



Office of the
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Vocabulary-Driven Enterprise Architecture Development Guidelines for DoDAF AV-2: Design and Development of the Integrated Dictionary

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Version History

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Acronym List

Acronym	Definition
AV-2	All Viewpoint 2: Integrated Dictionary
BTA	Business Transformation Agency
C.A.R.P.	Capability, Activity, Resource, Performer
COI	Community Of Interest
CV	Capability Viewpoint
DARS	Department of Defense Architecture Registry System
DIV	Data and Information Viewpoint
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
DM2	DoDAF Meta Model
DMR	DoD Metadata Registry
EA	Enterprise Architecture
OV	Operational Viewpoint
SvcV	Services Viewpoint
SV	Systems Viewpoint

Executive Summary

This document describes *Vocabulary-Driven Architecture Development*, providing a process for AV-2 development of a controlled vocabulary focused on a central set of key concepts from the DoDAF v2.0 Meta Model (DM2). This central core of DM2 concepts provides a common ground across different architectures to enable architecture federation and re-use.

This report also provides guidance on constructing the AV-2 Integrated Dictionary DoDAF-described Model with a method driven by a clear consistent vocabulary for a core set of architecture models and views that explicitly identifies AV-2 terms with the concept they represent in the DoDAF Meta Model (DM2).

1 Introduction

1.1 Vocabulary-Driven Architecture Development

The AV-2 Integrated Dictionary DoDAF-described Model defines the terms used in a DoDAF architecture description. Its purpose is to serve as a common vocabulary and consistent terminology reference for architecture models, derived 'fit for purpose' views, and other architectures to provide unambiguous architecture concepts for architecture model developers and users. The current state of AV-2 construction in DoDAF development results in architectures that typically require additional effort to integrate the various models and are difficult to federate with other DoDAF architectures. This current practice suggests a number of changes leading towards a *Vocabulary-Driven* approach to development of DoDAF Architectures where:

- AV-2 definition leads the architecture development effort, providing a clear, common, controlled vocabulary for architects to use as they develop the architecture models and views.
- The AV-2 can provide a validation instrument for the architecture based on explicit relationships between the AV-2 contents and other DoDAF architecture models and views. AV-2 terms should be identified with the concept they represent in the DoDAF Model (DM2). Since DoDAF V2.0 provides a mapping of DM2 concepts to DoDAF-described models, the presentation of this mapping in the AV-2 View can support coverage and completeness analysis.
- AV-2 terms and relationships are stored in a repository with data management capabilities that allows data persistency for future reference and reuse and supports reasoning over the terms, definitions, and relationships among terms of the architecture.

1.2 The Current State of AV-2 Construction

The *Vocabulary-Driven Architecture Development* approach differs from current practice for developing the AV-2 Integrated Dictionary DoDAF-described Model, which typically has several weaknesses:

- The AV-2 is typically a derived view that does not lead development efforts. To date, AV-2 dictionary is commonly derived from existing architecture models and typically generated 'after the fact', i.e. after other architecture views are completed. However, a generation of architecture models from an AV-2 is typically not possible, i.e., while an AV-2 can be derived from a DIV-2 (data model) it is significantly more difficult to generate a DIV-2 from an existing AV-2.
- The relationship between AV-2 contents and other architecture models and views is through the DM2. The identification of individual terms in an AV-2 View with the concepts they represent in the underlying DoDAF Meta Model (DM2) is typically not explicit. This implies that an architect cannot check the completeness of architecture views against a list of mandatory concepts set by architecture users in an AV-2 or analyze the coverage of the architecture views against the concepts of the DM2 to discover of linkages (or the lack thereof) between architecture models.
- The AV-2 is typically a simple table structure that neglects data management capabilities provided by other representations, such as the cross-referencing of terms, extensions of pre-populated AV-2s, and/or the reuse of common definitions. This means that a user cannot browse or reason about relationships among terms, and increases the risk that terminology conflicts go unnoticed and create ambiguities and inaccuracies in the resulting architecture.

