DoD Extensible Markup Language Registry and Clearinghouse and the Net-Centric Implementation Document (NCID) are potential sources for taxonomies.

In some cases, a specific community may have its own operational vocabulary. This local operational vocabulary may use the same terms in radically different ways from other operational communities. (For example, the use of the term track refers to very different concepts in the carrier battle group community than in the mine-sweeper community. Yet both of these communities are Navy operational groups and may participate together in littoral warfare task forces.) In these cases, the internal community versions of the models and views within the Architectural Description should use the vocabulary of the local operational community to achieve community cooperation and buy-in. Data elements need to be uniquely identified and consistently used across all viewpoints, models and views within the Architectural Description. These populated views should include notes on any unique definitions used and provide a mapping to standard definitions, where possible.

<< AV-1: Integrated Dictionary

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DoDAF Viewpoints and Models

Capability Viewpoint

The Capability Viewpoint and the DoDAF-described Models within the viewpoint are introduced into DoDAF V2.0 to address the concerns of Capability Portfolio Managers. In particular, the Capability Models describe capability taxonomy and capability evolution.

The DoD increasingly employs incremental acquisition to help manage the risks of complex procurements. Consequently, there is a need to provide visualizations of the evolving capabilities so that Portfolio Managers can synchronize the introduction of capability increments across a portfolio of projects. The Capability Models included within DoDAF are based on the program and capability information used by Portfolio Managers to capture the increasingly complex relationships between interdependent projects and capabilities.

Another justification for the Capability Viewpoint is the increasing importance of transformational programs within the DoD (e.g., Global Exchange [GEX], Defense Acquisition Initiative [DAI]). These types of programs are focused on the delivery of capabilities and do not conform to the standard for project management and tend to be benefit-driven rather than capability delivery focused. An ability to view these transformational programs, and their interdependencies, provides a potentially powerful tool for DoD Enterprise Architects.

Capability Model Descriptions

Model	Description
CV-1: Vision	Describes a Project's Visions, Goals, Objectives, Plans, Activities, Events, Conditions, Measures, Effects (Outcomes), and produced objects.
CV-2: Capability Taxonomy	An architectural data repository with definitions of all terms used throughout the architectural data and presentations.
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.

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Mappings of the Capability Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in ***DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models***. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

The Capability Viewpoint DoDAF-described Models are discussed with examples in the DoDAF Product Development Questionnaire Analysis Report.

Use of Capability Viewpoint Models. The CV DoDAF-described Models are intended to provide support to various decision processes within the Department, one of which is portfolio management. Since the DoD has moved toward the delivery of capabilities, these models take on a more important role. Developing an architecture that includes the relationships necessary to enable a capability thread is essential to improving usability of architectures, as well as increasing the value of federation.

In the above context, a capability thread is similar to the result of a query that would be run on a particular capability. For example, if an architecture were to include operational activities, rules, and systems, a capability thread would equate to the specific activities, rules, and systems that are linked to that particular capability. The CV DoDAF-described Models are used to provide the strategic perspective and context for other architectural information.

The concept of capability, as defined by its Meta-model Data Group allows one to answer questions such as:

- How does a particular capability or capabilities support the overall mission/vision?
- What outcomes are expected to be achieved by a particular capability or set of capabilities?
- What services are required to support a capability?
- What is the functional scope and organizational span of a capability or set of capabilities?
- What is our current set of capabilities that we are managing as part of a portfolio?

CV-1: Vision

CV-2: Capability Taxonomy

CV-3: Capability Phasing

CV-4: Capability Dependencies

CV-5: Capability to Organizational Development Mapping

CV-6: Capability to Operational Activities Mapping

CV-7: Capability to Services Mapping

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Capability Viewpoint - Capability Model Descriptions

CV-1: Vision

The CV-1 addresses the enterprise concerns associated with the overall vision for transformational endeavors and thus defines the strategic context for a group of capabilities. The purpose of a CV-1 is to provide a strategic context for the capabilities described in the Architectural Description. It also provides a high-level scope for the Architectural Description which is more general than the scenario-based scope defined in an OV-1.

The intended usage is communication of the strategic vision regarding capability development.

Detailed Description:

The CV-1 defines the strategic context for a group of capabilities described in the Architectural Description by outlining the vision for a capability area over a bounded period of time. It describes how high-level goals and strategy are to be delivered in capability terms. A CV-1 may provide the blueprint for a transformational initiative. The CV-1 may be primarily textual descriptions of the overarching objectives of the transformation or change program that the Enterprise is engaged in. Of key importance is the identification of Goals, together with the desired outcomes and measurable benefits associated with these.

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CV-2: Capability Taxonomy

The CV-2 captures capability taxonomies. The model presents a hierarchy of capabilities. These capabilities may be presented in context of a timeline - i.e., it can show the required capabilities for current and future capabilities. The CV-2 specifies all the capabilities that are referenced throughout one or more architectures. In addition, it can be used as a source document for the development of high-level use cases and user requirements.

The intended usage of the CV-2 includes:

- Identification of capability requirements.
- Capability planning (capability taxonomy).
- Codifying required capability elements.
- Capability audit.
- Capability gap analysis.
- Source for the derivation of cohesive sets of user requirements.
- Providing reference capabilities for architectures.

In CV-2, the Capabilities are only described in the abstract - i.e., CV-2 does not specify how a capability is to be implemented. A CV-2 is structured as a hierarchy of capabilities, with the most general at the root and most specific at the leaves. At the leaf-level, capabilities may have a measure specified, along with an environmental condition for the measure.

When capabilities are referenced in operational or systems architectures, it may be that a particular facility, location, or organization or configuration meets more than one level of capability. The CV-2 is used to capture and organize the capability functions - required for the vision set out in the CV-1 Vision.

In contrast to AV-2 Integrated Dictionary, a CV-2 is structured using only one type of specialization relationship between elements: sub-supertype. A sub-supertype relationship is a relationship between two classes with the second being a pure specialization of the first.

In DoDAF V2.0, capabilities exist in space and over time, that is they are intended to provide a framework across the lifetime of the enterprise that is being modeled. This means that it is feasible to develop a capability taxonomy that can apply to all architecture phases.

In addition to the capability nomenclature, appropriate quantitative attributes and measures for that specific capability or function need to be included e.g., the required speed of processing, the rate of advance, the maximum detection range, etc. These attributes and measures will remain associated with the capability whenever it is used across the Architectural Description. The quantitative values expressed may be linked to specific phases (or be "As-Is" values and/or or "To-Be" targets).

The CV-2 has no mandated structure although the architectural data must be able to support the representation of a structured/hierarchal list. This structure may be delivered using textual, tabular or graphical methods. The associated attributes and measures for each capability can either be included on the main CV-2 or in tabular format as an appendix if the inclusion of the attributes and measures would over complicate the presentation of the populated view.

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CV-1: Vision

CV-2: Capability Taxonomy

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CV-3: Capability Phasing

The CV-3 addresses the planned achievement of capability at different points in time or during specific periods of time, i.e., capability phasing. The CV-3 supports the capability audit processes and similar processes used across the different COIs by providing a method to identify gaps or duplication in capability provision. The CV-3 indicates capability increments, which should be associated with delivery milestones within acquisition projects (when the increments are associated with capability deliveries).

The intended usage of the CV-3 includes:

- Capability planning (capability phasing).
- Capability integration planning.
- Capability gap analysis.

Detailed Description:

The CV-3 provides a representation of the available capability at different points in time or during specific periods of time (associated with the phases - see CV-1 Vision model). A CV-3 can be used to assist in the identification of capability gaps/shortfalls (no fielded capability to fulfill a particular capability function) or capability duplication/overlap (multiple fielded capabilities for a single capability function).

The CV-3 is populated by analyzing programmatic project data to determine when projects providing elements of capability are to be delivered, upgraded and/or withdrawn (this data may be provided in part by a PV-2 Project Timelines model). Then capability increments identified can be structured according to the required capabilities determined in the CV-2 Capability Taxonomy model and the phases. Alternatively, a set of desired capability increments can be viewed and then compared to the project plans. In practice, the population of the model tends to iterate between considering the desired capability and considering what capability is planned to be delivered. The output from this iterative approach can be a table that represents the required capability phasing.

The CV-3 can be presented as a table consisting of rows representing Capabilities (derived from the CV-2 Capability Taxonomy model) and columns representing phases (from CV-1 Vision model).

At each row-column intersection in the CV-3 table, the capability increment that represents the change in Capability within that phase can be displayed. If the availability of the Capability spans multiple periods of time, then this can be indicated by an elongated color-coded bar. If there are no Capabilities planned to satisfy the Capability Requirements in that period of time then a blank space can be left.

A variant CV-3, in which the names of the projects that can deliver the capability increments are included, can identify capability gaps and shortfalls. The essence is the relationship between projects, capabilities and time. The model may be used to envisage the need for interventions in projects (to fulfill a capability gap) or to represent current plans (the availability of capability according to their delivery timescales).

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CV-4: Capability Dependencies

The CV-4 describes the dependencies between planned capabilities. It also defines logical groupings of capabilities.

The CV-4 is intended to provide a means of analyzing the dependencies between capabilities. The groupings of capabilities are logical, and the purpose of the groupings is to guide enterprise management. In particular, the dependencies and groupings may suggest specific interactions between acquisition projects to achieve the overall capability.

The intended usage of the CV-4 includes:

- Identification of capability dependencies.
- Capability management (impact analysis for options, disposal etc.).

Detailed Description:

The CV-4 describes the relationships between capabilities. It also defines logical groupings of capabilities. This contrasts with CV-2 Capability Taxonomy model which also deals with relationships between Capabilities; but CV-2 only addresses specialization-generalization relationship (i.e., capability taxonomy).

A CV-4 shows the capabilities that are of interest to the Architectural Description. It groups those capabilities into logical groupings, based on the need for those elements to be integrated.

An approach for describing a CV-4 is graphical. In some cases, it may be important to distinguish between different types of dependency in the CV-4. Graphically, this can be achieved by color-coding the connecting lines or by using dashed lines. From a data perspective, the CV-4 can make use pre-existing capability dependency types in the DoDAF Meta-model; else new, specific dependency types can be created. The new dependency types need to be recorded the in the AV-2: Integrated Dictionary.

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CV-5: Capability to Organizational Development Mapping

The CV-5 addresses the fulfillment of capability requirements.

This model shows the planned capability deployment and interconnection for a particular phase. and should provide a more detailed dependency analysis than is possible using the CV-3 Capability Phasing model. The CV-5 is used to support the capability management process and, in particular, assist the planning of fielding.

The intended usage of the CV-5 includes:

- Fielding planning.
- Capability integration planning.
- Capability options analysis.
- Capability redundancy/overlap/gap analysis.
- Identification of deployment level shortfalls.

Detailed Description:

The CV-5 shows deployment of Capabilities to specific organizations. CV-5 models are specific to a phase. If a particular Capability is/was used by (or is due to be used by) a specific organization during that phase, it should be shown on the CV-5, mapped to the organization. The CV-5 may also show interactions between them (where these have been previously defined in a SV-1 Systems Interface Description or SvcV-1 Services Context Description). The CV-5, along with SV-8 Systems Evolution Description, SvcV-8 Services Evolution Description and PV-2 Project Timelines models can be regarded as amplifying the information contained in the CV-3.

To conduct a comprehensive analysis, several CV-5s can be created to represent the different phases. Although the CV-5s are represented separately, Capabilities may exist in more than one model. The information used to create the CV-5 is drawn from other DoDAF-described Models (PV-2 Project Timelines, CV-2 Capability Taxonomy, OV-4 Organizational Relationships Chart, SV-1 Systems Interface Description, SvcV-1 Services Context Description), and the timing is based on PV-2 Project Timelines indicating delivery of Capabilities to actual organizational resources, and also the point at which those organizational resources cease to use a particular Capability.

System interaction (from the SV-1 Systems Interface Description) or Service interaction (from the SvcV-1 Services Context Description) can be shown on a CV-5. In addition, where a Capability or resources is deployed across a number of Organizations, a parent Organization can be created for context purposes, and the Capability or resource stretched across the domain of the parent Organization.

The architect should not overwhelm the diagram with capabilities and organizations. A CV-5 should be seen as a summary of the delivery schedules for capabilities (hence it could be argued that it belongs in the PV Viewpoint). To prevent constraining the solution space, CV-5 should not be produced at the time of developing capability/user requirements, but after the solution is determined. Instead, the CV-5 should be more of an informative from a programmatic standpoint.

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The CV-5 is usually based on a tabular representation, with the appropriate Organizational structure represented by one axis, and the capabilities by the other axis. Graphical objects representing Capabilities or resources can be placed in the relevant positions (intersections) relative to these axes.

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CV-6: Capability to Operational Activities Mapping

The CV-6 describes the mapping between the capabilities required and the activities that enable those capabilities.

It is important to ensure that the operational activity matches the required capability. The CV-6 DoDAF-described Model provides a bridge between capability analyzed using CVs and operational activities analyzed using OVs. Specifically, it identifies how operational activities can be performed using various available capability elements. It is similar in function to the SV-5a Operational Activity to Systems Function Traceability Matrix. The capability to activity mappings may include both situations where activities fully satisfy the desired capability and those where the activity only partially meets the capability requirement.

The intended usage of the CV-6 includes:

- Tracing capability requirements to operational activities.
- Capability audit.

Detailed Description:

A CV-6 shows which elements of capability may be utilized in support of specific operational activities by means of a mapping matrix. If the CV-6 is created as part of a strategic architecture (i.e., before the creation of supporting operational models), it is recommended that the operational activities described in the CV-6 should be common functions. This model may be used indicate that an operational capability (perhaps reflecting a particular user requirement) does or does not fulfill the requirements for capability for a particular phase.

In principle, there could be a different CV-6 created for each phase of the capability development, or perhaps for different capability phasing scenarios. In most cases, it is considered that a single table can be constructed because the operational activities that are most likely relevant to this model may be relatively high-level. If capabilities associated are generic (see CV-1 Vision model), then they should have a well understood relationship with a standard set of operational activities and this relationship is unlikely to change over time.

This model is analogous to the SV-5a Operational Activity to System Function Traceability Matrix - but provides the interface between Capability and Operational Models rather than Operational to System Models.

The CV-6 can have a tabular presentation. The rows can be the Capabilities and the columns can be the Operational Activities. An X may indicate that the capability may be utilized in support of that activity whereas a blank indicates that it does not. Alternatively, a date or phase can indicate that the capability may support that activity by the date or phase indicated.

CV-7: Capability to Services Mapping. The CV-7 describes the mapping between the capabilities required and the services that enable those capabilities. It is important to ensure that

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CV-2: Capability Taxonomy

CV-3: Capability Phasing

CV-4: Capability Dependencies

CV-5: Capability to Organizational Development Mapping

CV-6: Capability to Operational Activities Mapping

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CV-7: Capability to Services Mapping

The CV-7 describes the mapping between the capabilities required and the services that enable those capabilities. It is important to ensure that the services match the required capability. The CV-7 provides a bridge between capability analyzed using CVs and services analyzed using SvcVs. Specifically, it identifies how services can be performed using various available capability elements. It is similar in function to the SV-5a which maps system functions to operational activities. The capability to service mappings may include both situations where a service fully satisfies the desired capability and those where the service only partially meets the capability requirement.

The intended usage of the CV-7 includes:

- Tracing capability requirements to services.
- Capability audit.

Detailed Description:

The CV-7 describes the mapping between capabilities required and the services that those capabilities support. A CV-7 shows which elements of capability may be utilized in support of specific services by means of a mapping matrix. If the CV-7 is created as part of a strategic architecture (i.e., before the creation of supporting service models), it is recommended that the services used as part of the CV-7 are common functions. This model may be used indicate that an operational capability (perhaps reflecting a particular user requirement) does or does not fulfill the requirements for capability for a particular phase.

In principle, there could be a different CV-7 created for each phase of the capability development, or perhaps for different capability phasing scenarios. In most cases, it is considered that a single table can be constructed because the services that are most likely relevant to this model may be relatively high-level. If capabilities associated are generic (see CV-1 Vision model), then they should have a well understood relationship with a standard set of services and this relationship is unlikely to change over time.

This model is analogous to the SV-5a Operational Activity to System Function Traceability Matrix - but provides the interface between Capability and Service Models rather than Operational to System Models.

The CV-7 can have a tabular presentation. The rows can be the Capabilities and the columns can be the services. An X indicates that the capability may be utilized in support of that service whereas a blank indicates that it does not. Alternatively, a date or phase can indicate that the capability may support that service by the date or phase indicated.

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Data and Information Viewpoint

DoDAF-described Models within the Data and Information Viewpoint provide a means of portraying the operational and business information requirements and rules that are managed within and used as constraints on the organizations business activities. Experience gained from many enterprise architecture efforts within the DoD led to the identification of several levels of abstraction necessary to accurately communicate the information needs of an organization or enterprise. The appropriate level or levels of abstraction for a given architecture are dependent on the use and the intended users of the architecture. Where appropriate, the data captured in this viewpoint needs to be considered by COIs.

DoDAF V2.0 incorporates three levels of abstraction that correlate to the different levels associated with most data models developed in support of the operations or business. These levels are:

- Conceptual.
- Logical.
- Physical.

Data and Information Model Descriptions

Model	Description
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.

Mappings of the Data and Information Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. There is traceability between the DIV-1 to the DIV-2 to the DIV3 as follows:

- The information representations in the DIV-1 are same, decomposed into, or factored into the data representations in the DIV-2. The DIV-1 information representations can range in detail from concept lists to structured lists (i.e., whole-part, super-subtype), to inter-related concepts. At the DIV-1 level, any relationships are simply declared and then at the DIV-2 level they are made explicit and attributed. Similarly, attributes (or additional relationships) are added at the DIV-2 level.
- The DIV-3's performance and implementation considerations usually result in standard modifications of the DIV-2 and so it traces quite directly. That is, no new semantics are introduced going from the DIV-2 to the DIV-3.

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The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

Uses of Data and Information Viewpoint DoDAF-described Models. The DIV DoDAF-described Models provide means of ensuring that only those information items that are important to the organization’s operations and business are managed as part of the enterprise. They are also useful foundations for discussion with the various stakeholders of the architecture (e.g., decision-makers, architects, developers). These stakeholders require varying levels of detail to support their roles within the enterprise.

When building an architecture using a structured analysis approach, the items captured as part of the data model can be derived from the inputs and outputs associated to the organizations activities. Building the data model in this manner ties the data being managed within the architecture to the activities that necessitate that data. This provides a valuable construct enabling the information to be traceable to the strategic drivers of the architecture. This also enables the data to be used to map services and systems to the business operations. The conceptual data model would be a good tool to use when discussing this traceability with executive decision-makers and persons at that level.

The logical data model bridges the gap between the conceptual and physical-levels. The logical data model introduces attributes and structural rules that form the data structure. As evidenced by the content, this model provides more detail than the conceptual model and communicates more to the architects and systems analysts types of stakeholders. This is one model that helps bridge the gap between architecture and system development. It provides a valuable tool for generating requirements and test scripts against which services and systems can be tested.

Lastly, the physical data model is the actual data schema representative of the database that provides data to the services and applications using the data. This schema is usually a de-normalized data structure optimized to meet performance parameters. The physical data model usually can be generated from a well-defined logical data model then used by database developers and system developers or it can be developed separately from the logical data model (not the optimum method of development) and optimized by the database and system developers. This model can be used to develop XML message sets and other physical exchange specifications enabling the exchange of architecture information.

Metadata Groups Used to Create Data and Information Models. The previous DoDAF-described Models focused on particular areas within the DoDAF Meta-model from which the majority of the information within the models can be extracted. For example, the Capability Viewpoint DoDAF-described Models are in large part made up of data extracted from the Capability Metadata groups. The same is true for Project, Services and the like. The Data and Information DoDAF-described Models are somewhat different.

The Data and Information DoDAF-described Models contain information extracted from all of the metadata groups. Therefore, any information that an organization is managing using its enterprise architecture, should be captured within the Data and Information Models. As previously stated, there are levels of detail that are not included in all models (e.g., the conceptual data model is usually not fully attributed like the logical and physical) but the information item itself (e.g., capability, activity, service) should be represented in all models. Together, the three types of models help bridge the gap between architecture being used as requirements and architecture being used to support system engineering.

- DIV-1: Conceptual Data Model
- DIV-2: Logical Data Model
- DIV-3: Physical Data Model

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Data and Information Viewpoint

DIV-1: Conceptual Data Model

The DIV-1, a new DoDAF-described Model in DoDAF V2.0, addresses the information concepts at a high-level on an operational architecture.

The DIV-1 is used to document the business information requirements and structural business process rules of the architecture. It describes the information that is associated with the information of the architecture. Included are information items, their attributes or characteristics, and their inter-relationships.

The intended usage of the DIV-1 includes:

- Information requirements
- Information hierarchy

Detailed Description:

The DIV-1 DoDAF-described Model describes the structure of an Architectural Description domain's information types and the structural business process rules (defined in the OV Models).

The Architectural elements for DIV-1 include descriptions of information entity and relationship types. Attributes can be associated with entities and with relationships, depending on the purposes of the Architectural Description.

The intention is that DIV-1 describes information or data of importance to the business (e.g., information products that might be referred to in doctrine, SOPs, etc.) whereas the DIV-3 Physical Data Model describes data relevant at the system-level.

The purpose of a given Architectural Description helps to determine the level of detail needed in this model. This level of detail is driven in particular by the criticality of the interoperability requirements.

Often, different organizations may use the same Entity name to mean very different kinds of information having different internal structure. This situation could pose significant interoperability risks, as the information models may appear to be compatible, e.g., each having a Target Track data Entity, but having different and incompatible interpretations of what Target Track means.

A DIV-1 may be necessary for interoperability when shared information syntax and semantics form the basis for greater degrees of information systems interoperability, or when an information repository is the basis for integration and interoperability among business activities and between capabilities.

The DIV-1 defines the Architectural Description's information classes and the relationships among them. For example, if the architecture effort is describing missile defense, some possible information classes may be trajectory and target with a relationship that associates a target with a certain trajectory. The DIV-1 defines each kind of information classes associated with the Architectural Description scope, mission, or business as its own Entity, with its associated attributes and relationships. These Entity definitions correlate to OV-2 Operational Resource Flow Description information elements and OV-5b Operational Activity

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Model inputs, outputs, and controls.

The DIV-1 should not be confused with the DoDAF Meta-model. Architectural data types for the DoDAF (i.e., DoDAF-defined architectural data elements and DM2 entities) are things like Performer and Operational Activity. The DM2 does provide a specification of the underlying semantics for DoDAF-described Models such as DIV-1. DIV-1 describes information about a specific Architectural Description scope.

DIV-1: Conceptual Data Model

DIV-2: Logical Data Model

DIV-3: Physical Data Model

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DIV-2: Logical Data Model

The DIV-2 allows analysis of an architecture's data definition aspect, without consideration of implementation specific or product specific issues.

Another purpose is to provide a common dictionary of data definitions to consistently express models wherever logical-level data elements are included in the descriptions. Data definitions in other models include:

- Data described in a DIV-2 may be related to Information in an OV-1 High Level Operational Concept Graphic or and Activity Resource (where the Resource is Data) flow object in an OV-5b Operational Activity Model. This relation may be a simple subtype, where the Data is a proceduralized (structured) way of describing something. Recall that Information describes something. Alternatively, the relation may be complex using Information and Data whole-part (and overlap) relationships.
- The DIV-2 information entities and elements can be constrained and validated by the capture of business requirements in the OV-6a Operational Rules Model.
- The information entities and elements modeled in the DIV-2 also capture the information content of messages that connect life-lines in an OV-6c Event-Trace Description.
- The DIV-2 may capture elements required due to Standards in the StdV-1 Standards Profile or StdV-2 Standards Forecast.

Detailed Description:

The DIV-2 is a generalized formal structure in computer science. It directly reflects the paradigm or theory oriented mapping from the DIV-1 Conceptual Data Model to the DIV-2.

Possible Construction Methods: DoDAF does not endorse a specific data modeling methodology. The appropriate way to develop a logical data model depends on the technology chosen as the main design solution (e.g., relational theory or object-orientation). For relational theory, a logical data model seems best described using an entity relationship diagramming technique. For Object-Oriented, a logical data model seems best described using Class and/or Object diagrams.

In either case, attention should be given to quality characteristics for the data model. Definition and acceptance of data model quality measures (not data quality measures) for logical data models are sparse. There is some research and best practices. Framed as a software verification, validation, and quality factors, types of best practices include:

- Validation Factors - Was the Right Model Built?
- Information Requirements Fidelity.
- Conceptual, Logical, and Physical Traceability.
- Adherence to Government and Industry Standards and Best Practices.
- Domain Values.
- Resource Exchange and Other Interoperability Requirements.
- Net-Centric Factors.
  - XML Registration.

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- COI Participation.
- DDMS Compatibility.

- Identifiers and Labels.
- Verification Factors - Was it Well Built?
- Design Factors.
- Compactness.
- Abstraction and Generalization.
- Ontologic Foundations.
- Semantic Purity.
- Logical and Physical Redundancy.
- Separation of Concerns.
- Software Quality Factors.
- Documentation.
- Naming Conventions.
- Naming and Business Languages.
- Definitions.
- Completeness.
- Consistency.
- Implementability.
- Enumerations/free text ratio.

An example design factor is normalization- essentially one representation for any particular real-world object. There are degrees of normalization with third normal form (3NF) being commonly used. At 3NF, there are no repeating attributes; instead techniques like lookup tables, super-subtyping to carry the common attributes at the supertype-level, and entity decomposition into smaller attribute groupings are used. For the DIV-2, care should be taken to avoid hidden overlaps, where there is a semantic overlap between concepts with different entity, attribute, or domain value names.

DIV-1: Conceptual Data Model

DIV-2: Logical Data Model

DIV-3: Physical Data Model

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DIV-3: Physical Data Model

The DIV-3 defines the structure of the various kinds of system or service data that are utilized by the systems or services in the Architectural Description. The Physical Schema is one of the models closest to actual system design in DoDAF. DIV-3 is used to describe how the information represented in the DIV-2 Logical Data Model is actually implemented.

While the mapping between the logical and physical data models is relatively straightforward, the relationship between the components of each model (e.g., entity types in the logical model versus relational tables in the physical model) is frequently one-to-many or many-to-many.

The intended usage of the DIV-3 includes:

- Specifying the system/service data elements exchanged between systems and/or services, thus reducing the risk of interoperability errors.
- Definition of physical data structure.
- Providing as much detail as possible on data elements exchanged between systems, thus reducing the risk of interoperability problems.
- Providing data structures for use in the system design process, if necessary.
- Providing a common dictionary of data implementation elements (e.g., tables and records in a relational database schema) to consistently express models wherever physical-level data elements are included in the descriptions.
- Providing as much detail as possible on the system or service data elements exchanged between systems, thus reducing the risk of interfacing errors.
- Providing system and service data structures for use in the system and service design process, if necessary.

Note that DoDAF talks about information in the Operational Viewpoint and data in the System Viewpoint or Services Viewpoint. The intention of this distinction is that DIV-2 Logical Data Model describes information of importance to the business, (e.g., information products that might be referred to in doctrine, SOPs etc.) whereas DIV-3 describes data relevant at the system or service-level.

Detailed Description:

The DIV-3 is an implementation-oriented model that is used in the Systems Viewpoint and Services Viewpoint to describe how the information requirements represented in DIV-2 Logical Data Model are actually implemented. Entities represent:

- System Resource flows in SV-4 Systems Functionality Description.
- System Resource elements specified in SV-6 Systems Resource Flow Matrix and SV-10c Systems Event-Trace Description.
- Service Resource flows in SvcV-4 Services Functionality Description.
- Service Resource elements specified in SvcV-6 Services Resource Flow Matrix and SvcV-10c Services Event-Trace Description.
- Triggering events in SV-10b Systems State Transition Description or SvcV-10b Services State Transition Description.

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- Events in SV-10c Systems Event-Trace Description or SvcV-10c Services Event-Trace Description.
- Elements required due to Standards in the StdV-1 Standards Profile or StdV-2 Standards Forecast.

For some purposes, an Entity relationship style diagram of the physical database design is sufficient. References to message format standards may be sufficient for message-oriented implementations. Descriptions of file formats may be used when file passing is the model used to exchange information. Interoperating systems may use a variety of techniques to exchange system data and have several distinct partitions in their DIV-3 with each partition using a different form.

Standards associated with entities are also often identified in the development of the DIV-3; these should be recorded in the StdV-1 Standards Profile. Structural Assertions - these involve static aspects of business rules - are best captured in the DIV-3.

Possible Construction Methods: DoDAF does not endorse a specific data modeling methodology. The physical data schema model specifies how the logical data model will be instantiated. The most predominant are the relational database management systems and object repository products. In addition, this model may employ other technology mechanisms, such as messages or flat files. The essential elements of a physical data schema model (in the case of a relational database) are: tables, records and keys. In an object-oriented data model, all data elements are expressed as objects; whether they are classes, instances, attributes, relationships, or events.

The appropriate way to develop a physical data model depends on the product chosen to instantiate the logical data model (e.g., a relational database management system [RDBMS]). A physical data schema model seems best described using an entity-relationship diagramming technique. For Object-Oriented data modeling, a physical data schema seems best described using by Class and/or Object diagrams. For other implementation technologies, such as message orientation, a reference to a message format standard might be more appropriate.

DIV-1: Conceptual Data Model

DIV-2: Logical Data Model

DIV-3: Physical Data Model

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Operational Viewpoint

DoDAF-described Models in the Operational Viewpoint describe the tasks and activities, operational elements, and resource flow exchanges required to conduct operations. A pure operational model is materiel independent. However, operations and their relationships may be influenced by new technologies, such as collaboration technology, where process improvements are in practice before policy can reflect the new procedures. There may be some cases, as well, in which it is necessary to document the way activities are performed, given the restrictions of current systems, to examine ways in which new systems could facilitate streamlining the activities. In such cases, operational models may have materiel constraints and requirements that need to be addressed. For this reason, it may be necessary to include some high-level system architectural data to augment information onto the operational models.

Uses of Operational Viewpoint DoDAF-described Models. The OV DoDAF-described Models may be used to describe a requirement for a “To-Be” architecture in logical terms, or as a simplified description of the key behavioral and information aspects of an “As-Is” architecture. The OV DoDAF-described Models re-use the capabilities defined in the Capability Viewpoint and put them in the context of an operation or scenario. The OV DoDAF-described Models can be used in a number of ways, including the development of user requirements, capturing future concepts, and supporting operational planning processes.

One important way that architectural modeling supports the definition of requirements is in terms of boundary definition. Boundary definition is a process that often requires a significant degree of stakeholder engagement; the described models provided by DoDAF provide ideal support for this interactive process. The DoDAF provides support to the concept of functional scope and organizational span. When performing analysis of requirements relative to a particular capability or capabilities, it is important to know the specific functionality intended to be delivered by the capability. It is also important to know the limits of that functionality, to be able to determine necessary interfaces to other capabilities and organizations. The use of OV DoDAF-described Models (e.g., Operational Resource Flow Description and Operational Activity Model) supports identification of the boundaries of capabilities, thus rendering the functional scope and organizational span.

Definition of user-level interoperability requirements is another use for which there is applicability of the Operational Viewpoint DoDAF-described Models. Within the Operational Viewpoint DoDAF-described Models, DoDAF supports interoperability analysis in a number of ways.

Operational models can be used to help answering questions such as:

- What are the lines of business supported by this enterprise?
- What activities are in place to support the different lines of business?
- What is the functional scope of the capability or capabilities for which I am responsible? This can be answered by a combination of information from the activity model and CV DoDAF-described Models.
- What is the organizational span of influence of this capability or capabilities?
- What information must be passed between capabilities?

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- What strategic drivers require that certain data are passed or tracked? This can be answered by a combination of data within the logical data model, information exchanges, activities, and CV DoDAF-described Models.
- What activities are being supported or automated by a capability or capabilities?
- What role does organization X play within a capability or capabilities?
- What are the functional requirements driving a particular capability?
- What rules are applied within a capability, and how are they applied?

Use of Operational Viewpoint DoDAF-described Models should improve the quality of requirements definitions by:

- Explicitly tying user requirements to strategic-level capability needs, enabling early agreement to be reached on the capability boundary.
- Providing a validated reference model of the business/operations against which the completeness of a requirements definition can be assessed (visualization aids validation).
- Explicitly linking functional requirements to a validated model of the business or operations activities.
- Capturing information-related requirements (not just Information Exchange Requirements [IERs]) in a coherent manner and in a way that really reflects the user collaboration needs.
- Providing a basis for test scenarios linked to user requirements.
- Capturing the activities for Process Engineering or Process Re-engineering.

Operational Model Descriptions

Model	Description
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.
OV-5a: Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in a 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 activity (operational activity). It traces actions in a scenario or sequence of events.

Mappings of the Data and Information Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

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Operational Viewpoint

OV-1: High Level Operational Concept Graphic

The OV-1 describes a mission, class of mission, or scenario. It shows the main operational concepts and interesting or unique aspects of operations. It describes the interactions between the subject architecture and its environment, and between the architecture and external systems. The OV-1 is the pictorial representation of the written content of the AV-1 Overview and Summary Information. Graphics alone are not sufficient for capturing the necessary architectural data.

The OV-1 provides a graphical depiction of what the architecture is about and an idea of the players and operations involved. An OV-1 can be used to orient and focus detailed discussions. Its main use is to aid human communication, and it is intended for presentation to high-level decision-makers.

The intended usage of the OV-1 includes:

- Putting an operational situation or scenario into context.
- Providing a tool for discussion and presentation; for example, aids industry engagement in acquisition.
- Providing an aggregate illustration of the details within the published high-level organization of more detailed information in published architectures.

Detailed Description:

Each Operational Viewpoint relates to a specific point within the Enterprise's timeline. The OV-1 describes a mission, class of mission, or scenario. The purpose of OV-1 is to provide a quick, high-level description of what the architecture is supposed to do, and how it is supposed to do it. An OV-1 can be used to orient and focus detailed discussions. Its main utility is as a facilitator of human communication, and it is intended for presentation to high-level decision-makers. An OV-1 identifies the mission/scope covered in the Architectural Description. OV-1 conveys, in simple terms, what the Architectural Description is about and an idea of the players and operations involved.

The content of an OV-1 depends on the scope and intent of the Architectural Description, but in general it describes the business activities or missions, high-level operations, organizations, and geographical distribution of assets. The model frames the operational concept (what happens, who does what, in what order, to accomplish what goal) and highlight interactions to the environment and other external systems. However, the content is at an executive summary-level as other models allow for more detailed definition of interactions and sequencing.

It may highlight the key Operational concepts and interesting or unique aspects of the concepts of operations. It provides a description of the interactions between the Architectural Description and its environment, and between the Architectural Description and external systems. A textual description accompanying the graphic is crucial. Graphics alone are not sufficient for capturing the necessary architectural data.

The OV-1 consists of a graphical executive summary for a given Architectural Description with accompanying text.

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During the course of developing an Architectural Description, several versions of an OV-1 may be produced. An initial version may be produced to focus the effort and illustrate its scope. After other models within the Architectural Description's scope have been developed and verified, another version of the OV-1 may be produced to reflect adjustments to the scope and other Architectural Description details that may have been identified as a result of the architecture development. After the Architectural Description has been used for its intended purpose and the appropriate analysis has been completed, yet another version may be produced to summarize these findings to present them to high-level decision-makers. In other cases, OV-1 is the last model to be developed, as it conveys summary information about the whole Architectural Description for a given scenario.

The OV-1 is useful in establishing the context for a suite of related operational models. This context may be in terms of phase, a time period, a mission and/or a location. In particular, this provides a container for the spatial-temporally constrained performance parameters (measures).

To describe this, the operational performance measures for desert warfare in Phase 1 may be different to those in Phase 2. The measures for jungle warfare in Phase 2 may be different to those for desert warfare in Phase 2.

The context may also explicitly involve a Mission. When the subject of the Architectural Description is a business capability rather than a battlespace capability, then some adjustment is needed in the use of terminology. However, the idea of having a high-level (Business) operational concept still makes sense and the graphical representation in OV-1 adds value to the more structured models that may be created.

OV-1 is the most general of the architectural models and the most flexible in format. However, an OV-1 usually consists of one or more graphics (or possibly a video-clip), as needed, as well as explanatory text.

OV-1: High-Level Operational Concept Graphic

OV-2: Operational Resource Flow Description

OV-3: Operational Resource Flow Matrix

OV-4: Organizational Relationships Chart

OV-5a: Operational Activity Decomposition Tree

OV-5b: Operational Activity Model

OV-6a, 6b, 6c: Introduction

OV-6a: Operational Rules Model

OV-6b: State Transition Description

OV-6c: Event-Trace Description

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Operational Viewpoint

OV-2: Operational Resource Flow Description

The OV-2 DoDAF-described Model applies the context of the operational capability to a community of anticipated users. The primary purpose of the OV-2 is to define capability requirements within an operational context. The OV-2 may also be used to express a capability boundary.

New to DoDAF V2.0, the OV-2 can be used to show flows of funding, personnel and materiel in addition to information. A specific application of the OV-2 is to describe a logical pattern of resource (information, funding, personnel, or materiel) flows. The logical pattern need not correspond to specific organizations, systems or locations, allowing Resource Flows to be established without prescribing the way that the Resource Flows are handled and without prescribing solutions.

The intended usage of the OV-2 includes:

- Definition of operational concepts.
- Elaboration of capability requirements.
- Definition of collaboration needs.
- Applying a local context to a capability.
- Problem space definition.
- Operational planning.
- Supply chain analysis.
- Allocation of activities to resources.

Detailed Description:

The OV-2 depicts Operational Needlines that indicate a need to exchange resources. New to DoDAF V2.0, the OV-2 show flows of funding, personnel and materiel in addition to information. The OV-2 may also show the location of Operational facilities or locations, and may optionally be annotated to show flows of information, funding, people or materiel between Operational Activities. The Operational Activities shown in an OV-2 may be internal to the architecture, or may be external activities that communicate with those internal activities.

Use of OV-2 is intended to be logical. It is to describe who or what, not how. This model provides a focus for the operational requirements which may reflect any capability requirements that have been articulated but within the range of operational settings that are being used for operational architecture. In an "As-Is" architecture, an OV-2 may be used as an abstract (i.e., simplified) representation of the Resource Flows taking place in the Enterprise. An OV-2 can be a powerful way of expressing the differences between an "As-Is" Architectural Description and a proposed "To-Be" Architectural Description to non-technical stakeholders, as it simply shows how Resource Flows (or does not flow). The aim of the OV-2 is to record the operational characteristics for the community of anticipated users relevant to the Architectural Description and their collaboration needs, as expressed in Needlines and Resource Flows.

A specific application of the OV-2 is to describe a logical pattern of resource (information, funding, personnel, or materiel) flows. The purpose of an OV-2 model is to describe a logical

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pattern of Resource Flows. The logical pattern need not correspond to specific organizations, systems or locations, allowing Resource Flows to be established without prescribing the way that the Resource Flows are handled and without prescribing solutions. The OV-2 is intended to track the need for Resource Flows between specific Operational Activities and Locations that play a key role in the Architectural Description. OV-2 does not depict the physical connectivity between the Activities and Locations. The logical pattern established in an OV-2 model may act as the backbone onto which architectural elements may be overlaid - e.g., a SV-1 Systems Interface Description model can show which systems are providing the necessary capability.

The main features of this model are the Operational Resource Flows, and the location (or type of location/environment) where the resources need to be or are deployed, and the Needlines that indicate a need to exchange or share resources. An OV-2 indicates the key players and the interactions necessary to conduct the corresponding operational activities of OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model.

A Needline documents the required or actual exchanges of resources. A Needline is a conduit for one or more resource exchanges - i.e., it represents a logical bundle of Resource Flows. The Needline does not indicate how the transfer is implemented. For example, if information (or funding, personnel, or materiel) is produced at location A, routed through location B, and is used at location C, then location B would not be shown on the OV-2 - the Needline would go from Location A to Location C. The OV-2 is not a communications link or communications network diagram but a high-level definition of the logical requirement for resource exchange.

A OV-2 can also define a need to exchange items between Operational Activities and locations and external resources (i.e., Operational Activities, Locations, or Organizations that are not strictly within the scope of the subject Architectural Description but which interface to it either as important sources of items required within the Architectural Description or important destinations for items provided within the Architectural Description).

The OV-2 is intended to track the need to exchange items between key Operational Activities and Locations within the Architectural Description. The OV-2 does not depict the physical connectivity between the Operational Activities and Locations. The Needlines established in an OV-2 can be realized by resources and their interactions in a SV-1 Systems Interface Description model or SvcV-1 Services Context Description model. There may not be a one-to-one correspondence between an operational activity and a location in OV-2 and a resource in SV-1 Systems Interface Description model or SvcV-1 Services Context Description model. For example, an Operational Activity and location may be realized by two systems, where one provides backup for the other, or it may be that the functionality of an Operational Activity has to be split between two locations for practical reasons.

Needlines can be represented by arrows (indicating the direction of flow) and are annotated with a diagram-unique identifier and a phrase that is descriptive of the principal type of exchange - it may be convenient to present these phrases (or numerical labels) in a key to the diagram to prevent cluttering. It is important to note that the arrows (with identifiers) on the diagram represent Needlines only. This means that each arrow indicates only that there is a need for the transfer of some resource between the two connected Activities or locations. A Needline can be uni-directional. Because Needline identifiers are often needed to provide a trace reference for Resource Flow requirements (see OV-3 Operational Resource Flow Matrix), a combined approach, with numerical and text labels, can be used.

There may be several Needlines (in the same direction) from one resource to another. This may occur because some Needlines are only relevant to certain scenarios, missions or mission phases. In this case, when producing the OV-2 for the specific case, a subset of all of the Needlines should be displayed. There can be a one-to-many relationship from Needlines to Resource Flow (e.g., a single Needline in OV-2 represents multiple individual Resource Flows). The mapping of the Resource Flows to the Needlines of OV-2 occurs in the Operational Resource Flow Matrix (OV-3). For example, OV-2 may list Situation Report as a descriptive name for a Needline between two Operational resources. In this case, the Needline represents a number of resource flow (information in this case) exchanges, consisting of various types of reports (information elements), and their attributes (such as periodicity and timeliness) that are associated with the Situation Report Needline. The identity of the individual elements and their attributes are documented in OV-3 Operational Resource Flow Matrix model.

For complex Architectural Descriptions, OV-2 may consist of multiple graphics. There are several different ways to decompose OV-2. One method involves using multiple levels of abstraction and decomposing the Resource Flows. Another method involves restricting the Resource Flows and Needlines on any given graphic to those associated with a subset of operational activities. Finally it is possible to organize OV-2 in terms of scenarios, missions or mission phases. All of these methods are valid and can be used together.

Flows of Funding, Personnel and Material:

In addition to Needlines, Resource Flow Connectors can be used to overlay contextual information about how the Operational Activities and Locations interact via physical flows. This information helps to provide context for the business roles. Examples of Resource Flow Connector usage would be:

- Representing a logistics capability may have an interaction which involves supplying (physically delivering) personnel.
- Representing an air-to-air refueling capability may have an interaction with airborne platform capabilities which involves transfer of fuel.
- Representing a sensor capability may have an interaction with a target through a flow of physical energy that is sensed; this is not an information flow.

This is achieved by overlaying the Resource Flow Connectors on the diagram using a notation that is clearly distinct from Needlines (which only represent the requirement to flow resources).

Operational Activities:

The operational activities (from the OV-5b Operational Activity Model) performed may be listed on the graphic, if space permits. OV-2 and the OV-5b Operational Activity Model are complementary descriptions. OV-2 focuses on the Operational Resource Flows, with the activities being a secondary adornment. The OV-5b, on the other hand, places first-order attention on operational activities and only second-order attention on Resource Flows, which can be shown as annotations or swim lanes on the activities. In developing an Architectural Description, OV-2 and OV-5b Operational Activity Model are often the starting points and these may be developed iteratively.

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OV-3: Operational Resource Flow Matrix

The OV-3 addresses operational Resource Flows exchanged between Operational Activities and locations.

Resource Flows provide further detail of the interoperability requirements associated with the operational capability of interest. The focus is on Resource Flows that cross the capability boundary.

The intended usage of the OV-3 includes:

. Definition of interoperability requirements.

Detailed Description:

The OV-3 identifies the resource transfers that are necessary to support operations to achieve a specific operational task. This model is initially constructed from the information contained in the OV-2 Operational Resource Flow Description model. But the OV-3 provides a more detailed definition of the Resource Flows for operations within a community of anticipated users.

The Operational Resource Flow Matrix details Resource Flow exchanges by identifying which Operational Activity and locations exchange what resources, with whom, why the resource is necessary, and the key attributes of the associated resources. The OV-3 identifies resource elements and relevant attributes of the Resource Flows and associates the exchange to the producing and consuming Operational Activities and locations and to the Needline that the Resource Flow satisfies. OV-3 is one of a suite of operational models that address the resource content of the operational architecture (the others being OV-2 Operational Resource Flow Description, OV-5b Operational Activity Model, and DIV-2 Logical Data Model). Needlines are logical requirements-based collaboration relationships between Operational Activities and locations (as shown in OV-2 Operational Resource Flow Description). A Needline can be uni-directional.

A resource element (see DIV-2 Logical Data Model) is a formalized representation of Resource Flows subject to an operational process. Resource elements may mediate activity flows and dependencies (see OV-5b Operational Activity Model). Hence they may also be carried by Needlines that express collaboration relationships. The same resource element may be used in one or more Resource Flows.

The emphasis in this model is on the logical and operational characteristics of the Resource Flows being exchanged, with focus on the Resource Flows crossing the capability boundary. It is important to note that OV-3 is not intended to be an exhaustive listing of all the details contained in every Resource Flow of every Operational Activity and location associated with the Architectural Description in question. Rather, this model is intended to capture the most important aspects of selected Resource Flows.

The aspects of the Resource Flow that are crucial to the operational mission will be tracked as attributes in OV-3. For example, if the subject Architectural Description concerns tactical battlefield targeting, then the timeliness of the enemy target information is a significant attribute of the Resource Flow. To support the needs of security architecture, Resource Flows should also address criticality and classification. There is an important caveat on use of OV-3

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for security architectures. In that context, it is important to identify every possible and required exchange.

There is not always a one-to-one mapping of OV-3 Resource Flows to OV-2 Operational Resource Flow Description Needlines; rather, many individual Resource Flows may be associated with one Needline.

The OV-3 information can be presented in tabular form. DoDAF V2.0 does not prescribe the column headings in an OV-3 Matrix.

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OV-4: Organizational Relationships Chart

The OV-4 shows organizational structures and interactions. The organizations shown may be civil or military. The OV-4 exists in two forms; role-based (e.g., a typical brigade command structure) and actual (e.g., an organization chart for a department or agency).

A role-based OV-4 shows the possible relationships between organizational resources. The key relationship is composition, i.e., one organizational resource being part of a parent organization. In addition to this, the architect may show the roles each organizational resource has, and the interactions between those roles, i.e., the roles represent the functional aspects of organizational resources. There are no prescribed resource interactions in DoDAF V2.0: the architect should select an appropriate interaction type from the DM2 or add a new one. Interactions illustrate the fundamental roles and management responsibilities, such as supervisory reporting, Command and Control (C2) relationships, collaboration and so on.

An actual OV-4 shows the structure of a real organization at a particular point in time, and is used to provide context to other parts of the architecture such as AV-1 and the CVs.

The intended usage of the role-based OV-4 includes:

- Organizational analysis.
- Definition of human roles.
- Operational analysis.

The intended usage of the actual OV-4 includes:

- Identify architecture stakeholders.
- Identify process owners.
- Illustrate current or future organization structures.

Detailed Description:

The OV-4 addresses the organizational aspects of an Architectural Description. A typical OV-4 illustrates the command structure or relationships (as opposed to relationships with respect to a business process flow) among human roles, organizations, or organization types that are the key players in the business represented by the architecture. An actual OV-4 shows real organizations and the relationships between them.

The more commonly used types of organizational relationship will be defined, in time, in the DoDAF Meta-model. DoDAF defines fundamental relationships between Organizational Resources; including structure (whole-part) and interaction. The interaction relationship covers most types of organizational relationship. An OV-4 clarifies the various relationships that can exist between organizations and sub-organizations within the Architectural Description and between internal and external organizations. Where there is a need for other types of organizational relationships, these should be recorded and defined in the AV-2 Integrated Dictionary as extensions to the DM2.

