DoDAF 2.0 Viewpoints, Views, and Models

After extensively covering architecture development, now it is time to explore the nitty-gritty of the DoDAF 2.0 viewpoints and models. Use this as an opportunity to briefly introduce the students to each model. There is no need to go into every little detail of every model at this point in time. Utilize the case study you develop to explore the viewpoints and models in greater depth. Also, the DoDAF 2.0 website is a tremendous resource for your students. If they are having a difficult time mastering viewpoints and views, direct them to the website where all viewpoints and views are thoroughly discussed.

- All Viewpoint (required) (AV)
- Capability Viewpoint (CV)
- Data and Information Viewpoint (DIV)
- Operation Viewpoint (OV)
- Project Viewpoint (PV)
- Services Viewpoint (SvcV)
- Standards Viewpoint (STDV)
- Systems Viewpoint (SV)
- Models

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 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.

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:

- 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.
- 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.

All Viewpoints and Models

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 architectural 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.

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.

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

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

Scope

The 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

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

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

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

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

Assumptions and Constraints as well as the architecture development schedule including start date, development milestones, date completed, and other key dates should be included. 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

The Findings section 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

Costs include 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

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, or any listed in Architecture Resources, 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, 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.

Capability Viewpoints and Models

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.

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

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.

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.

CV-3: Capability Phasing: 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).

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.

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.

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.

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 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.

Data and Information Viewpoint and Models (again, chart for appendix on website)

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.

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.

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

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 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-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.
    - 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-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.
- 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.

Operational Viewpoint and Models (again, chart for appendix)

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?
- 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.

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.

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 battle space 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-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 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.

An 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.

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 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.

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 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.

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.

Detailed Description:

The OV-5a and OV-2 Operational Resource Flow Description model are, to a degree, complements of each other. The OV-5a 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 activities (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.

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

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 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.

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 state chart 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.

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.

Project Viewpoint and Models

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.

Mappings of the Project 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 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?

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.

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 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 road mapping.

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-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.

Services Viewpoint and Models

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.

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.

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 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-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-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.

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).
- 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.

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.

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.

SvcV-5: Operational Activity to Service 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 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.

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 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.

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.

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.

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 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 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.

Introduction to SvcV-10a, SvcV-10b and SvcV-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 service functions described in SvcV-4 Services Functionality Description).

Behavioral modeling and documentation are key to a successful Architectural Description, because it is about 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.

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-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 state chart 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.” 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 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 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-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.

Standards Viewpoint and Model

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.

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.

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 needed 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.
- 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.

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 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.

Systems Viewpoint and Models

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.

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.

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 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.

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.

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.

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 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).

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 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.

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.

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.

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 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.

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.

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.

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 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.

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.

SV-10a: Systems Rules Models

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.

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 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-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.

Models (refer to appendix for table)

- Model List
- Model Categories
- Level of Architecture
- Architecture Interrogatives
- Architecture Primitives
- Mapping to DM2

Model List

Table 3.1
DoDAF 2.0 Models

Models	Descriptions
AV-1: Overview and Summary Information	Describes a Project's Visions, Goals, Objectives, Plans, Activities, Events, Conditions, Measures, Effects (Outcomes), and produced objects.
AV-2: Integrated Dictionary	An architectural data repository with definitions of all terms used throughout the architectural data and presentations.
CV-1: Vision	The overall vision for transformational endeavors, which provides a strategic context for the capabilities described and a high-level scope.
CV-2: Capability Taxonomy	A hierarchy of capabilities which specifies all the capabilities that are referenced throughout one or more Architectural Descriptions.
CV-3: Capability Phasing	The planned achievement of capability at different points in time or during specific periods of time. The CV-3 shows the capability phasing in terms of the activities, conditions, desired effects, rules complied with, resource consumption and production, and measures, without regard to the performer and location solutions.
CV-4: Capability Dependencies	The dependencies between planned capabilities and the definition of logical groupings of capabilities.
CV-5: Capability to Organizational Development	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

Mapping	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 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.
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.

Model Categories

See Figure 3.1 on page 14 of the Appendix.

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.

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.

Architecture Interrogatives (appendix)

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).

Table 3.2 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.

Table 3.2
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 *in the appendix*:

- 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 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.

Mapping to DM2 (appendix)

A mapping of the DM2 Concepts (classes), Associations (relationships), and Attributes to DoDAF-described Models, is shown in *Figure3.2 on page 15 of the Appendix*. 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.