Organizational relationships are important to depict in an architecture model, because they can illustrate fundamental human roles (e.g., who or what type of skill is needed to conduct

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operational activities) as well as management relationships (e.g., command structure or relationship to other key players). Also, organizational relationships are drivers for some of the collaboration requirements that are viewed using Needlines.

Note that individual people are not viewed in DoDAF, but specific billets or Person Types may be detailed in an actual OV-4.

In both the typical and specific cases, it is possible to overlay resource interaction relationships which denote relationships between organizational elements that are not strictly hierarchical (e.g., a customer-supplier relationship).

The organizations that are modeled using OV-4 may also appear in other models, for example in the SV-1 Systems Interface Description as organizational constituents of a capability or a resource and PV-1 Project Portfolio Relationships where organizations own projects. In a SV-1 Systems Interface Description, for instance, the organizational resources defined in a typical OV-4 may be part of a capability or resources. Also, actual organizations may form elements of a fielded capability which realizes the requirements at the system-level (again, this may be depicted on a SV-1 Systems Interface Description).

A OV-4 may show types of organizations and the typical structure of those organizations. The OV-4 may alternatively show actual, specific organizations (e.g., the DoD) at some point in time. Alternatively, an OV-4 may be a hybrid diagram showing typical and actual organization structures.

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OV-5a: Operational Activity Decomposition Tree and OV-5b: Operational Activity Model

The OV-5a and the OV-5b describe the operations that are normally conducted in the course of achieving a mission or a business goal. It describes operational activities (or tasks); Input/Output flows between activities, and to/from activities that are outside the scope of the Architectural Description.

The OV-5a and OV-5b describes the operational activities that are being conducted within the mission or scenario. The OV-5a and OV-5b can be used to:

- Clearly delineate lines of responsibility for activities when coupled with OV-2.
- Uncover unnecessary Operational Activity redundancy.
- Make decisions about streamlining, combining, or omitting activities.
- Define or flag issues, opportunities, or operational activities and their interactions (information flows among the activities) that need to be scrutinized further.
- Provide a necessary foundation for depicting activity sequencing and timing in the OV-6a Operational Rules Model, the OV-6b State Transition Description, and the OV-6c Event-Trace Description.

The OV-5b describes the operational, business, and defense portion of the intelligence community activities associated with the Architectural Description, as well as the:

- Relationships or dependencies among the activities.
- Resources exchanged between activities.
- External interchanges (from/to business activities that are outside the scope of the model).

An Operational Activity is what work is required, specified independently of how it is carried out. To maintain this independence from implementation, logical activities and locations in OV-2 Operational Resource Flow Description are used to represent the structure which carries out the Operational Activities. Operational Activities are realized as System Functions (described in SV-4 Systems Functionality Description) or Service Functions (described in SvcV-4 Services Functionality Description) which are the how to the Operational Activities what, i.e., they are specified in terms of the resources that carry them out.

The intended usage of the OV-5a and OV-5b includes:

- Description of activities and workflows.
- Requirements capture.
- Definition of roles and responsibilities.
- Support task analysis to determine training needs.
- Problem space definition.
- Operational planning.
- Logistic support analysis.
- Information flow analysis.

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Detailed Description:

The OV-5s and OV-2 Operational Resource Flow Description model are, to a degree, complements of each other. The OV-5s focuses on the operational activities whereas OV-2 Operational Resource Flow Description model focuses on the operational activities in relation to locations. Due to the relationship between locations and operational activities, these types of models should normally be developed together. An OV-5a or OV-5b describes the operational activites (or tasks) that are normally conducted in the course of achieving a mission or a business goal. The OV-5b also describes Input/Output flows between activities, and to/from activities that are outside the scope of the Architectural Description. The OV-5a and OV-5b are equally suited to describing non-military activities and are expected to be used extensively for business modeling.

The activities described in an OV-5a or OV-5b are standard Operational Activities which are mapped to corresponding capabilities in the CV-6 Capability to Operational Activities Mapping. Standard Operational Activities are those defined in doctrine, but which are not tailored to a specific system, i.e., they are generic enough to be used without closing off a range of possible solutions.

Possible Construction Methods: DoDAF does not endorse a specific activity modeling methodology. The OV-5b can be constructed using Integration Definition for Function Modeling (IDEF0) or Class Diagrams.

There are two basic ways to depict Activity Models:

- The Activity Decomposition Tree shows activities depicted in a tree structure and is typically used to provide a navigation aid.
- The Activity Model shows activities connected by Resource Flows; it supports development of an OV-3 Operational Resource Flow Matrix.

The OV-5a helps provide an overall picture of the activities involved and a quick reference for navigating the OV-5b.

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Introduction to OV-6a, OV-6b and OV-6c

OV Models discussed in previous sections model the static structure of the Architectural elements and their relationships. Many of the critical characteristics of an architecture are only discovered when the dynamic behavior of these elements is modeled to incorporate sequencing and timing aspects.

The dynamic behavior referred to here concerns the timing and sequencing of events that capture operational behavior of a business process or mission thread. Thus, this behavior is related to the activities of OV-5b. Behavior modeling and documentation is essential to a successful Architectural Description, because it describes how the architecture behaves and that is crucial in many situations. Knowledge of the Operational Activities and Resource Flow exchanges is important; but knowing when, for example, a response should be expected after sending message X to Activity Y at Location A can also be essential to achieving successful operations.

Several modeling techniques may be used to refine and extend the Architectural Description's OV to adequately describe the dynamic behavior and timing performance characteristics of an architecture. The OV-6 DoDAF-described Models includes three such models. They are:

- Operational Rules Model (OV-6a)
- Operational State Transition Description (OV-6b)
- Operational Event-Trace Description (OV-6c)

OV-6 DoDAF-described Models portray some of the same architectural data elements, but each also portrays some unique architectural data elements. OV-6b and OV-6c may be used separately or together, as necessary, to describe critical timing and sequencing behavior in the OV. Both types of models are used by a wide variety of business process methodologies as well as Object-Oriented methodologies. OV-6b and OV-6c describe Operational Activity or business process responses to sequences of events. Events may also be referred to as inputs, transactions, or triggers. Events can be internally or externally generated and can include such things as the receipt of a message, a timer going off, or conditional tests being satisfied. When an event occurs, the action to be taken may be subject to a rule or set of rules (conditions) as described in OV-6a.

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OV-2: Operational Resource Flow Description

OV-3: Operational Resource Flow Matrix

OV-4: Organizational Relationships Chart

OV-5a: Operational Activity Decomposition Tree

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OV-6a: Operational Rules Model

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OV-6b: State Transition Description

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OV-6a: Operational Rules Model

An OV-6a specifies operational or business rules that are constraints on the way that business is done in the enterprise. At a top-level, rules should at least embody the concepts of operations defined in OV-1 High Level Operational Concept Graphic and provide guidelines for the development and definition of more detailed rules and behavioral definitions that should occur later in the Architectural definition process.

The intended usage of the OV-6a includes:

- Definition of doctrinally correct operational procedures.
- Definition of business rules.
- Identification of operational constraints.

Detailed Description:

The OV-6a specifies operational or business rules that are constraints on the way business is done in the enterprise. While other OV Models (e.g., OV-1 High Level Operational Concept Graphic, OV-2 Operational Resource Flow Description, and OV-5b Operational Activity Model) describe the structure and operation of a business, for the most part they do not describe the constraints and rules under which it operates.

At the mission-level, OV-6a may be based on business rules contained in doctrine, guidance, rules of engagement, etc. At lower levels, OV-6a describes the rules under which the architecture behave under specified conditions. Such rules can be expressed in a textual form, for example, If (these conditions) exist, and (this event) occurs, then (perform these actions). These rules are contrasted with the business or doctrinal standards themselves, which provide authoritative references and provenance for the rules (see StdV-1 Standards Profile). Operational Rules are statements that constrain some aspect of the mission or the architecture. Rules may be expressed in natural language (English) in one of two forms:

- Imperative - a statement of what shall be under all conditions, e.g., "Battle Damage Assessment (BDA) shall only be carried out under fair weather conditions."
- Conditional Imperative - a statement of what shall be, in the event of another condition being met. If battle damage assessment shows incomplete strike, then a re-strike shall be carried out.

As the model name implies, the rules captured in OV-6a are operational (i.e., mission-oriented) whereas resource-oriented rules are defined in the SV-10s or the SvcV-10s (OV-6 is the *what* to the SV-10's or SvcV-10's *how*). OV-6a rules can include such guidance as the conditions under which operational control passes from one entity to another or the conditions under which a human role is authorized to proceed with a specific activity.

A rule defined in textual form OV-6a may be applied to any Architectural element defined in an OV. A rule defined in a more structured way (i.e., for the purposes of sharing with other architects) should be defined in association with locations, operational activities or missions.

Rules defined in an OV-6a may optionally be presented in any other OV. For example, a rule "battle damage assessment shall be carried out under fair weather conditions" may be linked

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to the Conduct BDA activity in OV-5b. Any natural language rule presented (e.g., in a diagram note) should also be listed in OV-6a.

OV-6a rules may be associated with activities in OV-5a Operational Activity Decomposition Tree and OV-5b Operational Activity Model and can be useful to overlay the rules on an OV-5a Operational Activity Decomposition or OV-5b Operational Activity Model. OV-6a can also be used to extend the capture of business requirements by constraining the structure and validity of DIV-2 Logical Data Model elements.

Detailed rules can become quite complex, and the structuring of the rules themselves can often be challenging. DoDAF does not specify how OV-6a rules will be specified, other than in English.

From a modeling perspective, operational constraints may act upon Locations, Operational Activities, Missions, and Entities in Logical Data Models.

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OV-6b: State Transition Description.

The OV-6b is a graphical method of describing how an Operational Activity responds to various events by changing its state. The diagram represents the sets of events to which the Activities respond (by taking an action to move to a new state) as a function of its current state. Each transition specifies an event and an action.

An OV-6b can be used to describe the detailed sequencing of activities or work flow in the business process. The OV-6b is particularly useful for describing critical sequencing of behaviors and timing of operational activities that cannot be adequately described in the OV-5b Operational Activity Model. The OV-6b relates events and states. A change of state is called a transition. Actions may be associated with a given state or with the transition between states in response to stimuli (e.g., triggers and events).

The intended usage of the OV-6b includes:

- Analysis of business events.
- Behavioral analysis.
- Identification of constraints.

Detailed Description:

The OV-6b reflects the fact that the explicit sequencing of activities in response to external and internal events is not fully expressed in OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model. Alternatively, OV-6b can be used to reflect the explicit sequencing of actions internal to a single Operational Activity or the sequencing of operational activities. OV-6b is based on the statechart diagram. A state machine is defined as "a specification that describes all possible behaviors of some dynamic view element. Behavior is viewed as a traversal of a graph of state interconnected by one or more joined transition arcs that are triggered by the dispatching of a series of event instances. During this traversal, the state machine executes a series of actions associated with various elements of the state machine."

State chart diagrams can be unambiguously converted to structured textual rules that specify timing aspects of operational events and the responses to these events, with no loss of meaning. However, the graphical form of the state diagrams can often allow quick analysis of the completeness of the rule set, and detection of dead ends or missing conditions. These errors, if not detected early during the operational analysis phase, can often lead to serious behavioral errors in fielded systems or to expensive correction efforts.

States in an OV-6b may be nested. This enables quite complex models to be created to represent operational behavior.

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[OV-5a: Operational Activity Decomposition Tree]

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OV-6c: Event-Trace Description

The OV-6c provides a time-ordered examination of the Resource Flows as a result of a particular scenario. Each event-trace diagram should have an accompanying description that defines the particular scenario or situation. Operational Event/Trace Descriptions, sometimes called sequence diagrams, event scenarios, or timing diagrams, allow the tracing of actions in a scenario or critical sequence of events. The OV-6c can be used by itself or in conjunction with an OV-6b State Transition Description to describe the dynamic behavior of activities.

The intended usage of the OV-6c includes:

- Analysis of operational events.
- Behavioral analysis.
- Identification of non-functional user requirements.
- Operational test scenarios.

Detailed Description:

The OV-6c is valuable for moving to the next level of detail from the initial operational concepts. An OV-6c model helps define interactions and operational threads. The OV-6c can also help ensure that each participating Operational Activity and Location has the necessary information it needs at the right time to perform its assigned Operational Activity.

The OV-6c enables the tracing of actions in a scenario or critical sequence of events. OV-6c can be used by itself or in conjunction with OV-6b State Transition Description to describe the dynamic behavior of business activities or a mission/operational thread. An operational thread is defined as a set of operational activities, with sequence and timing attributes of the activities, and includes the resources needed to accomplish the activities. A particular operational thread may be used to depict a military or business capability. In this manner, a capability is defined in terms of the attributes required to accomplish a given mission objective by modeling the set of activities and their attributes. The sequence of activities forms the basis for defining and understanding the many factors that impact on the overall capability.

The information content of messages in an OV-6c may be related with the Resource Flows in the OV-3 Operational Resource Flow Matrix and OV-5b Operational Activity Model and information entities in the DIV-2 Logical Data Model.

Possible Construction Methods: DoDAF does not endorse a specific event-trace modeling methodology. An OV-6c may be developed using any modeling notation (e.g., BPMN) that supports the layout of timing and sequence of activities along with the Resource Flow exchanges that occur between Operational Activities/Locations for a given scenario. Different scenarios can be depicted by separate diagrams.

OV-1: High-Level Operational Concept Graphic

OV-2: Operational Resource Flow Description

OV-3: Operational Resource Flow Matrix

OV-4: Organizational Relationships Chart

OV-5a: Operational Activity Decomposition Tree

OV-5b: Operational Activity Model

OV-6a, 6b, 6c: Introduction

OV-6a: Operational Rules Model

OV-6b: State Transition Description

OV-6c: Event-Trace Description

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DoDAF Viewpoints and Models

Project Viewpoint

The DoDAF-described Models within the Project Viewpoint describe how programs, projects, portfolios, or initiatives deliver capabilities, the organizations contributing to them, and dependencies between them. Previous versions of DoDAF took a traditional model of architecture in which descriptions of programs and projects were considered outside scope. To compensate for this, various DoDAF models represented the evolution of systems, technologies and standards (e.g., Systems and Services Evolution Description, Systems Technology Forecast, and Technical Standards Forecast).

The integration of Project Models (organizational and project-oriented) with the more traditional architecture models is a characteristic aspect of DoDAF V2.0-based enterprise Architectural Descriptions. These models expand the usability of the DoDAF by including information about programs, projects, portfolios, or initiatives and relating that information to capabilities and other programs, projects, portfolios, or initiatives thus expanding DoDAF's support to the portfolio management (PfM) process. Different levels of cost data can be captured in the architecture, based on the Process-owners requirements. An example is a Work Breakdown Structure, depicted as a Gantt chart.

Project Model Descriptions

Model	Description
PV-1: Project Portfolio Relationships	It 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.

Mappings of the Project Viewpoint Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

Uses of Project Viewpoint DoDAF-described Models. As stated above, the Project Viewpoint DoDAF-described Models contain information that improves DoDAF's support to the portfolio management process. It is important to be able to look across portfolios (i.e., groups of investments) to ensure that all possible alternatives for a particular decision have been exhausted to make the most informed decision possible in support of the Department. Relating project information to the responsible organizations, as well as to other projects, forms a valuable architecture construct that supports PfM.

Incorporation of these models also makes the DoDAF a value-added framework to support the PPBE process. These models are especially applicable to the Programming Phase of the PPBE process. It is within this phase that the Program Objective Memorandum (POM) is

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developed. The POM seeks to construct a balanced set of programs that respond to the guidance and priorities of the Joint Programming Guidance within fiscal constraints. When completed, the POM provides a fairly detailed and comprehensive description of the proposed programs, which can include a time-phased allocation of resources (personnel, funding, materiel, and information) by program projected into the future. The information captured within the Project models (e.g., project relationships, timelines, capabilities) can be used within the PPBE process to develop the POM. Using these models enables decision-makers to perform well-informed planning and complements the use of the Capability Models.

The Project Models can be used to answer questions such as:

- What capabilities are delivered as part of this project?
- Are there other projects that either affect or are affected by this project? To what portfolios do the projects or projects belong?
- What are the important milestones relative to this project? When can I expect capabilities to be rendered by this project to be in place?

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Project Viewpoint

PV-1: Project Portfolio Relationships

The PV-1 represents an organizational perspective on programs, projects, portfolios, or initiatives.

The PV-1 enables the user to model the organizational structures needed to manage programs, projects, portfolios, or initiatives. It shows dependency relationships between the actual organizations that own the programs, projects, portfolios, or initiatives. This model could be used to represent organizational relationships associated with transformation initiatives along with those who are responsible for managing programs, projects, and portfolios. The PV-1 provides a means of analyzing the main dependencies between acquisition elements or transformation elements.

The intended usage of the PV-1 includes, but is not limited to:

- Program management (specified acquisition program structure).
- Project organization.
- Cross-cutting initiatives to be tracked across portfolios.

Detailed Description:

The PV-1 describes how acquisition projects are grouped in organizational terms as a coherent portfolio of acquisition programs or projects, or initiatives related to several portfolios. The PV-1 provides a way of describing the organizational relationships between multiple acquisition projects or portfolios, each of which are responsible for delivering individual systems or capabilities. By definition, this model covers acquisition portfolios or programs consisting of multiple projects and is generally not for an individual project. In essence, PV-1 is an organizational breakdown consisting of actual organizations (see OV-4 Organizational Relationships Chart model). The model is strongly linked with the CV-4 Capability Dependencies model which shows capability groupings and dependencies.

The PV-1 is hierarchical in nature. Higher-level groupings of projects (the organizations that own these projects) form acquisition programs or initiatives.

The intent of a PV-1 is to show:

- All of the acquisition projects delivering services, systems, or SoS within the acquisition programs under consideration.
- Cross-cutting initiatives to be tracked across portfolios.
- Other services, systems, and SoS which may have a bearing on the architecture.
- How the services or systems will be best integrated into an acquisition program.
- The nesting of acquisition programs to form a hierarchy.

A PV-1 is specific to a particular point in the project lifecycle. This may change through time, i.e., the projects may change as new services, systems and capabilities are introduced into the acquisition program. Hence, it is possible that an acquisition program could have more than one PV-1, each showing how the acquisition projects are arranged for relevant periods of time. This is achieved by tying the PV-1 model to a capability phase in the CV-3 Capability Dependencies model.

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PV-1: Project Portfolio Relationships

PV-2: Project Timelines

PV-3: Project to Capability Mapping

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PV-2: Project Timelines

The PV-2 provides a timeline perspective on programs. The PV-2 is intended primarily to support the acquisition and fielding processes including the management of dependencies between projects and the integration of DoDD 5000.1 Defense Acquisition System policies to achieve a successfully integrated capability. The PV-2 is not limited to the acquisition and fielding processes.

The intended usage of the PV-2 includes:

- Project management and control (including delivery timescales).
- Project dependency risk identification.
- Management of dependencies.
- Portfolio management.

Detailed Description:

The PV-2 provides an overview of a program or portfolio of individual projects, or initiatives, based on a timeline. Portfolios, Programs, Projects, and Initiatives may be broken into work streams to show the dependencies at a lower-level. For capability-based procurement, these work streams might conveniently be equated with JCA. Sometimes, however, it is more appropriate to consider these acquisition projects in their own right.

Where appropriate, the PV-2 may also summarize, for each of the projects illustrated, the level of maturity achieved across the DoDD 5000.1 Defense Acquisition System policies at each stage of the DAS lifecycle, and the interdependencies between the project stages.

The PV-2 is intended primarily to support the acquisition and fielding processes including the management of dependencies between projects and the integration of DoDD 5000.1 Defense Acquisition System policies to achieve a successfully integrated capability. However, the PV-2 is not limited to the acquisition and fielding processes. The information provided by the Model can be used to determine the impact of either planned or unplanned programmatic changes, and highlight opportunities for optimization across the delivery program. The inclusion of the DoDD 5000.1 Defense Acquisition System policy information allows areas of concern that are outside the immediate scope being considered. Areas of concern identified across the DoDD 5000.1 Defense Acquisition System policies, e.g., a shortfall in training resource, can be coordinated across a program or group of projects, each of which require additional activity to be initiated for successfully delivery according to the project/program schedule.

Although a PV-2 may be compiled for a single system project, with supporting work streams, the model becomes particularly useful when considering the dependencies between the multiple projects (or increments within them) that contribute to an acquisition program. Such an acquisition program may be an oversight organization or any other useful grouping of projects that have strong dependencies or contribute towards a common goal (see CV-1 Vision model). Typical use of PV-2 is to represent an individual system development for use in the CV-3 Capability Phasing, while an Integrated Product Team (IPT) may be delivering several systems simultaneously. While PV-2 is expected to support acquisition management for a program consisting of a portfolio of acquisition projects, it may sometimes be

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convenient to use a PV-2 timeline model for other purposes, e.g., to show temporal relationships between transformation initiatives at the strategic-level or for technology roadmapping.

A PV-2 graphically displays the key milestones and interdependencies between the multiple projects that constitute a program, portfolio, or initiative. Use of PV-2 should support the management of capability delivery and be aligned with the CV-3 Capability Phasing model, if one exists. One presentational format for a PV-2 can be a Gantt chart that displays the entire lifecycle of each project, together with dependencies between them.

Optionally, the Gantt chart may be enhanced to show the level of maturity for each of the DOTMLPF factors associated with that project at each key milestone. The colored icon can be a segmented circular pie chart, a regular polyhedron or any appropriate graphic, providing that the graphic is explained and covers all DAS requirements.

PV-1: Project Portfolio Relationships

PV-2: Project Timelines

PV-3: Project to Capability Mapping

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PV-3: Project to Capability Mapping

The PV-3 supports the acquisition and deployment processes, including the management of dependencies between projects and the integration of all relevant project and program elements to achieve a capability.

The PV-3 maps programs, projects, portfolios, or initiatives to capabilities to show how the specific elements help to achieve a capability. Programs, projects, portfolios, or initiatives are mapped to the capability for a particular timeframe. Programs, projects, portfolios, or initiatives may contribute to multiple capabilities and may mature across time. The analysis can be used to identify capability redundancies and shortfalls, highlight phasing issues, expose organizational or system interoperability problems, and support program decisions, such as when to phase out a legacy system.

The intended usage of the PV-3 includes:

- Tracing capability requirements to projects.
- Capability audit.

Detailed Description:

The PV-3 describes the mapping between capabilities and the programs, projects, portfolios, or initiatives that would support the capabilities. This model may be used to indicate that a project does or does not fulfill the requirements for a capability for a particular phase.

This model is analogous to the SV-5a Operational Activity to System Function Traceability Matrix, but provides the interface between Capability and Project Models rather than Operational to System Models.

In principle, there could be a different PV-3 table created for each development phase of the program, project, portfolio, or initiative development, or perhaps for different phasing scenarios. In most cases, a single table can be constructed because the programs, projects, portfolios, or initiatives that are most likely relevant to this model can be relatively high-level. If capabilities associated are generic (see CV-1 Vision model), then they should have a well understood relationship with a set of programs, projects, portfolios, or initiatives and this relationship is unlikely to change over time.

The PV-3 can have a tabular presentation. The rows can be the Capabilities and the columns can be the programs, projects, portfolios, or initiatives. An X can indicate where the capability is supported by the programs, projects, portfolios, or initiatives whereas a blank can indicate that it does not. Alternatively, a date or phase can indicate when programs, projects, portfolios, or initiatives will support capabilities by the date or phase indicated.

PV-1: Project Portfolio Relationships

PV-2: Project Timelines

PV-3: Project to Capability Mapping

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DoDAF Viewpoints and Models

Services Viewpoint

The DoDAF-described Models within the Services Viewpoint describes services and their interconnections providing or supporting, DoD functions. DoD functions include both warfighting and business functions. The Service Models associate service resources to the operational and capability requirements. These resources support the operational activities and facilitate the exchange of information. The relationship between architectural data elements across the Services Viewpoint to the Operational Viewpoint and Capability Viewpoint can be exemplified as services are procured and fielded to support the operations and capabilities of organizations. The structural and behavioral models in the OVs and SvcVs allow architects and stakeholders to quickly ascertain which functions are carried out by humans and which by Services for each alternative specification and so carry out trade analysis based on risk, cost, reliability, etc.

Services are not limited to internal system functions and can include Human Computer Interface (HCI) and Graphical User Interface (GUI) functions or functions that consume or produce service data to or from service functions. The external service data providers and consumers can be used to represent the human that interacts with the service.

Service Model Descriptions

Model	Description
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 timeframe(s).
SvcV-8 Services Evolution Description	The planned incremental steps toward migrating a

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	suite of services to a more efficient suite or toward evolving current services to a future implementation.
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.

Mappings of the Services Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

Uses of Services Viewpoint DoDAF-described Models. Within the development process, the service models describe the design for service-based solutions to support operational requirements from the development processes (JCIDS) and Defense Acquisition System or capability development within the JCAs.

Some of the Services Viewpoint DoDAF-described Models are discussed with examples in the DoDAF Product Development Questionnaire Analysis Report.doc. This document can be viewed online in the public DoDAF Journal.

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Services Viewpoint

SvcV-1: Services Interface Description

The SvcV-1 addresses the composition and interaction of Services. For DoDAF V2.0, SvcV-1 incorporates human elements as types of Performers - Organizations and Personnel Types.

The SvcV-1 links together the operational and services architecture models by depicting how resources are structured and interact to realize the logical architecture specified in an OV-2 Operational Resource Flow Description. A SvcV-1 may represent the realization of a requirement specified in an OV-2 Operational Resource Flow Description (i.e., in a “To-Be” Architectural Description), and so there may be many alternative SvcV models that could realize the operational requirement. Alternatively, in an ”As-Is” Architectural Description, the OV-2 Operational Resource Flow Description may simply be a simplified, logical representation of the SvcV-1 to allow communication of key Resource Flows to non-technical stakeholders.

It is important for the architect to recognize that the SvcV-1 focuses on the Resource Flow and the providing service. This differs from a SV-1 System Interface Description which focuses on the System-to-System point-to-point interface, for which the Source System and Target System have an agreed upon interface. For the SvcV-1, the focus on the provider and the data provided is a Net-Centric Data Strategy tenet appropriate for a publish/subscribe pattern. This pattern is not the only type of service that can be captured in the SvcV-1.

Sub-services may be identified in SvcV-1 to any level (i.e., depth) of decomposition the architect sees fit. The SvcV-1 may also identify the Physical Assets (e.g., Platforms) at which Resources are deployed, and optionally overlay Operational Activities and Locations that utilize those Resources. In many cases, an operational activity and locations depicted in an OV-2 Operational Resource Flow Description may well be the logical representation of the resource that is shown in SvcV-1.

The intended usage of the SvcV-1 includes:

- Definition of service concepts.
- Definition of service options.
- Service Resource Flow requirements capture.
- Capability integration planning.
- Service integration management.
- Operational planning (capability and performer definition).

The SvcV-1 is used in two complementary ways:

- Describe the Resource Flows exchanged between resources in the architecture.
- Describe a solution, or solution option, in terms of the components of capability and their physical integration on platforms and other facilities.

Detailed Description:

A SvcV-1 can be used simply to depict services and sub-services and identify the Resource Flows between them. The real benefit of a SvcV-1 is its ability to describe the human aspects of an architecture and how they interact with Services. In addition, DoDAF has the

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concept of Capability and Performers (see the Capability Meta-model group in the LDM) which is used to depict Services, assets and people into a configuration, which can meet a specific capability. A primary purpose of a SvcV-1 model is to show resource structure, i.e., identify the primary sub-services, performer and activities (functions) and their interactions. SvcV-1 contributes to user understanding of the structural characteristics of the solution.

The physical resources contributing to a capability are either an organizational resource or a physical asset, i.e., a service cannot contribute alone (it must be hosted on a physical asset used by an organizational resource of both). Organizational aspects can now be shown on SvcV-1 (e.g., who uses a service). Resource structures may be identified in SvcV-1 to any level (i.e., depth) of decomposition the architect sees fit. DoDAF does not specifically use terms like sub-service and component as these terms often denote a position relative to a structural hierarchy. Any service may combine hardware and software or these can be treated as separate (sub) services. DoDAF V2.0 includes human factors (as Personnel Types and a type of Performer). Should an architect wish to describe a service which has human elements, then groupings of Services, Personnel Types and Performers should be used to wrap the human and service elements together.

A SvcV-1 can optionally be annotated with Operational Activities and Locations originally specified in OV-2 Operational Resource Flow Description. In this way, traceability can be established from the logical OV structure to the physical Service Model structure.

If a single SvcV-1 is not possible, the resource of interest should be decomposed into multiple SvcV-1 models.

Functions (Activities):

Some Resources can carry out service functions (activities) as described in SvcV-4 Services Functionality Description models and these functions can optionally be overlaid on a SvcV-1. In a sense SvcV-1 and SvcV-4 Services Functionality Description provide complementary representations (structure and function). Either could be viewed first, but usually an iterative approach is used to model these together gradually building up the level of detail in the service description. Note that the same type (class) of resource may be used in different contexts in a given SvcV-1. For this reason, the tracing of functions to resources is specified in context of their usage (see DM2 for details).

Resource Flows in SvcV-1:

In addition to depicting Services (Performers) and their structure, SvcV-1 addresses Service Resource Flows. A Service Resource Flow, as depicted in SvcV-1, is an indicator that resources pass between one service and the other. In the case of Services, this can be expanded into further detail in SvcV-2 Services Resource Flow Description model. A Service Resource Flow is a simplified representation of a pathway or network pattern, usually depicted graphically as a connector (i.e., a line with possible amplifying information). The SvcV-1 depicts all Resource Flows between resources that are of interest. Note that Resource Flows between resources may be further specified in detail in the SvcV-2 Services Resource Flow Description model and the SvcV-6 Services Resource Flow Matrix.

Interactions are only possible between services and systems. Service Resource Flows provide a specification for how the Resource Flow exchanges specified in OV-2 Operational Resource Flow Description Needlines are realized with services. A single Needline shown in the OV-2 Operational Resource Flow Description may translate into multiple Service Resource Flows. The actual implementation of Service Resource Flows may take more than one form (e.g., multiple physical links). Details of the physical pathways or network patterns that implement the interfaces are documented in SvcV-2 Services Resource Flow Description. Resource Flows are summarized in a SvcV-3a System-Service Matrix or SvcV-3b Service-Service Matrix and detailed definitions and attributes specific to each Service Resource Flows may be described in SvcV-6 Services Resource Flow Matrix.

The functions performed by the resources are specified in a SvcV-4 Service Functionality Description, but may optionally be overlaid on the Resources in a SvcV-1.

SvcV-1 Services Context Description

SvcV-2 Services Resource Flow Description

SvcV-3a Systems-Services Matrix

SvcV-3b Services-Services Matrix

SvcV-4 Services Functionality Description

SvcV-5 Operational Activity to Services Traceability Matrix

SvcV-6 Services Resource Flow Matrix

SvcV-7 Services Measures Matrix

SvcV-8 Services Evolution Description

SvcV-9 Services Technology & Skills Forecast

SvcV-10abc Introduction to SvcV-10a, SvcV-10b and SvcV-10c

SvcV-10a Services Rules Model

SvcV-10b Services State Transition Description

SvcV-10c Services Event-Trace Description

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Services Viewpoint

SvcV-2: Services Resource Flow Description

A SvcV-2 specifies the Resource Flows between Services and may also list the protocol stacks used in connections.

A SvcV-2 DoDAF-described Model is used to give a precise specification of a connection between Services. This may be an existing connection or a specification of a connection that is to be made for a future connection.

The intended usage of the SvcV-2 includes:

- Resource Flow specification.

Detailed Description:

For a network data service, a SvcV-2 comprises Services, their ports, and the Service Resource Flows between those ports. The SvcV-2 may also be used to describe non-IT type services such as Search and Rescue. The architect may choose to create a diagram for each Service Resource Flow and the producing Service, each Service Resource Flow and consuming Service, or to show all the Service Resource Flows on one diagram, if this is possible.

Each SvcV-2 model can show:

- Which ports are connected.
- The producing Services that the ports belong to.
- The Services that the Service Resource Flows are consumed by.
- The definition of the Service Resource Flow in terms of the physical/logical connectivity and any protocols that are used in the connection.

Note that networks are represented as Services. The architect may choose to show other Services being components of the network, i.e., if they are part of the network infrastructure.

Any protocol referred to in a SvcV-2 diagram needs be defined in the StdV-1 Standards Profile.

SvcV-1 Services Context Description

SvcV-2 Services Resource Flow Description

SvcV-3a Systems-Services Matrix

SvcV-3b Services-Services Matrix

SvcV-4 Services Functionality Description

SvcV-5 Operational Activity to Services Traceability Matrix

SvcV-6 Services Resource Flow Matrix

SvcV-7 Services Measures Matrix

SvcV-8 Services Evolution Description

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[SvcV-9 Services Technology & Skills Forecast](#)

[SvcV-10abc Introduction to SvcV-10a, SvcV-10b and SvcV-10c](#)

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SvcV-3a: Systems-Services Matrix

A SvcV-3a enables a quick overview of all the system-to-service resource interactions specified in one or more SvcV-1 Services Context Description models. The SvcV-3a provides a tabular summary of the system and services interactions specified in the SvcV-1 Services Context Description for the Architectural Description. This model can be useful in support existing systems that are transitioning to provide services. The matrix format supports a rapid assessment of potential commonalities and redundancies (or, if fault-tolerance is desired, the lack of redundancies).

The SvcV-3a can be organized in a number of ways to emphasize the association of system-to-service interactions in context with the architecture's purpose.

The intended usage of the SvcV-3a includes:

- Summarizing system and service resource interactions.
- Interface management.
- Comparing interoperability characteristics of solution options.

Detailed Description:

The SvcV-1 concentrates on Service resources and their interactions, and these are summarized in a SvcV-3a or SvcV-3b. The SvcV-3a DoDAF-described Model can be a useful tool for managing the evolution of solutions and infrastructures, the insertion of new technologies and functionality, and the redistribution of Systems and Services and activities in context with evolving operational requirements.

Depending upon the purpose of the architecture, there could be several SvcV-3a DoDAF-described Models. The suite of SvcV-3a models can be organized in a number of ways (e.g., by domain, by operational mission phase, by solution option) to emphasize the association of groups of resource pairs in context with the Architectural Description's purpose.

The SvcV-3a is generally presented as a matrix, where the System and Services resources are listed in the rows and columns of the matrix, and each cell indicates an interaction between Systems and Services if one exists. Many types of interaction information can be presented in the cells of a SvcV-3a. The resource interactions can be represented using different symbols and/or color coding that depicts different interaction characteristics, for example:

- Status (e.g., existing, planned, potential, de-activated).
- Key interfaces.
- Category (e.g., command and control, intelligence, personnel, logistics).
- Classification-level (e.g., Restricted, Confidential, Secret, Top Secret).
- Communication means (e.g., Rim Loop Interface, Scalable Loop Interface).

DoDAF does not specify the symbols to be used. If symbols are used, a key for the symbols is needed.

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SvcV-3b: Services-Services Matrix

A SvcV-3b enables a quick overview of all the services resource interactions specified in one or more SvcV-1 Services Context Description models. The SvcV-3b provides a tabular summary of the services interactions specified in the SvcV-1 Services Context Description for the Architectural Description. The matrix format supports a rapid assessment of potential commonalities and redundancies (or, if fault-tolerance is desired, the lack of redundancies). In addition, this model is useful in support of net-centric (service-oriented) implementation of services as an input to the SvcV-10a Services Rules Model, SvcV-10b Services State Transition Description, and SvcV-10c Services Event-Trace Description, implemented as orchestrations of services.

The SvcV-3b can be organized in a number of ways to emphasize the association of service pairs in context with the architecture's purpose. One type of organization is a Service Hierarchy or Taxonomy of Services.

The intended usage of the SvcV-3b includes:

- Summarizing service resource interactions.
- Interface management.
- Comparing interoperability characteristics of solution options.

It is important to note that one usage of the Service-Service Matrix (SvcV-3b) can support a net- centric (service-oriented) implementation in describing the interactions between producing services and consuming services.

Detailed Description:

The SvcV-1 concentrates on Service resources and their interactions, and these are summarized in a SvcV-3a or SvcV-3b. The SvcV-3b can be a useful tool for managing the evolution of solutions and infrastructures, the insertion of new technologies and functionality, and the redistribution of Services and activities in context with evolving operational requirements.

Depending upon the purpose of the architecture, there could be several SvcV-3b DoDAF-described Models. The suite of SvcV-3b DoDAF-described Models can be organized in a number of ways (e.g., by domain, by operational mission phase, by solution option) to emphasize the association of groups of resource pairs in context with the Architectural Description purpose.

The SvcV-3b is generally presented as a matrix, where the Services resources are listed in the rows and columns of the matrix, and each cell indicates an interaction between Services if one exists. There are many types of information that can be presented in the cells of a SvcV-3b. The resource interactions can be represented using different symbols and/or color coding that depicts different interaction characteristics, for example:

- Status (e.g., existing, planned, potential, de-activated).
- Key interfaces.
- Category (e.g., command and control, intelligence, personnel, logistics).

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- Classification-level (e.g., Restricted, Confidential, Secret, Top Secret).
- Communication means (e.g., Rim Loop Interface, Scalable Loop Interface).

DoDAF does not specify the symbols to be used. If symbols are used, a key for the symbols is needed.

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SvcV-4: Services Functionality Description

The SvcV-4 DoDAF-described Model addresses human and service functionality.

The primary purpose of SvcV-4 is to:

- Develop a clear description of the necessary data flows that are input (consumed) by and output (produced) by each resource.
- Ensure that the service functional connectivity is complete (i.e., that a resource's required inputs are all satisfied).
- Ensure that the functional decomposition reaches an appropriate level of detail.

The Services Functionality Description provides detailed information regarding the:

- Allocation of service functions to resources.
- Flow of resources between service functions.

The SvcV-4 is the Services Viewpoint counterpart to the OV-5b Operational Activity Model of the Operational Viewpoint.

The intended usage of the SvcV-4 includes:

- Description of task workflow.
- Identification of functional service requirements.
- Functional decomposition of Services.
- Relate human and service functions.

It is important to note that one usage of the SvcV-4 can support a net-centric (service-oriented) implementation in describing the producing services and consuming services. The Services Functionality Description information can support the registration of services in net-centric (service-oriented) implementation.

Detailed Description:

The SvcV-4 is used to specify the service functionality of resources in the architecture. The SvcV-4 is the behavioral counterpart to the SvcV-1 Services Context Description (in the same way that OV-5b Operational Activity Model is the behavioral counterpart to OV-2 Operational Resource Flow Description).

The scope of this model may be capability wide, without regard to which resources perform which service functions, or it may be resource-specific. Variations may focus on intra- or inter-resource data flows, or may simply allocate service functions to resources.

There are two basic ways to depict a SvcV-4:

- The Taxonomic Service Functional Hierarchy shows a decomposition of service functions depicted in a tree structure and is typically used where tasks are concurrent but dependent, such as a production line, for example.
- The Data Flow Diagram shows service functions connected by data flow arrows and data stores.

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Within an Architectural Description, the SvcV-4 document service functions, the Resource Flows between those service functions, the internal system data repositories or service data stores, and the external sources and sinks for the service data flows, but not external to the Architectural Description's scope. They may also show how users behave in relation to those services.

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SvcV-5: Operational Activity to Services Traceability Matrix

The SvcV-5 addresses the linkage between service functions described in SvcV-4 and Operational Activities specified in OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model. The SvcV-5 depicts the mapping of service functions (and, optionally, the capabilities and performers that provide them) to operational activities and thus identifies the transformation of an operational need into a purposeful action performed by a service solution.

During requirements definition, the SvcV-5 plays a particularly important role in tracing the architectural elements associated with system function requirements to those associated with user requirements.

The intended usage of the SvcV-5 includes:

- Tracing service functional requirements to user requirements.
- Tracing solution options to requirements.
- Identification of overlaps or gaps.

Detailed Description:

An SvcV-5 is a specification of the relationships between the set of operational activities applicable to an Architectural Description and the set of service functions applicable to that Architectural Description. The relationship between operational activities and service functions can also be expected to be many-to-many (i.e., one activity may be supported by multiple functions, and one function may support multiple activities). The service functions shown in the SvcV-5 may be those associated with capabilities and performers. More focused SvcV-5 models might be used to specifically trace system functions to operational activities if desired.

DoDAF uses the term Operational Activity in the OVs and the term Service Function in the SVs to refer to essentially the same kind of thing—both activities and service functions are tasks that are performed, accept inputs, and develop outputs. The distinction between an Operational Activity and a Service Function is a question of what and how. The Operational Activity is a specification of what is to be done, regardless of the mechanism used. A Service Function specifies how a resource carries it out. For this reason, the SvcV-5 is a significant model, as it ties together the logical specification in the OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model with the physical specification of the SvcV-4 Services Functionality Description. Service Functions can be carried out by Resources.

Care should be taken when publishing a SvcV-5 with status information. Any presentation should clearly state the date of publication, so that users can see when status information is old.

The SvcV-5 may be further annotated with Services, Capabilities, Performers executing Activities, and capabilities and performers that conduct the functions.

The SvcV-5 is generally presented as a matrix of the relationship between service functions and activities. The SvcV-5 can show requirements traceability with Operational Activities on

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one axis of a matrix, the System Functions on the other axis, and with an X, date, or phase in the intersecting cells, where appropriate.

An alternate version of the tabular SvcV-5 can allow the implementation status of each function to be shown. In this variant model, each service function-to-operational activity mapping is described by a traffic light symbol that may indicate the status of the service support. DoDAF V2.0 does not prescribe a presentation technique. These symbols are usually colored circles with the following possible representations:

- Red may indicate that the functionality is planned but not developed.
- Yellow may indicate that partial functionality has been provided (or full functionality provided but system has not been fielded).
- Green may indicate that full functionality has been provided to the field.
- A blank cell may indicate that there is no service support planned for an Operational Activity, or that a relationship does not exist between the Operational Activity and the Service Function.

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SvcV-6: Services Resource Flow Matrix

The SvcV-6 specifies the characteristics of the Service Resource Flows exchanged between Services. The focus is on resource crossing the service boundary. The SvcV-6 focuses on the specific aspects of the Service Resource Flow and the Service Resource Flow content in a tabular format.

In addition, this model is useful in support of net-centric (service-oriented) implementation of services. According to the Net-Centric Data Strategy, a net-centric implementation needs to focus in on the data in the Service Resource Flow, as well as the services that produce or consume the data of the Service Resource Flow. In a net-centric implementation, not all the consumers are known and this model emphasizes the focus on the producer and Service Resource Flow.

The intended usage of the SvcV-6 includes:

• Detailed definition of Resource Flows.

Detailed Description:

The SvcV-6 specifies the characteristics of Service Resource Flow exchanges between Services. The SvcV- is the physical equivalent of the logical OV-3 Operational Resource Flow Matrix and provides detailed information on the service connections which implement the Resource Flow exchanges specified in OV-3 Operational Resource Flow Matrix. Resource flow exchange solutions, whether automated or not, e.g., such as verbal orders, are also captured.

Service Resource Flow exchanges express the relationship across the three basic architectural data elements of a SvcV (Services, service functions, and Service Resource Flows) and focus on the specific aspects of the Service Resource Flow and the service resource content. These aspects of the service Resource Flow exchange can be crucial to the operational mission and are critical to understanding the potential for overhead and constraints introduced by the physical aspects of the implementation such as security policy and communications and logistics limitations.

The focus of SvcV-6 is on how the Service Resource Flow exchange is affected, in service-specific details covering periodicity, timeliness, throughput, size, information assurance, and security characteristics of the resource exchange. In addition, for Service Resource Flow of data, their format and media type, accuracy, units of measurement, applicable system data standards, and any DIV-3 Physical Data Models are also described or referenced in the matrix.

Modeling discipline is needed to ensure that the architecture models are coherent. Each Service Resource Flow exchange listed in the SvcV-6 table should be traceable to at least one Operational Resource Flow exchanged listed in the corresponding OV-3 Operational Resource Flow Matrix and these in turn trace to OV-2 Operational Resource Flow Description.

It should be noted that each resource exchanged may relate to a known service function (from SvcV-4) that produces or consumes it. However, there need not be a one-to-one correlation between data elements listed in the SvcV-6 matrix and the Resource Flows (inputs and outputs) that are produced or consumed in a related SvcV-4 because the SvcV-4

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is more a logical solution, whereas the SvcV-6 is a more physical solution. In addition, Resource flows between known service functions performed by the same Services may not be shown in the SvcV-6 matrix. The SvcV-6 is about showing flows across service boundaries or a service boundary. If the Resource Flow is information, it may need to be reflected in the Data and Information Models.

The SvcV-7 Services Measures Matrix builds on the SvcV-6 and should be developed at the same time.

DoDAF does not prescribe the column headings in a SvcV-6 Matrix. Identifiers of the operational Resource Flow exchanges (OV-3) that are implemented by the Service Resource Flow Exchanges may be included in the table. All elements carried by the Resource Flow exchanges may be shown.

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SvcV-7: Services Measures Matrix

The SvcV-7 depicts the measures (metrics) of resources. The Services Measures Matrix expands on the information presented in a SvcV-1 Services Context Description by depicting the characteristics of the resources in the SvcV-1 Services Context Description.

In addition, this model is useful in support of net-centric (service-oriented) implementation of services. Service measures for Service Level Agreements for each service and may include number of service consumers, service usage by consumers, and the minimum, average and maximum response times, allowed down time, etc. Measures of interest for a Chief Information Office or Program manager may include measures that assess service reuse, process efficiency, and business agility.

The intended usage of the SvcV-7 includes:

- Definition of performance characteristics and measures (metrics).
- Identification of non-functional requirements.

Detailed Description:

The SvcV-7 specifies qualitative and quantitative measures (metrics) of resources. It specifies all of the measures. The measures are selected by the end user community and described by the architect.

Performance parameters include all performance characteristics for which requirements can be developed and specifications defined. The complete set of performance parameters may not be known at the early stages of Architectural Description, so it is to be expected that this model is updated throughout the specification, design, development, testing, and possibly even its deployment and operations lifecycle phases. The performance characteristics are captured in the Measures Meta-model group.

One of the primary purposes of SvcV-7 is to communicate which measures are considered most crucial for the successful achievement of the mission goals assigned. These particular measures can often be the deciding factors in acquisition and deployment decisions, and figure strongly in services analysis and simulations done to support the acquisition decision processes and system design refinement and be input or may impact decisions about Service Level Agreement content. Measures of Effectiveness (MOEs) and Measures of Performers (MOPs) are measures that can be captured and presented in the Services Measures Matrix model.

SvcV-7 is typically a table, listing user defined measures (metrics) with a time period association. It is sometimes useful to analyze evolution by comparing measures (metrics) for current and future resources. For this reason, a hybrid SvcV-7 Model which spans architectures across multiple phases may be useful.

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SvcV-8: Services Evolution Description

The SvcV-8 presents a whole lifecycle view of resources (services), describing how it changes over time. It shows the structure of several resources mapped against a timeline.

In addition, this model is useful in support of net-centric (service-oriented) implementation of services. This model can present a timeline of services evolve or are replaced over time, including services that are internal and external to the scope of the architecture.

The intended usage of the SvcV-8 includes:

- Development of incremental acquisition strategy.
- Planning technology insertion.

Detailed Description:

The SvcV-8, when linked together with other evolution Models such as CV-2 Capability Taxonomy, CV-3 Capability Phasing and StdV-2 Standards Forecast, provides a rich definition of how the Enterprise and its capabilities are expected to evolve over time. In this manner, the model can be used to support an architecture evolution project plan or transition plan.

A SvcV-8 can describe historical (legacy), current, and future capabilities against a timeline. The model shows the structure of each resource, using similar modeling elements as those used in SvcV-1. Interactions which take place within the resource may also be shown.

The changes depicted in the SvcV-8 DoDAF-described Model are derived from the project milestones that are shown in a PV-2 Project Timelines model. When the PV-2 Project Timelines model is used for capability acquisition projects, there is likely to be a close relationship between these two models.

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SvcV-9: Services Technology and Skills Forecast

The SvcV-9 defines the underlying current and expected supporting technologies and skills. Expected supporting technologies and skills are those that can be reasonably forecast given the current state of technology and skills, and expected improvements or trends. New technologies and skills are tied to specific time periods, which can correlate against the time periods used in SvcV-8 Services Evolution Description model milestones and linked to Capability Phases.

The SvcV-9 provides a summary of emerging technologies and skills that impact the architecture. The SvcV-9 provides descriptions of relevant:

- Emerging capabilities.
- Industry trends.
- Predictions (with associated confidence factors) of the availability and readiness of specific hardware and software services.
- Current and possible future skills.

In addition to providing an inventory of trends, capabilities and services, the SvcV-9 also includes an assessment of the potential impact of these items on the architecture. Given the future-oriented nature of this model, forecasts are typically made in short, mid and long-term timeframes, such as 6, 12 and 18-month intervals.

In addition, this model is useful in support of net-centric (service-oriented) implementation of services. As technologies change, like incorporation of Representational State Transfer (REST) services in the Web Services Description Language, this model can present a timeline of technologies related services over time.

The intended usage of the SvcV-9 includes:

- Forecasting technology readiness against time.
- HR Trends Analysis.
- Recruitment Planning.
- Planning technology insertion.
- Input to options analysis.

The SvcV-9 can be presented in a table, timeline, or a Herringbone diagram.

Detailed Description:

A SvcV-9 summarizes predictions about trends in technology and personnel. Architects may produce separate SvcV-9 products for technology and human resources. The specific time periods selected (and the trends being tracked) can be coordinated with architecture transition plans (which the SvcV-8 Services Evolution Description can support). That is, insertion of new capabilities and upgrading or re-training of existing resources may depend on or be driven by the availability of new technology and associated skills. The forecast includes potential impacts on current architectures and thus influences the development of transition and target architectures. The forecast is focused on technology and human resource areas that are related to the purpose for which a given architecture is being

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described and identifies issues affecting that architecture.

If standards are an integral part of the technologies important to the evolution of a given architecture, then it may be convenient to combine SvcV-9 with the StdV-2 Standards Forecast into a composite Fit-for-Purpose View.

The SvcV-9 is constructed as part of a given Architectural Description and in accordance with the its purpose. Typically, this involves starting with one or more overarching reference models or standards profiles to which the architecture is subject to using. Using these reference models or standards profiles, the architect selects the service areas and services relevant to the architecture. The SvcV-9 forecasts relate to the StdV-1Standards Profile in that a timed forecast may contribute to the decision to retire or phase out the use of a certain standard in connection with a resource. Similarly, the SvcV-9 forecasts relate to the StdV-2 Standards Forecasts in that a certain standard may be adopted depending on a certain technology or skill becoming available (e.g., the availability of Java Script may influence the decision to adopt a new HTML standard).

Alternatively, the SvcV-9 may relate forecasts to Service Model elements (e.g., Services) where applicable. The list of resources potentially impacted by the forecasts can also be summarized as additional information in SvcV-9.

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Many of the critical characteristics of an architecture are only discovered when an architecture's dynamic behaviors are defined and described. These dynamic behaviors concern the timing and sequencing of events that capture resource performance characteristics (i.e., a performer executing the service functions described in SvcV-4 Services Functionality Description).

Behavioral modeling and documentation are key to a successful Architectural Description, because it is understanding how the architecture behaves that is crucial in many situations. Although knowledge of the functions and interfaces is also crucial, knowing whether, for example, a response should be expected after sending message X to Service Y can be crucial to successful overall operations.

The SvcV-10 models are useful in support of net-centric (service-oriented) implementation of services as orchestrations of services. The SvcV-3 Services-Services Matrix can provide input for the SvcV-10 models. Three types of models may be used to adequately describe the dynamic behavior and performance characteristics of Service elements. These three models are:

- Services Rules Model (SvcV-10a).
- Services State Transition Description (SvcV-10b).
- Services Event-Trace Description (SvcV-10c).

SvcV-10b and SvcV-10c may be used separately or together, as necessary, to describe critical timing and sequencing behavior in the Service Model. Both types of diagrams are used by a wide variety of different Services methodologies.

Both SvcV-10b and SvcV-10c describe functional responses to sequences of events. Events may also be referred to as inputs, transactions, or triggers. When an event occurs, the action to be taken may be subject to a rule or set of rules as described in SvcV-10a.

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SvcV-10a Services Rules Model

The SvcV-10a is to specify functional and non-functional constraints on the implementation aspects of the architecture (i.e., the structural and behavioral elements of the Services Model).

The SvcV-10a describes constraints on the resources, functions, data and ports that make up the Service Model physical architecture. The constraints are specified in text and may be functional or structural (i.e., non-functional).

The intended usage of the SvcV-10a includes:

- Definition of implementation logic.
- Identification of resource constraints.

Detailed Description:

The SvcV-10a describes the rules that control, constrain or otherwise guide the implementation aspects of the architecture. Service Rules are statements that define or constrain some aspect of the business, and may be applied to:

- Performers.
- Resource Flows.
- Service Functions.
- System Ports.
- Data Elements.

In contrast to the OV-6a Operational Rules Model, the SvcV-10a focuses physical and data constraints rather than business rules.

Constraints can be categorized as follows:

- Structural Assertions – non-functional constraints governing some physical aspect of the architecture.
- Action Assertions – functional constraints governing the behavior of resources, their interactions and Resource Flow exchanges.
- Derivations – these involve algorithms used to compute facts.

Where a Service Rule is based on some standard, then that standard should be listed in the StdV-1 Standards Profile.

Some Service Rules can be added as annotations to other models. The SvcV-10a then should provide a listing of the complete set of rules with a reference to any models that they affect.

SvcV-1 Services Context Description

SvcV-2 Services Resource Flow Description

SvcV-3a Systems-Services Matrix

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SvcV-3b Services-Services Matrix

SvcV-4 Services Functionality Description

SvcV-5 Operational Activity to Services Traceability Matrix

SvcV-6 Services Resource Flow Matrix

SvcV-7 Services Measures Matrix

SvcV-8 Services Evolution Description

SvcV-9 Services Technology & Skills Forecast

SvcV-10abc Introduction to SvcV-10a, SvcV-10b and SvcV-10c

SvcV-10a Services Rules Model

SvcV-10b Services State Transition Description

SvcV-10c Services Event-Trace Description

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SvcV-10b Services State Transition Description

The SvcV-10b is a graphical method of describing a resource (or function) response to various events by changing its state. The diagram basically represents the sets of events to which the resources in the Activities respond (by taking an action to move to a new state) as a function of its current state. Each transition specifies an event and an action.

The explicit time sequencing of service functions in response to external and internal events is not fully expressed in SvcV-4 Services Functionality Description. SvcV-10b can be used to describe the explicit sequencing of the service functions. Alternatively, SvcV-10b can be used to reflect explicit sequencing of the actions internal to a single service function, or the sequencing of service functions with respect to a specific resource.

The intended usage of the SvcV-10b includes:

- Definition of states, events, and state transitions (behavioral modeling).
- Identification of constraints.

Detailed Description:

The SvcV-10b relates events to resource states and describes the transition from one state to another.

The SvcV-10b is based on the statechart diagram. A state machine is defined as “a specification that describes all possible behaviors of some dynamic view element. Behavior is viewed as a traversal of a graph of specific states interconnected by one or more joined transition arcs that are triggered by the dispatching of series of event instances. During this traversal, the state machine executes a series of actions associated with various elements of the state machine.” Statechart diagrams can be unambiguously converted to structured textual rules that specify timing aspects of events and the responses to these events, with no loss of meaning. However, the graphical form of the state diagrams can often allow quick analysis of the completeness of the rule set, and detection of dead ends or missing conditions. These errors, if not detected early during the solution analysis phase, can often lead to serious behavioral errors in fielded capabilities and to expensive correction efforts.

The SvcV-10b models state transitions from a resource perspective, with a focus on how the resource responds to stimuli (e.g., triggers and events). As in the OV-6b Operational State Transition Description, these responses may differ depending upon the rule set or conditions that apply, as well as the resource’s state at the time the stimuli is received. A change of state is called a transition. Each transition specifies the response based on a specific event and the current state. Actions may be associated with a given state or with the transition between states. A state and its associated actions specify the response of a resource or service function, to events. When an event occurs, the next state may vary depending on the current state (and its associated action), the event, and the rule set or guard conditions.

The SvcV-10b can be used to describe the detailed sequencing of service functions described in SvcV-4 Services Functionality Description. However, the relationship between the actions included in SvcV-10b and the functions in SvcV-4 depends on the purposes of the

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Architectural Description and the level of abstraction used in the models. The explicit sequencing of functions in response to external and internal events is not fully expressed in SvcV-4 Services Functionality Description. SvcV-10b can be used to reflect explicit sequencing of the functions, the sequencing of actions internal to a single function, or the sequencing of functions with respect to a specific resource.

States in a SvcV-10b model may be nested. This enables quite complex models to be created to represent Services behavior. Depending upon the architecture project's needs, the SvcV-10b may be used separately or in conjunction with the SvcV-10c Services Event-Trace Description.

- SvcV-1 Services Context Description
- SvcV-2 Services Resource Flow Description
- SvcV-3a Systems-Services Matrix
- SvcV-3b Services-Services Matrix
- SvcV-4 Services Functionality Description
- SvcV-5 Operational Activity to Services Traceability Matrix
- SvcV-6 Services Resource Flow Matrix
- SvcV-7 Services Measures Matrix
- SvcV-8 Services Evolution Description
- SvcV-9 Services Technology & Skills Forecast
- SvcV-10abc Introduction to SvcV-10a, SvcV-10b and SvcV-10c
- SvcV-10a Services Rules Model
- SvcV-10b Services State Transition Description
- SvcV-10c Services Event-Trace Description

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SvcV-10c Services Event-Trace Description

The SvcV-10c provides a time-ordered examination of the interactions between services functional resources. Each event-trace diagram should have an accompanying description that defines the particular scenario or situation. The SvcV-10c is valuable for moving to the next level of detail from the initial solution design, to help define a sequence of service functions and service data interfaces, and to ensure that each participating resource or Service Port role has the necessary information it needs, at the right time, to perform its assigned functionality.

The intended usage of the SvcV-10c includes:

- Analysis of resource events impacting operation.
- Behavioral analysis.
- Identification of non-functional system requirements.

Detailed Description:

The SvcV-10c specifies the sequence in which Resource Flow elements are exchanged in context of a resource or Service Port. Services Event-Trace Descriptions are sometimes called sequence diagrams, event scenarios or timing diagrams. The components of a SvcV-10c include functional resources or service ports, owning performer, as well as the port which is the subject for the lifeline.

Specific points in time can be identified. The Resource Flow from one resource/port to another can be labeled with events and their timing. The Service Event-Trace Description provides a time-ordered examination of the Resource Flow elements exchanged between participating resources (external and internal) or service ports. Each Event-Trace diagram should have an accompanying description that defines the particular scenario or situation.

The SvcV-10c is typically used in conjunction with the SvcV-10b Services State Transition Description to describe the dynamic behavior of resources. The data content of messages that connect Resource Flows in a SvcV-10c model may be related, in modeling terms, with Resource Flows (interactions, in SvcV-1 Services Context Description, SvcV-3a Systems-Services Matrix, and SvcV-3b Services-Services Matrix), Resource Flows (data, in SvcV-4 Services Functionality Description and SvcV-6 Services Resource Flow Matrix) and entities (in DIV-3 Physical Data Model) modeled in other models.

SvcV-1 Services Context Description

SvcV-2 Services Resource Flow Description

SvcV-3a Systems-Services Matrix

SvcV-3b Services-Services Matrix

SvcV-4 Services Functionality Description

SvcV-5 Operational Activity to Services Traceability Matrix

SvcV-6 Services Resource Flow Matrix

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SvcV-7 Services Measures Matrix

SvcV-8 Services Evolution Description

SvcV-9 Services Technology & Skills Forecast

SvcV-10abc Introduction to SvcV-10a, SvcV-10b and SvcV-10c

SvcV-10a Services Rules Model

SvcV-10b Services State Transition Description

SvcV-10c Services Event-Trace Description

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Standards Viewpoint

The DoDAF-described Models within the Standards Viewpoint is the set of rules governing the arrangement, interaction, and interdependence of parts or elements of the Architectural Description. These sets of rules can be captured at the enterprise level and applied to each solution, while each solution's architectural description depicts only those rules pertinent to architecture described. Its purpose is to ensure that a solution satisfies a specified set of operational or capability requirements. The Standards Models capture the doctrinal, operational, business, technical, or industry implementation guidelines upon which engineering specifications are based, common building blocks are established, and solutions are developed. It includes a collection of the doctrinal, operational, business, technical, or industry standards, implementation conventions, standards options, rules, and criteria that can be organized into profiles that govern solution elements for a given architecture. Current DoD guidance requires the Technical Standards portions of models be produced from DISR to determine the minimum set of standards and guidelines for the acquisition of all DoD systems that produce, use, or exchange information.

Standard Model Descriptions

Models	Descriptions
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.

Uses of Standards Viewpoint DoDAF-described Models. The Standards Viewpoint can articulate the applicable policy, standards, guidance, constraints, and forecasts required by JCIDS, DAS, System Engineering, PPBE, Operations, other process owners, and decision-makers.

Mappings of the Standards Viewpoint DoDAF-described Models to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models** and are described in the DoDAF Meta-model Data Dictionary.

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DoDAF Viewpoints and Models

Standards Viewpoint

StdV-1: Standards Profile

The StdV-1 defines the technical, operational, and business standards, guidance, and policy applicable to the architecture being described. As well as identifying applicable technical standards, the DoDAF V2.0 StdV-1 also documents the policies and standards that apply to the operational or business context. The DISR is an architecture resource for technical standards that can be used in the generation of the StdV-1 and StdV-2 Standards Forecast.

In most cases, building a Standards Profile consists of identifying and listing the applicable portions of existing and emerging documentation. A StdV-1 should identify both existing guidelines, as well as any areas lacking guidance. As with other models, each profile is assigned a specific timescale (e.g., "As-Is", "To-Be", or transitional). Linking the profile to a defined timescale enables the profile to consider both emerging technologies and any current technical standards that are expected to be updated or become obsolete. If more than one emerging standard time-period is applicable to an architecture, then a StdV-2 Standards Forecast should be completed as well as a StdV-1.

The intended usage of the StdV-1 includes:

- Application of standards (informing project strategy).
- Standards compliance.

Detailed Description:

The StdV-1 collates the various systems and services, standards, and rules that implement and constrain the choices that can be or were made in the design and implementation of an Architectural Description. It delineates the systems, services, Standards, and rules that apply. The technical standards govern what hardware and software may be implemented and on what system. The standards that are cited may be international such as ISO standards, national standards, or organizational specific standards.

With associated standards with other elements of the architecture, a distinction is made between applicability and conformance. If a standard is applicable to a given architecture, that architecture need not be fully conformant with the standard. The degree of conformance to a given standard may be judged based on a risk assessment at each approval point.

Note that an association between a Standard and an architectural element should not be interpreted as indicating that the element is fully compliant with that Standard. Further detail would be neededed to confirm the level of compliance.

Standards Profiles for a particular architecture must maintain full compatibility with the root standards they have been derived from. In addition, the StdV-1 model may state a particular method of implementation for a Standard, as compliance with a Standard does not ensure interoperability. The Standards cited are referenced as relationships to the systems, services, system functions, service functions, system data, service data, hardware/software items or communication protocols, where applicable, in:

- SV-1 Systems Interface Description.
- SV-2 Systems Resource Flow Description.

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- SV-4 Systems Functionality Description.
- SV-6 Systems Resource Flow Matrix.
- SvcV-1 Services Context Description.
- SvcV-2 Services Resource Flow Description.
- SvcV-4 Services Functionality Description.
- SvcV-6 Services Resource Flow Matrix.
- DIV-2 Logical Data Model.
- DIV-3 Physical Data Model.

That is, each standard listed in the profile is associated with the elements that implement or use the standard.

The protocols referred to Resource Flow descriptions (see SV-2 Systems Resource Flow Description or SvcV-2 Services Resource Flow Description) are examples of Standards and these should also be included in the StdV-1 listing, irrespective of which models they appear in or are referred from.

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Standards Viewpoint

StdV-2: Standards Forecast

The StdV-2 contains expected changes in technology-related standards, operational standards, or business standards and conventions, which are documented in the StdV-1 model. The forecast for evolutionary changes in the standards need to be correlated against the time periods mentioned in the SV-8 Systems Evolution Description, SvcV-8 Services Evolution Description, SV-9 Systems Technology & Skills Forecast, and SvcV-9 Services Technology & Skills Forecast models.

A StdV-2 is a detailed description of emerging standards relevant to the systems, operational, and business activities covered by the Architectural Description. The forecast should be tailored to focus on areas that are related to the purpose for which a given Architectural Description is being built, and should identify issues that affect the architecture. A StdV-2 complements and expands on the StdV-1Standards Profile model and should be used when more than one emerging standard time-period is applicable to the architecture.

One of the prime purposes of this model is to identify critical technology standards, their fragility, and the impact of these standards on the future development and maintainability of the architecture and its constituent elements.

The intended usage of the StdV-2 includes:

- Forecasting future changes in standards (informing project strategy).

Detailed Description:

The Standards Forecast DoDAF-described Model contains expected changes in standards and conventions, which are documented in the StdV-1 model. The forecast for evolutionary changes in the standards need to be correlated against the time periods mentioned in the SV-8 Systems Evolution Description, SvcV-8 Services Evolution Description, SV-9 Systems Technology & Skills Forecast, and SvcV-9 Services Technology & Skills Forecast models. One of the prime purposes of this model is to identify critical standards, their life expectancy, and the impact of these standards on the future development and maintainability of the Architectural Description and its constituent elements.

StdV-2 lists emerging or evolving standards relevant to the solutions covered by the Architectural Description. It contains predictions about the availability of emerging standards, and relates these predictions to the elements and the time periods that are listed in the SV-8 Systems Evolution Description, SvcV-8 Services Evolution Description, SV-9 Systems Technology & Skills Forecast, and SvcV-9 Services Technology & Skills Forecast models.

The specific time periods selected (e.g., 6-month and 12-month intervals) and the standards being tracked are coordinated with architecture transition plans (which the SV-8 Systems Evolution Description and SvcV-8 Services Evolution Description can support). That is, insertion of new capabilities and upgrading of existing solutions may depend on, or be driven by, the availability of new standards and models incorporating those standards. The forecast specifies potential standards and thus impacts current architectures and influences the development of transition and objective (i.e., target) architectures. The forecast is tailored to focus on standards areas that are related to the purpose for which a given architecture is

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being described and should identify potential standards affecting that architecture. If interface standards are an integral part of the technologies important to the evolution of a given architecture, then it may be convenient to combine StdV-2 with SV-9 Systems Technology & Skills Forecast or SvcV-9 Services Technology & Skills Forecast into a composite Fit-for-Purpose View. For other projects, it may be convenient to combine all the standards information into one composite Fit-for-Purpose View, combining StdV-2 with StdV-1 Standard Profile.

StdV-2 delineates the standards that potentially impact the relevant system and service elements (from SV-1 Systems Interface Description, SV-2 Systems Resource Flow Description, SV-4 Systems Functionality Description, SV-6 Systems Resource Flow Matrix, SvcV-1 Services Context Description, SvcV-2 Services Resource Flow Description, SvcV-4 Services Functionality Description, SV-6 Services Resource Flow Matrix, and DIV-2 Logical Data Model) and relates them to the time periods that are listed in the SV-8 Systems Evolution Description, SvcV-8 Services Evolution Description, SV-9 Systems Technology & Skills Forecast, and SvcV-9 Services Technology & Skills Forecast models. A system's evolution, specified in SV-8 Systems Evolution Description, or service's evolutions, specified in SvcV-8 Services Evolution Description, may be tied to a future standard listed in StdV-2. A timed technology and skills forecast from SV-9 Systems Technology & Skills Forecast or SvcV-9 Services Technology & Skills Forecast models is related to StdV-2 standards forecast in the following manner: a certain technology may be dependent on a StdV-2 standard (i.e., a standard listed in StdV-2 may not be adopted until a certain technology becomes available). This is how a prediction on the adoption of a future standard, may be related to standards listed in StdV-1 through the SV-9 Systems Technology & Skills Forecast or SvcV-9 Services Technology & Skills Forecast models.

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DoDAF Viewpoints and Models

Systems Viewpoint

The DoDAF-described Models within the Systems Viewpoint describes systems and interconnections providing for, or supporting, DoD functions. DoD functions include both warfighting and business functions. The Systems Models associate systems resources to the operational and capability requirements. These systems resources support the operational activities and facilitate the exchange of information. The Systems DoDAF-described Models are available for support of legacy systems. As architectures are updated, they should transition from Systems to Services and utilize the models within the Services Viewpoint.

Names of the models and their descriptions (in the **table below**) are provided below.

Systems Model Descriptions

Models	Descriptions
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

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	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.
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.

Uses of System Viewpoint DoDAF-described Models. Within the development process, the DoDAF-described Models describe the design for system-based solutions to support or enable requirements created by the operational development processes (JCIDS) and Defense Acquisition System.

Mappings of the Systems Viewpoint DoDAF-described Models, to the DM2 Concepts, Associations, and Attributes are in **DM2 Concepts, Associations, and Attributes Mapping to DoDAF-described Models**. The DM2 Concepts, Associations, and Attributes are described in the DoDAF Meta-model Data Dictionary.

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Systems Viewpoint

SV-1: Systems Interface Description

The SV-1 addresses the composition and interaction of Systems. For DoDAF V2.0, the SV-1 incorporates the human elements as types of Performers - Organizations and Personnel Types.

The SV-1 links together the operational and systems architecture models by depicting how Resources are structured and interact to realize the logical architecture specified in an OV-2 Operational Resource Flow Description. A SV-1 may represent the realization of a requirement specified in an OV-2 Operational Resource Flow Description (i.e., in a "To-Be" architecture), and so there may be many alternative SV models that could realize the operational requirement. Alternatively, in an "As-Is" architecture, the OV-2 Operational Resource Flow Description may simply be a simplified, logical representation of the SV-1 to allow communication of key Resource Flows to non-technical stakeholders.

A System Resource Flow is a simplified representation of a pathway or network pattern, usually depicted graphically as a connector (i.e., a line with possible amplifying information). The SV-1 depicts all System Resource Flows between Systems that are of interest. Note that Resource Flows between Systems may be further specified in detail in SV-2 Systems Resource Flow Description and SV-6 Systems Resource Flow Matrix.

Sub-System assemblies may be identified in SV-1 to any level (i.e., depth) of decomposition the architect sees fit. SV-1 may also identify the Physical Assets (e.g., Platforms) at which Resources are deployed, and optionally overlay Operational Activities and Locations that utilize those Resources. In many cases, an operational activity and locations depicted in an OV-2 Operational Resource Flow Description model may well be the logical representation of the resource that is shown in SV-1.

The intended usage of the SV-1 includes:

- Definition of System concepts.
- Definition of System options.
- System Resource Flow requirements capture.
- Capability integration planning.
- System integration management.
- Operational planning (capability and performer definition).

The SV-1 is used in two complementary ways:

- Describe the Resource Flows exchanged between resources in the architecture.
- Describe a solution, or solution option, in terms of the components of capability and their physical integration on platforms and other facilities.

Detailed Description:

A SV-1 can be used simply to depict Systems and sub-systems and identify the Resource Flows between them. The real benefit of a SV-1 is its ability to show the human aspects of an architecture, and how these interact with Systems. In addition, DoDAF has the concept of Capability and Performers (see Capability Meta-model group in Section 2) which is used to

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gather together systems, assets and people into a configuration, which can meet a specific capability. A primary purpose of a SV-1 DoDAF-described Model is to show resource structure, i.e., identify the primary sub-systems, performer and activities (functions) and their interactions. SV-1 contributes to user understanding of the structural characteristics of the capability.

The physical resources contributing to a capability are either an organizational resource or a physical asset, i.e., a system cannot contribute alone (it must be hosted on a physical asset used by an organizational resource of both). Organizational aspects can now be shown on SV-1 (e.g., who uses System). Resource structures may be identified in SV-1 to any level (i.e., depth) of decomposition the architect sees fit. DoDAF does not specifically use terms such as, sub-System and component as these terms often denote a position relative to a structural hierarchy. Any System may combine hardware and software or these can be treated as separate (sub) Systems. DoDAF V2.0 includes human factors (as Personnel Types and a type of Performer). Should an architect wish to describe a System which has human elements, then Systems, Personnel Types and Performers should be used to wrap the human and system elements together.

A SV-1 can optionally be annotated with Operational Activities, Capabilities, and/or Locations originally specified in OV-2 Operational Resource Flow Description model. In this way, traceability can be established from the logical OV structure to the physical System Viewpoint structure. If possible, a SV-1 shows Systems, Physical Assets and System interfaces for the entire Architectural Description on the same diagram. If a single SV-1 is not possible, the resource of interest should be decomposed into multiple SV-1 models.

Functions (Activities):

Some Resources can carry out System Functions (Activities) as described in SV-4 Systems Functionality Description model and these functions can optionally be overlaid on a SV-1. In a sense, the SV-1 and the SV-4 Systems Functionality Description model provide complementary representations (structure and function). Either could be modeled first, but usually an iterative approach is used to model these together gradually building up the level of detail in the System description. Note that the same type (class) of resource may be used in different contexts in a given SV-1. For this reason, the tracing of functions to resources is specified in context of their usage (see DM2 for details).

Resource Flows in SV-1:

In addition to depicting Systems (Performers) and their structure, the SV-1 addresses Resource Flows. A Resource Flow, as depicted in SV-1, is an indicator that resources pass between one System and the other. In the case of Systems, this can be expanded into further detail in SV-2 Systems Resource Flow Description.

Interactions are only possible between Systems and Services. System Resource Flows provide a specification for how the operational Resource Flows Exchanges specified in Needlines (in the OV-2 Operational Resource Flow Description model) are realized with Systems. A single Needline shown in the OV-2 Operational Resource Flow Description model may translate into multiple System Resource Flows.

The actual implementation of a System Resource Flow may take more than one form (e.g., multiple physical links). Details of the physical pathways or network patterns that implement the interfaces are documented in SV-2 Systems Resource Flow Description. System Resource Flows are summarized in a SV-3b Systems-Systems Matrix. The functions performed by the resources are specified in a SV-4 System Functionality Description, but may optionally be overlaid on the Resources in a SV-1.

An Operational Viewpoint (OV) suite may specify a set of requirements - either as a specific operational plan, or a scenario for procurement. As OV-2 Operational Resource Flow Description, OV-5a Operational Activity Decomposition Tree, and OV-5b Operational Activity Model specify the logical structure and behavior, SV-1 and SV-4 Systems Functionality Description specify the physical structure and behavior (to the level of detail required by the architectural stakeholders). This separation of logical and physical presents an opportunity for carrying out architectural trade studies based on the architectural content in the DoDAF-described Models.

The structural and behavioral models in the OVs and SVs allow architects and stakeholders to quickly ascertain which functions are carried out by humans and which by Systems for each alternative specification and so carry out trade analysis based on risk, cost, reliability, etc.

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SV-2: Systems Resource Flow Description

A SV-2 specifies the System Resource Flows between Systems and may also list the protocol stacks used in connections.

A SV-2 DoDAF-described Model is used to give a precise specification of a connection between Systems. This may be an existing connection, or a specification for a connection that is to be made.

The intended usage of the SV-2 includes:

- Resource Flow specification.

Detailed Description:

A SV-2 comprises Systems, their ports, and the Resource Flows between those ports. The architect may choose to create a diagram for each Resource Flow for all Systems or to show all the Resource Flows on one diagram if possible.

Each SV-2 model can show:

- Which ports are connected?
- The Systems that the ports belong to.
- The definition of the System Resource Flow in terms of the physical/logical connectivity and any protocols that are used in the connection.

Note that networks are represented as Systems. The architect may choose to show other Systems being components of the network, i.e., if they are part of the network infrastructure.

Any protocol referred to in a SV-2 diagram needs to be defined in the StdV-1 Standards Profile.

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SV-3: Systems-Systems Matrix

A SV-3 enables a quick overview of all the system resource interactions specified in one or more SV-1 Systems Interface Description models. The SV-3 provides a tabular summary of the system interactions specified in the SV-1 Systems Interface Description model for the Architectural Description. The matrix format supports a rapid assessment of potential commonalities and redundancies (or, if fault-tolerance is desired, the lack of redundancies).

The SV-3 can be organized in a number of ways to emphasize the association of groups of system pairs in context with the architecture's purpose.

The intended usage of the SV-3 includes:

- Summarizing system resource interactions.
- Interface management.
- Comparing interoperability characteristics of solution options.

Detailed Description:

The SV-1 concentrates on System resources and their interactions, and these are summarized in a SV-3. The SV-3 can be a useful tool for managing the evolution of solutions and infrastructures, the insertion of new technologies and functionality, and the redistribution of systems and activities in context with evolving operational requirements.

Depending upon the purpose of the Architectural Description, there could be several SV-3s. The suite of SV-3 models can be organized in a number of ways (e.g., by domain, by operational mission phase, by solution option) to emphasize the association of groups of resource pairs in context with the Architectural Description purpose.

The SV-3 is generally presented as a matrix, where the Systems resources are listed in the rows and columns of the matrix, and each cell indicates an interaction between resources if one exists. Many types of interaction information can be presented in the cells of a SV-3. The resource interactions can be represented using different symbols and/or color coding that depicts different interaction characteristics, for example:

- Status (e.g., existing, planned, potential, de-activated).
- Key interfaces.
- Category (e.g., command and control, intelligence, personnel, logistics).
- Classification-level (e.g., Restricted, Confidential, Secret, Top Secret).
- Communication means (e.g., Rim Loop Interface, Scalable Loop Interface).

DoDAF does not specify the symbols to be used. If symbols are used, a key is needed.

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SV-4: Systems Functionality Description

The SV-4 addresses human and system functionality.

The primary purposes of SV-4 are to:

. Develop a clear description of the necessary data flows that are input (consumed) by and output (produced) by each resource. . Ensure that the functional connectivity is complete (i.e., that a resource's required inputs are all satisfied). . Ensure that the functional decomposition reaches an appropriate level of detail.

The Systems Functionality Description provides detailed information regarding the:

. Allocation of functions to resources. . Flow of resources between functions.

The SV-4 is the Systems Viewpoint model counterpart to the OV-5b Activity Model of the Operational Viewpoint.

The intended usage of the SV-4 includes:

- Description of task workflow.
- Identification of functional system requirements.
- Functional decomposition of systems.
- Relate human and system functions.

Detailed Description:

The SV-4 is used to specify the functionality of resources in the architecture (in this case, functional resources, systems, performer and capabilities). The SV-4 is the behavioral counterpart to the SV-1 Systems Interface Description (in the same way that OV-5b Operational Activity Model is the behavioral counterpart to OV-2 Operational Resource Flow Matrix).

The scope of this model may be capability wide, without regard to which resources perform which functions, or it may be resource-specific. Variations may focus on intra- or inter-resource data flows, or may simply allocate functions to resources.

There are two basic ways to depict SV-4:

- The Taxonomic Functional Hierarchy shows a decomposition of functions depicted in a tree structure and is typically used where tasks are concurrent but dependent, such as a production line, for example.
- The Data Flow Diagram shows functions connected by data flow arrows and data stores.

The Taxonomic Functional Hierarchy may be particularly useful in capability-based procurement where it is necessary to model the functions that are associated with particular capability (see SV-5).

Within an Architectural Description, the SV-4 documents system functions, the Resource Flows between those functions, the internal system data repositories or system data stores, and the external producers and consumers for the system data flows, but not those external

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to the Architectural Description scope. They may also show how users behave in relation to those systems.

The functions are likely to be related to Operational Activities captured in OV-5a. Although there is a correlation between the Operational Activity Model (OV-5b) and the functional hierarchy of SV-4, it need not be a one-to-one mapping, hence, the need for the Function to Operational Activity Traceability Matrix (SV-5), which provides that mapping.

Systems are not limited to internal system functions and can include HCI and GUI functions or functions that consume or produce system data. The external system data producers or consumers can be used to represent the human that interacts with the system. The System Resource Flows between the external system data source/sink (representing the human or system) and the HCI, GUI, or interface function can be used to represent human-system interactions, or system-system interfaces. Standards that apply to system functions, such as HCI and GUI standards, are also specified during development of this model (and recorded in StdV-1).

A graphical variant of the SV-4 Data Flow model may be used with swim lanes. A system swim lane may be associated with:

- A System.
- A grouping of Capabilities and System Functions (usually based on a Physical Asset).
- A Performer executing an Activity.

Swim lanes are presented either vertically or horizontally. A function can be placed in the swim lane associated with the System, Resources or Performer executing an Activity that it is allocated in the solution architecture. This provides a graphical means of presenting the interactions between Systems or Capabilities (shown through system connections on SV-1) in functional terms. This is a powerful technique for visualizing the differences between alternative solution options (which may have a common set of functions).

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SV-5a: Operational Activity to Systems Function Traceability Matrix

The SV-5a addresses the linkage between System Functions described in SV-4 Systems Functionality Description and Operational Activities specified in OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model. The SV-5a depicts the mapping of system functions and, optionally, the capabilities and performers that provide them to operational activities. The SV-5a identifies the transformation of an operational need into a purposeful action performed by a system or solution.

During requirements definition, the SV-5a plays a particularly important role in tracing the architectural elements associated with system function requirements to those associated with user requirements.

The intended usage of the SV-5a includes:

- Tracing functional system requirements to user requirements.
- Tracing solution options to requirements.
- Identification of overlaps or gaps.

Detailed Description:

An SV-5a is a specification of the relationships between the set of operational activities applicable to an Architectural Description and the set of system functions applicable to that Architectural Description. The relationship between operational activities and system functions can also be expected to be many-to-many (i.e., one activity may be supported by multiple functions, and one function may support multiple activities). The system functions shown in the SV-5a may be those associated with capabilities and performers. More focused SV-5a models might be used to specifically trace system functions to operational activities if desired.

DoDAF uses the term Operational Activity in the OVs and the term System Function in the SVs to refer to essentially the same kind of thing; both activities and functions are tasks that are performed, accept inputs, and develop outputs. The distinction between an Operational Activity and a Function is a question of what and how. The Operational Activity is a specification of what is to be done, regardless of the mechanism used. A System Function is specifies how a resource carries it out. For this reason, SV-5a is a significant model, as it ties together the logical specification in the OV-5a with the physical specification of the SV-4 Systems Functionality Description. System Functions can be carried out by Functional Resources (systems, performers executing activities, and performers).

The SV-5a is generally presented as a matrix of the relationship between system functions and operational activities. The SV-5a can show requirements traceability with Operational Activities on one axis of a matrix, the System Functions on the other axis, and with an X, date, or phase in the intersecting cells, where appropriate.

An alternate version of the tabular SV-5a can allow the implementation status of each function to be shown. In this variant model, each system function-to-operational activity mapping is described by a traffic light symbol that may indicate the status of the system support. DoDAF V2.0 does not prescribe a presentation technique. These symbols are usually

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colored circles with the following possible representations:

- Red may indicate that the functionality is planned but not developed.
- Yellow may indicate that partial functionality has been provided (or full functionality provided but system has not been fielded).
- Green may indicate that full functionality has been provided to the field.
- A blank cell may indicate that there is no system support planned for an Operational Activity, or that a relationship does not exist between the Operational Activity and the System Function.

Care should be taken when publishing a SV-5a with status information. Any presentation should clearly state the date of publication, so that users can see when status information is old.

SV-5a may be further annotated with Systems, Capabilities, Performers executing Activities, and capabilities and performers that conduct the functions.

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SV-5b: Operational Activity to Systems Traceability Matrix

The SV-5b addresses the linkage between described in SV-1 Systems Functionality Description and Operational Activities specified in OV-5a Operational Activity Decomposition Tree or OV-5b Operational Activity Model. The SV-5b depicts the mapping of systems and, optionally, the capabilities and performers that provide them to operational activities. The SV-5b identifies the transformation of an operational need into a purposeful action performed by a system or solution.

During requirements definition, the SV-5b plays a particularly important role in tracing the architectural elements associated with system requirements to those associated with user requirements.

The intended usage of the SV-5b includes:

- Tracing system requirements to user requirements.
- Tracing solution options to requirements.
- Identification of overlaps or gaps.

Detailed Description:

An SV-5b is a specification of the relationships between the set of operational activities applicable to an Architectural Description and the set of systems applicable to that Architectural Description. The relationship between operational activities and systems can also be expected to be many-to-many (i.e., one activity may be supported by multiple systems, and one system may support multiple activities). The system shown in the SV-5b may be those associated with resources. More focused SV-5b models might be used to specifically trace system to operational activities if desired.

The SV-5b is generally presented as a matrix of the relationship between systems and activities and can be a summary of the Operational Activity to System Function Traceability Matrix (SV-5a). The SV-5b can show requirements traceability with Operational Activities on one axis of a matrix, the System Functions on the other axis, and with an X, date, or phase in the intersecting cells, where appropriate.

An alternate version of the tabular SV-5b model can allow the implementation status of each system to be shown. In this variant model, each system-to-operational activity mapping is described by a traffic light symbol that may indicate the status of the system support. DoDAF V2.0 does not prescribe a presentation technique. These symbols are usually colored circles with the following possible representations:

- Red may indicate that the system is planned but not developed.
- Yellow may indicate that partial system functionality has been provided (or full functionality provided but system has not been fielded).
- Green may indicate that full system functionality has been provided to the field.
- A blank cell may indicate that there is no system support planned for an Operational Activity, or that a relationship does not exist between the Operational Activity and the System Function.

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Care should be taken when publishing a SV-5b with status information. Any presentation should clearly state the date of publication, so that users can see when status information is old.

The SV-5b may be further annotated with Capabilities, Performers executing Activities, and capabilities and performers that conduct the functions. This can be used to identify which systems can support a particular capability. The architect may also wish to hide the systems in a SV-5b so that the table simply shows the mapping from performers executing activities, and capabilities and performers to Operational Activities.

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SV-6: Systems Resource Flow Matrix

The SV-6 specifies the characteristics of the System Resource Flows exchanged between systems with emphasis on resources crossing the system boundary.

The SV-6 focuses on the specific aspects of the system Resource Flow and the system Resource Flow content in a tabular format.

The intended usage of the SV-6 includes:

- Detailed definition of Resource Flows.

Detailed Description:

The SV-6 specifies the characteristics of Resource Flow exchanges between systems. The SV-6 is the physical equivalent of the logical OV-3 table and provides detailed information on the system connections which implement the Resource Flow exchanges specified in OV-3. Non-automated Resource Flow exchanges, such as verbal orders, are also captured.

System Resource Flow exchanges express the relationship across the three basic architectural data elements of a SV (systems, system functions, and system Resource Flows) and focus on the specific aspects of the System Resource Flow and the system resource content. These aspects of the System Resource Flow exchange can be crucial to the operational mission and are critical to understanding the potential for overhead and constraints introduced by the physical aspects of the implementation such as security policy and communications limitations.

The focus of SV-6 is on how the System Resource Flow exchange is affected, in system-specific details covering periodicity, timeliness, throughput, size, information assurance, and security characteristics of the resource exchange. In addition, the System Resource Flow elements, their format and media type, accuracy, units of measurement, and system data standard are also described in the matrix.

Modeling discipline is needed to ensure that the architecture models are coherent. Each system Resource Flow exchange listed in the SV-6 table should be traceable to at least one operational Resource Flow exchanged listed in the corresponding OV-3 Operational Resource Flow Matrix and these, in turn, trace to operation Resource Flows in the OV-2 Operational Resource Flow Description.

It should be noted that each data element exchanged may be related to the system function (from SV-4) that produces or consumes it. However, there need not be a one-to-one correlation between data elements listed in the SV-6 matrix and the data flows (inputs and outputs) that are produced or consumed in a related SV-4 Services Functionality Description. In addition, Data flows between system functions performed by the same systems may not be shown in the SV-6 matrix. SV-6 is about showing flows across system boundaries.

The SV-7 System Measures Matrix model builds on the SV-6 and should be developed at the same time.

DoDAF does not prescribe the column headings in a SV-6 Matrix. Identifiers of the operational Resource Flows from the OV-3 Operational Resource Flow Matrix that are

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implemented by the System Resource Flow Exchanges may be included in the table. All elements carried by the Resource Flow exchanges may be also shown.

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SV-7: Systems Measures Matrix

The SV-7 depicts the measures (metrics) of resources. The Systems Measures Matrix expands on the information presented in a SV-1 by depicting the characteristics of the resources in the SV-1.

The intended usage of the SV-7 includes:

- Definition of performance characteristics and measures (metrics).
- Identification of non-functional requirements.

Detailed Description:

The SV-7 specifies qualitative and quantitative measures (metrics) of resources; it specifies all of the measures. The measures are selected by the end user community and described by the architect.

Performance parameters include all performance characteristics for which requirements can be developed and specifications defined. The complete set of performance parameters may not be known at the early stages of Architectural Description, so it is to be expected that this model is updated throughout the specification, design, development, testing, and possibly even its deployment and operations lifecycle phases. The performance characteristics are captured in the Measures Meta-model group.

One of the primary purposes of SV-7 is to communicate which measures are considered most crucial for the successful achievement of the mission goals assigned and how those performance parameters will be met. These particular measures can often be the deciding factors in acquisition and deployment decisions, and figures strongly in systems analysis and simulations done to support the acquisition decision processes and system design refinement. Measures of Effectiveness (MOEs) and Measures of Performers (MOPs) are measures that can be captured and presented in the Services Measures Matrix model.

The SV-7 DoDAF-described Model is typically a table listing user defined measures (metrics) with a time period association. It is sometimes useful to analyze evolution by comparing measures (metrics) for current and future resources. For this reason, a hybrid SV-7 model which spans architectures across multiple phases may be useful.

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SV-8: Systems Evolution Description

The SV-8 presents a whole lifecycle view of resources (systems), describing how they change over time. It shows the structure of several resources mapped against a timeline.

The intended usage of the SV-8 includes:

- Development of incremental acquisition strategy.
- Planning technology insertion.

Detailed Description:

The SV-8, when linked together with other evolution Models, e.g., such as CV-3 Capability Phasing and StdV-2 Standards Forecast, provides a rich definition of how the Enterprise and its capabilities are expected to evolve over time. In this manner, the model can be used to support an architecture evolution project plan or transition plan.

A SV-8 can either describe historical (legacy), current, and future capabilities against a timeline. The model shows the structure of each resource, using similar modeling elements as those used in SV-1. Interactions which take place within the resource may also be shown.

The changes depicted in the SV-8 are derived from the project milestones that are shown in a PV-2 Project Timelines. When the PV-2 Project Timelines is used for capability acquisition projects, there is likely to be a close relationship between these two models.

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SV-9: Systems Technology and Skills Forecast

The SV-9 defines the underlying current and expected supporting technologies and skills. Expected supporting technologies and skills are those that can be reasonably forecast given the current state of technology and skills as well as the expected improvements or trends. New technologies and skills are tied to specific time periods, which can correlate against the time periods used in SV-8 milestones and linked to Capability Phases.

The SV-9 provides a summary of emerging technologies and skills that impact the architecture. The SV-9 provides descriptions of relevant:

- Emerging capabilities.
- Industry trends.
- Predictions (with associated confidence factors) of the availability and readiness of specific hardware and software systems.
- Current and possible future skills.

In addition to providing an inventory of trends, capabilities and systems, the DoDAF-described Model SV-9 also includes an assessment of the potential impact of these items on the architecture. Given the future-oriented nature of this model, forecasts are typically made in short, mid and long-term timeframes, such as 6, 12 and 18-month intervals.

The intended usage of the SV-9 includes:

- Forecasting technology readiness against time.
- HR Trends Analysis.
- Recruitment Planning.
- Planning technology insertion.
- Input to options analysis.

The SV-9 can be presented in a table, timeline, or a Herringbone diagram.

Detailed Description:

A SV-9 summarizes predictions about trends in technology and personnel. Architects may produce separate SV-9 products for technology and human resources. The specific time periods selected (and the trends being tracked) are coordinated with architecture transition plans (which the SV-8 Systems Evolution Description model can support). That is, insertion of new capabilities and upgrading or re-training of existing resources may depend on or be driven by the availability of new technology and associated skills. The forecast includes potential impacts on current architectures and thus influences the development of transition and target architectures. The forecast is focused on technology and human resource areas that are related to the purpose for which a given architecture is being described and identifies issues affecting that architecture.

If standards are an integral part of the technologies important to the evolution of a given architecture, then it may be convenient to combine SV-9 with the StdV-2 Standards Forecast in a composite Fit-for-Purpose View.

The SV-9 is constructed as part of a given Architectural Description and in accordance with

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the Architectural Description purpose. Typically, this involves starting with one or more overarching reference models or standards profiles to which the architecture must conform. Using these reference models or standards profiles, the architect selects the service areas and services relevant to the architecture. The SV-9 DoDAF-described Model forecasts relates to the Standards Profile (StdV-1) in that a timed forecast may contribute to the decision to retire or phase out the use of a certain standard in connection with a resource. Similarly, SV-9 forecasts relate to the Standards Forecasts (StdV-2) in that a certain standard may be adopted depending on a certain technology or skill becoming available (e.g., the availability of Java Script may influence the decision to adopt a new HTML standard).

Alternatively, the SV-9 may relate forecasts to SV elements (e.g., systems) where applicable. The list of resources potentially impacted by the forecasts can also be summarized as additional information in a SV-9.

SV-1 Systems Interface Description

SV-2 Systems Resource Flow Description

SV-3 Systems-Systems Matrix

SV-4 Systems Functionality Description

SV-5a Operational Activity to Systems Function Traceability Matrix

SV-5b Operational Activity to Systems Traceability Matrix

SV-6 Systems Resource Flow Matrix

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Introduction to SV-10a, SV-10b and SV-10c

Many of the critical characteristics of an architecture are only discovered when an architecture's dynamic behaviors are defined and described. These dynamic behaviors concern the timing and sequencing of events that capture resource performance characteristics (i.e., a performer executing the system functions described in SV-4).

Behavioral modeling and documentation are key to a successful Architectural Description, because it describes how the architecture behaves which is crucial in many situations. Although knowledge of the functions and interfaces is also crucial, knowing whether, for example, a response should be expected after sending message X to System Function Y can be crucial to successful overall operations.

The SV-10 DoDAF-described Models are useful in support of net-centric (service-oriented) implementation of services as orchestrations of services. The SV-3 Systems-Systems Matrix can provide input for the SV-10 DoDAF-described Models. Three types of models may be used to adequately describe the dynamic behavior and performance characteristics of System elements. These three models are:

- Systems Rules Model (SV-10a).
- Systems State Transition Description (SV-10b).
- Systems Event-Trace Description (SV-10c).

SV-10b and SV-10c may be used separately or together, as necessary, to describe critical timing and sequencing behavior in the SV. Both types of diagrams are used by a wide variety of different systems methodologies.

Both SV-10b and SV-10c describe functional responses to sequences of events. Events may also be referred to as inputs, transactions, or triggers. When an event occurs, the action to be taken may be subject to a rule or set of rules as described in SV-10a.

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SV-2 Systems Resource Flow Description

SV-3 Systems-Systems Matrix

SV-4 Systems Functionality Description

SV-5a Operational Activity to Systems Function Traceability Matrix

SV-5b Operational Activity to Systems Traceability Matrix

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SV-10a: Systems Rules Model

The SV-10a specifies functional and non-functional constraints on the implementation aspects of the architecture (i.e., the structural and behavioral elements of the Systems Viewpoint).

The SV-10a DoDAF-described Model describes constraints on the resources, functions, data, and ports that make up the SV physical architecture. The constraints are specified in text and may be functional or structural (i.e., non-functional).

The intended usage of the SV-10a includes:

- Definition of implementation logic.
- Identification of resource constraints.

Detailed Description:

The Systems Rules Model DoDAF-described Model describes the rules that control, constrain or otherwise guide the implementation aspects of the architecture. System Rules are statements that define or constrain some aspect of the business, and may be applied to:

- Performers.
- Resource Flows.
- System Functions.
- System Ports.
- Data Elements.

In contrast to the OV-6a Operational Rules Model, SV-10a focuses on physical and data constraints rather than business rules.

Constraints can be categorized as follows:

- Structural Assertions - non-functional constraints governing some physical aspect of the architecture.
- Action Assertions - functional constraints governing the behavior of resources, their interactions and Resource Flow exchanges.
- Derivations - these involve algorithms used to compute facts.

Where a System Rule is based on some standard, then that standard should be listed in the StdV-1 Standards Profile.

Some System Rules can be added as annotations to other models. The SV-10a then should provide a listing of the complete set of rules with a reference to any models that they affect.

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SV-2 Systems Resource Flow Description

SV-3 Systems-Systems Matrix

SV-4 Systems Functionality Description

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SV-5a Operational Activity to Systems Function Traceability Matrix

SV-5b Operational Activity to Systems Traceability Matrix

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SV-10b: Systems State Transition Description

The SV-10b is a graphical method of describing a resource (or system function) response to various events by changing its state. The diagram basically represents the sets of events to which the resources in the Activities respond (by taking an action to move to a new state) as a function of its current state. Each transition specifies an event and an action.

The explicit time sequencing of service functions in response to external and internal events is not fully expressed in SV-4 Systems Functionality Description. The SV-10b can be used to describe the explicit sequencing of the functions. Alternatively, SV-10b can be used to reflect explicit sequencing of the actions internal to a single function, or the sequencing of system functions with respect to a specific resource.

The intended usage of the SV-10b includes:

- Definition of states, events and state transitions (behavioral modeling).
- Identification of constraints.

Detailed Description:

The SV-10b relates events to resource states and describes the transition from one state to another. The SV-10b is based on the state chart diagram. A state machine is defined as "a specification that describes all possible behaviors of some dynamic view element. Behavior is modeled as a traversal of a graph of specific states interconnected by one or more joined transition arcs that are triggered by the dispatching of series of event instances. During this traversal, the state machine executes a series of actions associated with various elements of the state machine." State chart diagrams can be unambiguously converted to structured textual rules that specify timing aspects of events and the responses to these events, with no loss of meaning. However, the graphical form of the state diagrams can often allow quick analysis of the completeness of the rule set, and detection of dead ends or missing conditions. These errors, if not detected early during the solution analysis phase, can often lead to serious behavioral errors in fielded capabilities, or to expensive correction efforts.

The SV-10b models state transitions from a resource perspective, with a focus on how the resource responds to stimuli (e.g., triggers and events). As in the OV-6b Operational State Transition Description, these responses may differ depending upon the rule set or conditions that apply as well as the resource's state at the time the stimuli is received. A change of state is called a transition. Each transition specifies the response based on a specific event and the current state. Actions may be associated with a given state or with the transition between states. A state and its associated actions specify the response of a resource or function, to events. When an event occurs, the next state may vary depending on the current state (and its associated action), the event, and the rule set or guard conditions.

The SV-10b can be used to describe the detailed sequencing of functions described in SV-4 Systems Functionality Description. However, the relationship between the actions included in SV-10b and the functions in SV-4 Systems Functionality Description depends on the purposes of the architecture and the level of abstraction used in the models. The explicit sequencing of functions in response to external and internal events is not fully expressed in SV-4 Systems Functionality Description. SV-10b can be used to reflect explicit sequencing of

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the functions, the sequencing of actions internal to a single function, or the sequencing of functions with respect to a specific resource.

States in a SV-10b model may be nested. This enables quite complex models to be created to represent systems behavior. Depending upon the architecture project's needs, the SV-10b may be used separately or in conjunction with the SV-10c Systems Event-Trace Description.

SV-1 Systems Interface Description

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SV-10c: Systems Event-Trace Description

The SV-10c provides a time-ordered examination of the interactions between functional resources. Each event-trace diagram should have an accompanying description that defines the particular scenario or situation.

The SV-10c is valuable for moving to the next level of detail from the initial solution design, to help define a sequence of functions and system data interfaces, and to ensure that each participating resource or System Port role has the necessary information it needs, at the right time, to perform its assigned functionality.

The intended usage of the SV-10c includes:

- Analysis of resource events impacting operation.
- Behavioral analysis.
- Identification of non-functional system requirements.

Detailed Description:

The SV-10c specifies the sequence in which Resource Flow elements are exchanged in context of a resource or System Port. Systems Event-Trace Descriptions are sometimes called sequence diagrams, event scenarios or timing diagrams. The components of a SV-10c include functional resources or system ports, owning performer as well as the port which is the subject for the lifeline.

Specific points in time can be identified. The Resource Flow from one resource/port to another can be labeled with events and their timing. The System Event-Trace Description provides a time-ordered examination of the Resource Flow elements exchanged between participating resources (external and internal) or system ports. Each Event/Trace diagram should have an accompanying description that defines the particular scenario or situation.

The SV-10c is typically used in conjunction with the SV-10b Systems State Transition Description to describe the dynamic behavior of resources. The data content of messages that connect Resource Flows in a SV-10c may be related with Resource Flows (the interactions in the SV-1 Systems Interface Description and SV-3 Systems-Systems Matrix), Resource Flows (the data in the SV-4 Systems Functionality Description and SV-6 Systems Resource Flow Matrix) and entities (in DIV-3 Physical Data Model) modeled in other models.

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- SV-2 Systems Resource Flow Description
- SV-3 Systems-Systems Matrix
- SV-4 Systems Functionality Description
- SV-5a Operational Activity to Systems Function Traceability Matrix
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Model List

The DoDAF-described Models that are available in DoDAF V2.0 are listed in the **table below**. 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. The DoDAF-described Models are grouped into the following viewpoints:

- All Viewpoint (AV)
- Capability Viewpoint (CV)
- Data and Information Viewpoint (DIV)
- Operational Viewpoint (OV)
- Project Viewpoint (PV)
- Services Viewpoint (SvcV)
- Standard Viewpoint (StdV)
- Systems Viewpoint (SV)

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	The fulfillment of capability requirements shows the

Organizational Development Mapping	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.
OV-5a: Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in a 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 activity (operational activity). It traces actions in a scenario or sequence of events.
PV-1: Project Portfolio	It describes the dependency relationships between the

Relationships	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.
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.
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.

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Model Categories

To aid the decision-maker and process owners, the DoDAF-described Models have been categorized into the following types:

- Tabular: Models which present data arranged in rows and columns, which includes structured text as a special case.
- Structural: This category comprises diagrams describing the structural aspects of an architecture.
- Behavioral: This category comprises diagrams describing the behavioral aspects of an architecture.
- Mapping: These models provide matrix (or similar) mappings between two different types of information.
- Ontology: Models which extend the DoDAF ontology for a particular architecture.
- Pictorial: This category is for free-form pictures.
- Timeline: This category comprises diagrams describing the programmatic aspects of an architecture.

DoDAF Architectural Descriptions are expressed in the form of sets of data, expressed as DoDAF-described Models, which can be classified into categories. The table below provides a summary of how the DoDAF-described Models can be sorted using the categories above and can provide insight for the decision-maker and process owners for the DoDAF-described Models needed.

DoDAF-Described Models Categorized by Type

Category / VP	Tabular	Structural	Behavioral	Mapping	Taxonomy	Pictorial	Timeline
All Viewpoint	AV-1				AV-2		
Capability	CV-1	CV-4		CV-6 CV-7	CV-2		CV-3 CV-5
Operational	OV-3	OV-2 OV-4	OV-6a OV-6b OV-6c		OV-5	OV-1	
System	SV-6 SV-7 SV-9	SV-1 SV-2	SV-4 SV-10a SV-10b SV-10c	SV-3 SV-5a SV-5b			SV-8
Standards	StdV-1 StdV-2						
Data and Information		DIV-1 DIV-2 DIV-3					
Service	SvcV-6 SvcV-7 SvcV-9	SvcV-1 SvcV-2	SvcV-4 SvcV-10a SvcV-10b SvcV-10c	SvcV-3a SvcV-3b SvcV-5			SvcV-8
Project		PV-1		PV-3			PV-2

Some of the DoDAF-described Models above were based on analysis of Ministry of Defence Architecture Framework (MODAF) and North Atlantic Treaty Organization (NATO) Architecture Framework (NAF) views and information requirements provided in the key process workshops by the subject matter experts. In addition, analysis on the DoDAF V1.5 products was performed by the DoDAF V2.0 Presentation Technical Working Group . The objective of the analysis was to determine if any product could be eliminated or if any product was created in every architecture effort. The OV-1 is the most created product at 92 percent of the projects. The SV-7 was the least created product at 5 percent. What is revealing is that there was not a product that could be deleted. The results of the survey are documented in the DoDAF Product Development Questionnaire Analysis Report online in the DoDAF Journal.

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San Antonio, TX May 10-14, 2010
Registration will be available at:
WWW.DODENTERPRISEARCHITECTURE.ORG
Targeted Date TBD
Co-hosted by DoD CIO Enterprise Architecture & Standards and Joint Staff

Models

Levels of Architecture

In addition, based on the level of the architecture effort, the decision-maker and architect need to determine the DoDAF-described Models and Fit-for-Purpose Views needed. To assist, the table below uses the Zachman Framework with the levels of architecture overlaid for consideration by the decision-maker and architect. The table is only provided as input; DoDAF is not prescribing DoDAF-described Model or Fit-for-Purpose Views or presentations.

Zachman Framework with Levels of Architecture

Strategic Architectures apply to entire Department | Capability Architectures specific to CPM & Component Tiers | Solution Architecture: Materiel/Non-materiel | DoD EA: Strategic, Capability

	Layer	What (Data)	How (Function)	Where (Network)	Who (People)	When (Time)	Why (Motivation)
1	Scope Context Boundary **(Planner)**	List of things important to the business	List of processes the business performs	List of locations in which the business operates	List of organizations important to the business	List of events significant to the business	List of business goals/ strategies
2	Business Model Concepts **(Owner)**	e.g., Semantic or Entity-relationship Model	e.g., Business Process Model	e.g., Business Logistics System	e.g., Work Flow Model	e.g., Master Schedule	e.g., Business Plan
3	System Model Logic **(Designer)**	e.g., Logical Data Model	e.g., Application Architecture	e.g., Distributed System Architecture	e.g., Human Interface Architecture	e.g., Processing Structure	e.g., Business Rule Model
4	Technology Model Physics **(Builder)**	e.g., Physical Data Model	e.g., System Design	e.g., Technology Architecture	e.g., Presentation Architecture	e.g., Control Structure	e.g., Rule Design
5	Component Configuration **(Implementer)**	e.g., Data Definition	e.g., Program	e.g., Network Architecture	e.g., Security Architecture	e.g., Timing Definition	e.g., Rule Specification
6	Functioning Enterprise Instances **(Worker)**	e.g., Data	e.g., Function	e.g., Network	e.g., Organization	e.g., Schedule	e.g., Strategy

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Architecture Interrogatives

A critical part of defining an architecture is answering what is known as, the set of standard interrogatives, which are the set of questions, who, what, when, where, why, and how, that facilitate collection and usage of architecture-related data. DoDAF provides a means of answering these interrogatives through the DoDAF Viewpoints and DoDAF-described Models, and the DoDAF Meta-model Data Groups, as the major parts of the DoDAF Conceptual Data Model (CDM).

The table below is a simple matrix that presents the DoDAF Viewpoints and DoDAF-described Models as they relate to the DoDAF Meta-model Groups, and how these viewpoints, models, and groups answer the standard interrogatives. When architecture is required to support decision-making, the matrix is useful in both data collection, and decisions on how to best represent the data in DoDAF-described Models that are appropriate to the purpose for which the architecture is created.

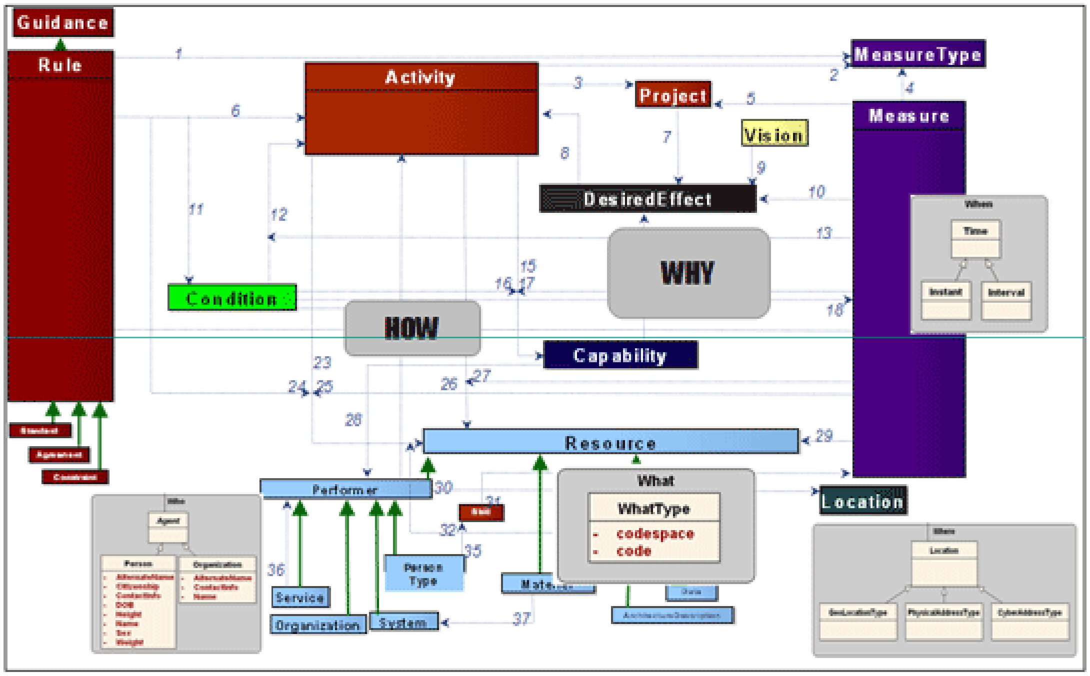
Standard Interrogatives Matrix

	What (Date)	How (Function)	Where (Network)	Who (People)	When (Time)	Why (Motivation)
Viewpoint	AV, DIV	OV, SV, SvcV	OV, SV, SvcV	OV	CV, OV, PV, SV, SvcV	AV, CV, OV, StdV, SV, SvcV
DoDAF-described Models	AV-2, DIV-1, DIV-2, DIV-3	OV-5a, OV-5b, OV-6a, b, c, SV-4, SV-10a, b, c, SvcV-10a, b, c	OV-2, SV-2, SvcV-2	OV-2, OV-4	CV-2, CV-4, OV-6c, PV-2, SV-8, SvcV-8, Sv-10c, SvcV-10c	AV-1, CV-1, OV-6a, StdV-1, StdV-2, SV-10a, SvcV-10a
Meta-model group	Information and Data, Project	Activity, Capability, Service, Measures	Location	Performer	All	Rules, Goals

As an example, a decision is required on changing a logistics transaction process (a composite of activities). The process is documented (how), to include the measures of performance, services required, and the capability supported by the action (activity). Data required to execute the process (what) is collected concurrently. Included in that data collection is the location and other administrative data on the place of process execution (where), and the performers of the action (who). The time frames required (when) and the Rules, Goals, and Expected Results (why) are also determined. These interrogatives impact on measures of performance. Each of these interrogatives can be represented by either a DoDAF-described Model or a Fit-for-Purpose View defined by the architectural development team that meets agency requirements. Either way, the models and views needed are created utilizing data defined and derived from the DoDAF Meta-model.

The architecture interrogatives are overlaid on the DM2 Conceptual Data Model below:

- The Data Description — What (DM2 generalizes to other Resources besides just Data)
- The Function Description — How (and also the Performer that performs the Function, Measures, Rules, and Conditions associated with)
- The Network Description — Where (generalized)
- The People Description — Who (DM2 includes Organizations)
- The Time Description — When
- The Motivation Description — Why (broadened to include Capability requirements)



Architecture Interrogative overlay on the DM2 Conceptual Data Model

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Architecture Modeling Primitives

Work is presently underway within the Department to ensure uniform representation for the same semantic content within architecture viewing, called Architecture Modeling Primitives. The Architecture Modeling Primitives, hereafter referred to as Primitives, will be a standard set of viewing elements and associated symbols mapped to DM2 concepts and applied to viewing techniques. Use of the Primitives to support the collection of architecture content in concert with the Physical Exchange Specification will aid in generating common understanding and improving communication. As the Primitives concepts are applied to more viewing 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 DoDAF-described Models, as with the current BPMN Primitives, will be coordinated for adoption by architecture tool vendors. Examples of presentations can be viewed online in the public DoDAF Journal.

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Mapping to DM2

A mapping of the DM2 Concepts (classes), Associations (relationships), and Attributes to DoDAF-described Models, is shown in the table below. In the DM2 Concept, Association, or Attribute column, the Black text is a concept or attribute, the Red text is an association, and the Green Text is the security attributes in the DM2.

Click on the image below to open or save the Excel worksheet.

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
3	**Technical Term**	**Composite Definition**	AV-1	AV-2	OV-1	OV-2	OV-3	OV-4	OV-5a	OV-5b	OV-6a	OV-6b	OV-6c	SV-1	SV-2	SV-3
4	**Activity**	Work, not specific to a single organization, weapon system or individual that transforms inputs (Resources) into outputs (Resources) or changes their state.	n	o		n	n		n	n	o	n	n	n	n	n
5	**activityChangesResource**	Represents that an activity was / is / will-be the cause of change in the effected object with a before-after relationship.	o								o	o	o			
6	**activityChangesResourceTypeInstanceOfMeasure**	activityChangesResource is a member of Measure	o								o	o	o			
7	**activityPartOfCapability**	A disposition to manifest an Activity. An Activity to be performed to achieve a desired effect under specified [performance] standards and conditions through combinations of ways and means.														
8	**activityPartOfCapabilityTypeInstanceOfMeasure**	activityPartOfCapability is a member of Measure														
9	**activityPartOfProjectType**	A wholePart relationship between a Project and an Activity (Task) that is part of the Project														
10	**activityPerformableUnderCondition**	Represents that an activity was / is / can-be/ must-be conducted under certain conditions with a spatiotemporal overlap of the activity with the condition.	o			o	o			o	o	o	o			
11	**activityPerformableUnderConditionTypeInstanceOfMeasure**	activityPerformableUnderCondition is a member of Measure								o	o	o	o			
		An overlap between a Performer and an Activity that is non-specific as to whether:														

DM2 Mapping

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DM2 - DoDAF Meta-Model

Note: The DM2 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 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.

A ***PES*** 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.

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.

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DM2 - DoDAF Meta-Model

The DoDAF Conceptual Data Model

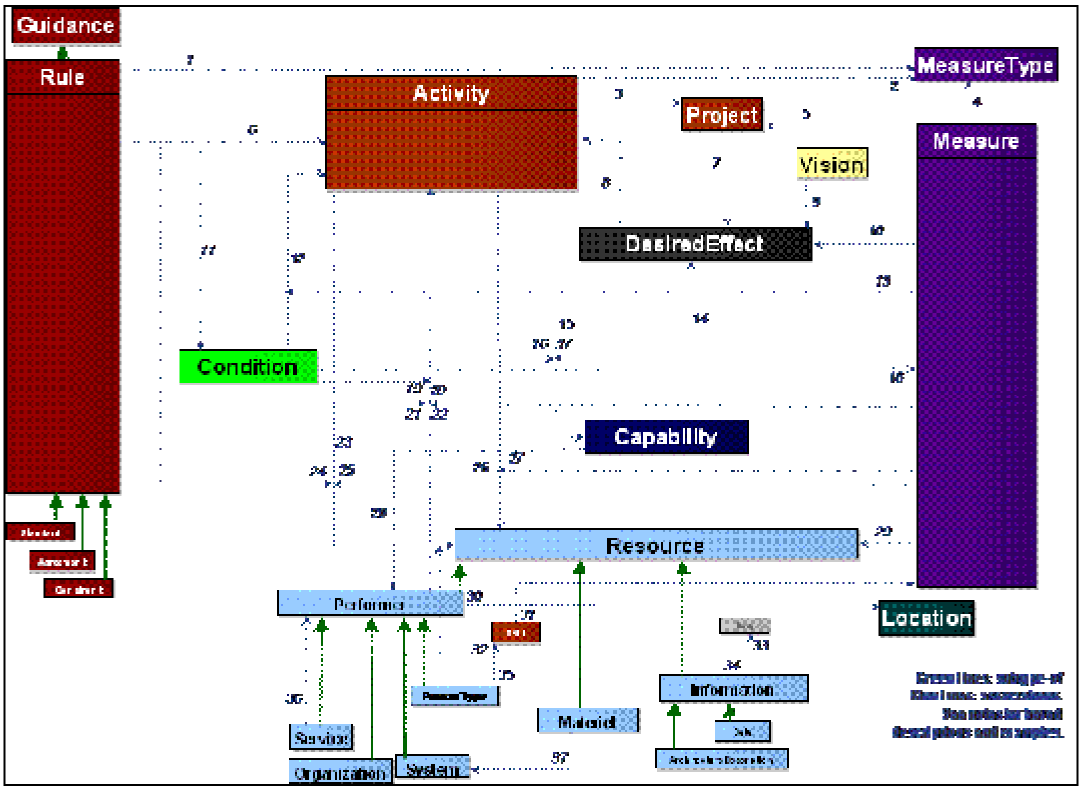
The CDM defines concepts involving high-level data constructs from which Architectural Descriptions are created, enabling executives and managers at all levels to understand the data basis of Architectural Description. The key concepts are as follows:

- 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.

The CDM also describes the relationships among data constructs in relatively non-technically and easily understood terms. The image below 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).

Click on image below to link to the DM2 Data Dictionary



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.

Underlying the CDM is a foundation that utilizes common data modeling constructs that facilitate the reuse of common data patterns.

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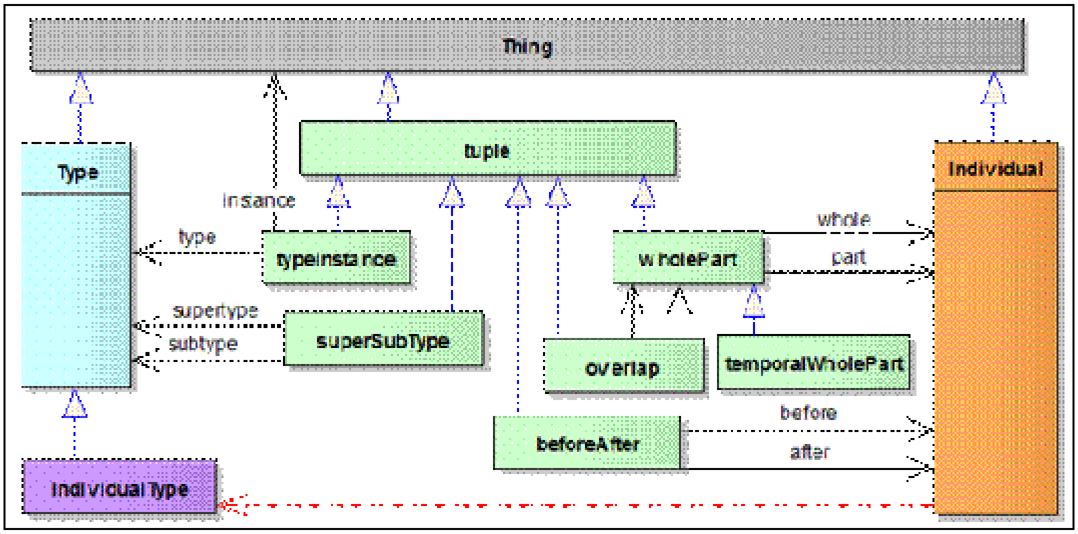
The DoDAF Conceptual Data Model



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 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.

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Architect Role

Developer Role

DM2 - DoDAF Meta-Model

Meta-Model Data Groups

The logical model -- concepts, attributes, and relationships that:

1. Form the vocabulary for description and discourse about DoDAF-described Models and
2. Is the basis for generation of the physical exchange specification for exchange of data between architecture tools and databases.

There are three underlying concepts that were followed in the Development of the DoDAF Meta-model: Principles, grouping of semantically related concepts, and foundation ontology where the properties are inherited by all the DoDAF Concepts.

The **first** underlying concept is the DM2 was developed in accordance with the following principles:

- The DM2 models Core Process (PPBE, Defense Acquisition System [DAS], Joint Capabilities Integration and Development System [JCIDS], Capability Portfolio Management [CPM], Systems Engineering [SE], Ops) business objects
- Terms enter the model via thorough semantic research:
  - Assignment to a researcher
  - Collection of authoritative definitions, documenting source - Assessment of redundant (alias) or composite terms
  - Formulation/selection of definition based on authoritative definitions
  - Examples
  - Outbrief to team
  - Recording of research and decision rationale
- No need to distinguish or label concepts that differ only in level of aggregation - e.g., subfunction - function. Whole-part relationship covers the need without different names for different types of wholes and parts. When a user has a need to label, the naming pattern accommodates.
- Relationships (associations) should be typed using the foundation.
- There is no commitment to an implementation type. The DM2 should logically support Relational Database Management System (RDBMS), eXtensible Markup Language (XML) Schema Definition (XSD), Java, etc.
- The DM2 is a core that can be extended by user communities; it does not try to cover all user detail. Extenders should be careful to not create redundant representations.
- The model will enter a Configuration Management (CM) process.

Extensions (subtypes (e.g., Unified Modeling Language (UML) specializations), additional attribution, and concepts beyond scope of DM2) to the DM2 are expected and can be done by architecture development efforts. If an extension becomes widespread, it may be appropriate to submit a change request to the DoDAF so that it can be considered by the DoDAF Change Control Board and the Data Technical Working Group for inclusion in the baseline DM2.

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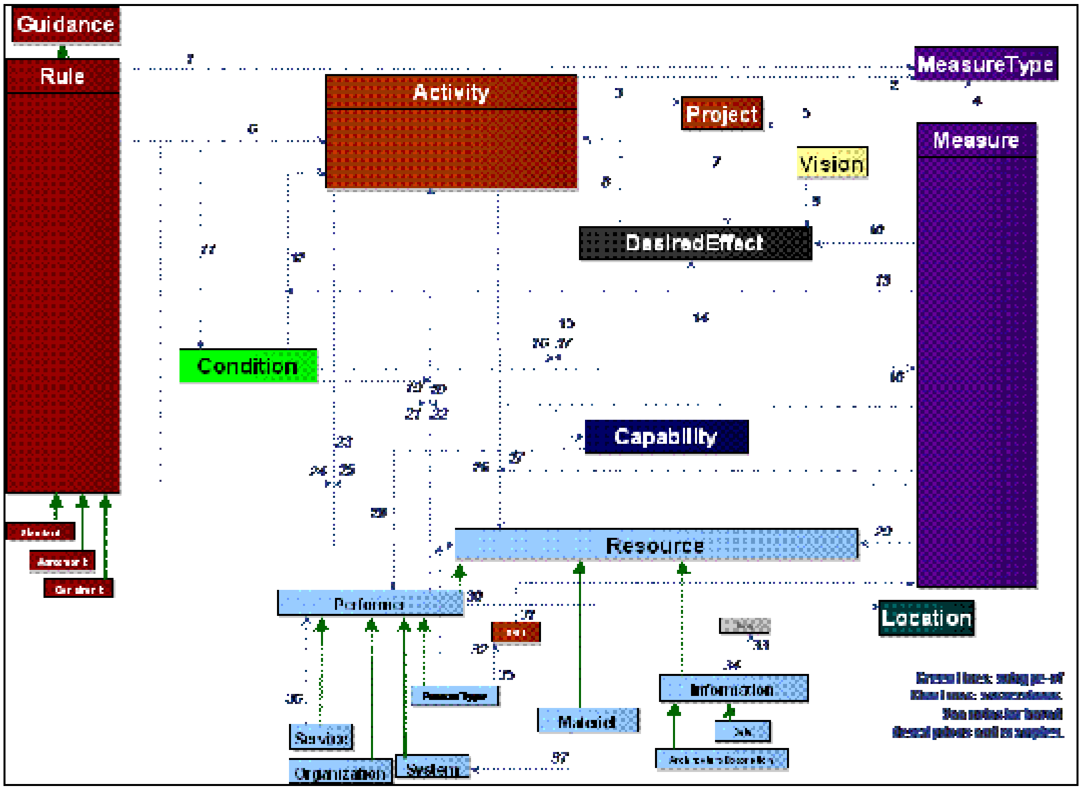
The **second** underlying concept is the grouping of semantically related concepts into the following clusters:

- Goals. How goals, visions, objectives, and effects relate and bear on architectures.
- Capability. Models of what is needed to perform a set of activities under certain conditions and standards to achieve desired effects and the way in which those needs are satisfied.
- Activities. Activities are work that transforms (changes) inputs into outputs or changes their state.
- Performer. Things that perform activities such as service performers, systems, personnel, and organizations.
- Services. Business and software services, what they do for what effects, by what measures and rules, how they are described for discovery and use, and how and where they can be accomplished.
- Resource Flows. The interaction between Activities (which are performed by Performers) that is both temporal and results in the flow or exchange of objects such as information, data, materiel, and performers.
- Information and Data. Representations (descriptions) of things of interest and necessary for the conduct of activities.
- Project. All forms of planned activities that are responsive to visions, goals, and objectives that aim to change the state of some situation.
- Training/Skill/Education. Definitions, descriptions, and the promulgation of training requirements, skills sets required for specific capabilities and operations, and the formal education required
- Rules. How rules, standards, agreements, constraints, and regulations and are relevant to architectures.
- Measures. All form of measures (metrics) applicable to architectures including needs satisfaction measures, performance measures, interoperability measures, organizational measures, and resource measures.
- Locations. All forms of locations including points, lines, areas, volumes, regions, installations, facilities, and addresses including electronic addresses (e.g., Uniform Resource Locators [URLs]) and physical (e.g., postal.)

The data groups are related, as illustrated below, conceptually as is described in the Conceptual Data Model description. They can be roughly grouped as:

1. Goals and desired effects (Goals and Capabilities);
2. Tthe actual mission configurations (Activities, Performers, Services, Resource Flows, and Information and Data);
3. The means by which the end items are put in place (Projects and Training / Skills / Education), and
4. The characteristics of the end items (Rules they comply with, Measures associated with them, and where they are Located).

Click on image below to link to the DM2 Data Dictionary



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DM2 - DoDAF Meta-Model

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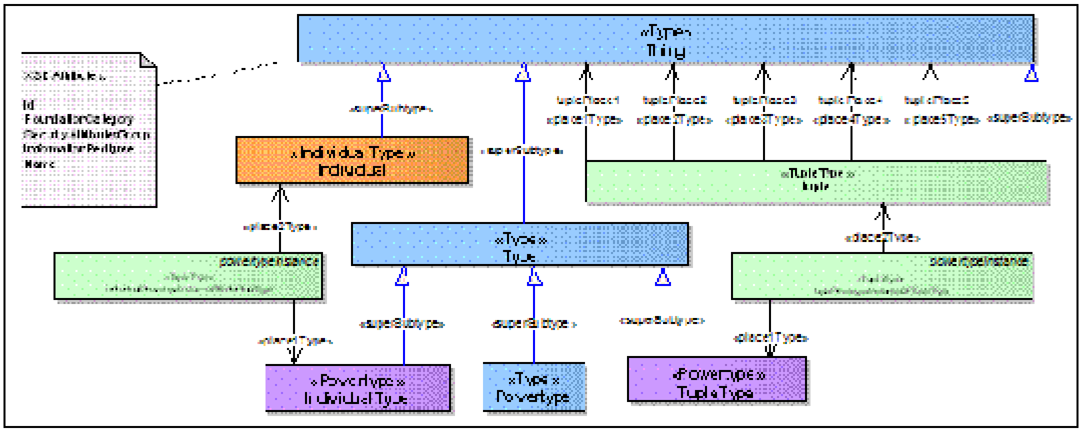
There are three underlying concepts that were followed in the Development of the DoDAF Meta-model: Principles, grouping of semantically related concepts, and foundation ontology where the properties are inherited by all the DoDAF Concepts.

The **third** underlying concept is the root foundation from the International Defence Enterprise Architecture Specification (IDEAS), from which all DoDAF concepts inherit several important properties. None of these foundation properties are unusual; they are all used in reasoning everyday:

- Individuals, things that exist in 3D space and time, i.e., have spatial-temporal extent.
- Types, sets of things.
- Tuples, ordered relations between things, e.g., ordered pairs in 2D analytic geometry, rows in relational database tables, and subject-verb-object triples in Resource Description Framework.
- Whole-part; e.g., components of a service or system, parts of the data, materiel parts, subdivisions of an activity, and elements of a measure.
- Temporal whole-part; e.g., the states or phases of a performer, the increments of a capability or projects, the sequence of a process (activity).
- Super-subtype; e.g., a type of system or service, capability, materiel, organization, or condition.
- Interface; e.g., an overlap between two things.

The foundation is usually called a formal ontology. It is a formal, higher-order, 4D, based on four dimensionalism. It is extensional (see Extension [metaphysics]), using physical existence as its criterion for identity. In practical terms, this means the ontology is well suited to managing change-over time and identifying elements with a degree of precision that is not possible using names alone. The methodology for defining the ontology is very precise about criteria for identity by grounding reasoning about whether two things are the same using something that can be accurately identified. So, comparing two individuals, if they occupy precisely the same space at the same time, they are the same. Clearly this only works for individuals, but the principle can be used to compare types too. For two types to be the same, they must have the same members. If those members are individuals, their physical extents can be compared. If the members are types, then the analysis continues until individuals are reached, then they can be compared. The advantage of this methodology is that names are separated from things and so there is no possibility of confusion about what is being discussed. The upper foundation is shown below.



Foundation Top-Level

Several items are notable:

- There are three subtypes of Thing: 1) Individuals meaning Things that have spatio-temporal extent, i.e., that exist in space and time - can be kicked; 2) Types or sets of Things; and 3) Tuples or ordered relations between Things. Types include sets of Tuples and sets of sets. Tuples can have other Tuples in their tuple places. There are three subtypes of Type: 1) Individual Type, sets whose members are Individuals (Things with spatio-temporal extent); Power Types, sets whose members are generated from a powerset on some other set; and 3) Tuples, sets of ordered relations between Things. The participants in a super-subtype relationship can be from the same class, e.g., the supertype can be an instance of Measure Type as well as the subtype. This allows for representation of as much of a super-subtype taxonomy as is needed. Power Type members are generated from some Type by taking all the possible subsets of the members of the Type. For example consider the Type whose members are a, b, c. The powerset would be:

  $$\{a,b,c\},\{a,b\},\{a,c\},\{b,c\},\{a\},\{b\},\{c\},\{\varnothing\}$$

- For example, take the Individual Type AIRCRAFT, whose members include all the aircraft of the world. The powerset generated from this set would have:

  $$\{a_1,a_2,\ldots,a_n\},\{\varnothing\}$$
  $$\{\text{F-15}_1,\text{F-15}_2,\ldots,\text{F-15}_{lastF-15built}\}$$
  $$\{\text{F-15}_1,747_1,\ldots,\text{Cessna}_1\}$$

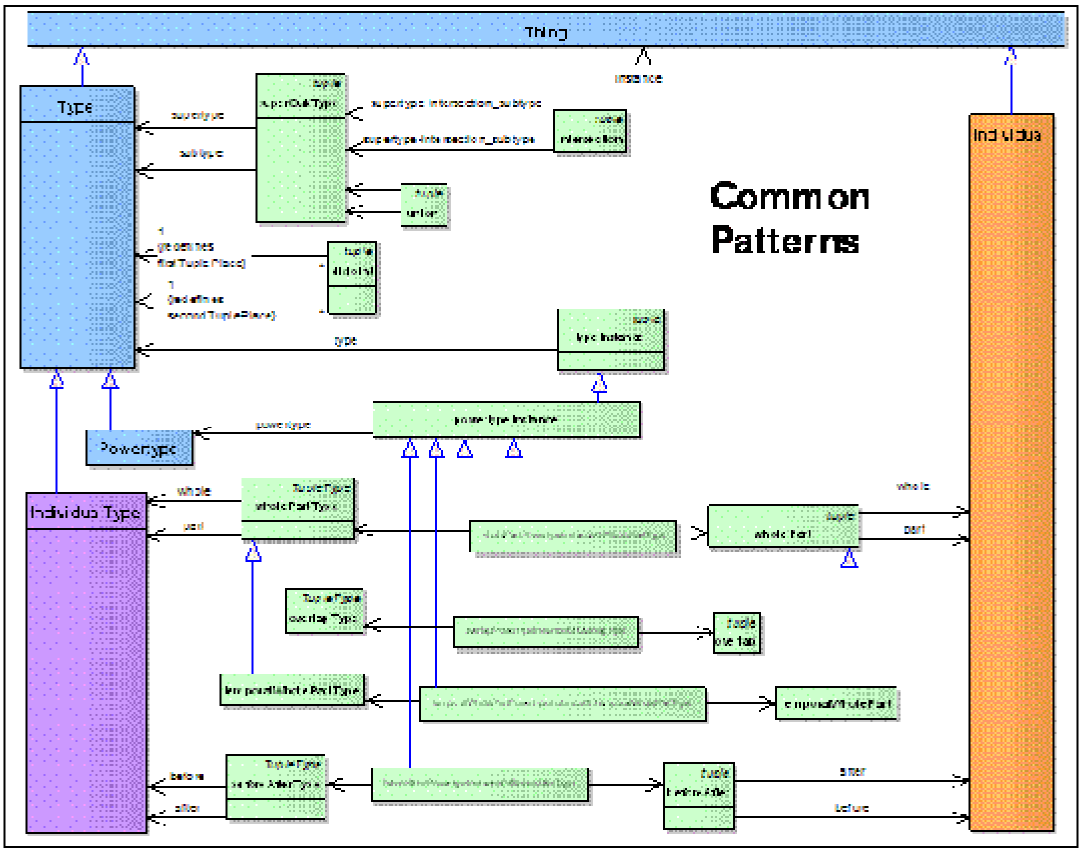
- Some of these subsets are not used by anyone, e.g., the full set, the null set, or just some random subset. However, the second one, which might be name F-15 Type, is quite useful. The last example is not useful to most unless you are interested in the first (assuming the subscript 1 means first) of any particular aircraft type, e.g., if you were doing a study of first-off-the-line aircraft production lessons-learned. This is the usefulness of Power Types and why they are employed in DM2: they allow for multiple categorization schemes, according to someone else's use, yet traceability back to the common elements so that the relationships between multiple categorization schemes can be understood. This was a DM2 requirement – multiple categorization schemes or taxonomies – because across a large enterprise it is not possible to employ a single categorization scheme; rather schemes vary depending on function. For example, a weaponeer's classifies ordnance is naturally different from a logistician's, the former concerned with delivery means, lethality, etc. and the latter with weight, size, and other transportation issues.
- Note also that a powerset can then be taken of the powerset. This allows for build up of what is often called a taxonomic hierarchy. These are quite useful in enterprise

Architectural Descriptions.

The DM2 utilizes the formal ontology of IDEAS because it provides:

- Mathematical rigor needed for precision Architectural Descriptions that can be analyzed and used in detailed processes such as Systems Engineering and Operations Planning.
- Reuse of common patterns to economize the model and implementations.
- Improved interoperation with Unified Profile for DoDAF and MODAF (UPDM)-SysML tools which are following IDEAS concepts.
- Improved opportunities for Coalition and NATO data exchange since MODAF is following IDEAS and NAF is interested in following IDEAS.

The re-use patterns useful to Architectural Descriptions are shown below.



The DM2 made some ease-of-use modifications to the formalism and naming convention in IDEAS as follows:

- In DM2, all Individuals (Things with spatial and temporal extent - things you can kick) and their Types are States, i.e., the whole-life Individual is just a special state case, that is, where the temporal extent is the Individual's start and end times. The names of the concepts do not include the word State because in all cases where it is applicable, it is implied.
- Since most architectural concern is with types of things, rather than specific individual things (e.g., not a specific President or System), the IDEAS convention of appending Type to the name was left off. In cases where both specific (individual) things and types are useful in DoDAF architectures, an appendage of Individual or Type is made to the less prevalent case.
- Detailed formal modeling of Tuple Types, Numerals, and Symbols is assumed. This detail is proper formalism but, once worked out, does not need to be included in the domain modeling of the DM2.

- Several names were changed due to familiarity in the United States (U.S.) DoD. This was expected in IDEAS and is one use of the Naming pattern. An example is Agent, which the DM2 Technical Working Group (TWG) felt should be called Performer. These are all simple aliases. National aliasing was understood as a requirement at the start of IDEAS; the naming pattern was developed in part to satisfy that requirement. Using the naming pattern, simple aliases are easily accommodated.
- IDEAS Proper Overlap required a cardinality constraint, that is, two overlap Part tuples were required. One represented the part of individual A that overlapped with individual B; the other represented the part of individual B that overlapped with individual A. In addition, it was required the two parts (the part of A, the part of B) equal. For DM2, it was simplified this by removing the unenforceable constraints by re-modeling overlap as a couple of couples where each couple is a whole-Part, one of Individual A and its part, the other of Individual B and its part. This is easily interoperable with IDEAS but is simpler to implement since there are no informal constraints.
- Security classification and information pedigree were added a core attributes, to apply to any element of data. This was done to follow DoD's Net-Centric Data Strategy.
- Some IDEAS concepts are left out because their exact mathematical meaning has not yet been modeled by the IDEAS Group.
- Agent Capable of Responsibility. Although both the IDEAS Group and the DM2 TWG feel there is a sense of distinction between Agents (Performers) in general and Agents capable of responsibility, the actual mathematical distinction has not yet been modeled in IDEAS. Both groups believe a mathematical distinction exists but it involves more research in the nature of responsibility to complete.

The IDEAS foundation concepts, common to all data groups are shown in the table below. It is important to remember that even though these are not repeated in the descriptions of the data groups, they are nevertheless present in the model and apply to the data group concepts according to the Doman Class Hierarchy figure below.

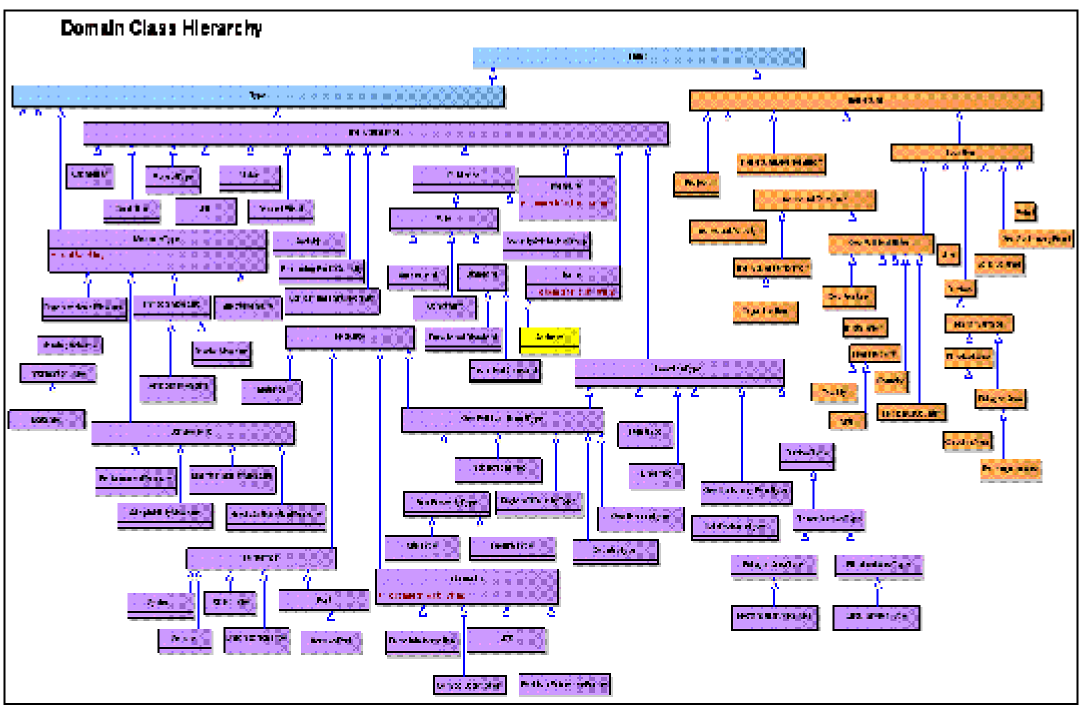
IDEAS Concept	Definition
Classes	
endBoundary	The maximum time value of a temporal extent.
endBoundaryType	The maximum value of a temporal extent taken over a Type, i.e., the maximum time value taken over all it's members.
Individual	A Thing that has spatio-temporal extent. Note - this may be something that existed in the past, exists now, or may exist in some future possible world.
IndividualType	The powertype of Individual.
Information	Information is the state of a something of interest that is materialized -- in any medium or form -- and communicated or received.
InformationType	Category or type of information
Name	The type of all utterances of a given name for a Thing. The exemplarText provides a written example of the uttered name.
NamingScheme	A Type whose members are Names. What kind of name the name is.

Powertype	A Type that is the set (i.e., Type) of all subsets (i.e., subTypes) that can be taken over the some Type.
startBoundary	The beginning of a temporalBoundary.
temporalBoundary	The start and end times for the spatio-temporal extent of an Individual
temporalBoundaryType	The start and end times for the Individual members of a Type.
Thing	The union of Individual, Type, and tuple.
TupleType	The powertype of tuple that provides the stereotype for tuples of Types.
Type	A set (or class) of Things. Note1: Types are identified by their members (i.e. all the things of that type). Note2: The IDEAS Foundation is a higher-order ontology, so Types may have members that are also Types.
Associations	
beforeAfter	A couple that represents that the temporal extent end time for the individual in place 1 is less than temporal extent start time for the individual in place 2.
beforeAfterPowertypeInstanceOfBeforeAfterType	beforeAfter is a member of BeforeAfterType
beforeAfterType	An association between two Individual Types signifying that the temporal end of all the Individuals of one Individual Type is before the temporal start of all the Individuals of the other Individual Type.
couple	An ordered relationship (tuple) between two Things, i.e., that has two place positions.
couplePowertypeInstanceOfCoupleType	couple is a member of CoupleType
coupleType	A couple in which the places are taken by Types only.
describedBy	A tuple that asserts that Information describes a Thing.
disjoint	Asserts that two Types define disjoint sets (i.e. they share no common members).
endBoundaryPowertypeInstanceOfEndBoundaryType	endBoundary is a member of EndBoundaryType
endBoundaryTypeInstanceOfMeasure	endBoundary is a member of Measure

endBoundaryTypeTypeInstanceOfMeasure	endBoundaryType is a member of Measure
individualPowertypeInstanceOfIndividualType	individual is a member of IndividualType
informationPowertypeInstanceOfInformationType	information is a member of InformationType
intersection	A couple of couples where each constituent couple represents the subset that is common to both sets.
namedBy	A couple that asserts that a Name describes a Thing.
namePowertypeInstanceOfNamingScheme	Name is a member of NameType
overlap	A couple of wholePart couples where the part in each couple is the same.
overlapPowertypeInstanceOfOverlapType	overlap is a member of OverlapType
overlapType	An overlap in which the places are taken by Types only.
powertypeInstance	An association that between of the sets within the powerType and the powerType. A special form of typeInstance.
startBoundaryPowertypeInstanceOfStartBoundaryType	startBoundary is a member of startBoundaryType
startBoundaryType	The beginning of a temporalBoundaryType.
startBoundaryTypeInstanceOfMeasure	startBoundary is a member of Measure
startBoundaryTypeTypeInstanceOfMeasure	startBoundaryType is a member of Measure
superSubType	An association in which one Type (the subtype) is a subset of the other Type (supertype).
temporalBoundaryPowertypeInstanceOfTemporalBoundaryType	temporalBoundary is a member of temporalBoundaryType
temporalWholePart	A wholePart that asserts the spatial extent of the (whole) individual is co-extensive with the spatial extent of the (part) individual for a particular period of time.
temporalWholePartPowertypeInstanceOfTemporalWholePartType	temporalWholePart is a member of temporalWholePartType
temporalWholePartType	A couple between two Individual Types where for each member of the whole set, there is a corresponding member of the part set for

	which a wholePart relationship exists, and conversely
tuple	A relationship between two or more things. Note: Tuples are identified by their places (i.e. the ends of the relationship).
tuplePowertypeInstanceOfTupleType	tuple is a member of TupleType
typeInstance	A Thing can be an instance of a Type - i.e. set membership. Note that IDEAS is a higher-order model, hence Types may be instances of Types.
union	A couple of couples where each constituent couple represents the superset union over the unioned sets.
wholePart	A couple that asserts one (part) Individual is part of another (whole) Individual.
wholePartPowertypeInstanceOfWholePartType	wholePart is a member of wholePartType
wholePartType	A coupleType that asserts one Type (the part) has members that have a whole-part relation with a member of the other Type (whole).

Click on figure below to see larger version.



The IDEAS Model is represented in UML. The UML language is not ideally suited to ontology specification in its native form. The UML language can be extended through the use of profiles. The IDEAS Model has been developed using a UML Profile - any UML elements that are not stereotyped by one of the IDEAS foundation elements will not be considered part of an IDEAS ontology. The IDEAS Foundation specifies the fundamental types that define the profile stereotypes. The super-subtype structure in IDEAS is quite comprehensive, and showing the super-type relationships on some diagrams can result in a number of crossed lines. In these cases, supertypes of a given type will be listed in italic text in the top-right-hand corner of the UML element box.

The stereotype of an element in an IDEAS UML model is shorthand for the element being an instance of the type referred to by the Stereotype, though the type must be one that has been defined in the root package of the foundation. Hence, if the stereotype is < > then the element is an instance of an Individual. The following stereotyped classes, with their color-coding are used in the model:

1. < > An instance of an Individual - something with spatio-temporal extent [Color Name: Grey(80%), Color Codes: R40 G40 B40]
2. < > The specification of a Type [Color Name: Pale Blue, Color Code: R153 G204 B255]
3. < > The specification of a Type whose members are Individuals [Color Name: Light Orange, Color Codes: R255 G173 B91]
4. < > The specification of a Type whose members are tuples [Color Name: Light Green, Color Codes: R204 G255 B204]
5. < > The specification of a Type that is the set of all subsets of a given Type [Color Name: Lavender, Color Codes: R204 G153 B255]
6. < > The specification of a name, with the examplar text provided as a tagged value [Color Name: Tan, Color Codes: R255 G254 B153]
7. < > The specification of a Type whose members are names [Color Name: Yellow, Color Codes: R255 G255 B0]

The following stereotyped relationships are used in the model:

1. <<typeInstance>> a relationship between a type and one of its instances (UML:Dependency) [Color Name: Red, Color Codes: R255 G0 B0]
2. <<powertypeInstance>> a relationship between a type and its powerset (UML:Dependency) [Color Name: Red, Color Codes: R255 G0 B0]
3. <<nameTypeInstance>> a relationship between a name and its NameType (UML:Dependency) [Color Name: Red, Color Codes: R255 G0 B0]
4. <<super-subtype>> a relationship between a type and one of its subtypes (UML:Generalisation) [Color Name: Blue, Color Codes: R0 G0 B255]
5. <<wholePart>> a relationship between an individual and one of its parts (UML:Aggregation) [Color Name: Green, Color Codes: R0 G147 B0]
6. <<namedBy>> a relationship between a name and the thing it names [Color Name: Black, Color Codes: R0 G0 B0]
7. <<tuple>>/<<couple> a relationship between a things (UML:n-ary relationship diamond) [Color Name: Grey(80%), Color Codes: R40 G40 B40]

Some examples are depicted below:

The naming convention for classes, attributes, and association names is camel case as follows:

- Class names start with uppercase.
- Attributes and association names start with lowercase.
- Acronyms are all uppercase. Acronyms in the middle of a name are avoided because of the concatenation of the acronym uppercase and the succeeding string leading uppercase.

Note that the size of the icons is not indicative of their importance; the sizes are adjusted to reduce line crossings and bends to make the diagrams easier to understand.

The following subparagraphs describe each of the data groups, how such data is collected and put together, and how it can be used.

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DM2 - DoDAF Meta-Model

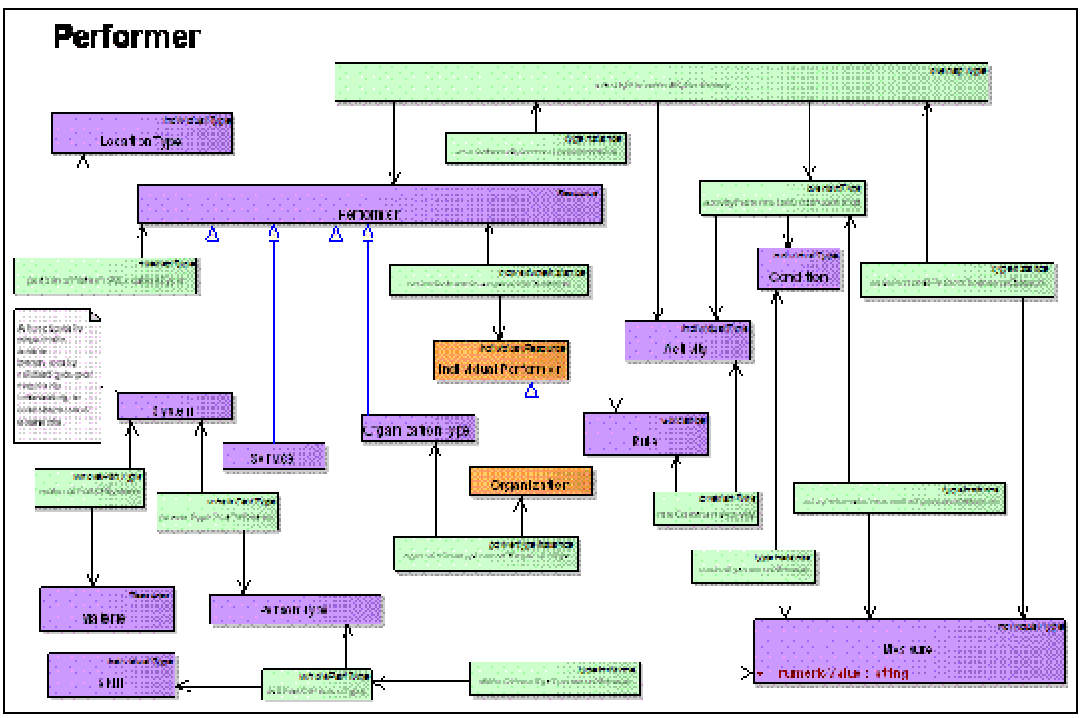
Performers

Performer is a class of entities that are central to the description of architecture. It is the Who in the Architectural Development Process. The How, tasks, activities, and processes (composite of activities), are assigned to Performers to accomplish the desired outcome. Performers are further subdivided and allocated to organizations, personnel and mechanization. Rules, locations and measures are then applied to organizations, personnel and mechanization. Within this assignment and allocation process there are many major tradeoff opportunities. Automation (mechanization versus people) tradeoffs, analysis for items such as performance and cost/benefit are involved in the process. When these tradeoffs and associated decisions are sufficiently mature, an allocated baseline can be declared and initial work breakdown structures refined.

Data

The DoDAF Meta-model for the data comprising Performers is shown below. Definitions for the model terms, along with summary of aliases and composite term definitions, Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Performer Group in the DM2 Data Dictionary



DoDAF Meta-model for Performers

a. The first thing to note about Performer is that it can represent:

1. A Personnel Type such as described by the Amy's Military Occupational Specialties

(MOS). MOS describe Skills and their measurement (not shown in this diagram).

2. An Organization (type or actual Individual Organization) meaning a mission chartered organization, not limited to just collections of people or locations, e.g., the Federal Bureau of Investigation (FBI) has a chartered mission and it chooses the locations, people, etc., to accomplish such.
3. A System in the general sense of an assemblage of components - machine, human - that accomplish a function, i.e., anything from small pieces of equipment to FoS and SoS. Note that Systems are made up of Materiel (e.g., equipment, aircraft, and vessels) and Personnel Types, and organizational elements.
4. A Service, from a software service to a business service such as Search and Rescue.
5. Any combination of the above.

b. The performance of an Activity by a Performer occurs in physical space and time. That is, at some place and time, the Activity is conducted. This is referred to as a spatial-temporal overlap, simply meaning that the Activity and Performer overlap in space and time. There are two ways in which a Performer spatial-temporally overlaps an Activity:

1. In the act of performing the Activity. This relationship is sometimes called assigned to for the purposes of traceability.
2. The other way is as part of a larger process (aggregated Activity). This is sometimes called allocated to and forms the initial stages of system or process decomposition. Allocated Performer elements (parts of Performers) are assigned Activities (or processes, tasks) in the initial stages of Performer definition.

c. A standard (Rule) constrains an Activity in general. Some of those constraints might also apply to the performance of the Activity by a Performer.

d. A Performer may have Measures associated with the performance of an Activity (e.g., target tracking accuracy.) It may also have Measures associated with the Performer overall (e.g., operational condition.)

e. Performers perform at Locations that can be specific positions or areas, regions, or installations, sites, or facilities. Location type requirements/capabilities of a Performer are captured/expressed via the Activities that are performed under certain Conditions (e.g., must be able to perform Maneuver under Desert Conditions.)

Method

Methods for collecting and viewing Performer data are as follows:

Performer Modeling and Core Usage. In a typical modeling methodology, an event (contextually, a short activity) initiates an action (single-step activity) within (part of) an activity (multiple steps) to form (aggregation) a process (multiple activities) which accomplishes a defined outcome. Activities and composition activities (processes) can be serial or parallel. Activities are assigned to Performers (organizational, human, materiel, or some combination thereof). Capabilities or lower-level derived capabilities, measures, conditions, constraints and other expressions of requirements are assigned to the various levels of Performer decomposition. Allocation occurs from level-to-level as part of the structural design decomposition.

Allocation is the term used by architects and engineers to denote the organized cross-association (mapping) of elements within the various structures or hierarchies of a user view regardless of modeling convention or standard. The concept of allocation requires flexibility suitable for abstract system specification, rather than a particular constrained method of system or software design. System modelers often associate various elements in abstract, preliminary, and sometimes tentative ways. Allocations can be used early in the design as a precursor to more detailed rigorous specifications and implementations. As the requirements definition stage gives way to the design stage and actual components become visible, it becomes important to distinguish between allocated to and assigned to.

Some types of performers under configuration control called system Configuration Items (CIs). Software Configuration items are termed Computer Software Configuration Items

(CSCIs) or Software Configuration items (SCIs) in MIL-HDBK-881A. Hardware Configuration items may follow the Mil-STD-161E taxonomy (Central, Center, System, Subsystem, Set, Group, Unit.) MIL-HDBK-881A , which guides DoD Work Breakdown Structures (WBS), defines software only by levels (e.g., 1, 2, 3, etc.)

System Functions. Activities performed by a System are defined as system or service functions (i.e., activities and/or processes performed by a system). System or service functions (activities) are allocated to hardware, software, firmware or personnel (when the person is considered integral to the system).

Personnel Activities. Personnel processes are typically termed Tactics, Techniques and Procedures (TTP) in DoD. Procedures are allocated sets of activities and/or processes, where Tactics and Techniques, typically, are made up of the procedures as influenced by rules, doctrine, paradigms, etc. acquired through skill development during the education and training process.

Performer Data Capture Method. A method to capture Performer data is described in the table below.

Performer Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Performer
Definition:	Define a process by which architectural information relative to the Performer entity within the DoDAF Meta-model can be captured and structured to enable it to support the major decision processes of the Department (e.g., PPBE, PfM, and JCIDS). A Performer can be one of several actors/mechanisms that execute a function, activity or process. Within the context of DoDAF V2.0, a Performer can be a person, organization, service or system.
Input:	• Concepts of Operations documentation • Organization Charts • Operational Roles • Human Resources (HR)/Personnel Data/Documentation • Systems Documentation • Services Documentation • Requirements Documentation

Method:	DoDAFV 2.0 is intended to be methodology agnostic. Therefore, structured analysis and object-oriented analysis techniques can be used to capture the information that constitutes a Performer. The following process can be used to capture the architectural information relative to Performer.
	
	1. For the purpose identified as driving the architecture effort, identify the business functions required to support the purpose.
	2. Identify the capabilities required to support the functions.
	3. Identify the organizations and organizational roles that are responsible for executing the functions and/or delivering the capabilities.
	    a. For any organizational roles identified as required for the function or capability, identify the requisite skills for the role.
	    b. Associate the roles to the skills.
	    c. In some cases there may be levels of skill required to fulfill a role or roles. Associate the requisite skill levels to the appropriate roles.
	4. Identify any services either in place or planned to support the functions and capabilities.
	5. Identify any systems either in place or planned to support the

	functions and capabilities. 6. If identifying and defining processes to support the functions, identify the roles responsible for executing the steps of the process. a. If defining a process at a level of granularity to support automation, identify roles, and services and systems responsible for executing the process. 7. The roles that have been previously identified can now be used as mechanisms on an activity model, swim lanes in a process model, or as actors in a use-case model.
Primary Output:	Types of Persons/Roles, Skills or Skill Sets, Services, Systems, Organizations
Secondary Output:	Skill Levels (i.e., measures), Personnel
Disciplines:	Structured Analysis, Object-Oriented Analysis, Business Process Analysis

Use

Data for Performer are used in the following ways:

MIL-HDBK-881A, 30 July 2005 and DoDD 5000.1, in providing fundamental guidance for specifications, WBS, Statement of Works (SOWs) of the DAS all require the identification of the Performers and their component parts and types as fundamental elements.

In typical uses, the Activities are represented by verbs and Performers are represented by nouns. This distinguishes the how from the who. In a typical specification process allocation to performers can take place at varying levels of detail depending on the design maturity or the intended degree of design constraint.

Performers are represented in many places and stages in the detailed architecture. It should be noted that a pure Requirements Architectural Description may not show allocations or performer. This may be left to later stages of the design process. Further, not all architecture modeling standards explicitly provide for allocation. For example, the Systems Modeling Language (SysML) extensions to the UML modeling standard have added this feature.

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DM2 - DoDAF Meta-Model

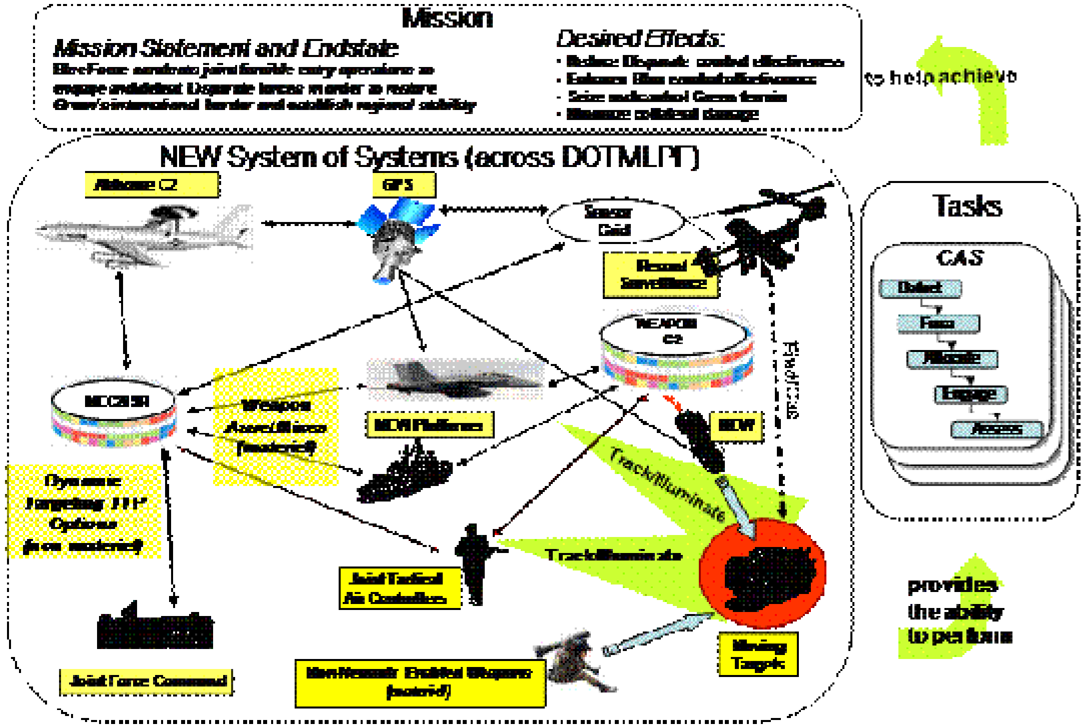
Resource Flows

Resource flows are oriented toward the use and methods associated with Resource Flows that are typically used to model the behavioral aspects of activities (processes, tasks, etc.) and performers. Resource Flows should be used to model the flow of material, information or personnel. Resource Flows are extensively used as a key technique in systems engineering, process improvement, work flow, mission planning and many other disciplines. Resource Flow models and associated analysis techniques reveal behavior such as:

- The connectivity between resources.
- The content of the information flowing between resources (e.g., interface definition).
- The order or sequential behavior (parallel or serial) of the resources in relation to one another (e.g., project task execution and critical path).
- The behavior of Resource Flow between or within organizations (e.g., work flow, information flow, etc.).
- The changes in state during the spatial and/or temporal existence of the resource.
- The rules that modify the behavior of the Resource Flow (e.g., business rules, controls, decisions, etc.).
- The measures that define the quality, constraints, timing, etc. of the Resource Flow (e.g., Quality of Service (QoS), measures of performance, measures of effectiveness, etc.).
- The flow of control orchestrating the behavior of the Resource Flow.

These techniques apply to the flow of material, personnel, and information; the focus is on the Information Flow between activities and performers. Resource flow representing flow of material and/or personnel should also be represented using the same techniques. Activity Resource Flows should be used for process improvement analysis including automation tradeoffs. Performer Resource Flows should be used in disciplines, such as system engineering, interface definition, and organizational work flow planning. The Resource Flows should be directly traceable to the capability and/or upper-level process defining the root need or requirement. Operations utilizing information flows should be technology independent. However, operations and their relationships may be influenced by new technologies where process improvements instituted before policy can reflect the new procedures. There may be some cases in which it is necessary to document the way activities are performed to examine ways in which new systems could facilitate streamlining the activities. In such cases, information Resource Flows may have technology constraints and requirements.

The figure below represents a dated example of an Enterprise-level View of Resource Flow depicting high-level connectivity between resources, high-level mission and goals, and net-centric architectural concepts. This type of Resource Flow is typically used as a high-level operational concept graphic with lower-level models detailing the Resource Flows.

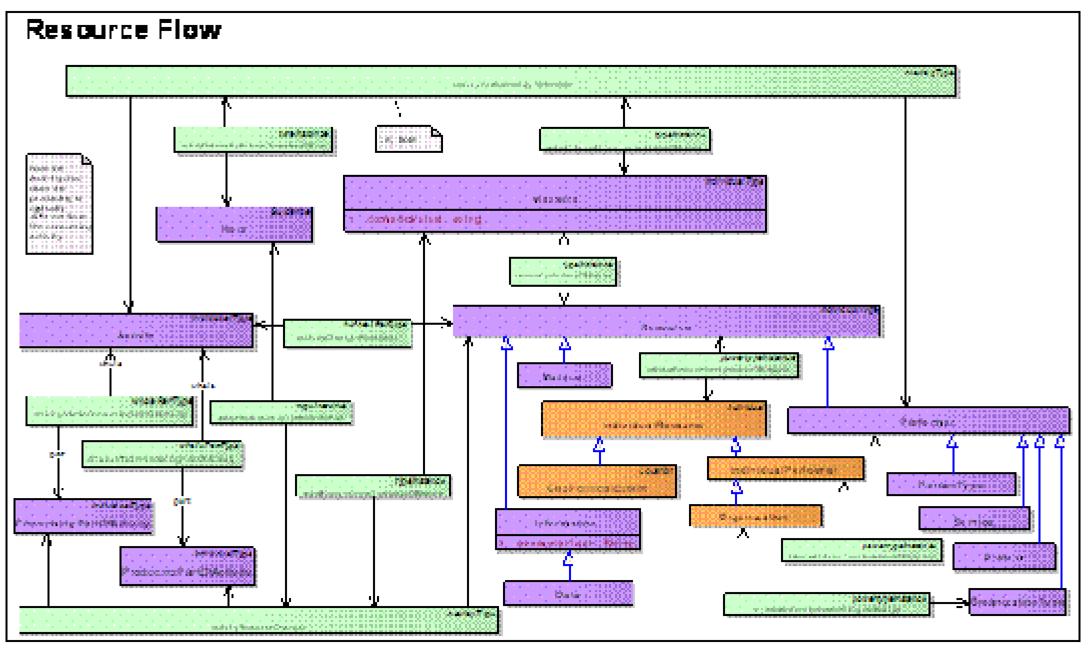


A Dated Example Diagram Illustrating Resource Flow

Data

The DoDAF Meta-model for the data comprising Resource Flow is below. Definitions for the model terms, alias and composite terms related to Resource Flows, Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Resource group in the DM2 Data Dictionary



DoDAF Meta-model for Resource Flow

The Resource Flow Meta-model describes the resources that can flow between activities, tasks performed by performers. Activity-based Resource Flows are typically modeling techniques that define and describe operations. Performer based Resource Flows should be used to define and describe solutions. Resources in Resource Flows can be Personnel, Materiel, Data or Information. Rules and Measures are applied to specific Activities and their Performers. Activities, Systems and Personnel can be assigned to Locations and further can be assigned Conditions and Constraints. Resource Flows are key modeling techniques used in the definition of Interfaces and assurance of Interoperability between Activities and their performing Performers (e.g., Systems and Personnel.)

a. Whereas prior versions of DoDAF modeled only information and data exchanges and flows, this version also allows modeling of other flows, such as:
    1) Materiel flows such as ammunition, fuel, etc. important for modeling the fire rate, logistics, etc., aspects of a Capability solution so it can be compared with other alternative solutions.
    2) Personnel Types such as Military Occupational Specialty (MOS) that allow representation of the Training and Education pipeline aspects of Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities (DOTMLPF).
    3) Performers such as Services, Systems, or Organizations that might be the output or result of a Project's design and production process (activities). This allows modeling of, for instance, an acquisition project.
b. Another difference from prior versions of DoDAF is that all exchanges and flows are by virtue of a producing or consuming Activity. That is, a Performer can only provide or consume by conducting an activity of production or consumption. For instance, publication and subscription are modeled as an interaction between the publishing Activity, the subscribing Activity, and the information or data Resource. Note that publication is typically not at the same time as subscription but the subscriber does have to go to the publication place to retrieve the Resource. For example, data might be published at 2:00 GMT on a server located at some URL and the subscriber may not overlap until 10:00 GMT. Also note in the diagram the overlap is a triple - the producing Activity, the Consuming Activity, and the Resource.
c. The exchange or flow triple may have standards (Rules) associated with it such as Information Assurance (IA)/Security rules or, for data publication or subscription, data COI and web services standards.
d. The exchange or flow triple may have Measures associated with it such as timeliness, throughput, reliability, or QoS.

Method

Methods for collecting and modeling Resource Flow data are as follows:

Resource Flow Modeling and Core Usage. The Resource Flow models represent the activities and their performers that either publish or subscribe to the resource containing the information. Activities are assigned to performers in defining and describing how the transition occurs when moving from operational or capability position to those describing solutions. These assignments are a result of various tradeoffs and should be maintained for traceability. Mechanization or automation trades will reveal the performer subtypes (organizations, systems, etc.) and the activities that are assigned define the functionality of the performer subtypes. Detailed design will further detail the whole-part taxonomies associated with the subtype portions of the automated aspects of the performer. It may be desirable to standardize these taxonomies for particular communities of interest (e.g., common components, common system functions [activities], common service functions [activities [, etc.). Note: The Joint Common System Function List (JCSFL) is representative of initiatives in this area. Non-automated performer subtypes (e.g., organization, personnel or procedures) maintain traceability to their root activity and form the basis for the definition of lower-level TTP. Individual communities of interest typically standardize these procedures and processes as Doctrine or policy and as such become the focus of process improvement.

It should be noted that information inputs and outputs between resources for some levels of decomposition may be at a higher-level of abstraction than the information characteristics represented in the matrix. This is commonly done to simplify graphical representations of information flow or in the initial definition stages where the characteristics are still unknown. In this case, multiple information exchanges will map to a single resource input or output. Similarly, the information inputs and outputs between resources at a low-level of decomposition may be at a higher-level of detail than the information exchanges in the matrix, and multiple information inputs and outputs may map to a single information exchange. In these cases, to provide the necessary clarity and precision, an ontological or taxonomic structure of information aggregation should be developed for use in each level of decomposition of the Resource Flow models (e.g., The Navy Common Information Exchange List [CIEL] represents initiatives showing taxonomic structure or levels of aggregation).

The upper-level aggregations have been termed *need lines* in previous versions DoDAF. Other terminology expressing levels of aggregation are used depending on the community of interest (e.g., The SysML modeling standard uses *lifeline*).

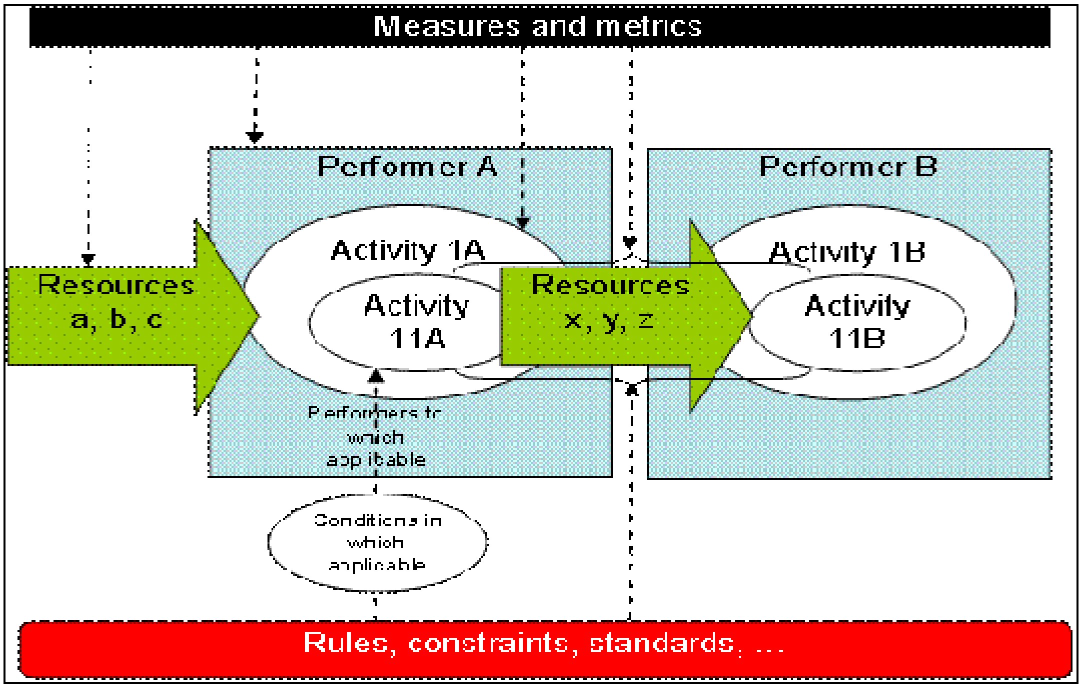
The Resource Flow model provides a key tool for engineering operational and solutions-oriented DoDAF-described Models. Examples of analysis considerations that should be included in trade methods employed in the analysis Resource Flows are below.

Operations Models	Solutions Models
• What are the activities of the Enterprise? • What are the primary activities of concern? • What capability limitations are associated with the processes? • What are the issues associated with these processes?	• What activities or portions of activities are currently automated and by what means? (Current baseline). • View the current activities and automation (automated performers) at the level of detail appropriate to address areas of concern.
• What process improvements are needed? • What are the specific objectives associated with the improvements?	• Define activity and system assumptions and constraints.
• Is the activity as efficient as required?	• Apply process streamlining analysis techniques (e.g., Lean Six Sigma or similar techniques).
• What are the missing or unnecessary steps? • Where are the process bottlenecks?	• Define new process change alternatives. • Define alternative for eliminating bottlenecks.
• Will the activities benefit substantially from new or modified automation/mechanization? • Define the Automation opportunities and expected benefits.	• Identify new automation possibilities afforded from new technology and associated material performers. • Evaluate cost/benefit.

• Are improvements needed in TTP? • Are TTP improvements adequate versus developing new automation?	• Define candidate TTP changes. • Evaluate personnel and training impact.
• Prioritize Automation opportunities? • Prioritize TTP changes?	• Identify requirements for new performers (technology components, building blocks, etc.) and performance characteristics. • Identify new system or service, functions (activities), components and modifications required.
• Do we need to integrate among other related Service and Mission areas, and system efforts?	• Identify new system integration requirements. • Identify new Resource Flow requirements.
• Are the activities and procedures interoperable?	• Identify new and emerging systems interoperability requirements. • Identification of the need for Application of new standards.

Specific automation or mechanization trades (e.g., analysis of automation opportunities and possibilities) could initially be described from the operational or capability position and then iterated as part of a proposed solution as part of the tradeoff space.

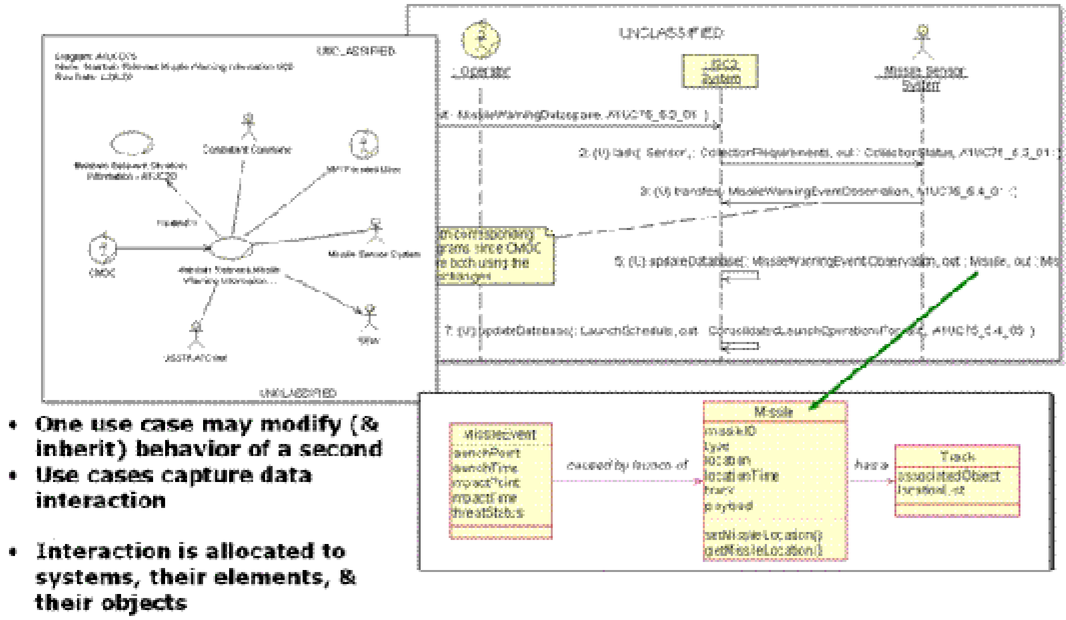
Various methods can be employed in modeling and analyzing Resource Flow. Both structured and object-oriented techniques should be used where appropriate. Typically structured methods are useful in representing requirements traceability, testing, and decomposition of detailed procedures dealing with Resource Flow. Object-oriented techniques can be used in the gathering of user needs and the design of software. Typically structured analysis emphasizes process and functions, while object-oriented analysis emphasizes system behavior using objects. Resource flow can use both techniques to adequately represent the behavior in both Operational and Solutions-related Viewpoints and DoDAF-described Models. Careful consideration should be given to where and when to apply the appropriate methods. Typical modeling methodologies are illustrated in the structured design technique example and the object oriented design technique example. In the structured design approach, performers, activities, resources, rules, conditions, and measures have whole-part (spatial, temporal) and super-subtype relationships that allow successive refinement of the model.



Non-Prescriptive, Illustrative Structured Design Technique Example

The Resource Flow also provides a key tool for engineering the interfaces needed to define and describe Operational and Solution-related Viewpoints and DoDAF-described Models. Interfaces can be considered at varying levels of the enterprise and their granularity of definition depends on the purpose. Interface identification, explicit definition and control are essential in every enterprise. These interfaces, for the purpose of this document, can be considered to be any interconnection or interaction between producing and consuming activities and their performers. The focus in Solution-related Viewpoints and DoDAF-described Models should be on interfaces within and between equipment, subsystems, systems, an SoS, or other technology driven aspects of an enterprise. Attention to this area is critical to cost effective acquisition and development under the DAS. Human and organizational interactions typically are the focus of the Operational Viewpoint and DoDAF-described Models except when human beings are considered an integral part of the system's operation and functionality (e.g., system operator versus system user).

Interfaces are generally documented in interface documentation representing the agreements of the responsible parties in charge of each end of the interface (both information supplier and information consumer). This, in no way implies a point-to-point interface. Interfaces implemented with an enterprise service bus, for example, are defined with appropriate publish/subscribe documentation formalized, if necessary, with contractual agreements between information supplier and consumer.



Object Oriented Design Technique Example

Resource Flow Data Capture Method. A method to capture Resource Flow data is described in the table below.

Resource Flow Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Resource Flow
Definition:	Define a process by which architectural information relative to the Resource Flow entity within the DoDAF Meta-model can be captured and structured to enable it to support the major decision processes of the Department (e.g., PPBE, PfM, and JCIDS). Per the definition of Resource Flow, it becomes apparent that interfaces are integral to accurately identifying and defining the resources for a particular architecture effort. Within the context of DoDAF V2.0, a resource can be data, information, performer, materiel, or personnel types.
Input:	• Concepts of Operations documentation • Operational Roles • HR/Personnel Data/Documentation • Systems Documentation • Requirements Documents • Services Documentation
Method:	DoDAF V2.0 is intended to be methodology agnostic. Therefore, structured analysis and object-oriented analysis techniques can be used to capture the information that constitutes a Performer. The Performer entity is included here because resources can be transmitted between Performers by virtue of their producing and consuming activities. The following process can be used to capture the architectural information relative to Resource Flow. The term flow implies that something (e.g., materiel, information) is moving from point A to point B. This means that interfaces must be a focus of the analysis for Resource Flow. DoDAF has identified several entities that would have interfaces that enable exchange of resources. These entities are:

	• Activities • Performers e.g.: - Services - Systems - Organizations (Operations Department) - Personnel Types (e.g., Commanding Officer) 1. For the purpose identified as the intended purpose for the architecture, determine the level of granularity needed for things being exchanged or interchanged. (For example, if the purpose of the architecture were to serve as a source of design requirements to constrain system development, the resources need to be identified and defined at the data element-level. If the purpose of the architecture were to support Investment Managers in categorizing systems, the resources may need to be defined only at a categorization-level, such as Sales Reimbursement Information. 2. For activities, identify and define the objects that are being either consumed or produced by the activity or process. 3. If being consumed, designate the object as an input to the activity or process. If being produced, designate the object as an output of the activity or process. 4. To be able to complete the description of Resource Flow, it is imperative that the origination and destination of the resources being exchanged are identified and defined. This creates a logical flow between activities or process steps that can be modeled and analyzed in support of the everyday operations. For services and systems, the interfaces are integral to definition of Resource Flow. 1. Identify the services and/or systems that must talk to each other. This implies that there must be an interface between those services or systems. 2. Identify the data or information that must be exchanged via the interfaces. 3. As mentioned above, designate whether the exchanged information is being either consumed or produced. This is especially important when accommodating services within the architecture. 4. Show traceability to the portion of the operational process being automated by the performing system or service.
Methodology Description	Capture Data for Architectural Description of Resource Flow
Primary Output:	Types of Persons/Roles, Skills or Skill Sets, Services, Systems, Organizations, Data and Information
Secondary Output:	Skill Levels (i.e., measures), Personnel
Disciplines:	Structured Analysis, Object-Oriented Analysis, Business Process Analysis

Use

Resource Flow modeling is a fundamental engineering based technique used in Information Technology (IT) Architecture, System Engineering, Process Re-engineering, Resource Planning and many other disciplines. Resource Flow modeling provides an explicit means to describe the behavior of activities, systems, organizations and their composite effects on the overall enterprise. Resource Flow modeling can be performed at varying levels of detail and fidelity depending on the areas of concern being analyzed and the solutions being sought. Key areas where Resource Flow modeling is used include:

- Process Improvement Analysis including reengineering, and gap/overlap identification.
- System Engineering including architecture, design, testing and production.
- Interface Identification and Definition including interoperability analysis and standardization.
- Project Planning including scheduling and task sequencing.
- Mission Planning including simulation and training.
- Logistics planning.

Examples of detailed use of Resource Flow models in the developing the Operational Viewpoint and DoDAF-described Models are:

- Clearly identify the Activities required to provide a Capability.
- Clearly associate activities with responsible organizational or personnel performers.
- Uncover unnecessary or inefficient operational activities and information flows.
- Evaluate alternative architectures with different connectivity and Resource Flow to maximize capability and minimize automation complexity.
- Provide a necessary foundation for depicting information needs and task sequencing to assist in producing procedures, operational plans and facilitate associated personnel training.
- Identify critical mission threads and operational Resource Flow exchanges by annotating which activities are critical (i.e., identify the activities in the DoDAF-described Model that are critical e.g., Critical Path).
- Identify and prioritize activities that are candidates for automation.
- Identify common activities that can be standardized across capability or mission areas, communities of interest, etc.
- Identify or flag issues, automation opportunities, or changes to activities and information flow that need to be scrutinized further.
- Identify critical connectivity needs and interfaces (or Key Interface Profiles (KIPs) between activities and their performers (organizations and personnel types).

Examples of more detailed use of Resource Flow models in solution-related Viewpoints and DoDAF-described Models are:

- Clearly identify the relationship and information flow between systems and system/services in an SoS or between services in a Service Oriented Architecture (SOA).
- Identify the Interfaces and/or Publish/Subscribe needs between systems and/or services.
- Define Interface details.
- Support configuration management of interfaces.
- Support Analysis of Alternatives (AoA) and other Systems Engineering Analysis.
- Verify the decomposition of the Activities (System Functions or Service Functions).
- Support the various levels of system definition and design.
- Define explicit traceability to needs, capabilities and goals in the Operational Viewpoint and DoDAF-described Models.
- Support functional allocation in a System of Systems or within Systems.
- Evaluate alternative system architectures.
- Support the development of test sequences and procedures.
- Support system design and training documentation.

Among the many uses of Resource Flow modeling is DoD's Enterprise Architecture focus on Interoperability and net-centric goals to improve the interfaces between activities and their performers. In that light some amplification with regard to Interface definition and analysis relationship to the DoD's primary processes of JCIDS, PfM, and the DAS is in order.

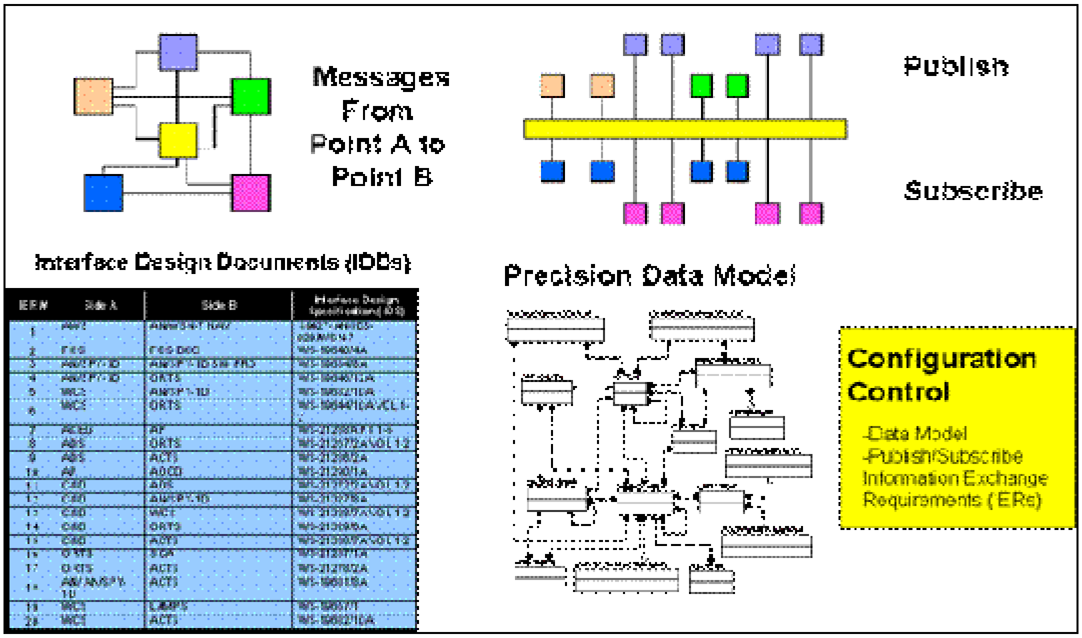
System interfaces reflect and are traceable to information flow needs or requirements identified in the Operational Viewpoint and DoDAF-described Models. Resource Flow descriptions, produced at varying levels of detail, substantially contribute to the quality of this process and aid in the understanding and documentation.

The Details of Resource Flow (materiel, personnel, or data) are generally documented in Interface Control Documents (ICDs), Interface Requirements Specifications (IRSs) and Interface Description Documents (IDDs). This data is typically provided to DoD Investment Review Board (IRB) registry systems for the purpose of milestone reviews and support of acquisition decisions points.

Critical Interfaces are generally documented in formal interface documentation signed by the responsible authorities (both information supplier and information consumer) in charge of each end of the interface. This type of interface may be annotated as a Key Interface (KI). A KI is defined as an interface where one or more of the following criteria are met:

- The interface spans organizational boundaries (may be across instances of the same system, but utilized by different organizations).
- The interface is mission critical.
- The interface is difficult or complex to manage.
- There are capabilities, interoperability, or efficiency issues associated with the interface.

Critical Interfaces should be traceable to the interfaces identified in the JCIDS process. Further, critical interfaces are generally documented in formal interface documentation signed by the responsible authorities (both information supplier and information consumer) in charge of each end of the interface. For legacy point-to-point interfaces this may be in the form of ICDs, Interface Requirement Documents (IRSs), Interface Design Documents (IDDs), etc. In multiple access or common connectivity (radio communications or bus type connectivity) implementations may be in the form of formal agreements (defined herein as a consent among parties regarding the terms and conditions of activities that said parties participate in) detailing the specific set of implementations (e.g., Tactical Digital Information Links [TADILs]) data elements implementation tables or in the case of a SOA, a publish/subscribe implementation document. These agreements are, in general, managed and controlled by the SoS or System Project manager. In new systems, and where possible the interface should be managed and configuration controlled using a common precision data model. The figure below illustrates the evolution from configuration control of legacy point-to-point interfaces to a net-centric, distributed processing means of connectivity using carefully managed publish and subscribe agreements and documentation based on formally documented logical and physical data models.



Migrating from Legacy to Data Focused Configuration Management

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DoD Architecture Framework Version 2.0
DoD Deputy Chief Information Officer

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DM2 - DoDAF Meta-Model

Information and Data

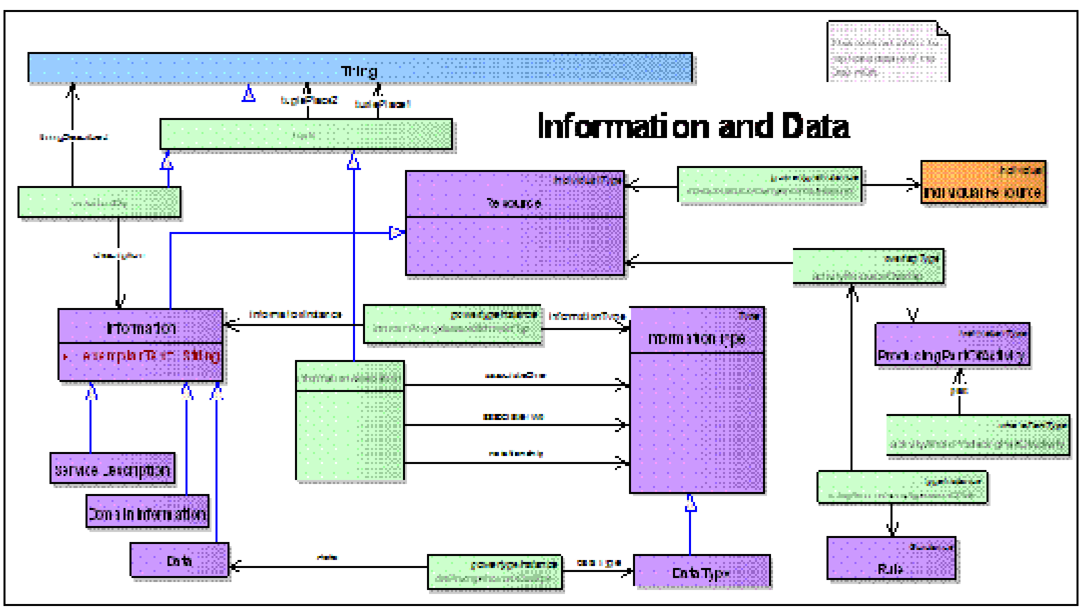
Information is the state of a something-of-interest that is materialized, in any medium or form, and communicated or received. In DoDAF V1.0, this took the form of what was called a logical data model which even in DoDAF V1.0 permitted a less structured and formalized description than the computer science definition of a logical data model. In DoDAF V2.0, the emphasis is on the identification and description of the information in a semantic form (what it means) and why it is of interest (who uses it). Although this may entail some formality such as describing relationships between concepts, its purpose is to convey the interests in the operator, executive, or business person's frame of reference.

Data is the representation of information in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means, and is concerned with the encoding of information for repeatability, meaning, and proceduralized use. While information descriptions are useful in understanding requirements, e.g., inter-federate information sharing requirements or intra-federate representation strategies, data descriptions are important in responsive implementation of those requirements and assurances of interoperable data sharing within and between federates.

Data

The DoDAF Meta-model for the data comprising Information and Data is shown below. Definitions for the model terms are here. Aliases and composite terms related to Information and Data are shown here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to view the Information and Data group in the DM2 Data Dictionary



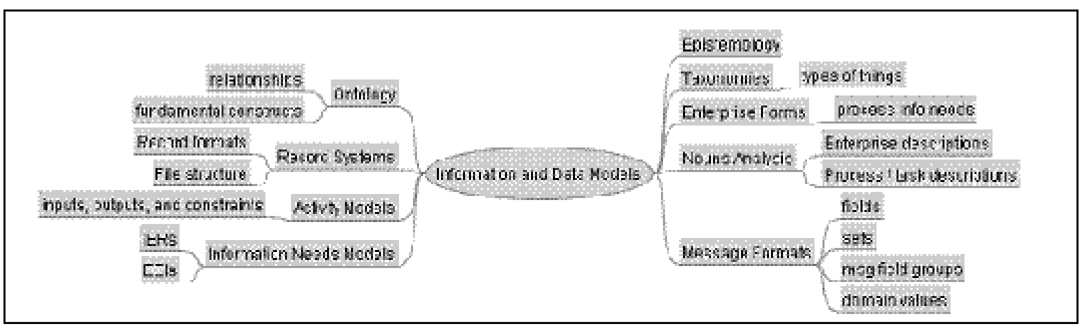
Information and Data Model Diagram

Items of note:

- The key concept in this model is that Information describes some Thing - material, temporal, or even abstract, such as a relationship (Tuple) or set (Type).
- Since Information is a Thing, Information can describe other Information, e.g., metadata.
- A Name is a type of Information in that it describes a Thing. A Name may be short or long - there is no restriction. So a textual description can be thought of a just a long Name. Information is more general than text strings and could be structured, formalized, or include other manners of description such as diagrams or images.
- Information, as a Resource Type, inherits whole-part, super-subtype, and before-after relationships.
- If Information is processable by humans or machines in a repeatable way, it is called proceduralized. Not all proceduralized information is necessarily computerized; forms are examples of data proceduralized for human repeatable processing.
- Data to be proceduralized has associations such as parts and types as well as other application specific associations. So for an Entity-Relationship model, Attributes are has associations with Entities and Entities are related according to verb phrases and cardinalities. In the physical schema, the fields are associated to datatypes.
- The representation for Data is not intended to cover all the details of, for instance, a relational data base management system (DBMS) underlying Meta-model, but just those aspects necessary to support the decision-making of the core processes.
- Architectural Descriptions describes architectures. An Activity Model is an example of an Architectural Description. Two subtypes of Architectural Description are called out - the AV-1 and the Manifest - because of their importance in discovery and exchange, respectively. Note that the AV-1 information can also be provided in a structured manner, using the Project data group to describe the architecture project's goals, timeline, activities, resources, productions, rules, measures, etc.

Method

Methods for collecting and constructing models of Information and Data vary. They are taught in academic and vocational curricula. There is considerable literature, such as books, professional journals, conference proceedings, and professional magazines, on best practices, experiences, and theory. The Figure below illustrates some of the basic methods for model creation.



Some of the Ways Information and Data Models are Constructed

It should be noted that all methods, even the most philosophical and methodical, involve the ingestion of some record of the enterprise's processes, legacy information-keeping systems, and descriptions of what types of things it thinks it deals with. Upon collection of this raw data, terms within it are then:

- Identified. This is done by noting recurring or key terms.
- Understood. Definitions of terms are sought and researched. In most cases, there are multiple authoritative definitions. Definitions selected should be appropriate for the context of use of the term within the enterprise activities.

- Collated and correlated. This is done by grouping seemingly similar or related terms.
- Harmonized. In this step, aliases, near-aliases, and composite terms are identified. A consensus definition is formulated from the authoritative source definitions. Often super-subtype and whole-part relationships begin to emerge.

The next step is to relate the harmonized terms. Some of the relationships are implicit in the definitions and these definitions may contribute to the relationship description. At this point, the formality can vary. A formal ontological approach will type all relationships to foundational concepts such as whole-part and super-subtype. However, there are many metaphysical challenges with such an approach and it is not necessary for many applications. This constitutes the conceptual-level of modeling, defined and related terms, now considered concepts because the definitions and relationships lend a meaning to the terms. The conceptual model should be understandable by anyone knowledgeable about the enterprise. Super-subtype and whole-part relationships can provide cognitive economy. Conceptual models can be done in Entity-Relationship or UML Class model style although any format that documents definitions and relationships is functionally equivalent. Note that the subtype concept in UML generally results in the subclass inheriting properties from the supertype while in Entity-Relationship (E-R) modeling only the identifying keys are inherited directly; the other supertype properties are available after a join operation.

At the logical-level, relationships may have cardinalities or other rules added that indicate how many of one instance of something relates to an instance of something else, the necessity of such relations, and so on. The concepts may also be attributed, meaning they will be said to have some other concept, e.g., the concept of eye has the concept of color. Often at the logical-level, the relationships are reified or made concrete or explicit. At the logical-level, this is done in case there is something additional that needs to be stated about the relationship, e.g., the quantity of some part of something or the classification of the related information, which may be different from the classification of the individual elements. There may also be considerations of normalization, meaning that the database structure is modified for general-purpose querying and is free of certain undesirable characteristics during insertion, update, and deletion operations that could lead to a loss of data integrity. The benefits of normalization are to uncover additional business rules that might have been overlooked without the analytical rigor of normalization and ensure the precise capture of business logic. The logical model, though having more parts than the conceptual model, should still be understandable by enterprise experts. At the logical-level, some sort of modeling style is normally used such as Entity-Relationship or UML Class modeling.

At the physical-level, the exact means by which the information is to be exchanged, stored, and processed is determined. At this level, we are talking about data. The efficiency, reliability, and assured repeatability of the data use are considered. The datatypes, the exact format in which the data is stored are determined. The datatype needs to accommodate all the data that is permissible to store or exchange yet be efficient and disallow formats that are not permissible. The entities may be de-normalized for efficiency so that join operations don't have to be performed. Logical associations may be replaced with identifiers (e.g., as associative entities or foreign or migrated keys in Entity Relationship Diagrams [ERDs] or explicit identifier attributes or association classes in class models). Keys, identifiers, and other means of lookup are setup. Indexes, hashes, and other mechanisms may be setup to allow data access in accordance with requirements. The physical target may be any of the following:

- Database - relational, object, or flat file.
- Message exchange format - document (e.g., XML), binary (e.g., Interface Definition Language (IDL)).
- Cybernetic (human - machine), e.g., print or screen formats, such as forms.

Use

Information and Data models are used in the following ways:

Information models materialize for enterprise participants what things are important to the enterprise and how they are related.
- Information models can serve as a basis for standardization of terminology and concept inter-relationships for human, machine, and human-machine communications.
- Information models can provide cognitive compactness for an enterprise's personnel through the use of taxonomies and other relationship structures. This can improve clarity, efficiency, accuracy, and interoperability of action within the enterprise.
- Information models document the scope of things the enterprise is concerned with in a form that allows comparison with other communities of interest to reveal common interests.
- Data models can be used to generate persistent storage of information such as in databases.
- Data models can be used to generate formats for exchanging data between machines, humans, and machine-to-human. For example, an XSD is a physical data model that is generally an exchange format. Web services can be used with relational DBMS' to generate XML for exchange in the format of the data model implemented in the DBMS. The underlying data models (the physical data model and the exchange data format) do not have to be the same; a translator or mediator may be invoked to translate during the exchange.
- Data models can be used to compare whether Performers are compatible for data exchange.
- Data and information models can be used to determine if components of a portfolio have: - Overlapping data or information production (an indication of potential unwanted redundancy). - Interdependent data or information needs.
- Data and information models can be used to determine if a proposed capability will interoperate, be redundant with, or fill gaps in conjunction with other capabilities.
- Data and information models can be used during milestone reviews to verify interoperability, non-redundancy, and sufficiency of the solution.
- Information models are useful in initial discovery of a service, to know what sorts of information it may provide access to or its accessed capabilities need. An information model is part of a service description.
- Data models are useful in knowing how to interact with a service and the capabilities it provides and for establishing the service contract. A data model is part of a service description and service contract.
- COI coordination and harmonization.
- Data assets management.
- Database/sources consolidation and migration.
- Authoritative sources identification and management.
- Mediation and cross-COI sharing.
- Standards definition and establishment.

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Site Map

DM2 - DoDAF Meta-Model

Activities

An Activity is work, not specific to a single organization, weapon system, or individual, that transforms inputs into outputs or changes their state. Activity has been a central concept in architectures since the early DoDAF definitions. At that time the focus was on:

- Business activities and how they could be re-engineered or streamlined.
- Strategic, theater, operational, and tactical tasks.
- Activities (System Functions) performed by Systems.
- Operational activities performed by organizations (and their Types) and in the course of conducting an operational role.

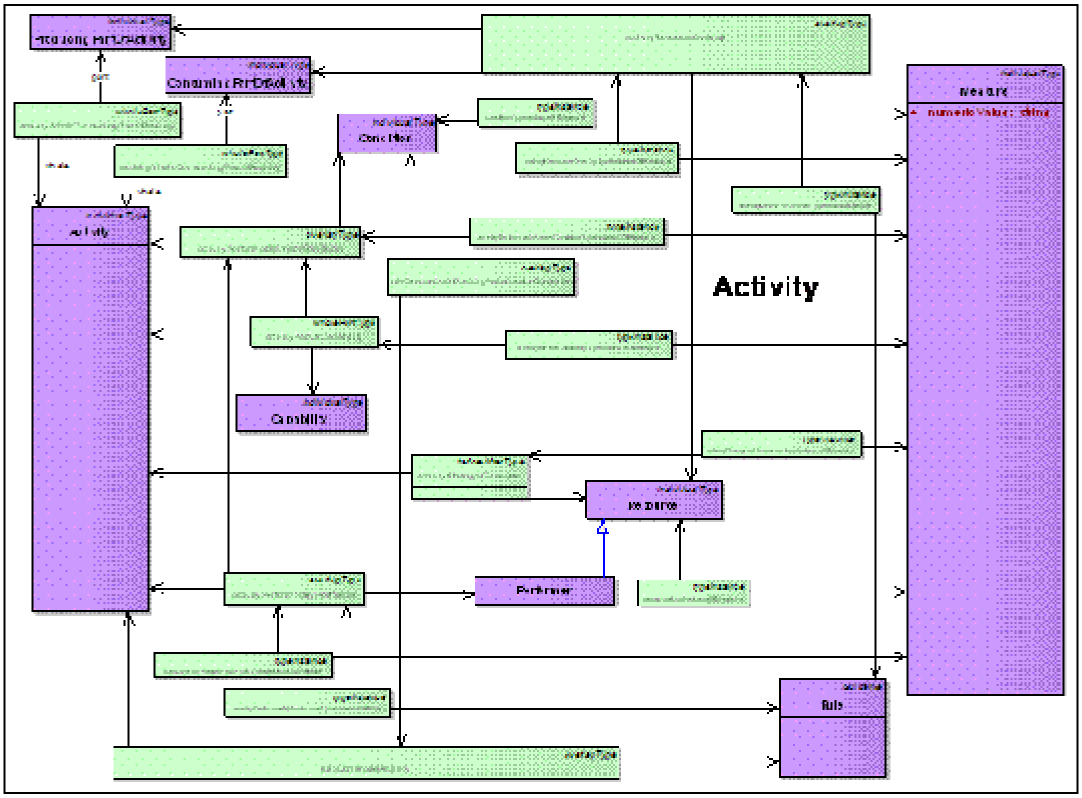
The concept remains central in net-centric, service-oriented, Capabilities-focused, and Project-aligned architectures, as well as Goal-responsive architectures, such as:

- The Activities involved in the service mechanism and the Capabilities thereby accessed.
- As a part of a Service description.
- Part of a Capability.
- The core of a Project.
- The response to a Goal.

Data

The DoDAF Meta-model for the data comprising Activities is shown below. Definitions for the model terms, alias and composite terms related to Activities are shown here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Activity group in the DM2 Data Dictionary



DoDAF Meta-model for Activities

A method to capture Activity data is described in the table below.

Activity Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Activity
Definition:	Define a method by which activities can be defined and architected in a manner that enables them to be used in composing the major decision processes of the DoD. The Activity Method includes characteristics used to ensure proper definition of activities as well as a process by which architectural information relative to activities can be captured and structured to enable it to support the major decision processes of the Department (e.g., PPBE, PfM, and JCIDS).
Input:	• Enterprise/Component/Program vision documentation • Enterprise/Component/Program strategic documentation • Mission Statements • Directives • Objectives and goals documentation • Concept of operations documentation • Doctrine
Method:	This method is described in two sections. The first section describes the attributes of an activity. The second section describes steps that can be taken to architect an activity. **Attributes of a Well-Defined Activity** A well-defined activity consists of: • resource inputs

- resource outputs
- activity production and consumption relationships
- rules that constrain the activity as performed by certain performers
- rules that constrain the resource production and consumption (rules about resource production and consumption, e.g., resource exchange IA rules)
- conditions under which those rules apply
- conditions under which the activity is to be performed
- measures associated with the activity
- measures associated with the production and consumption of resources and performers

To clarify some of the terms:

- Inputs are the triggers that cause an activity to occur are other activities or events (zero duration activities).
- Outputs are the results of activity performance. These can be outputs of products, services, or requirements for further action, or outcomes (i.e., demonstration that an action has produced a desired change).
- Rules include doctrine, regulations, or other documents that prescribe how an activity is to take place, what course the activity must follow, and, what form or format is expected/required for the result. Resources are those things that assist in performance of the activity. These can be physical, logical, technological, or human resources. Resources are inputs and outputs of activities performed by performers.

Attributes of a well-defined activity also include quality, focus, granularity and modularity.

Quality: A high quality activity is a modular representation of the specific steps taken to perform the action being described, along with its sub-activities, services and systems used. An activity can be created and described in either a baseline or future (i.e., “To-Be”) model.

Focus: Well-focused activities are both necessary and sufficient (as a group) to achieve the desired action.

Granularity: Activities should be defined at a level of granularity that is:

- meaningful and consistent in an operations context
- appropriate for intended use by the stakeholders
- consistent with approved taxonomies to be used to help architecturally define the activity
- consistent with the DoD EA Reference Models to support federation

Modularity: Each Activity should describe a complete action.

Minimum steps for architecting activities

- Define the activity.
- Provide a name for the activity (Each activity should have a unique identifier).
- Define the triggers (inputs) that cause activity performance
- Identify the steps taken to perform the activity, to include linkages to other activities (i.e., inputs from other actions that trigger the activity being described).
- Identify the rules, requirements, and limitations on the activity.

	• Identify the expected results and outputs of activity performance.
Primary Output:	Information, physical products, inputs to other activities and their performers.
Secondary Output:	Personnel, Roles, Services, Systems, Rules, Organizations that relate to the activity.
Disciplines:	Structured Analysis, Object-Oriented Analysis, Business Process Analysis. Activity modeling, functional decomposition

Use

Data for Activities are used as follows:

Data for activity is used to describe how an activity is or will be performed, and often when it is performed as a part of some larger process. In general, data on activity describes work being performed for some purpose. The data describes how the input (i.e., trigger or other artifact that causes an action to occur) interacts through business rules to perform the requested activity, and produce the desired output.

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Training/Skill/Education

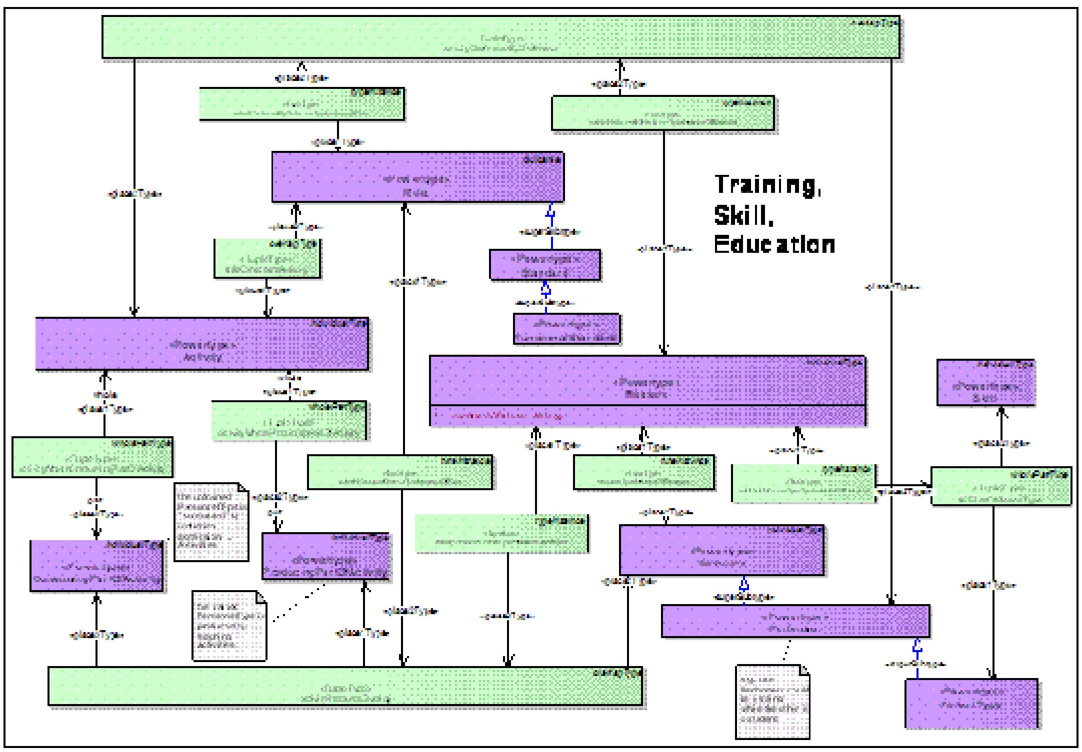
The Training/Skill/Education data group provides information on the identification of data and information used to define, describe, and promulgate training requirements, skills sets required for specific capabilities and operations, and the formal education required for commissioned and non-commissioned officers of all grades.

Training provides an understanding of military procedures. Skill Sets are those sets of personal capabilities and competencies required to perform a designated military task. Education is the knowledge or skill obtained or developed by an organized learning process that provides a specified kind or level of information.

Data

The DoDAF Meta-model for the data comprising Training/Skill/Education is shown below. Definitions for the model terms, alias and composite terms related to Training/Skill/Education are shown here. Authoritative source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click image below to link to the Training/Skill/Education group in the DM2 Data Dictionary



DoDAF Meta-model for Training/Skill/Education

Training/Skill/Education Information Capture Method

A method to capture Training/Skill/Education data is described in the table below.

Training/Skill/Education Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Capability
Definition:	Per the DoDAF V2.0, training/skill/education data provides necessary information needed to determine specific training, skills, and education requirements necessary to execute a particular activity. The following information describes a process by which data associated with training, skills, or education can be captured to support development of an enterprise architecture.
Input:	• Training Information • Training Policy • Training Performance Measures • Training Triggering Events • Skill Information • Education Information • Education Policy • Education Performance Measures • Education Triggering Events
Method:	Training/Skill/Education Data is a type of Information which is collected to determine when specific activities are executed by a performer who executes activities to create, fill, transfer, or adjust positions that execute those activities. Conduct of training or education necessary to acquire necessary skills are provided by a service provider. The following steps can be taken to capture Training/Skill/Education information to support the intended purpose of the architecture: • Identify and capture the operations, business activities and processes requiring training/skill/education. • Describe specific training/skill/education requirements necessary to perform some specific action. • Identify the organization needed to perform the services required to provide the necessary training/skill/education. • Using the Training/Skill/Education Requirement Description, capture the information to be provided by the training/education service and the information required to be produced by the training/education service to provide required skills. • Define and capture the rules applied to the information produced by the training/education service. Also define and capture the rules governing or constraining the use of the training/education service in skill development. • If not captured as part of the previously mentioned rules, define and capture the measures that will be used to gauge the performance of the training/education service as applied to required skills. • Identify and capture other services or systems on which the training/education service is dependent or are dependent on the service.
Primary Output:	Traceability to: • Capabilities • Business activities

	• Activities • Performance measure
Secondary Output:	Organization responsible for providing the service.
Disciplines:	Structured analysis, Object-oriented Analysis (UML or SysML), BPMN

Use

Training and Education, in their broadest sense, are well-defined ways to ensure that requisite skills are available and can be applied to execute a unit of work that provides a useful result to a consumer. Training and Education to acquire Skills are activities performed by a Service provider (Performer) to achieve desired results for a Service consumer (other Performer). Training and Education Services may utilize web-based technology or functions, although their use in the net-centric environment generally involves the use of web-based, or network-based, resources.

Functionally, a Training and Education Services to enable required Skills are a set of strictly delineated functionalities, restricted to answering the what-question, independent of construction or implementation issues.

There are a number of uses for architecture information to support Training and Education:

- First, hierarchical descriptions of activities with increasing levels of decomposition assist training designers when mapping out course content. By understanding the activity, related activities, and sub-activities the trainer can decide what is appropriate for course content and the logical order in which it should be presented. Thorough understanding of the activities to be trained will aid in focusing lesson plan development and measures of student comprehension.
- Second, an appreciation for the complexity of the activities derived from architectural data can provide insight about what knowledge, skills, and abilities are prerequisite for students prior to participation in increasingly advanced training.
- Third, an understanding of composite activities comprised of component that are sequenced over time and the events and triggers that initiate them, can assist in planning a logical flow for training which will provide the student with an understanding of how an overall process or procedure occurs and where they fit in that process.
- Lastly, an understanding of the existing automation that supports or enables the activities being trained, can aid in planning curricula for appropriate levels of training on information technology where and when applicable throughout the Program of Instruction (POI). These concepts and constructs can be applied across a broad educational spectrum from institutional to unit and to individual training and has the same value for classroom or hands-on instruction. Utilizing architectural information in the planning and conduct of training can insure that the correct training is received at the appropriate educational level to produce the desired skills and abilities in the student.

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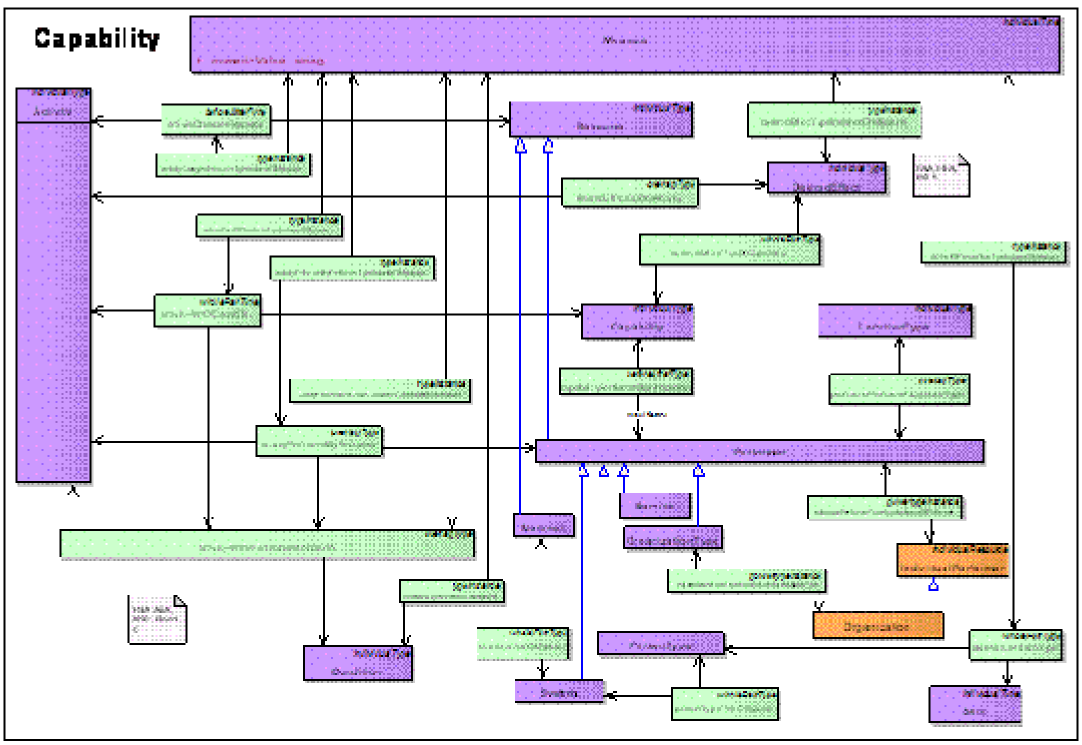
Capability

The Capability Data Group provides information on the collection and integration of activities that combine to respond to a specific requirement. A capability, as defined here is “the ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks.” This definition is consistent with that contained in the JCIDS Instruction published by the Joint Staff.

Data

The DoDAF Meta-model for the data comprising Capability is shown below. Definitions for the model terms are here. Aliases and composite terms related to Capabilities are shown here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Capability group in the DM2 Data Dictionary



DoDAF Meta-model for Capability

Capability Data Capture Method

A method to capture Capability data is described in the table below.

Capability Data Capture Method Description

Methodology	Capture Data for Architectural Description of Capability

Description	
Definition:	Define a method by which capabilities can be defined and architected in a manner that enables them to support the major decision processes of the DoD. The Capability Method includes characteristics used to ensure proper definition of capabilities as well as a process by which architectural information relative to capabilities can be captured and structured to enable it to support the major decision processes of the Department (e.g., PPBE, PfM, and JCIDS).
Input:	• Enterprise/Component/Program Vision Documentation • Enterprise/Component/Program Strategy Documentation • Mission Statements • Directives • Objectives and Goals Documentation • Concept of Operations Documentation • Organization Needs • Compliance Requirements • Material Weaknesses • Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis

Method:	This method is described in two sections. The first section describes the attributes of a well-defined capability as defined within the Business Mission Areas Business Transformation Guidance dated 6 July 2007. The second section describes steps that can be taken to architect a capability.
	The method described here is done so with the assumption that enterprise priorities have been identified and defined. The assumption is also made that the desired goals and objectives for the enterprise priority have been defined.
	Attributes of a Well-Defined Capability
	If a new capability is added or an existing capability is being updated, then it must be defined. Attributes of a well-defined capability include quality, focus, granularity and modularity.
	
	• Quality: A high quality capability is a modular representation of the activities, the conditions under which they are to be performed and the desired effects to be achieved. A high quality capability has minimal overlap with other capabilities.
	• Focus: Well-focused capabilities are both necessary and sufficient (as a group) to achieve the enterprise priority.
	• Granularity: Capabilities should be defined at a level of granularity that is:
	    ◦ meaningful and consistent in an operations context
	    ◦ appropriate for intended use by the stakeholders
	    ◦ consistent with approved taxonomies to be used to help architecturally define the capabilities
	    ◦ consistent with the DoD EA Reference Models to support federation
	    ◦ defined according to an appropriate level of roles and responsibility such as:
	        ▪ Governance: setting strategy, prioritizing enterprise efforts, assigning responsibilities and authorities, allocating resources, and communicating a shared vision.
	        ▪ Management: focusing on organizing tasks, people, relationships, and technology.
	        ▪ Work: Executing the strategy and plans established at a management level.

	• Modularity: Each capability should serve as a unit of transformation
	  ◦ Cleanly identified with tiered implementation accountability assigned at the appropriate level (Enterprise, Component, Program).
	  ◦ Developed using one or more solutions that encompass people, activities, and technology.
	  ◦ Developed to be implementable via various transformation mechanisms such as the PPBE, PfM and Acquisition Processes.
	
	Minimum steps for architecting capabilities:
	
	1. Define the capability or capability improvement. (The above items serve as guidelines for defining a capability or capability improvement).
	2. Provide a name for the capability (Each capability should have a unique identifier).
	3. Describe, as discretely as possible the anticipated beneficial outcome(s) in terms of efficiency, effectiveness, or improved responsiveness to warfighter needs, decision-maker requirements, or taxpayer interests.
	4. Briefly describe the problems/needs/gaps that this capability or capability improvement addresses.
	5. Derive from the enterprise priority a list of questions that this capability or capability improvement addresses.
	6. Identify the enterprise priority objectives supported by the capability or capability improvement.
	7. Identify activities, services, systems, initiatives that can or will provide the capability or improvement.

Primary Output:	Capabilities, goals, performance measures, milestones, related activities
Secondary Output:	Personnel, Services, Systems, Organizations that relate to the capability
Disciplines:	Structured analysis, activity modeling, functional decomposition

Use

Data for Capabilities are used to describe the capability; define acquisition and development requirements necessary to provide the required capability; facilitate understanding of capability execution; develop/update/improve doctrine and educational materials in support of capability execution; and to facilitate sharing and reuse of data.

The 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 by an architecture, and an accompanying high-level scope, more general than the scenario-based scope defined in an operational concept diagram. The models within the CV 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.

Factors considered in a Capability Based Analysis are:

- Doctrine
- Organizations
- Training

Materiel
- Leadership and Education
- Personnel
- Facilities

The following sections document how the Capability Data Group and DM2 support analysis of each of these factors.

Doctrine. In Joint Pub 1-02, Dictionary of Military and Associated Terms, doctrine is defined as “Fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgment in application.”

The concept of judgment required in application deals with decision making and cannot be precisely modeled except perhaps as rules affecting the applicability of other rules. The parts of doctrine that can be modeled are included in the capability data group as follows:

- Principles are modeled as Rules.
- Military forces and elements thereof are modeled as types and assemblies of Performers.
- Actions are modeled as Activities.

Thus, doctrine is contained in the specification of certain fundamental Rules, Activities, and Performers and the relationships among them. These relationships are:

- Each Performer must be of one or more Activities.
- Each Activity must be by one or more Performers.
- Each Rule may be a constraint on one or more Activities.
- Each Activity may be constrained by one or more Rules.
- Each Rule may be a constraint on one or more Performers.
- Each Performer may be constrained by one or more Rules.

Thus, since the DM2 contains the entities and relationships listed above it contains the necessary and sufficient set of entities and relationships to permit the modeling of doctrine and a separate data group for Doctrine is not required.

Organizations. An organization is a specific real-world assemblage of people and other resources organized for an ongoing purpose. DM2 models Organizations as a type of Performer.

Defining an Organization as an assemblage means that each Organization exhibits a whole/part relationship whereby each Organization may be an assembly of other Organizations and each Organization may also be a component of one or more other Organizations. The following DM2 relationships are involved in the capability based analysis of Organization where each Organization is a type of Performer:

- Each Capability must be the result of one or more Activities.
- Each Activity must be by one or more Performers, where each Performer must be a type of Organization, therefore, each Capability must be provided by one or more Organizations.
- Each Organization must be the Performer of one or more Activities.
- Each Rule may be a constraint on one or more Organizations.
- Each Organization may be constrained by one or more Rules.
- Each Rule may be a constraint on one or more Activities.
- Each Activity may be constrained by one or more Rules.

Training. Training is defined as an activity or set of Activities to increase the capacity of one or more performers to perform one or more tasks under specified conditions to specific standards:

- Each Performer may be either an Organization or a Person.

- Each Performer must be of one or more Activities.
- Each Activity must be performed under one or more Conditions.
- Each Activity must be completed to meet one or more Standards.
- Each Standard must be specified by one or more Measures.

Materiel. Materiel is a type of Performer and is tracked as an individual Materiel. Like Organization above, each Materiel exhibits a whole/part relationship whereby each Materiel may be an assembly of other Materiels and each Materiel may also be a component of one or more other Materiels.

The following DM2 relationships are involved in the capability based analysis of materiel where each Materiel is a type of Performer:

- Each Materiel must be assigned to one or more Organizations.
- Each Materiel must be used by one or more Persons, where each Person must be the member of only one Organization at any one time.
- Each Capability must be the result of one or more Activities.
- Each Activity must be by one or more Performers, where each Performer must be either an Organization or a Person using a Materiel.
- Each Materiel must be the Performer of one or more Activities.
- Each Rule may be a constraint on one or more Materiels.
- Each Materiel may be constrained by one or more Rules.
- Each Rule may be a constraint on one or more Activities.
- Each Activity may be constrained by one or more Rules

Leadership and Education. Joint Pub 1-02 does not define leadership. In the context of the DM2, leadership is defined as the ability to lead. Joint Pub 1-02 defines Military Education as the systematic instruction of individuals in subjects that will enhance their knowledge of the science and art of war. Thus, to a certain extent, leadership is a set of skills that can be taught as part of the science and art of war and a smaller set of skills that can be trained as Activities that must be performed under specified conditions to meet specified standards.

Leadership is about the judgment required in application of doctrine; it deals with decision making and cannot be precisely modeled except perhaps as rules affecting the applicability of other rules.

Personnel. Personnel refer to Persons. Each Person is a type of Performer.

The following DM2 relationships are involved in the capability based analysis of materiel where each Person is a type of Performer:

- Each Person must be assigned to only one Organization at any one time.
- Each Person may the user of one or more Materiels.
- Each Materiel must be used by one or more Persons.
- Each Capability must be the result of one or more Activities.
- Each Activity must be by one or more Performers, where each Performer must be either an Organization or a Person using a Materiel.
- Each Person must be the Performer of one or more Activities.
- Each Rule may be a constraint on one or more Persons.
- Each Person may be constrained by one or more Rules.
- Each Rule may be a constraint on one or more Persons.
- Each Activity may be constrained by one or more Rules.

Facilities. A Facility is defined as 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. Please note that this definition requires that facilities be firmly sited on or beneath the surface of the earth. Things like tents, aircraft, and satellites that are not affixed to a single location on or beneath the surface of the earth are a type of Materiel. Materiel are germane to capability-based analysis through the following relationships:

- Each Facility or Materiel may be the site of one or more Performers.
- Each Performer may be at only one Facility or within a Materiel enclosure at any one time.
- Because a Facility is an Individual, it has a spatial and temporal extent.
- An Individual instance of Materiel has a spatial and temporal extent in contrast to a Type which does not. Generally Architectural Descriptions deal with Types of Materiel, not specific Individuals, e.g., not specific serial-numbered items of equipment. However, the DM2 does represent a Performer at a Location and, consequently, any Materiel that is part of the Performer would also be at the Location.

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Services

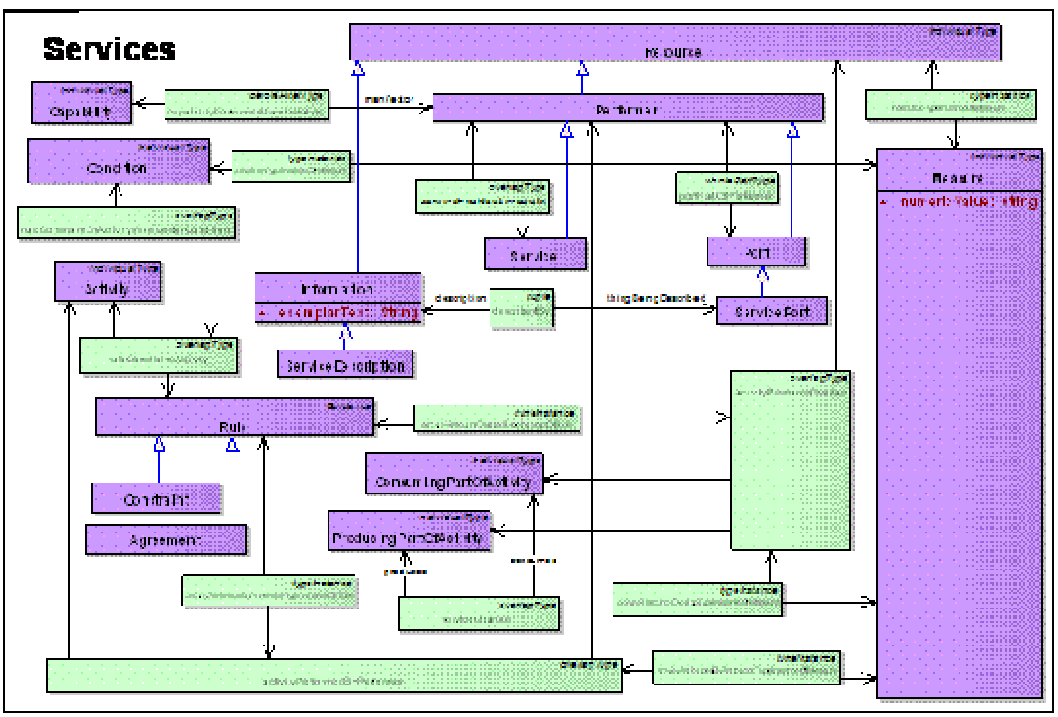
The Services Data Group provides those data that support the definition and use of Services within the net-centric environment. This page:

- Identifies and describes the data within the group
- Provides an example method for collecting data on services
- Provides illustrative uses of the data
- Provides presentation examples for using the Services-related data for presentation to/for management in decision-making

Data

The DoDAF Meta-model for the data comprising services is shown below. Definitions for the model terms are here. Aliases and composite terms related to Services are shown here. Authoritative Source definitions, aliases, and rationale are also provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Services group in the DM2 Data Dictionary



DoDAF Meta-model for Services

Note the following:

- Capabilities and Services are related in two ways. One, the realization or implementation of a Capability by a Performer (usually a configuration of Performers, including Locations) may include within the configuration Services (or Service compositions) to access other Performers within the overall Performer configuration.

Conversely, the realization or implementation of a Capability by a Performer (configuration, including Location) may provide the Performers that are accessed by a Service (or Service composition).

- Unlike DoDAF V1.5, Services in DoDAF V2.0 include business services, such as Search and Rescue. This is important to keep in mind because much of the SOA literature is IT-oriented.
- Although, in principle, anything has a description, the importance of self-description for discovery and use of Services merits its call-out as a class. Further, because only a public-facing side is described, the Service description needs to represent that it describes the Service Port, not the entire Service. A Service Port is a special type of Port that is self-describing and visible. The Service Description of the Service Port is of all aspects necessary to utilize the Service and no more. As such, it may include visible functionality, QoS, interface descriptions, data descriptions, references to Standards or other Rules (Service Policy), etc. The inner workings of the Service are not described in a Service Description.
- Since Service inherits whole-part, temporal whole-part (and with it before-after), Service may refer to an orchestrated or choreographed Service, as well as individual Service components.
- Since Service Ports are types of Ports and Ports are types of Performers, they inherit all of Performer's properties, including Measures associated with the Performer, performance of Activities (Service Functions) with associated Measures, and provision of objects (Materiel, Data, Information, Performers, Geopolitical Extents).
- Any Performer that consumes a Service may have a Service Port that is described in the service request. This description indicates how the Service provider should provide or respond back to the Service consumer. That is, Service Ports are parts of Performers that may or may not be Services themselves.
- The Service Port is a special type of Port that is the part of a Performer that provides access to the Performer capabilities. Note that the Performer capabilities provided access to can be an aggregate, e.g., an orchestration, of Performer components. The Service Port is the service consumer facing part of the Service and so has a Service Description, a type of Information.

Service Data Capture Method

A method to capture Services data is described in the table below.

Service Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Capability
Definition:	Per the DoDAF V2.0, a Service provides access to a capability through a prescribed interface and has certain constraints and policies applied to it. The following information describes a process by which data associated to a service can be captured to support development of an enterprise architecture.
Input:*	• Service Description • Service Policy • Performance Measures • Conditional Events
Method:	A Service is a type of Performer which means that it executes an activity and provides a capability. When analyzing the DM2, the information associated to a Service is very much akin to that related to a system. There is a description, interfaces and constraints that support its

	definition. The following steps can be taken to capture Services information to support the intended purpose of the architecture: • Identify and capture the capabilities supported or provided by the services. • Identify and capture the operations, business functions and activities supported or automated by the service. • Identify and capture the Organization responsible for providing the services. • Using the Service Description, capture the information to be consumed by the service and the information that is being produced by the service. • Define and capture the logical and/or physical interfaces required by the services. • Define and capture the rules applied to the information consumed and produced by the service. Also define and capture the rules governing or constraining the use of the service. • If not captured as part of the previously mentioned rules, define and capture the measures that will be used to gauge the performance of the service. • Identify and capture other services or systems on which the service is dependent or are dependent on the service.
Primary Output:	Traceability to: • Capabilities • Business functions • Activities Interface requirements, Input to Service Level Agreement Performance measures
Secondary Output:	Organization responsible for providing the service
Disciplines:	Structured analysis, Object-oriented Analysis (UML or SysML), Business Process Model (BPM)

*Inputs and Output sources and descriptions may be dependent upon the focus of the architecture efforts. For “To-Be” architectures, Inputs and Outputs may include resource flows between activities.

Use

A Service, in its broadest sense, is a well-defined way to provide a unit of work, through which a provider provides a useful result to a consumer. Services are activities done by a Service provider (Performer) to achieve desired results for a Service consumer (other Performer). Services do not necessarily equate to web-based technology or functions, although their use in the net-centric environment generally involves the use of web-based, or network-based, resources.

Functionally, *a Service is a set of strictly delineated functionalities, restricted to answering the what-question, independent of construction or implementation issues*. Services form a layer, decoupling operational activities from organizational arrangements of resources, such as people and information systems. Finally, Services form a pool that can be orchestrated in support of operational activities, and the operational activities define the level of quality at which the Services are offered.

The Services Data Group described above capture service requirements for supporting capabilities and operational activities, particularly the core processes (PPBE, DAS, JCIDS, SE, CPM, and Operations [Ops]). DoD processes include warfighting, business, intelligence, and Network Operations functions. The Services data are linkable to architecture artifacts in the Operational, Capability, and Project Viewpoints. Service functions (activities) and resources support operational requirements and facilitate the exchange of information among Performers.

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Project

A Project is a temporary endeavor undertaken to create Resources of Desired Effects. Projects form the major elements of the DAS and are the primary focus of the DoD PPBE system.

The Primary Construct of the PPBE system is the Program Element (PE). The PE is defined as:

> ***Program Element:*** *The program element is the basic building block of the Future Years Defense Program. The PE describes the program mission and identifies the organization responsible to perform the mission. A PE may consist of forces, manpower, materiel (both real and personal property), services, and associated costs, as applicable.*
>
> *(MIL-HDBK-881A, 30 July 2005)*

The key architectural construct within Project and the Program Element is the Work Breakdown Structure (WBS) subject to DoD Instruction 5000.2. The WBS is the primary instrument connecting an Architectural Description to the Defense Acquisitions System and the PPBE processes. The Work Breakdown Structure (WBS) is defined as:

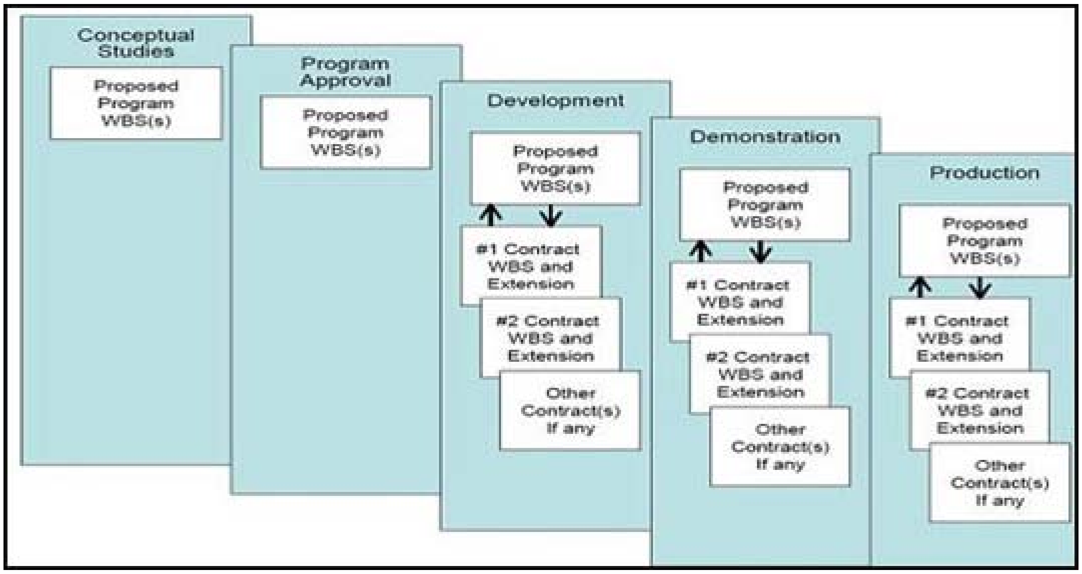
> ***Work Breakdown Structure:*** *"A product-oriented family tree composed of hardware, software, services, data, and facilities. The family tree results from systems engineering efforts during the acquisition of a defense materiel item". (MIL-HDBK-881A, 30 July 2005)*

MIL-HDBK-881A provides guidance for constructing the WBS applicable to programs subject to DoD Instruction 5000.2. The WBS is the process necessary for subdividing the major product deliverables and project work into smaller more manageable components and it serves as a valuable framework for the technical objectives, and therefore it is product-oriented. Its elements should represent identifiable work products, whether they are equipment, data, or related service products. A WBS is a product structure, not an organizational structure, providing the complete definition of the work to be performed by all participants and the required interfaces between them.

Hardware, software, services, data, and facilities are Resources in the DM2. The information captured in the project administrative tool/techniques (e.g., Project Management Body of Knowledge [PMBOK] 2004) provides the basis for resource information in the DM2. The WBS forms the basis of reporting structures used for contracts requiring compliance with ANSI/EIA 748 Earned Value Management System (EVMS) Guidelines and reports placed on contract such as Contractor Cost Data Reporting (CCDR), Software Resource Data Report (SRDR), Contract Performance Reports (CPR), and Contract Funds Status Reports (CFSR).

MIL-HDBK-881A states: *".the Program WBS and Contract WBS help document architectural products in a system life cycle. The DoD Architecture Framework (DoDAF) V1.0 defines a common approach for DoD Architecture Description development, presentation, and integration for warfighting operations and business operations and processes."*

Just as the system is defined and developed throughout its lifecycle, so is the WBS. In the early Project phases of concept refinement, system architecture, and technology development, the program WBS is usually in an early stage of development. The results of the Analysis of Material Approaches and the Analysis of Alternatives (AoA) provide the basis for the evolution of the WBS at all stages of Project evolution. As the architectural design of the project's product or service matures, so should the WBS. The WBS is a primary tool in maintaining efficient and cost effective developments of products and services. The figure below illustrates the evolution of the WBS during the lifecycle of Project.



Evolution of the Project WBS

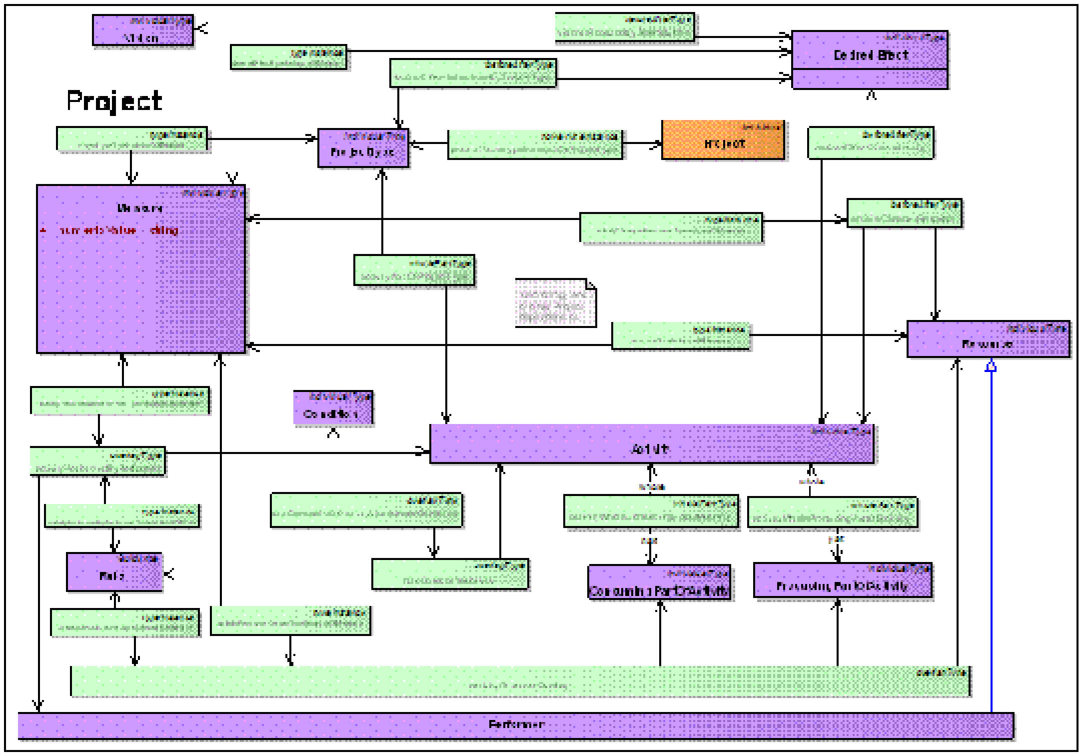
The following sections describe the DoDAF V2.0 Meta-model elements of Activities, Performers, Organizations, Objectives, Constraints, etc., that form the essential elements of the WBS Project definition and how their ontological and taxonomic structures are derived from Architectural Description.

It should be noted that the same ontological and taxonomic structures also directly apply and should be traceable to architecture and classical specifications, such as the Statement of Objectives (SOO), and the SOW.

Data

The DoDAF Meta-model for the data comprising Project is shown below. Definitions for the model terms are here. Aliases and composite terms related to Projects are shown here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Project group in the DM2 Data Dictionary



DoDAF Meta-model for Project

The DoDAF Meta-model contains the essential data required for defining a Project. Projects are defined in a Project Plan and supported by a System Engineering Plan. The Project Plan contains the project WBS (including Tasks and responsible Organizations). The Systems Engineering Plan (SEP) identifies the DoDAF-described Models to be produced and it defines the Project adoption and extensions (e.g., standard super-subtypes, whole-parts, and other architecture and engineering conventions) of DoDAF elements required by the specific Project. Further, the plans should define the project's primary areas of concern, as represented by Vision, Goals, and Objectives (VGOs). The VGOs should be directly traceable to the ICD, Capstone Requirements Document (CRD), Key Performance Parameter (KPP), and Capability Production Document (CPD) required by the JCIDS process. These VGOs should then be translated (e.g., requirements derived from the VGOs), to the Activities, Performers, Rules, and Measures in the Project. The Tasks and Performers form the essential elements of the project's WBS. The use of both Tasks and Performers focusing on products to be delivered (e.g., System, Service, Function, Component, etc.) in the WBS is the essential premise of the product-oriented WBS defined in MIL-HDBK-881A. Measures and Rules can be assigned at all levels of the Project decomposition. Top-level Measures and Rules (Conditions and Constraints) should be assigned to the VGOs. Lower-level Measures and Rules can then be derived and assigned to compliance and test criteria. When part of a legal contract, policy, or directive, the DoDAF Meta-model element (e.g., Activities (System Functions or Service Functions), Measures, and Rules) constitute a principle portion of the requirements for the Project. Any element of the DoDAF Meta-model may constitute a requirement if it is invoked by policy, directive, formal agreement, or contract instrument. The table below contains examples of requirements and their relationship to the DoDAF Meta-model terminology.

There are several items to note regarding this model:

- Like all concepts in the DM2, Project has whole-part, temporal whole-part, and super-subtype relationships so that major Projects can have minor Projects within them, Projects can have time phases, and Projects can be categorized.
- Because a Project involves execution of a plan composed of Activities (Tasks), there is a flow of resources into the project's activities and a flow of products out of them, as

described by the Resource Flow data group. So this model can describe a Project that results in a System, a Service, Personnel Types (i.e., Training), Organizations (i.e., organizational development), Materiel, or Locations (e.g., Facilities, Installations).

- Because technology is part of the Project, this group models the analog of the DoDAF V 1.0 and V1.5 SV-9 (System and Services Technology Forecast) and SV-8 (System and Services Evolution Description).
- Many kinds of measures may be associated with a Project - needs, satisfaction, performance, interoperability, organizational, and cost.

Requirements Related to the DoDAF Meta-model

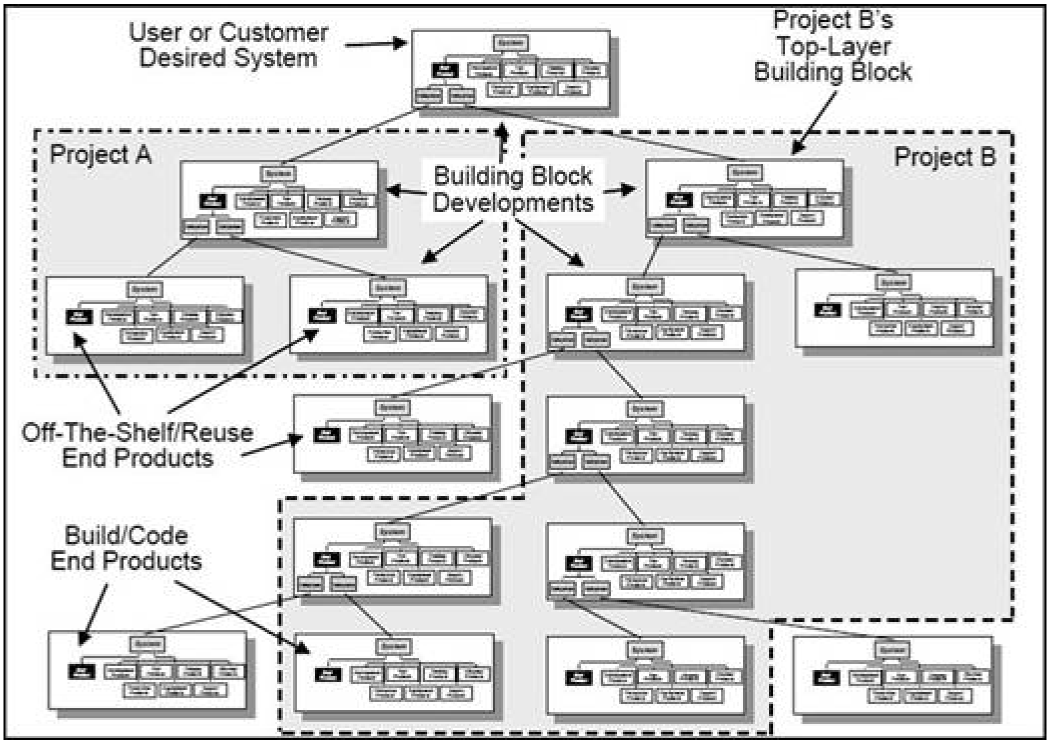
Types of Requirements	
Requirement Type	**Criterion**
State/Mode	States the required states and/or modes of the item, or the required transition between one state and another state, one mode and another mode, made in one state to mode in another state. A state is a condition of something. A mode is a related group of functionality for a purpose.
Functional (Activity, Process, Performer)	States what the item is to do.
Performance (Measures and Rules)	For a given function, states how well that function is to be performed.
External Interface (Derived from Resource Flow)	States the required characteristics at a point or region of connection of the item to the outside world (e.g., location, geometry, inputs and outputs by name and specification, allocation of signals to pins, etc).
Environmental (Conditions and Constraints)	Limits the effect that the external environment (natural or induced) is to have on the item, and the effect that the item is to have on the external environment.
Resource (Conditions and Constraints)	Limits the usage or consumption by the item of an externally provided resource.
Physical (Conditions and Constraints)	States the required physical characteristics of the item as a whole (e.g., mass, dimension, volume).
Other Quality	States any other required quality that is not one of the above types, nor is a design requirement.
Design	Directs the design (internals), by inclusion (build it this way), or exclusion (don't build it this way).
Note: The same Types apply also to Visions, Goals, and Objectives	

Method

Methods for collecting and modeling Project data are as follows:

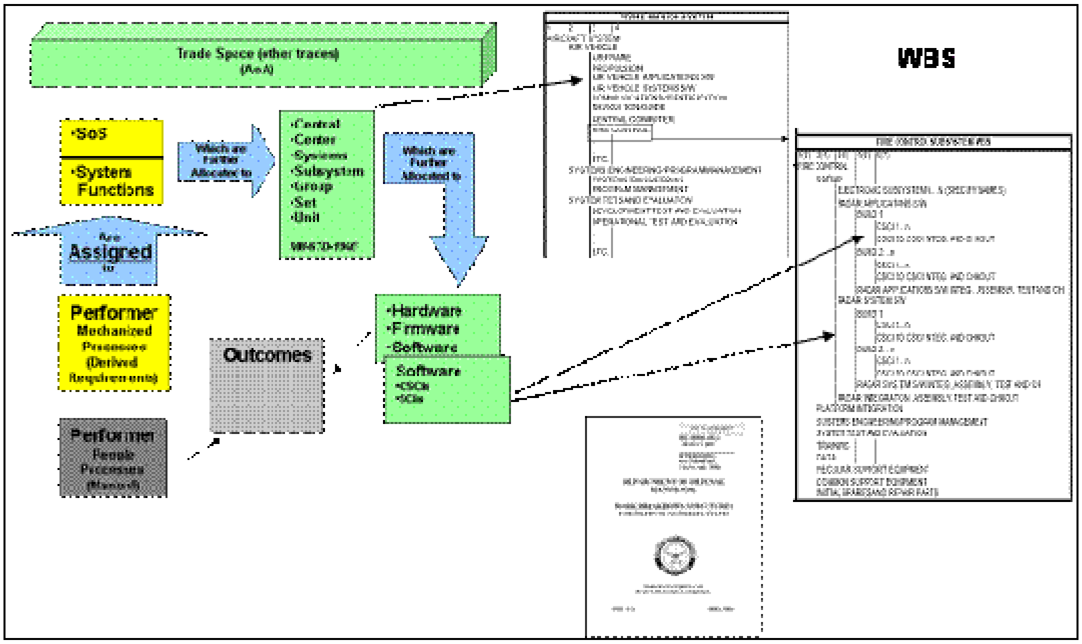
Project Modeling and Core Usage. The WBS is a system management tool very commonly used by program managers and industry. Created early in the life of a program, the WBS identifies deliverable work products (such as Products, Work Packages, Activities, Tasks, etc.). These work products are then further subdivided into successively smaller units until individual tasks can be assigned to people or organizations. This enables the responsibility to be assigned for individual tasks and provides traceability from low-level tasks to high-level work products.

Products and organizations are represented in the DoDAF V2.0 Meta-model as a taxonomic breakdown of the root architectural element Performer. These engineering decomposition methods are described in the Performer and Resource Flow Meta-model groups. The figure below illustrates how taxonomic structure can be used to partition the Project into manageable subprojects, identify where common off-the-shelf-building blocks (Reuse) can be utilized, and identify all components of the system. In the acquisition stages, the level of breakdown of this decomposition is dependent on perspective (e.g., SoS, Enterprise, System, etc.) and acquisition strategy.



Non-prescriptive, Illustrative Example of System Taxonomy Used to Develop the
Product Portion of the WBS

As stated in MIL-HDBK-881A, the WBS is a continually evolving instrument from Project conception to lifecycle management. This tracks closely with the evolution of the architecture. As key Activities are refined into primary Activities and assigned to or allocated to Performers, the WBS should mature and the project definition can gain additional focus. Early Project WBSs may contain high-level Activities (Tasks, Processes, System Functions, or Service Functions). As the Project matures, the WBS identifies the system components, such as subsystems and software configuration items (SCIs). The SCIs can be software services or individually testable and deliverable packages of software. Depending on the acquisition strategy, all or part of the Project WBS and, depending an acquisition strategy, may become the Contract WBS and form the basic outline of the requirements in a statement of work and the project Statement of Objectives (SOO) or Specification. The figure below illustrates this method.



Derivation of the Materiel Portion of the WBS

The other, non-materiel portions of the WBS (Work Packages, Task and Activities) are derived in a similar fashion, i.e., Activities assigned to or allocated to Performers that are, in turn, assigned to Organizations, Personnel and Facilities.

Project Data Capture Method. A method to capture Project data is described in the table below.

Project Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Project
Definition:	Programs are accountable for implementing and managing their respective solutions to achieve priorities. Programs are responsible for reporting progress through performance measures that quantify and qualify achievement of program goals. (e.g., IRB reviews, Defense Business Systems Management Committee [DBSMC] reviews and critical milestones) within the acquisition management process are checkpoints to measure progress.

Input:	• Program Plan, System Engineering Plan, Specifications, etc. containing:
	  ◦ Captured to be Vision/Goals
	  ◦ Work Breakdown Structure
	  ◦ Performance Measures
	  ◦ Scope
	  ◦ Program Requirements
	  ◦ Conditional Events
	  ◦ Program Baseline

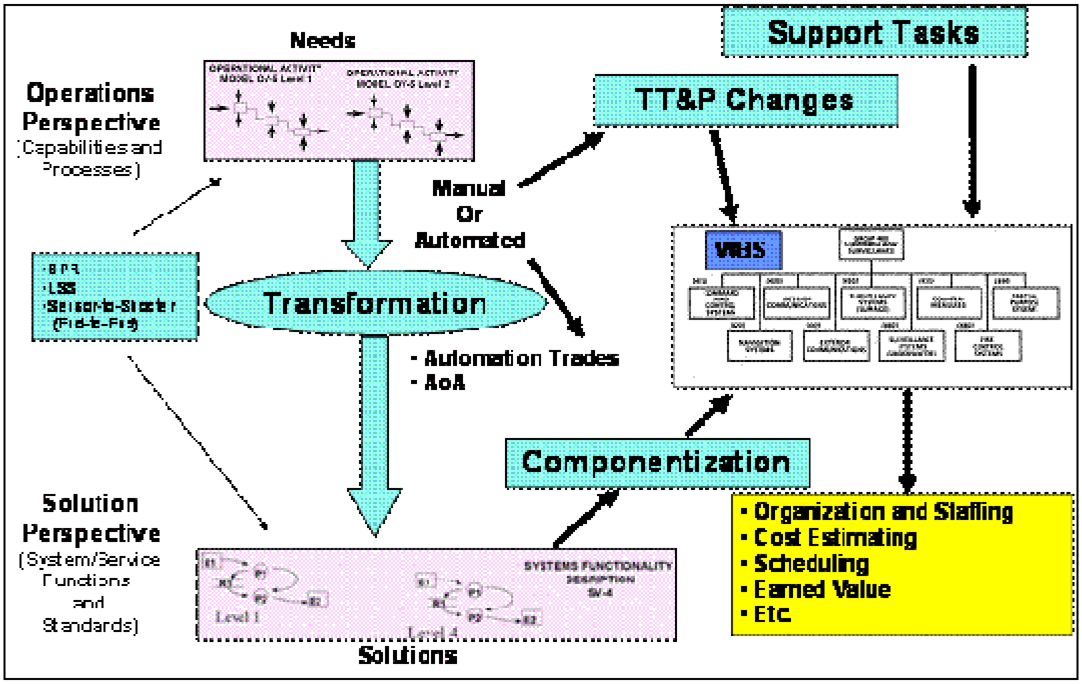
Method:	Plans and initiatives to coordinate transition planning in a documented program baseline, show critical success factors, milestones, measures, deliverables, and periodic program reviews. • There is a vision of the end result of the transformation that

	succinctly describes the changed conditions or environment. • Goals should be specific, detailed enough, and expressed in a way that DoD leadership can unambiguously assess whether and how it has been met. • Goals should have a focused, clearly defined scope that makes it possible to know when the capability has truly been achieved ensuring effectiveness. • A plan is then produced including activities with conditions and events that document the blueprint for desired outcomes and the roadmap for how to achieve those outcomes. • In this step, information from previous steps is leveraged to create or modify executable programs and begins the work to deliver improvements. Programs are defined through engagement in the existing requirements and acquisition management processes of the Department. • Transformation is then measured through performance measures that quantify and qualify achievement of program goals. The Execute and Evaluatestep includes managing execution, transforming via implementation (testing and deployment) of designated programs, and evaluating and assessing progress using performance measures and other DoD process checkpoints.
Primary Output:	Refined Vision, Defined Goals, Scope, Program Effectiveness, Transition Plan, WBS
Secondary Output:	Personnel, Services, Systems, Organizations that relate to the capability
Disciplines:	Structured analysis, Performance Assessment

Use

Data for Projects are used in the following ways:

The data derived from Architectural Descriptions directly support the definition and structuring of Projects. The architectural data elements are used in the WBS, Architectural, and Classical Specifications and the SOW essential in the DAS. The architectural process augments classical System Engineering techniques by emphasizing the taxonomic structures (hierarchies) and ontological relationships (e.g., the federation with other needs, Systems, and Projects) between them. As shown in the figure below, the Operational Viewpoint and DoDAF-described Models establish the needs typically used (depending on detail and purpose of the architecture) in defining the system requirements' baseline established at the Systems Requirements Review (SRR). Here the operational needs, as described in the Capabilities Description Document (CDD,) are translated into structured, engineerable requirements. Depending upon acquisition strategy, contracting may commence at this point, if assistance is required to establish Solution-related Viewpoints, DoDAF-described Models and associated baselines.



Architectural Description Usage in Forming Project Structure

Needs are transformed into Solutions through automation tradeoffs and AoA.

Various alternatives are iterated through the Operational Viewpoint and DoDAF-described Models to meet the required performance, cost, and schedule constraints. From here, Functional and Allocated baselines can be established. As increased detail is added to the architecture, classical systems engineering and design techniques are increasingly applied.

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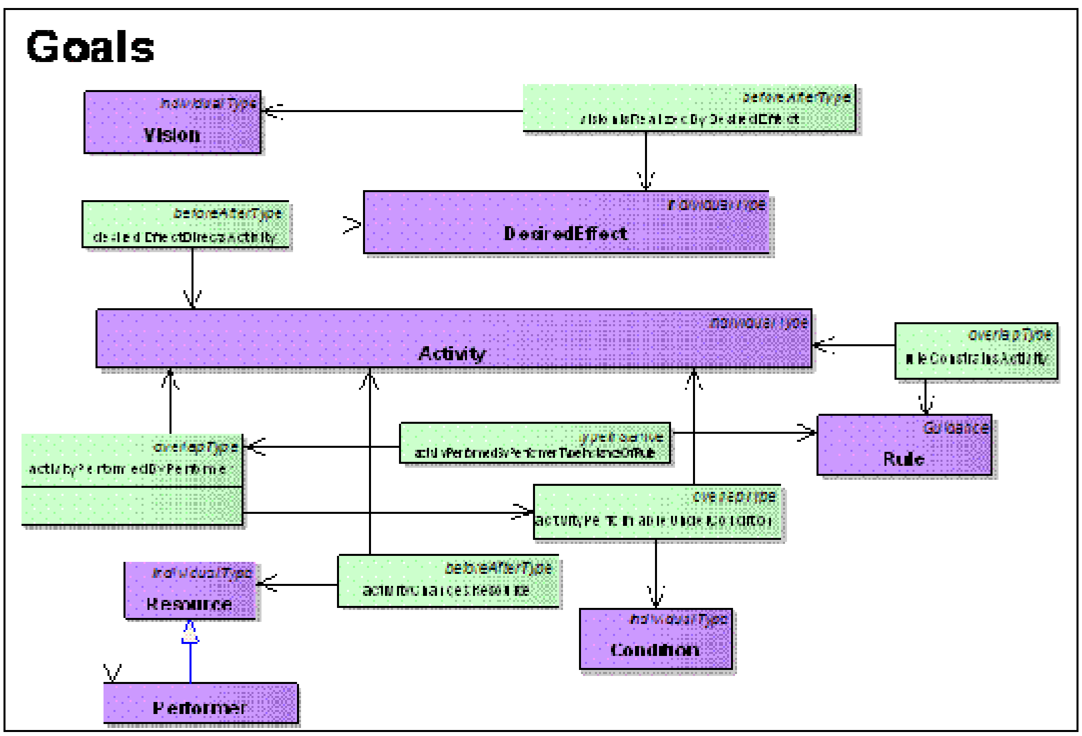
Goals

The Goals Data Group defines and describes the high-level data related to the establishment of goals, at some level, in the organization. Goals data are defined to represent the desired effect or outcome, or level of achievement, in operational processes, projects, or special programs. Goals data can be expressed as enterprise goals—high-level strategic goals that apply to the entire organization—or as more specific operational goals that define desired outcomes of the work process.

Data

The DoDAF Meta-model for the data comprising Goals are shown below. Definitions for the model terms are here. Aliases and composite terms are here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Goals group in the DM2 Data Dictionary



DoDAF Meta-model for Goals

The following should be noted about the Goals Data Group:

- Although the language sounds different, the meaning of a desired effect (a change in state of some object) is the same as the meaning of goal.
- A desired change in the state of some object leads to activities constrained by Rules that are performed by Performers. Some Activities are considered Events because they are of near-zero duration with respect to the frame of discernment of the Vision,

Performers, etc.

Goals

A method to capture Goals data is described in the table below.

Goals Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Goals
Definition:	A method or process by which architectural structural information relative to Goals can be captured to support the products used in the development of an architectural framework.
Input:	• DoD/Mission Area/Component Vision Documentation • DoD/Mission Area/Component Strategic Plan or other Strategic Documentation • DoD Directives • Operational Objectives • Organization Needs • Compliance Requirements • List of Performers (e.g., Roles, Services, Systems, Etc.)
Method:	Goals are used to help guide the Organizations to ensure that everyday operations are aligned to a strategic direction. The following information provides characteristics of well-defined goals. Well-defined goals should be relevant, attainable, timely and measurable. • Relevant means that it directly impacts the fulfillment of a Vision. • Attainable means that the Goal can be achieved given the available resources. • Timely means that the Goal must have a start and end time frame. • Measurable means that progress towards achieving the Goal can be quantified. The subsequent information describes steps that can be taken to properly architect goals that can be integrated within an architecture. • Reviewed the enterprise vision to determine desired effects and outcomes (i.e., Goals) that when accomplished will fulfill the Vision. Goals should be expressed in terms of information that is required to direct and manage the fulfillment of a Vision. • Identify and define a list of potential Goals to be reviewed with senior or executive level stakeholders for completeness and correctness. - Using the criteria stated in the previous section, answer the following questions: - - What makes this goal relevant? - - Is this attainable? - - Within timeframe do we desire to accomplish this goal? - - What are the measures that will be used to measure progress toward achieving this goal? - Any goal for which the above questions cannot be answered should be removed from the list of potential goals.

	From the list of potential Goals, final Goals should be selected and vetted by senior or executive level stakeholders. - Identify any special rules that must be applied during the course of attaining the goal - Identify any special events or triggers that must be accounted for when accomplishing the goal. • An input list of Performers should be reviewed for candidates to be responsible for meeting each of the final Goals. • Performers should be assigned to each of the final Goals. One Performer should be assigned the responsibility to see that a Goal is accomplished. Other Performers may be assigned that have the authority or expertise to perform the any tasks that may be assigned. • The tasks to be performed in support of the goals can be defined as activities or functions. An input list of Activities or functions would be most beneficial and can be reviewed for candidates to be assigned to the Goals. • If the accomplishment of a Goal requires an Activity not in the input list, then a new Activity is appropriately added to the Activity list. • The progress of accomplishing a Goal is captured as an Effect.
Primary Output:	Well-defined Goals, Responsible Performers, Measures.
Secondary Output:	New or Modified Activities, Events and Rules.
Disciplines:	Structured analysis, business process re-engineering, business planning.

Use

Goals are established at all levels of the organization and can be applied to the Enterprise or Solution architecture effort. Goals are particularly useful to teams undertaking an architecture development effort to evaluate the success of the effort and how the effort contributes to achieving higher level goals, mission requirements, capability developments, or development of Services and Systems to support Department or organizational business operations.

Data for Goals are useful for:

- Scoping an activity to ensure that resources utilized in executing an activity contribute to the overall goals and vision of the organization.
- Establishing rules under which activities are executed to create boundaries for efficiency and effectiveness (Constraints) and establishing those circumstances under which an activity is executed (Event).
- Establishing measures and measures to determine the success of an activity, consistent with an established goal.

A goal is an end toward which long-term, ongoing effort is directed. In general, goals are established to provide a description of the intended future state. They are established to provide a target to aim toward, whereby activity is focused on attaining the desired effect (goal). Goals provide participants in activities a sense of direction, and a view of what to expect as activity progresses toward some end point.

Goals are often expressed in terms of Specific, Measurable, Attainable, Relevant, Timely (SMART) qualities, needed for a useful goal.

Specific Goals describe expected effects that are easily understood and capable of being executed. Measurable Goals can be tracked, evaluated against standards, and analyzed for their progress toward a desired objective. Attainable Goals are those that can be successfully achieved, assuming that the means and capabilities to achieve them are present in the organization. Relevant Goals are those goals that have meaning within the context of the project or activity. Timely refers to the established timeframe in which the goals are expected to be achieved, and the ability of the person or team to achieve the goals within that desired timeframe.

Within DoDAF, goals are identified and described to provide direction to Activities and to orient those Activities toward a desired effect. When a Performer executes an Activity, the Performer does so within the limitations prescribed for the Activity (Rules) and aims toward a desired effect. That effect should either meet, or contribute to meeting, established Goals that reflect the vision of the organization.

The key to success in using Goals data is the level of acceptance by other individuals or teams (performers) who will use the data in their efforts.

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Rules

Rules are prescriptive sets of procedures regarding the execution of activities within an enterprise. Rules exist within the enterprise whether or not they are ever written down, talked about, or even part of an organization's consciousness. However, it is fairly common practice for organizations to gather rules in a formal manner for specific purposes.

Business rules are a type of Rule that govern actions and are initially discovered as part of a formal requirement-gathering process during the initial stages of a Project or during activity analysis, or event analysis. In this case, the collecting of the business rules is coincidental to the larger discovery process of determining the workflow of a process. Projects such as the launching of a new system or service that supports a new or changed business operation might lead to a new body of business rules for an organization that would require employees to conceptualize the purpose of the organization in a new way. This practice of coincidental business rule gathering is vulnerable to the creation of inconsistent or even conflicting business rules within different organizational units, or within the same organizational unit over time.

The DoDAF Meta-model provides a set of clear, concise data about rules, that facilitates the creation of rules and enables the sharing of those rules with others requiring similar information.

Creation of rules data must aim toward clear, easily understood, and totally unambiguous statements that define a procedure or function. Several best practices can be adopted to assist in this effort. These are:

- ***The rule must be declarative***. A business rule is a statement of truth about an organization. It is an attempt to *describe* the operations of an organization. That is why business rules are said to be *discovered* or *observed* and not *created*. The prescription of a rule may occur in a future-based timeframe of an architecture, a "*To-Be*" architecture.
- ***The rule must be atomic***. A rule is either completely true or completely false; there are no shades of gray. For example, a rule for an airline that states *passengers may upgrade to first class round-trip tickets if seats are available and they pay the fare increase* does not imply that this deal is available for just one leg of the journey. In other words, conditions apply to rules and rules apply only to certain scope of activities.
- ***The rule must contain distinct, independent constructs***. Business rules should focus on definitions and should be separate from processes (i.e., strategies and tactics). Business Rules should not be complex and should avoid cyclical dependencies.
- ***The rule must be expressed in natural language***. To appeal to the broadest audience, it is almost always best to express business rules in a natural language without the use of a lot of technical jargon. There can be many business rules statements associated with a business rule. The business rule statement should conform to Object Management Group (OMG) specified Semantics of Business Vocabulary and Business Rules (SBVR).
- ***The rule should be clearly understood by those outside the organization***. A company's business rules should not, for example, be foreign to a knowledgeable

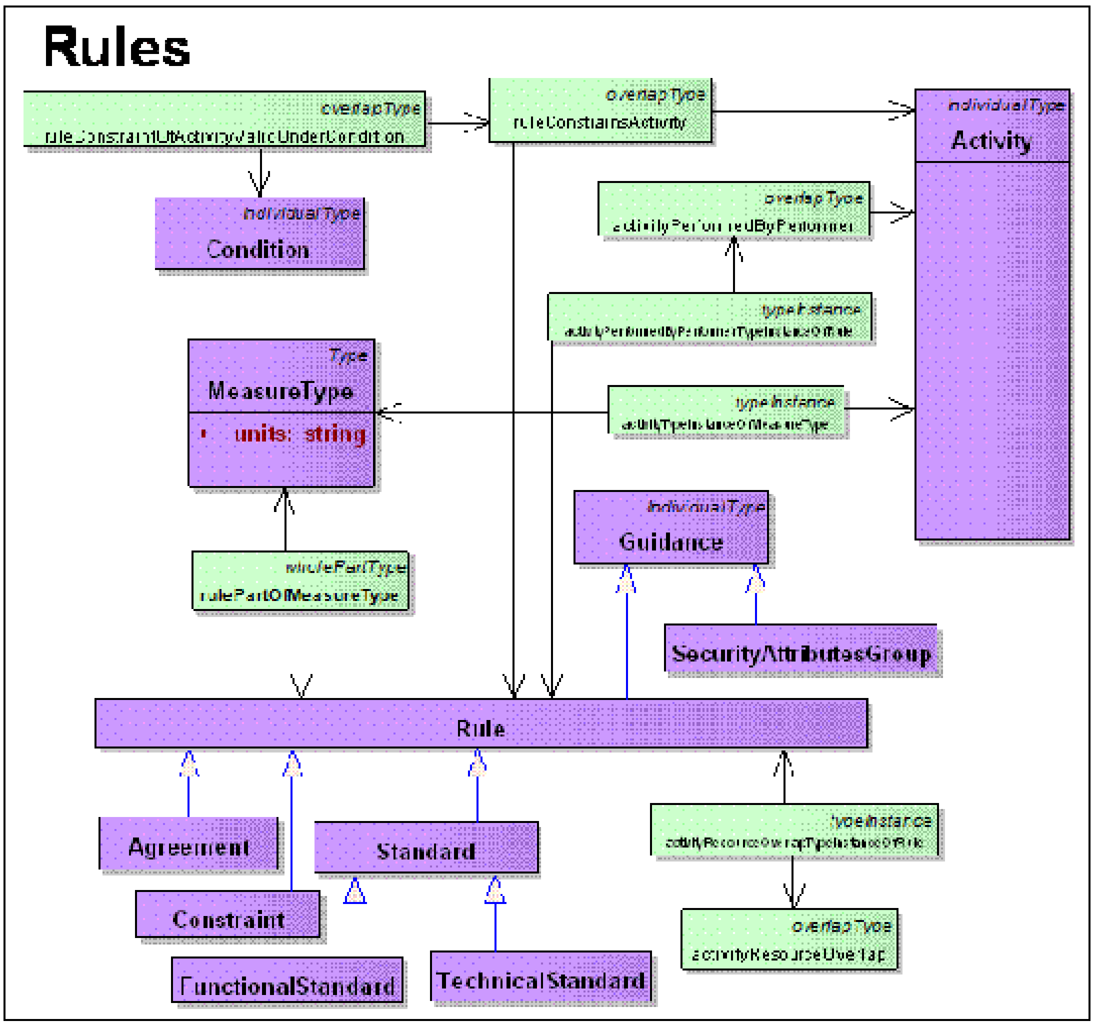
customer.

A rule is not a process - the two, while related, are very different. A *process* is a transformation that produces new things (outputs) from existing things (inputs), while a *rule* prescribes the exact procedures to be used to ensure that the output is as to be expected in each instance that the process is executed.

Data

The DoDAF Meta-model for the data comprising Rules is shown below. Definitions for the model terms are here. Aliases and composite terms are here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Rules group in the DM2 Data Dictionary



DoDAF Meta-model for Rules

The following should be noted about the Rules Data Group:

- A Rule constrains Activities. For example, a speed limit rule constrains driving activity. Some seemingly static rules have the effect of limiting possible activities. For example, a rule that security fences must be 10 feet high constrains the activity of building security fences. This constraint may apply or vary under certain conditions. For example, speed limits can be lower in poor weather conditions.
- Security classification, security marking, releasability, etc. are types of Guidance. Similarly; a Rule is a stronger form of Guidance.
- An important Constraint type is a Service Policy that constrains access to capability

Performers.
- Doctrine, by definition, constrains military action.

Rule Data Capture Method

A method to capture Rules data is described in the Table below.

Rule Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Rule
Definition:	A method or process by which architectural structural information relative to rules can be captured to support the products used in the development of an architectural framework.
Input:	• Rule description notation conventions. • The potential rule statement. • Rule classification, category or type. • The rule trigger or event, if appropriate. • The Activity object constrained by the rule.
Method:	• The input potential rule statement must be reviewed to determine whether the statement can be classified as a rule. Not all statements are rules. The classification, category or type of the input rule is identified as one of the following: - Agreement - Guidance - Constraint - Technical Standard - Functional Standard - Means • After the classification, category or type of Rule has been determined, the Activity to be constrained by the input potential rule statement is determined. A Rule must constrain an existing Activity in the architecture otherwise the rule is not required in the architecture. • The classification, category or type of Rule determines the allowable structure and notation of the Rule. A Rule that is a Functional Standard or Technical Standard should use a structured language and notation, be atomic and unambiguous, use a standard vocabulary and be directly enforceable. • A Rule that is not a Functional Standard or Technical Standard generally must be accepted without change because it was created by an entity out side of the architecture being developed; such as Congress. • The input rule statement description is restated, if necessary, to meet the approved Rule description notation conventions. (See Comment 3.) The guidelines for developing an architecture should contain a standard notation for writing Rules. • If required, the Rule trigger or event is evaluated and the Condition is determined. If an existing Condition does not exist, then a new Condition will have to be added. • The Rule is added to the architecture with the designated classification, category or type. • Based on the classification, category or type, the rule is associated with the appropriate Activity and Condition, if required.

	Functional Rules should be associated with functional or operational Activities and technical Rules should be associated with system Activities.
Primary Output:	A rule that is constructed using the notation standards, is properly classified, and is associated with the appropriate Activity or Activities.
Secondary Output:	Structured lists of Agreements, Guidance, Standards and Means that are the sources of the rules.
Disciplines:	Structured analysis and technical writing.

Use

Rules data are used to create, document, and share rules of all types that support operational activities and/or the execution of capabilities in operational processes (composite activities). These data can include:

- Processes that define transactions where data must be exchanged or passed to execute a specified activity, such as PPBE, CPM, JCIDS, or DAS.
- Rules that define methods of accessing information or services within the net-centric environment, such as Ops, PPBE, CPM, or JCIDS.
- The order of steps that occur in a series of actions that must be performed in a specific order, such as DAS, SE, PPBE, or CPM.
- Rules defining analysis of options or future actions, such as Ops Planning, JCIDS, PPBE or CPM.

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Measures

A measure is the magnitude of some attribute of an object. Measures provide a way to compare objects, whether Projects, Services, Systems, Activities, or Capabilities. The comparisons can be between like objects at a point in time, or the same object over time. For example, a Capability may have different measures when looking at the current baseline and over increments toward some desired end-state.

Measures play a much greater, central role in DoDAF V2.0, compared to earlier versions of DoDAF. This change has multiple drivers, including:

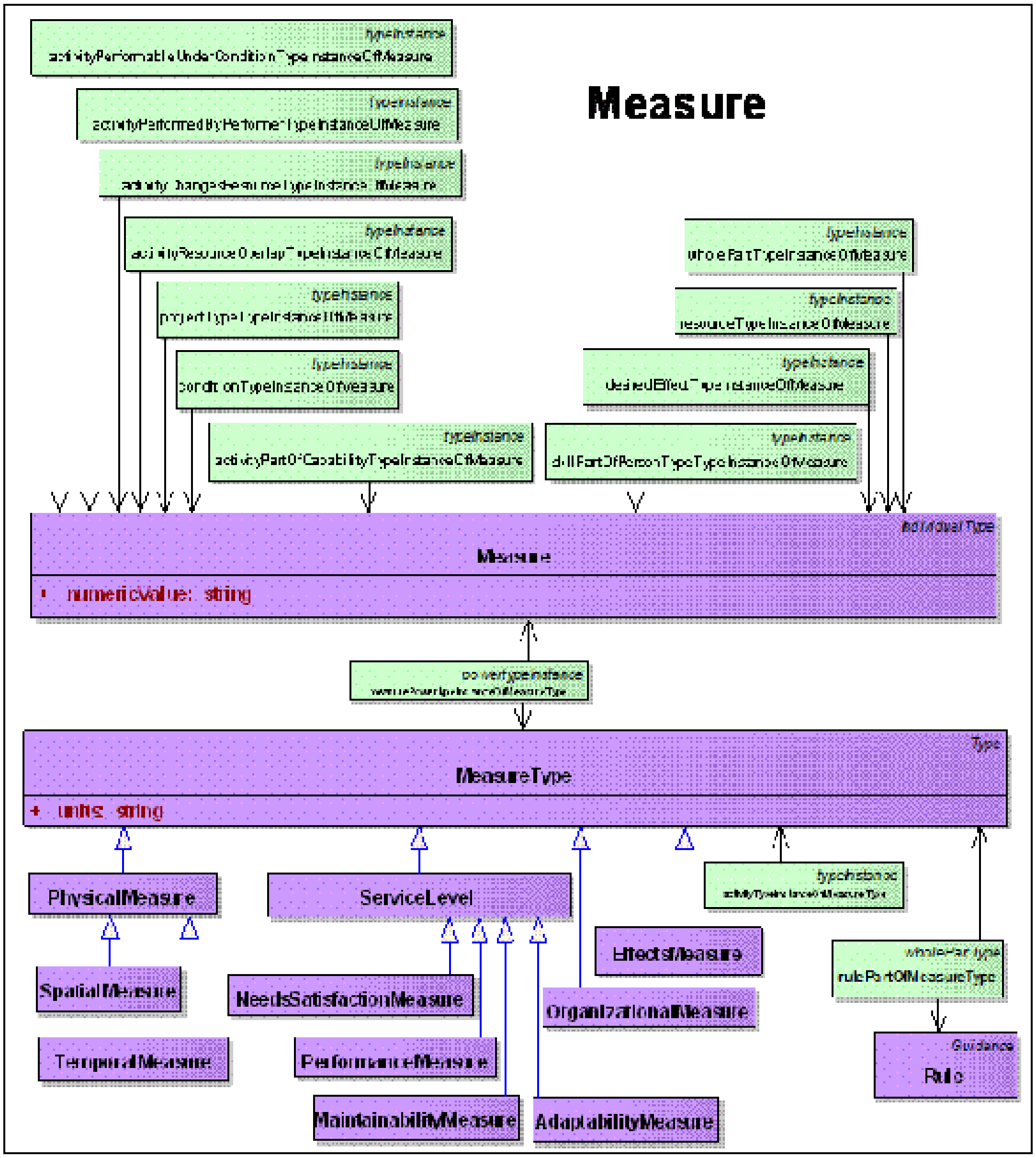
- Core Process use of architectural data. Those management and engineering processes depend on quantification as a means of improving objectivity, accountability, and efficiency of the processes.
- Federal Enterprise Architecture (FEA) Performance Reference Model.

There are many kinds of Measures that are applicable to many architecture elements. These are described in the following paragraph.

Data

The DoDAF Meta-model for the data comprising Measures are depicted below. Definitions for the model terms are here. Aliases and composite terms related to Measures are shown here. Authoritative Source definitions, aliases, and rationale are provided in the DoDAF V2.0 Meta-model Data Dictionary.

Click on image below to link to the Measures group in the DM2 Data Dictionary



DoDAF Meta-model for Measures

The following should be noted about the Measures Data Group:

- The key elements of the Measure Data group are Measure and Measure Type. Measure refers to the actual measure value and units. It relates to a Measure Type that describes what is being measured. Examples of each are shown below.

Non-prescriptive, Illustrative Examples of Measures and Measure Types

Measure	Measure Type
1 year	Timeliness
Mach 3	Rate
99 percent	Reliability
56K	BAUD
3 meters	Target Location Error (TLE) Accuracy

1,000 liters	Capacity
$1M	Cost
Level 3	Capability Maturity Model® Integration (CMMI) Organizational Level

- Formally, a Measure defines membership criteria for a set or class; e.g., the set of all things that has 2 kg mass. The relationship between Measure and Measure Type is that any particular Measure is an instance of all the possible sets that could be taken for a Measure Type.
- The lower part of the Measures DoDAF Meta-model figure depicts the upper tiers of a Measure Type taxonomy or classification scheme. It is expected that architects would add more detailed types (make the taxonomy more specialized), as needed, within their federate. Note that Service Level has multiple inheritances because a Service QoS or Service Level Agreement (SLA) could address User Needs, User Satisfaction, Interoperability, or Performance.
- All Measure Types have a Rule that prescribes how the Measure is accomplished; e.g., units, calibration, or procedure. Spatial measures' Rules include coordinate system rules. For example, latitude and longitude are understandable only by reference to a Geodetic coordinate system around the Earth.
- As a Measure Type, cost can be captured in the architecture at different levels, based on the Process-owners requirements
- The upper part of the Measures DoDAF Meta-model figure depicts how Measures apply to architecture elements. Note that they apply to relationships between objects; e.g., the Measure applies to a Performer performing an Activity. The Activity has a relationship to Measure Type that says what Measure Types apply to an Activity. This represents Universal Joint Task List (UJTL) tasks and their applicable Measure Types, including Conditions, that is, Condition is quantified by a Measure Type. (The whole-part relationship feature of Condition allows it to be singular.) This is accomplished by Condition's typeInstance association, saying an elementary Condition is a member (instance) of a Measure Type class.

Measures Data Capture Method

A method to capture Measures data is described below

Measures Data Capture Method Description

Methodology Description	Capture Data for Architectural Description of Measures
Definition:	A method or process by which architectural information relative to Measures (or Metrics) can be captured to support the products used in the development of an architectural.
Input:	• Organization Transition Plan • Well-defined Capabilities • Activities or Functions linked to Capabilities • Organization Milestones • Concepts of Operations • Rules or Constraints
Method:	• The DoDAF V2.0 has within its Meta-model several architectural constructs to which Measures should be associated. As a rule of thumb, any items against which performance must be measured or

	progress must be tracked should have Measures assigned to them to enable performance and progress to be gauged. Architectural constructs such as Capabilities, Activities (Functions, Processes, and Tasks), Performers (Persons, Systems, and Services) should have Measures assigned such that performance can be gauged. • The Measure must be associated with another object in the architecture including an Activity, Condition or Effect because a Measure defines the value and units of an object. A Measure not associated with another architectural object adds no value to the architecture. • After the associated object has been identified, the name, description, value and units of the Measure are determined. • The Measure Type is determined from the following subtypes: - Needs Satisfaction Measure - Performance Measure 1. Accuracy/Precision 2. Timeliness 3. Rate Throughput 4. Capacity 5. Dependability 6. Trustworthiness 7. Reliability 8. Security - Maintainability Measure - Adaptability Measure 1. Interoperability - Organizational Measure 1. Cost • The Measure is included in the architecture with the appropriate associations to other architectural objects.
Primary Output:	Measures or Metrics, Domain Values for the Measures or Metrics
Secondary Output:	None.
Disciplines:	Structured analysis.

Use

Data for Measures are used in the following ways:

- Planning - adequacy analysis. From an adequacy point of view, Measures that are associated with a Capability (including Capability increment, since Capabilities have whole-part inheritance). Capabilities can be compared with the Measures associated with the Performers to see if the Performer solution(s) are adequate. A set of alternative Performers as part of an Analysis of Alternatives could also be evaluated. Goals or Desired Effects could compare with Measures associated with Performers.
- Planning - overlap analysis. The purpose of an overlap analysis is to determine if there are overlaps, or undesired duplicative capability, in the spending plan, portfolio, capabilities development, or acquisition plan. Similar functionality is often only an indicator of overlapping or duplicative capability. Often Performers with similar functionality operate under different Measures which are not duplicative or overlapping capability. For example, operational-level situation awareness systems may not be as

fast or precise as a tactical-level, but they may handle a larger number of objects over a larger area.

- System Engineering/Design. Measures set the design envelope goals, sometimes called performance characteristics or attributes. They can also set the constraints; e.g., cost constraints.
- Performance-Cost Tradeoffs. Measures of performance (e.g., effectiveness) can be compared to different costs to evaluate and make decisions about alternative solutions.
- Requirements. Requirements often have Measure elements.
- Benchmarking. Measures can be used to establish benchmarks of performance, such as for a personnel skill or a radar tracking accuracy test.
- Organizational and Personnel Development. Organizational and personnel goals are often established and then monitored using Measures.
- Capacity Planning. Measures can be used to plan for needed capacity; e.g., for networks, training programs.
- Portfolio Balancing. Measures can be used to balance a portfolio so that it achieves the right mix of goals and constraints.
- Capability Evolution. Measures are part of capability evolution, showing increments of measurable improvement as the capability evolves and allowing monitoring about when the capability is projected to be achieved or has already been achieved.
- Quality of Service (QoS) Description. In SOA, QoS is often expressed as a Measure; e.g., bit loss rate or jitter. These Measures show up in the service description and are part of service discovery, so users can discover access to capabilities that meet their quality requirements.
- Project Constraints. Measures such as cost and risk can be constraints on Projects.
- Goal Setting. Measures are often part of Goals; e.g., production or efficiency Goals.

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DM2 - DoDAF Meta-Model

- Conceptual
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  - Performers
  - Resource Flows
  - Information and Data
  - Activities
  - Training/Skill/Education
  - Capability
  - Services
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  - Goals
  - Rules
  - Measures
  - Locations
- PES

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DM2 - DoDAF Meta-Model

Locations

A location is a point or extent in space. The need to specify or describe Locations occurs in some Architectural Descriptions when it is necessary to support decision-making of a core process. Examples of core process analyzes in which locations might have a bearing on the decisions to be made include the following:

- Base Realignment and Closure (BRAC) (SE process).
- Capability for a new regional command (JCIDS).
- Communications or logistics planning in a mission area (Ops process).
- System and equipment installation and Personnel Type assignments to Facilities (Operations and SE processes).

Examples where Locations play little, if any, role in the process are:

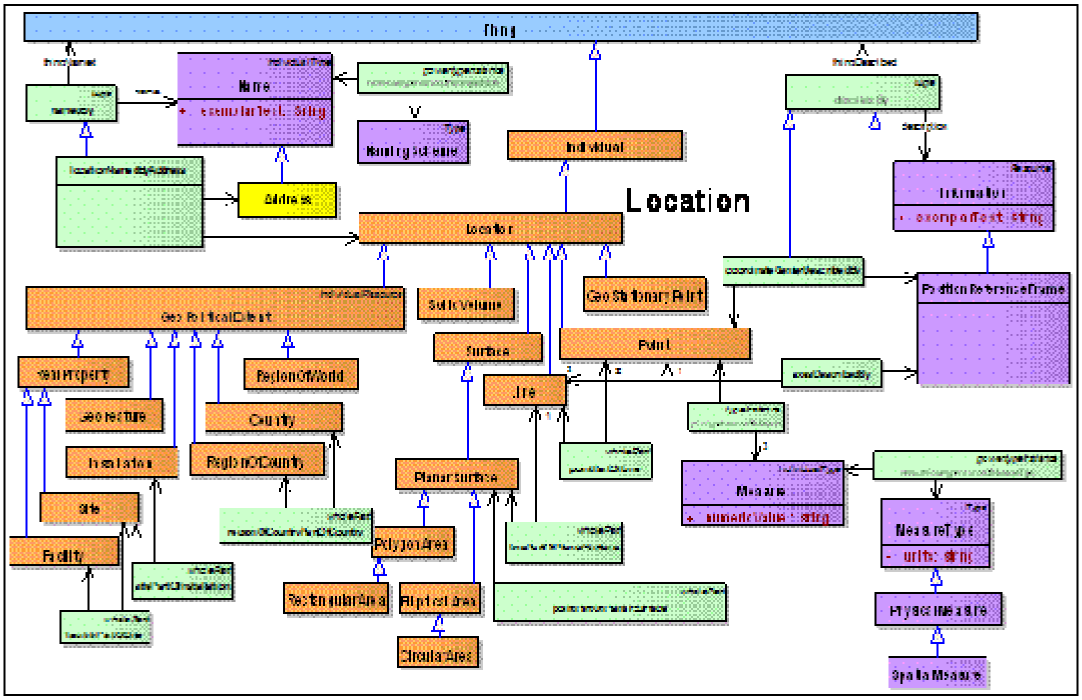
- Prioritization of precision engagement programs (PPBE and portfolio management processes).
- Streamlining of a business process (SE process).
- Doctrine development (JCIDS and Operations processes).

The role of Locations in the decision process was implicit in earlier versions of DoDAF. In this version, they are treated explicitly and precisely to allow more rigorous analysis of requirements (e.g., communications or logistics planning) and clearer differentiation among solutions alternatives).

Data

The DoDAF Meta-model for the data comprising Locations is shown below. Definitions for the model terms are here. Aliases and composite terms are here.

Click on image below to link to the Locations group in the DM2 Data Dictionary



DoDAF Meta-model for Locations

There are several items to note:

- Addresses such as URLs, Universal Resource Names (URNs), postal addresses, datalink addresses, etc. are considered Names for Locations. For example, a postal address is a naming system for the Location of a building. A Universal Resource Locator is a name for a server that is located somewhere on the Web.
- The naming pattern works by identifying the following: 1) the name string, 2) the object being named, and 3) the type of name (e.g., postal address). Name here is used in the broadest sense, such that a description is considered a long name.
- The lower left of the diagram is a model of types of Location objects. These can be alternatively named using the naming pattern in the upper left and delineated using the Extent pattern in the lower right.
- Minimal parts of the Spatial Extent (Point, Line, Surface, and Solid Volume) are detailed because of the varying requirements within a federate. That is, member of the federate may need to specialize the Spatial Extents. Some common and simple classes are modeled, such as a Line described by two Points and a Planar Surface defined by a Line and Point.
- Facilities are types of Locations. In prior versions of DoDAF it was not clear if a Facility could be thought of as a system or just a Location. This is now clarified. To describe the functionality of a Facility, the Activities performed by the Performers located at the Facility are described.
- Installation, Site, and Facility follow Army guidance from the Real Property Inventory Requirements (RIPR). Similarly, a Facility can be a linear structure, such as a road or pipeline.
- Geofeatures (called FEATURE in Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM)) cover man-made control features, as well as geophysical features (including meteorological and oceanographic phenomena).

Method

Methods for collecting and modeling Location data are as follows:

- First, determine the use of the Location data, such as the ones listed in the next paragraph.
- For many architecture applications, a locating scheme is some kind of geometric

system because many uses (see next paragraph) require geometric calculations. Named locations (e.g., facility, base, installation, region names) can be applicable since their use may be merely to describe where performance occurs. In addition, the naming pattern basically can use the name as a surrogate for the geometric location, such as postal addresses are rarely applicable to architectures.
- If a geometric system is needed, the coordinate system, reference frame, and units are chosen. The Geospatial Markup Language (GML) defines 26 different kinds of coordinate systems, including one called user defined. In many cases, a federate may choose reference to GML so issues like handed-ness and orientation don't have to be defined again.
- The accuracy should be determined. For many uses, Locations may not need to be as accurate as some Geospatial system can be, since the use calculation may have many approximations, assumptions, and minor influencing variables that are chosen to be ignored.
- In some cases, there may be need for speed and acceleration ranges. Since these are unusual, they are not part of the core DM2 but would be added as extensions for these kinds of models. The speed could be extended as an attribute or as a trajectory consisting of a set of spatial-temporal points, where the trajectory is a whole and the points are parts.

Use

Data for Locations are used to describe where Performers perform. The Location concept supported the system node in DoDAF V1.0 and V1.5. In DoDAF V2.0, it is generalized and more precisely defined. Examples of the uses of the various types of Locations are:

- Facility Locations allow description that certain systems or organizations are located at a specific facility. Note that the function of the Facility is determined by the Activities performed by the Performers located at the Facility; that is, the Facility itself is not a Performer.
- Installation Locations allow descriptions of certain organizations that operate or use an installation.
- Region Locations are used to describe what Performers and Activities are performed in certain regions.
- A Point Location can be used to state when a Performer is located at a specific Point; e.g., latitude and longitude. When the location is not that specific, Regions, Countries, and other geometric shapes can be used.
- Line (set of lines) allows description of Performers located on, beside, or within some enclosing lines. The line could be described mathematically so that it could specify an orbit, e.g., that certain satellites are in some orbit.
- Volume, e.g., that some systems cover a certain volume; e.g., an air defense system.
- Addresses (names for locations) allow descriptions of where something is located using the address scheme; e.g., the URL address scheme allows for looking up the internet protocol (IP) and then the files on the server.

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Introduction

Department of Defense Architecture Framework (DoDAF) Version 2.0 introduces a DoDAF Meta-model (DM2), consisting of a Conceptual Data Model (CDM), Logical Data Model (LDM), and Physical Exchange Specification (PES) as an integral part of the architecture framework. The DM2 replaces the Core Architecture Data Model (CADM) referenced in previous versions of DoDAF.

The DM2 provides a means to collect architecture-related data, organize the data into useful information by architects and architecture development teams, store the information for later reuse, and facilitate management analysis of architectural data and information for decision-making purposes, as further described below.

Links for DoDAF PES files, the role of the PES and its' relationships, and guidance for actions that need to be taken when exchanging architectural data between architectures developed using the same or different versions of DoDAF are on this page.

Purpose

Collection, management, utilization, and reuse of architectural data and information are a complex task. Successful execution of that task requires knowledge of both data structures and the body of knowledge related to the purpose for which an architecture is being created i.e., "Fit-for-Purpose".

If exchanging architectural data, the PES is the specification for the exchange. The PES provides an efficient and standard means to ensure that data sharing can occur in a toolset-agnostic, methodology-agnostic environment. Use of the eXtensible Markup Language (XML) Schema Definitions (XSDs) by architects to document architectural data and information in tools, through spreadsheets, or other means, and deposit that data and organized information into federated repositories is facilitated by the common understanding underlying the use of the PES.

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DoD Deputy Chief Information Officer

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XSD List

The PES is organized as a set of XML Schema Definition (XSD) files and is in the DoDAF Journal. The files are text format and an XML development application, Notepad, etc., will be required to view the files. The XSDs for each DoDAF-described View is listed in the table below:

Model	Model Name	XSD Filename
AV-1	Overview and Summary Information	AV1.XSD
AV-2	Integrated Dictionary	AV2.XSD
CV-1	Vision	CV1.XSD
CV-2	Capability Taxonomy	CV2.XSD
CV-3	Capability Phasing	CV3.XSD
CV-4	Capability Dependencies	CV4.XSD
CV-5	Capability to Organizational Development Mapping	CV5.XSD
CV-6	Capability to Operational Activities Mapping	CV6.XSD
CV-7	Capability to Services Mapping	CV7.XSD
DIV-1	Conceptual Data Model	DIV1.XSD
DIV-2	Logical Data Model	DIV2.XSD
DIV-3	Physical Data Model	DIV3.XSD
OV-1	High Level Operational Concept Graphic	OV1.XSD
OV-2	Operational Resource Flow Description	OV2.XSD
OV-3	Operational Resource Flow Matrix	OV3.XSD
OV-4	Organizational Relationships Chart	OV4.XSD
OV-5a	Operational Activity Decomposition Tree	OV5A.XSD
OV-5b	Operational Activity Model	OV5B.XSD
OV-6a	Operational Rules Model	OV6A.XSD
OV-6b	State Transition Description	OV6B.XSD
OV-6c	Event-Trace Description	OV6C.XSD

PV-1	Project Portfolio Relationships	PV1.XSD
PV-2	Project Timelines	PV2.XSD
PV-3	Project to Capability Mapping	PV3.XSD
StdV-1	Standards Profile	STDV1.XSD
StdV-2	Standards Forecast	STDV2.XSD
SvcV-1	Services Context Description	SVCV1.XSD
SvcV-2	Services Resource Flow Description	SVCV2.XSD
SvcV-3a	Systems-Services Matrix	SVCV3a.XSD
SvcV-3b	Services-Services Matrix	SVCV3b.XSD
SvcV-4	Services Functionality Description	SVCV4.XSD
SvcV-5	Operational Activity to Services Traceability Matrix	SVCV5.XSD
SvcV-6	Services Resource Flow Matrix	SVCV6.XSD
SvcV-7	Services Measures Matrix	SVCV7.XSD
SvcV-8	Services Evolution Description	SVCV8.XSD
SvcV-9	Services Technology & Skills Forecast	SVCV9.XSD
SvcV-10a	Services Rules Model	SVCV10A.XSD
SvcV-10b	Services State Transition Description	SVCV10B.XSD
SvcV-10c	Services Event-Trace Description	SVCV10C.XSD
SV-1	Systems Interface Description	SV1.XSD
SV-2	Systems Resource Flow Description	SV2.XSD
SV-3	Systems-Systems matrix	SV3.XSD
SV-4	Systems Functionality Description	SV4.XSD
SV-5a	Operational Activity to Systems Function Traceability Matrix	SV5a.XSD
SV-5b	Operational Activity to Systems Traceability Matrix	SV5b.XSD
SV-6	Systems Resource Flow Matrix	SV6.XSD
SV-7	Systems Measures Matrix	SV7.XSD
SV-8	Systems Evolution Description	SV8.XSD
SV-9	Systems Technology & Skills Forecast	SV9.XSD
SV-10a	Systems Rules Model	SV10A.XSD
SV-10b	Systems State Transition Description	SV10B.XSD

SV-10c	Systems Event-Trace Description	SV10C.XSD

These additional XSDs are also provided:

Name	Description	XSD Filename
IDEAS Foundation	The foundation for the DoDAF Logical Data Model and needed for all the DoDAF-described model XSDs	ideasFoundation.XSD
Pedigree	Describes the production of Information by what created it, who created it, the rules, conditions, and metrics that apply to that information production who, how,… it came into being	dm2Foundation.XSD
IC-ISM	Contains the Intelligence Community Information Security Marking (IC-ISM). Every piece of data can have a IC-ISM classification marking and pedigree.	IC-ISM-v2_1.XSD
Comprehensive	A comprehensive XSD with all DM2 concepts, including the optional concepts for the creation of "fit-for-purpose" views	Comp.XSD

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Exchange of DM2 PES XML Documents

The DM2 PES XML schema (XSD) provides a neutral format for data exchange between:

- EA databases.
- DoD Authoritative Source Databases (e.g., DoD Information Technology Portfolio Repository [DITPR]).
- Unified Profile for DoDAF and Ministry of Defence Architecture Framework (MODAF) (UPDM) and SysML-based Unified Markup Language (UML) Tools.
- Other Information Technology (IT) and enterprise architecture Tools.
- Modeling and Simulation Tools that are used in EA assessments, e.g., AoA's.
- Reporting Tools, e.g., for Chairman of the Joint Chief of Staff Instruction (CJCSI) or Department of Defense Instruction (DoDI) submission.
- Systems Engineering Tools.
- Other Federal agencies (e.g., Department of Homeland Security (DHS), Department of Justice (DoJ).
- Coalition partners and North Atlantic Treaty Organization (NATO).
- Other organizations with which DoD exchanges Enterprise Architecture (EA) data (e.g., industry, States, National Government Organizations [NGO's]).

This role is illustrated in the figure below.

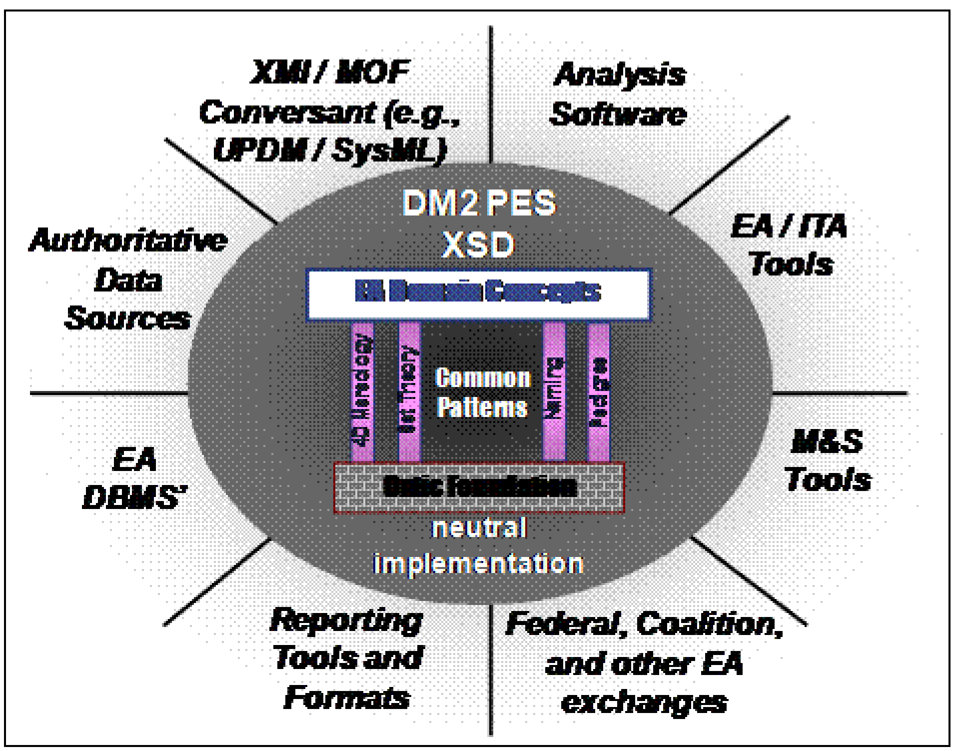
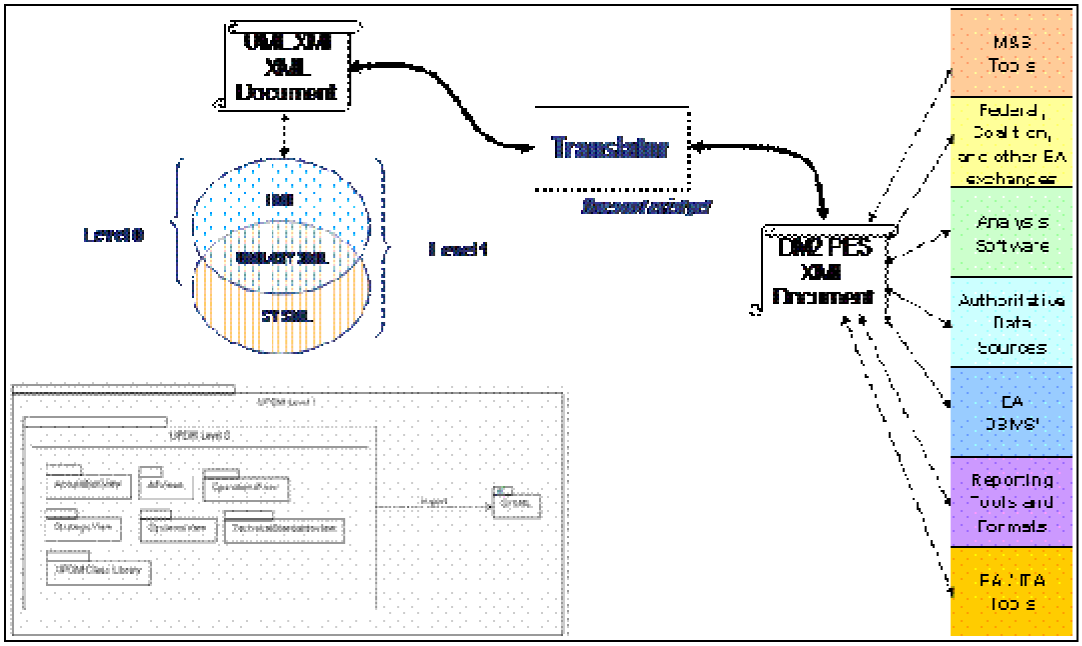


Illustration of DM2 Role in Providing a Neutral Model for Data Exchange

Note that within any particular community above, there may be a data exchange format particular to that community. A particularly important case is the UPDM-SysML XML Metadata Interchange (XMI) format for data exchange of UML models. XMI provides a neutral way to exchange model data, including diagram data, between UML tools. A universal DM2 PES to XMI translation will allow UPDM-SysML tools to interoperate with the other tools and data sources used in DoD EA.

The vision for the relationships between PES XSD, PES XML, XMI, UML, and SysML are illustrated in the figure below.



PES XSD, PES XML, XMI, UML, and SysML Relationships

The figure above shows on the left side is that UML and SYSML tools, when used in conjunction with UML4SYSML can export and import XMI XML files (documents). XMI files are relatively complex because they contain all the information to exchange complete UML models between UML tools, including diagram layout and implementation details. So a translator needs to be developed that will translate those XMI XML documents to and from DM2 PES XML documents that the non-XMI tools and databases can import and export. The non-XMI tools and databases categories are shown on the right side of the diagram. The reasoning for this approach is that one XMI-PES translator will serve for all the UPDM/SYSML tools and for non-XMI tools and databases the simple and tool-agnostic DM2 PES format will be used as the exchange standard.

Exchange of DM2 PES XML Documents

Architectural data will need to be exchanged between Architecture tools. Architectures developed in accordance with DoDAF V1.0 or V1.5 may need to exchange data with Architectures developed in accordance with DoDAF V1.0, V1.5, and V2.0.

DoDAF V1.0 and V1.0 architectures that use the Node concept will need to update the architecture to express the concrete concepts in place of the abstract concept that Node represents. When pre-DoDAF V2.0 architecture is compared with DoDAF V2.0 architecture, the concrete concepts that Node represents must be defined for the newer architecture.

The table below clarifies actions to be performed when exchanging information between Architectures developed on same or different versions of DoDAF.

Exchange Actions betweens Architectures

Architecture Source	Architecture Target	Actions
DoDAF V1.0 or V1.5	DoDAF V1.0 or V1.5	Use CADM as the exchange basis.

DoDAF V1.0 or V1.5	DoDAF V2.0	Determine the DoDAF V2.0 concepts of the Nodes in DoDAF V1.0 or V1.5 Architecture. Export the DoDAF V1.0 or V1.5 architectural data. As a step of the export, transform the DoDAF V1.0 or V1.0 Node concept into the appropriate DoDAF V2.0 concepts using DoDAF PES Import the architectural data in accordance to the PES into DoDAF V2.0 Architecture.
DoDAF V2.0	DoDAF V1.0 or V1.5	Determine the DoDAF V2.0 concepts of the Nodes in DoDAF V1.0 or V1.5 Architecture Export the DoDAF V2.0 architectural data. As a step of the export, transform the appropriate DoDAF V2.0 concepts into the appropriate DoDAF V1.0 or V1.0 Node concept. Import the architectural data in PES format into DoDAF V1.0 or V1.5 Architecture. Transformation into CADM format may be required.
DoDAF V2.0	DoDAF V2.0	Use PES as the exchange basis.

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Mapping of CADM Independent Entities to DM2 Data Elements

The table below indicates the alignment of the CADM independent entities (supertype or parent) to the DM2 data elements. The dependent entities (subtype entities or children) will map to the same DM2 data elements as their supertype entity or parent entity.

CADM Entity Name	CADM Entity Definition	DM2 Mappings	Mapping Notes
ACTION	(325/1) (A) AN ACTIVITY.	Activity	
ACTION-VERB	(11373/1) (A) A FUNCTION TO BE PERFORMED.	Activity	
ACTIVITY-MODEL-INFORMATION-ELEMENT-ROLE	(4182/2) (A) THE ROLE ASSIGNED TO AN INFORMATION-ELEMENT FOR A PROCESS-ACTIVITY IN A SPECIFIC ACTIVITY-MODEL.	N/A -- model artifact	
ACTIVITY-MODEL-PROCESS-ACTIVITY	(4188/3) (A) THE ASSOCIATION OF AN ACTIVITY-MODEL WITH A PROCESS-ACTIVITY.	describedBy	
ACTIVITY-MODEL-THREAD	(20160/1) (A) A PATH IN AN ACTIVITY-MODEL CONSISTING OF SEQUENTIAL INFORMATION FLOWS FROM ONE PROCESS-ACTIVITY TO ANOTHER.	Activity, activityResource Overlap, beforeAfter	
AGREEMENT	(332/1) (A) AN ARRANGEMENT BETWEEN PARTIES.	Agreement	
ANTENNA-TYPE	(6542/2) (A) THE CLASSIFICATION OF A DEVICE FOR THE COLLECTION OR RADIATION OF ELECTROMAGNETIC SIGNALS.	Materiel and powerType/superSubType	COI extension
	(19524/1) (A) THE STRUCTURE OF COMPONENTS, THEIR		

ARCHITECTURE	RELATIONSHIPS, AND THE PRINCIPLES AND GUIDELINES GOVERNING THEIR DESIGN AND EVOLUTION OVER TIME.	ArchitectureInformation	
ARCHITECTURE-ORGANIZATION	(19546/1) (A) THE RELATION OF AN ARCHITECTURE TO A SPECIFIC ORGANIZATION.	informationPedigree	
BATTLEFIELD-FUNCTIONAL-AREA-PROPONENT	(19563/1) (A) A DISCRETE AREA OF RESPONSIBILITY READILY IDENTIFIABLE BY FUNCTION PERFORMED WHICH CONTRIBUTES DIRECTLY TO BATTLEFIELD MANAGEMENT.	activityPerformerOverlap	COI extension
BUSINESS-SUBFUNCTION	(22594/1) (A) THE LOWER-LEVEL SET OF FUNCTIONS PERFORMED BY THE FEDERAL GOVERNMENT FOR A SPECIFIC LINE-OF-BUSINESS.	Activity, powerType/superSubType, wholePart	
CAPABILITY	(333/1) (A) AN ABILITY TO ACHIEVE AN OBJECTIVE.	Measure	
CAPABILITY-CATEGORY	(22750/1) (A) THE CLASS OF A CAPABILITY.	MeasureType	
COMMUNICATION-CIRCUIT	(19575/1) (A) A PATH USED FOR TRANSMITTING DATA.	System, Activity, beforeAfter	COI extension
COMMUNICATION-CIRCUIT-TYPE	(19576/1) (A) A KIND OF PATH USED FOR TRANSMITTING DATA.	System	COI extension
COMMUNICATION-LINK-TYPE	(19579/1) (A) A GENERIC KIND OF COMMUNICATION-LINK.	System and powerType/superSubType	COI extension
COMMUNICATION-MEANS	(19580/1) (A) A PHYSICAL OR ELECTROMAGNETIC INSTANTIATION OF TELECOMMUNICATIONS.	System	COI extension
COMMUNICATION-MEDIUM	(19582/1) (A) A MODE OF DATA TRANSMISSION.	Systems and overlap parts	COI extension
	(19585/1) (A) THE SPECIFICATION OF		

COMMUNICATION-SPACE-USE-CLASS	CATEGORIES OF UTILIZATION OF SPACE FOR TELECOMMUNICATION IN BUILDINGS AND OTHER FACILITIES.	Activity, Peformer, and performerTypeInstance Location	COI extension
COST-BASIS	(19590/1) (A) THE SPECIFICATION USED TO DETERMINE AN UNDERLYING EXPENSE.	MeasureType	
COUNTRY	(39/1) (A) A NATION OF THE WORLD.	Country	
DATA-ITEM-TYPE	(19595/1) (A) A KIND OF DATA-ITEM.	Data and powerType/superSubType	
DATA-REFERENCE	A SELECTION OF INSTANCES OF DATA THAT ARE FORMALLY CONTROLLED FOR DOD USE.	Data and Rule	Policy requirement rescinded
DECISION-MILESTONE	(20170/1) (A) A DECISION POINT THAT SEPARATES THE PHASES OF A DIRECTED, FUNDED EFFORT THAT IS DESIGNED TO PROVIDE A NEW OR IMPROVED MATERIAL CAPABILITY IN RESPONSE TO A VALIDATED NEED.	Activity	
DEFENSE-OCCUPATIONAL-SPECIALTY-CROSS-REFERENCE	(22526/1) (C) THE RELATIONSHIP OF THE DEPARTMENT OF DEFENSE OCCUPATIONAL CONVERSIONS TO SERVICE-SPECIFIC OCCUPATIONAL SPECIALTIES.	Skill	
DEPLOYMENT-LOCATION-TYPE	(19596/1) (A) THE CHARACTERIZATION OF A KIND OF GENERIC PLACE FOR DEPLOYED OPERATIONS.	Condition	
DISCOVERY-METADATA	(22757/1) (A) SPECIFICATION OF THE MEANING OF THE ATTRIBUTES OF ANY ENTITY THAT IS COMPRISED OF DATA.	powertype of Information	
DOCUMENT	(119/1) (A) RECORDED INFORMATION REGARDLESS OF PHYSICAL FORM.	Information	

EVENT	(49/1) (A) A SIGNIFICANT OCCURRENCE.	Activity	
EVENT-NODE-CROSS-LINK	(19978/1) (A) THE SPECIFICATION OF HOW A SPECIFIC EVENT FOR A SPECIFIC ORIGINATOR NODE TEMPORALLY RELATES TO ANOTHER TERMINATOR NODE SUBJECT TO A CONSTRAINT.	Activity, beforeAfter, temporalWholePart, overlap	
EVENT-TYPE	(12341/1) (A) A CATEGORY OF EVENT.	Activity and powerType/superSubType	
EXCHANGE-RELATIONSHIP-TYPE	(19608/1) (A) THE SPECIFICATION OF A CLASS OF PAIRING FOR INFORMATION EXCHANGE.	activityResourceOverlap and powerType/superSubType	
FACILITY	(334/1) (A) REAL PROPERTY, HAVING A SPECIFIED USE, THAT IS BUILT OR MAINTAINED BY PEOPLE.	Facility	
FACILITY-CLASS	(5742/1) (A) THE HIGHEST LEVEL OF REAL PROPERTY CLASSIFICATION BY THE DEPARTMENT OF DEFENSE.	Facility and powerType/superSubType	
FACILITY-IMPROVEMENT-ACTIVITY	(19541/1) (A) A PROCESS TO IMPROVE CAPABILITIES FOR A SPECIFIC FACILITY.	Project	COI extension
FACILITY-TYPE	(50/1) (A) A SPECIFIC KIND OF FACILITY.	Facility and powerType/superSubType	
FEDERAL-SERVICE-COMPONENT	(22751/1) (A) A SELF-CONTAINED BUSINESS PROCESS OR SERVICE WITH PREDETERMINED FUNCTIONALITY THAT MAY BE EXPOSED THROUGH A BUSINESS OR TECHNOLOGY INTERFACE.	Service	
	(22752/1) (A) A HIGH LEVEL CATEGORIZATION OF BUSINESS CAPABILITIES. Note: IT IS A BUILDING BLOCK OF THE FEDERAL		

FEDERAL-SERVICE-COMPONENT-TYPE	ENTERPRISE ARCHITECTURE SERVICE COMPONENT REFERENCE MODEL, WHICH IS A COMPONENT-BASED FRAMEWORK THAT PROVIDES--INDEPENDENT OF BUSINESS FUNCTION--A LEVERAGEABLE FOUNDATION TO SUPPORT THE REUSE OF APPLICATIONS, APPLICATION CAPABILITIES, COMPONENTS, AND BUSINESS SERVICES.	Service and powerType/superSubType	
FEDERAL-SERVICE-DOMAIN	(22754/1) (A) A HIGH-LEVEL VIEW OF THE SERVICES AND CAPABILITIES THAT SUPPORT ENTERPRISE AND ORGANIZATIONAL PROCESSES AND APPLICATIONS.	Service and powerType/superSubType	
FEDERAL-SERVICE-TYPE	(22755/1) (A) A GROUP OF SIMILAR CAPABILITIES THAT SUPPORT A SINGLE FEDERAL-SERVICE-DOMAIN.	Service and powerType/superSubType	
FUNCTIONAL-AREA	(4198/2) (A) A MAJOR AREA OF RELATED ACTIVITY.	Activity and powerType/superSubType	
FUNCTIONAL-PROCESS-FUNCTION	(22044/1) (A) A GENERAL CLASS OF ACTIVITY IN A SPECIFIC FUNCTIONAL-AREA.	Activity and powerType/superSubType	
GUIDANCE	(336/4) (A) A STATEMENT OF DIRECTION RECEIVED FROM A HIGHER ECHELON.	Guidance	
HAND-RECEIPT	(21353/1) (A) THE SPECIFICATION OF TRANSFER OF PROPERTY RESPONSIBILITY.	Information and powerType/superSubType	Not required in DoDAF 2
ICON-CATALOG	(19625/1) (A) A DIRECTORY OF IMAGES DEPICTED IN GRAPHICAL PRESENTATION	Information and powerType/superSubType	Not required in DoDAF 2

	SOFTWARE.		
ICON-DATA-CATEGORY	(22294/1) (A) A CLASSIFICATION OF ELEMENTS OF INFORMATION THAT APPLY TO ICONS WITHIN AN ICON-CATALOG.	Information and powerType/superSubType	Not required in DoDAF 2
IDENTIFICATION-FRIEND-FOE	(17031/1) (A) THE RECOGNIZED HOSTILITY CHARACTERIZATION OF A BATTLEFIELD OBJECT.	Performers whose dispositional Activities DesiredEffects dimishes ownforce DesiredEffect goals below a threshold	Not required in DoDAF 2
IMPLEMENTATION-TIME-FRAME	(19731/1) (A) THE SPECIFICATION OF A GENERAL CHRONOLOGICAL PERIOD FOR THE INSTANTIATION OF A CONCEPT, SYSTEM, OR CAPABILITY.	Project, an Activity within (Instantiation) and timePeriod of that Activity related to an activityResourceOverlap where the Resource is a System or Performer that manifests a Capability	
INFLATION-FACTOR	(19732/1) (A) ADJUSTMENTS TO COSTS THAT DEPEND ON FISCAL YEAR.	MeasureType	
INFORMATION-ASSET	(4246/3) (A) AN INFORMATION RESOURCE.	Information and, if needed, System and wholePart	
INFORMATION-ELEMENT	(4199/2) (A) A FORMALIZED REPRESENTATION OF DATA SUBJECT TO A FUNCTIONAL PROCESS.	Information, Performer, and Rule (In CADM, an Information Element is really an IDEF0 ICOM.)	
INFORMATION-TECHNOLOGY-REGISTRATION	(20501/1) (A) THE IDENTIFICATION OF A MISSION-CRITICAL/MISSION-ESSENTIAL INFORMATION TECHNOLOGY SYSTEM OR OTHER ASSET.	A type of Information (Registration) that describes a System and that possibly has been consumed by a registrar (type of Performer) after have been produced by a registrant, possibly in response to a Rule.	Not required in DoDAF 2
INFORMATION-TECHNOLOGY-STANDARD-CATEGORY	(20513/1) (A) A CLASSIFICATION OF INFORMATION-TECHNOLOGY-STANDARD.	Type of Standard	
INTERNAL-DATA-MODEL-TYPE	(9289/2) (A) A CLASSIFICATION OF AN INTERNAL-DATA-	Type of Data	COI extension

	MODEL.		
INTERNET-ADDRESS	(19762/1) (A) THE SPECIFICATION OF A VALUE OR RANGE OF VALUES CONSTITUTING THE LABEL FOR A NODE ON THE INTERNET.	Type of Address	COI extension
LANGUAGE	(2228/1) (A) A MEANS OF COMMUNICATION BASED ON A FORMALIZED SYSTEM OF SOUNDS AND/OR SYMBOLS.	Type of Rule or Standard	COI extension
LINE-OF-BUSINESS	(22593/1) (A) THE TOP-LEVEL SET OF FUNCTIONS PERFORMED BY THE FEDERAL GOVERNMENT.	Activity and powerType/superSubType	
LOCATION	(343/2) (A) A SPECIFIC PLACE.	Location	
MATERIEL	(337/1) (A) AN OBJECT OF INTEREST THAT IS NON-HUMAN, MOBILE, AND PHYSICAL.	Materiel	
MATERIEL-TYPE	(787/1) (A) A CHARACTERIZATION OF A MATERIEL ASSET.	Materiel and powerType/superSubType	
MATERIEL-TYPE-PRODUCTION	(733/2) (A) A MATERIEL-ITEM THAT IS IDENTIFIED BY PRODUCER OR INDUSTRY MANUFACTURER.	Materiel, activityResource Overlap, and activity Performer	COI extension
MILITARY-PLATFORM	(22100/1) (A) AN OBJECT FROM WHICH OR THROUGH WHICH MILITARY TASKS CAN BE CONDUCTED.	Performer	
MILITARY-TELECOMMUNICATION-USE	(19773/1) (A) THE CHARACTERIZATION OF SPECIFIC USE-DEPENDENT BUT FACILITY-INDEPENDENT PARAMETERS FOR ESTIMATING THE COMMUNICATIONS, WIRING, AND EQUIPMENT REQUIRED BY MILITARY OCCUPANTS OF FACILITIES.	Performer and wholePart of Organization, Materiel, and System	COI extension
	(42/2) (A) A MILITARY-UNIT ACCORDING TO A		

MILITARY-UNIT-LEVEL	STRATUM, ECHELON, OR POINT WITHIN THE MILITARY COMMAND HIERARCHY AT WHICH CONTROL OR AUTHORITY IS CONCENTRATED.	Measure, MeasureType, and a subtype of resourceTypeInstance OfMeasure	
MISSION	(1/3) (A) THE TASK, TOGETHER WITH THE PURPOSE, THAT CLEARLY INDICATES THE ACTION TO BE TAKEN.	Activities and DesiredEffect	
MISSION-AREA	(2305/1) (A) THE GENERAL CLASS TO WHICH AN OPERATIONAL MISSION BELONGS.	Activities, DesiredEffect, and powerType/superSubType	
MODELING-AND-SIMULATION-JUSTIFICATION	(19776/1) (A) A STATEMENT PROVIDING RATIONALE TO JUSTIFY REQUIREMENTS FROM THE POINT OF VIEW OF MODELING AND SIMULATION.	description of DesiredEffects and Performer dispositions	Not required in DoDAF 2
NETWORK	(10972/1) (A) THE SPECIFICATION FOR THE JOINING OF TWO OR MORE NODES FOR A SPECIFIC PURPOSE.	Systems and overlaps	
NETWORK-CONTROLLER-TYPE	(20591/2) (A) THE KIND OF FUNCTIONAL PROPONENT WHO EXERCISES AUTHORITY OVER A NETWORK.	Person Type or Organization Type	
NETWORK-ECHELON	(22486/1) (A) THE NORMAL OPERATIONAL LEVEL SUPPORTED BY A NETWORK.	System, Organization Type, and overlap	
NETWORK-TYPE	(11570/1) (A) A SPECIFIC KIND OF NETWORK.	System (made up of Systems and overlaps) and powerType/superSubType	
NODE	(956/1) (A) A ZERO DIMENSIONAL TOPOLOGICAL PRIMITIVE THAT DEFINES TOPOLOGICAL RELATIONSHIPS.	EffectObject	
NODE-ASSOCIATION	(19796/1) (A) AN ASSOCIATION OF ONE SPECIFIC NODE TO ANOTHER NODE.	could be wholePart, superSubType, overlap, or beforeAfter	

NODE-LINK-ASSOCIATION	(20498/1) (A) THE ASSOCIATION OF ONE NODE-LINK WITH ANOTHER NODE-LINK.	usually wholeParts or overlaps	
NODE-SYSTEM	(19840/1) (A) THE ASSOCIATION OF A SPECIFIC NODE WITH A SPECIFIC SYSTEM.	System and overlaps with other types of Nodes	
NODE-SYSTEM-ASSET-OWNERSHIP	(20009/1) (A) THE POSSESSION, IN WHOLE OR PART, OF THE OBJECTS OF VALUE ASSOCIATED TO A SPECIFIC NODE-SYSTEM.	Organization, Resources, Rule, and activityResourceOverlap	
NODE-SYSTEM-COST-MANAGEMENT	(20011/1) (A) THE AMOUNTS ASSOCIATED WITH VARIOUS ASPECTS OF THE MANAGEMENT OF A NODE-SYSTEM.	System, resourceType Instance OfMeasure, and possibly Location	
OCCUPATION	(2009/1) (A) A FIELD OF WORK.	Person Type	
OPERATIONAL-CONDITION	(19589/1) (A) A VARIABLE OF THE OPERATIONAL ENVIRONMENT OR SITUATION IN WHICH A UNIT, SYSTEM, OR INDIVIDUAL IS EXPECTED TO OPERATE THAT MAY AFFECT PERFORMANCE.	Condition	
OPERATIONAL-DEPLOYMENT-MISSION-TYPE	(19848/1) (A) THE KIND OF HIGH-LEVEL TASKING FOR DEPLOYED OPERATIONS.	Activity and powerType/superSubType	
OPERATIONAL-DEPLOYMENT-PHASE	(19849/1) (A) A STAGE OF THE OPERATIONAL ACTIVITIES CONDUCTED FOR DEPLOYED OPERATIONS.	Activities, temporalWholePart, and beforeAfter	
OPERATIONAL-FACILITY-ECHELON	(19853/1) (A) A SUBDIVISION OF A HEADQUARTERS (OR) A SEPARATE LEVEL OF COMMAND AS IT APPLIES TO AN OPERATIONAL-FACILITY.	Measure associated with Organization	
	(19854/2) (A) THE AGENT RESPONSIBLE	Organization, Facility,	

OPERATIONAL-FACILITY-PROPONENT	FOR REQUIREMENTS DEVELOPMENT OF OPERATIONAL FACILITIES.	Rule, and activityResourceOverlap	
OPERATIONAL-MISSION-THREAD	(19857/1) (A) AN IDENTIFIED INFORMATION EXCHANGE SEQUENTIAL PROCEDURE TO SUPPORT TASK EXECUTION BY INFORMATION SYSTEMS AND ORGANIZATION-TYPES.	Activities, temporalWholePart, overlaps, and beforeAfter and their System and Organization Type Performers	
OPERATIONAL-ROLE	(22459/1) (A) THE SPECIFICATION OF A SET OF ABILITIES REQUIRED FOR PERFORMING ASSIGNED ACTIVITIES AND ACHIEVING AN OBJECTIVE.	Activities, DesiredEffect, and activityTypeInstance OfMeasure	
OPERATIONAL-SCENARIO	(19860/1) (A) A CONCEPT AND SCRIPT FOR POSSIBLE EVENTS AND ACTIONS FOR MILITARY OPERATIONS.	Activities, Performers, beforeAfter, temporal WholePart, overlap (in an possible or future time)	
ORGANIZATION	(345/1) (A) AN ADMINISTRATIVE STRUCTURE WITH A MISSION.	Organization	
ORGANIZATION-ASSOCIATION	(1077/1) (A) AN ASSOCIATION OF AN ORGANIZATION WITH ANOTHER ORGANIZATION.	could be wholePart, superSubType, overlap, or beforeAfter	
ORGANIZATION-TYPE	(892/2) (A) A CLASS OF ORGANIZATIONS.	Organization Type	
ORGANIZATION-TYPE-ASSOCIATION	(9211/1) (A) THE ASSOCIATION OF AN ORGANIZATION-TYPE WITH ANOTHER ORGANIZATION-TYPE.	could be wholePart, superSubType, overlap, or beforeAfter	
PERIOD	(1321/1) (A) INTERVAL OF TIME.	temporalMeasure	
PERSON-TYPE	(897/2) (A) A CLASS OF PERSONS.	PersonType	
POINT-OF-CONTACT	(19867/1) (A) A REFERENCE TO A POSITION, PLACE, OFFICE, OR INDIVIDUAL ROLE IDENTIFIED AS A PRIMARY SOURCE FOR	Person	

	OBTAINING INFORMATION.		
POINT-OF-CONTACT-TYPE	(22039/1) (A) A KIND OF POINT-OF-CONTACT.	PersonType	
POSITION	(2112/1) (A) A SET OF ESTABLISHED DUTIES.	PersonType, Activities, and activityPerformerOverlap	
PROCESS-ACTIVITY	(4204/3) (A) THE REPRESENTATION OF A MEANS BY WHICH A PROCESS ACTS ON SOME INPUT TO PRODUCE A SPECIFIC OUTPUT.	Activity	
PROCESS-ACTIVITY-FUNCTIONAL-PROCESS	(22043/1) (A) THE MEANS BY WHICH TO CARRY OUT A HIGH-LEVEL FUNCTION.	Activity	
PROCESS-STATE-VERTEX	(20025/1) (A) THE ABSTRACTION OF AN OBSERVABLE MODE OF BEHAVIOR.	Activity	
RECORD-TRACKING	(19871/1) (A) INFORMATION REGARDING A SPECIFIC RECORD IN A TABLE OF DATA.	N/A -- modeling artifact	Not required in DoDAF 2
REGIONAL-COST-FACTOR	(19544/1) (A) THE EXPECTED EXPENSE MODIFICATION FOR A GEOGRAPHIC AREA THAT ACCOUNTS FOR SPECIFIC LOCAL COSTS IN RELATION TO A NATIONAL AVERAGE.	MeasureType	
RELATION-TYPE	(6515/2) (A) AN ASSOCIATION BETWEEN OBJECTS THAT DEFINES AN INFORMATION ASSET.	dataAssociation	
ROOM-TYPE	(5605/1) (A) A KIND OF A ROOM.	Facility and powerType/superSubType	COI extension
RULE-MODEL-OPERATIONAL-RULE	(20032/1) (A) AN ASSOCIATION OF A SPECIFIC RULE-MODEL WITH A SPECIFIC OPERATIONAL-RULE.	ArchitectureDescription, describedBy, and Rules	
	(14361/1) (A) A MAN-MADE BODY WHICH REVOLVES AROUND AN ASTROMETRIC-ELEMENT AND WHICH HAS A		COI

SATELLITE	MOTION PRIMARILY DETERMINED BY THE FORCE OF ATTRACTION OF THAT ASTROMETRIC-ELEMENT.	Type of Materiel	extension
SECURITY-ACCESS-COMPARTMENT	(16224/2) (A) THE SPECIFICATION OF AN EXCLUSION DOMAIN FOR INFORMATION RELEASED ON A FORMALLY RESTRICTED BASIS (E.G., TO PROTECT SOURCES OR POTENTIAL USE).	IC-ISM	
SECURITY-CLASSIFICATION	(940/2) (A) THE LEVEL ASSIGNED TO NATIONAL SECURITY INFORMATION AND MATERIAL THAT DENOTES THE DEGREE OF DAMAGE THAT ITS UNAUTHORIZED DISCLOSURE WOULD CAUSE TO NATIONAL DEFENSE OR FOREIGN RELATIONS OF THE UNITED STATES AND THE DEGREE OF PROTECTION REQUIRED.	IC-ISM	
SKILL	(2226/1) (A) AN ABILITY.	Skill	
SOFTWARE-LICENSE	(1856/1) (A) THE STIPULATION(S) (AND LEGAL TERMS) BY WHICH THE SOFTWARE MAY BE USED.	Type of Agreement	
SYSTEM	(326/1) (A) AN ORGANIZED ASSEMBLY OF INTERACTIVE COMPONENTS AND PROCEDURES FORMING A UNIT.	System	
SYSTEM-ASSOCIATION	(12546/1) (A) AN ASSOCIATION BETWEEN A SYSTEM AND ANOTHER SYSTEM.	could be wholePart, superSubType, overlap, or beforeAfter	
SYSTEM-STATUS	(19891/1) (A) THE SPECIFICATION OF THE CONDITION OF A SYSTEM AT A SPECIFIC POINT IN TIME.	generally typeInstances	
	(19892/1) (A) THE	The overlaps,	

SYSTEM-STATUS-DEPENDENCY	MANNER IN WHICH ONE SYSTEM-STATUS DEPENDS ON ANOTHER SYSTEM-STATUS.	beforeAfters, and temporalWholeParts of the objects for which systemTypeInstanceOf applies	
SYSTEM-STATUS-TYPE	(22098/1) (A) THE SPECIFICATION OF A KIND OF DEVELOPMENT OR TRANSITION OF ONE OR MORE SYSTEMS.	The powerType/super SubType of the objects for which systemTypeInstanceOf applies	
SYSTEM-TYPE	(9083/2) (A) A SPECIFIC KIND OF SYSTEM.	System and powerType/superSubType	
TASK	(290/2) (A) A DIRECTED ACTIVITY.	Activity	
TECHNICAL-INTERFACE	(21694/1) (A) A GENERIC CONNECTION BETWEEN TWO ELEMENTS THAT IMPLEMENT INFORMATION TECHNOLOGY IN WHICH INFORMATION IS CAPABLE OF BEING TRANSMITTED FROM THE SOURCE ELEMENT TO THE DESTINATION ELEMENT.	activityResourceOverlap and the Performers the perform the consuming and producing of the information	
TECHNICAL-INTERFACE-TYPE	(19761/1) (A) A KIND OF GENERIC CONNECTION BETWEEN ELEMENTS THAT IMPLEMENT INFORMATION TECHNOLOGY.	a powerType/superSubType on the TECHNICAL-INTERFACE	
TECHNICAL-SERVICE	(19676/1) (A) A DISTINCT PART OF THE SPECIALIZED FUNCTIONALITY THAT IS PROVIDED A SYSTEM ELEMENT ON ONE SIDE OF AN INTERFACE TO A SYSTEM ELEMENT ON THE OTHER SIDE OF AN INTERFACE.	activityResourceOverlap and the Performers the perform the consuming and providing service	
TECHNICAL-SERVICE-AREA	(19677/2) (A) A FIELD OF SPECIALIZED FUNCTIONALITY, USUALLY SPECIFIED BY A REFERENCE-MODEL TO DEFINE INTERFACES.	a powerType/superSubType on the TECHNICAL-SERVICE-AREA	
	(20043/2) (A) A		

TECHNICAL-STANDARD-FORECAST-ELEMENT	SECTION OF A SPECIFIC TECHNOLOGY-STANDARD-FORECAST, WHICH CITES A TECHNICAL-SERVICE, TIME FRAME, OR INFORMATION-TECHNOLOGY-STANDARD.	Standard with future date and pedigree of the forecaster	
TECHNOLOGY	(8936/1) (A) THE APPLICATION OF SCIENCE TO MEET ONE OR MORE OBJECTIVES.	Technology (TBD)	
TECHNOLOGY-FORECAST	(20078/1) (A) A DETAILED DESCRIPTION OF EMERGING TECHNOLOGIES.	Technology with future date and pedigree of the forecaster	
TELEPHONE-ADDRESS	(1938/1) (A) AN ELECTRONIC ADDRESS THAT SUPPORTS COMMUNICATION VIA TELEPHONIC MEDIA.	Type of Address	COI extension
TRANSITION-PROCESS	(20082/1) (A) THE DESCRIPTION OF A METHOD FOR RELATING A "SOURCE" PROCESS-STATE-VERTEX TO A "TARGET" PROCESS-STATE-VERTEX.	Activities, wholeParts, and beforeAfters, with some possibly in the future	
UML-MODEL-ELEMENT	(22684/1) (D) A BASIC ARTIFACT OF THE UNIFIED MODELING LANGUAGE. Comment: USED TO CONSTUCT DIAGRAMS FOR EACH TYPE OF UML-MODEL..	N/A -- modeling artifact	
UNIFORMED-SERVICE-ORGANIZATION-COMPONENT-TYPE	(2726/2) (A) A SPECIFIC KIND OF SUBDIVISION OF A UNIFORMED-SERVICE-ORGANIZATION.	Type of OrganizationType	
UNIT-OF-MEASURE	(2482/2) (A) THE INCREMENT BY WHICH MATTER IS MEASURED.	MeasureType	

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Manager

Introduces DoD architecture concepts to the Decision-Makers (Consumers) and Process-Owners (Executives, Senior Management, Subject Matter Experts, Project Directors, & Managers) and provides general guidance for development, use, and management of DoD architectures. Intended to help non-technical users understand the role of architecture in support of major decision support processes. Includes the 6-step Architecture Development Process methodology (with the Decision-Makers's roles and responsibilities) that can be used to develop architectures at all levels of the Department, and a Conceptual Data Model for organizing data and derived information collected by an architecture effort.

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Architect

For Architects, Program Managers, Portfolio Managers, and other technically oriented architecture users, describes the 6-step Architecture Development Process methodology (with the Architect's roles and responsibilities) that can be used to develop architectures at all levels of the Department. Describes the Meta-model data groups of the DoDAF Meta-model Logical Data Model, and their associated DoDAF-described Models. The Logical Data Model introduces the relationships and associations needed by data modelers and technical designers.

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Developer

Both for the developers of the tools that automate and enable the capture, modeling and exchange of architectural descriptions and architectural data and the developer of software, systems and services that are defined by the architecture, introduces the Physical Exchange Specification (PES) that relates the Conceptual Data Model structure, Logical Data Model relationships, associations, and business rules for the exchange of architectural data. The PES provides the constructs needed to enable exchange of data and derived information among users.

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DoDAF News/Events

DoD EA Conference 2010
San Antonio, TX May 10-14
Register at:
www.dodenterprisearchitecture.org
Co-hosted by DoD CIO Enterprise Architecture & Standards and Joint Staff

Director's Corner

Welcome to the DoDAF Journal. It is the electronic interface for DoDAF support, provides a place for submitting future change requests to DoDAF or the DM2, and provides examples.

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DoDAF Journal is the electronic interface for DoDAF support, provides a place for submitting future change requests to DoDAF or the DM2, and provides examples. 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 DoDAF V2.0. The DoDAF Journal is comprised of:

- The DoDAF CM Process and provides the means to submit, review, and comment on the adjudication of formal changes to DoDAF. It 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.
- An architecture community of practice 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.

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DoDAF V2.0 Sitemap

Introduction, Overview, and Concepts: Introduces DoD architecture concepts and provides general guidance for development, use, and management of DoD architectures to help non-technical users understand the role of architecture in support of major decision support processes. The Primary audiences are Executives, Project Directors, & Managers. The resources are:

- An introduction and vision for DoDAF.
- Defining “Fit-for-Purpose” Architectures.
- An overview of the Framework, DoDAF-based architecture development guidelines, and the historical background for DoDAF.
- An Introduction to Enterprise Architecture, Federated Architecting, and Architecture Enterprise Services, and an introduction to the Federal Enterprise Architecture published by the OMB.
- An overview for architecture planning.
- Addressing customer requirements in architecture development.
- Methodology for architecture development.
- Presentation methods and graphical views.
- The DM2 Conceptual Model.
- Analytics in support of architecture-based management analysis.
- Security considerations for Architecture
- Guidance on configuration management (CM) of architectures, and the CM process for DoDAF.
- Relationships among DoDAF and other architecture frameworks.

Architectural Data and Models. Describes the Meta-model data groups, and their associated models from a technical viewpoint. The primary audience are architects, program managers, portfolio managers, and other technically oriented architecture users. The resources are:

- The Logical Data Model and the Meta-model Data Groups.
- Mapping of Meta-Model Groups to Core Processes
- DoDAF Views and Models.
- Mapping of DM2 concepts to DoDAF-described Models.

DoDAF Meta-model Physical Exchange Specification (DM2 PES). Relates the CDM structure, LDM relationships, associations, and business rules. The PES provides the constructs needed to enable exchange of data and derived information among users and COIs.

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