2 Vocabulary-Driven DoDAF Architecture Development

An initial version of the AV-2 Integrated Dictionary should be developed at the beginning of any DoDAF architecture project to precisely define key terms and gain clarity over the scope, objectives and constraints of the architecture. This initial AV-2 provides a baseline to be refined and expanded in an iterative fashion throughout the architecture development process. The end result is a controlled vocabulary that is harmonized across the architecture and drives development of the various DoDAF described models and ‘fit for purpose’ views.

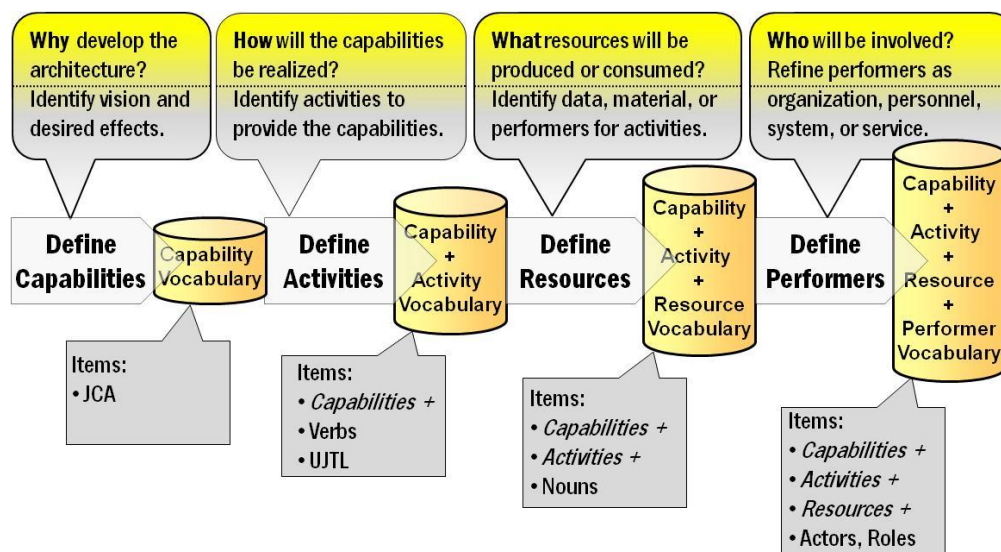
A controlled vocabulary drives development of integrated and federated architectures. By focusing on a core set of common concepts across all architectures, the vocabulary-driven development process encourages use of a common term for the same concept. This results in an integrated architecture where the same concept has the same name and definition across the multiple DoDAF-described models and views.

2.1 The C.A.R.P. Method: Central Points in the DM2

The initial AV-2 provides a baseline to be refined and expanded in an iterative fashion throughout the architecture development process. The C.A.R.P. method to produce a baseline AV-2 is embedded within a more general process for AV-2 development outlined in Appendix C. To support the major objective of architecture federation, the core AV-2 content for all DoDAF architecture should be focused on a central common foundation of concepts relevant to the domain of any DoDAF architecture. The starting points correspond to central key elements of the DM2:

- Capability (“why”): The ability to achieve a desired effect under specified [performance] standards and conditions through combinations of ways and means [activities and resources] to perform a set of activities. Capabilities describe the desired functionality of architecture.
- Activity (“how”): Work, consisting of atomic or composite steps that transform resources to achieve an objective/provide a capability. Activities describe the processes and procedures carried out to actively change an EffectObject, i.e. a target resource.
- Resource (“what”): Data, Information, Performers, Materiel, or Personnel Types that are produced or consumed.
- Performer (“who”): Any entity - human, automated, or any aggregation of human and/or automated - that performs an activity and provides a capability.

Figure 2-1: C.A.R.P. in the DM2



Additional guidance for the AV-2 representation of these central DM2 elements is provided in Appendix A. Since DoDAF prescribes a mapping from DM2 elements to architecture models, an initial set of identified DM2 elements suggests additional architecture models relevant to those concepts that the architect may develop using formal modeling methods for more comprehensive data collection.

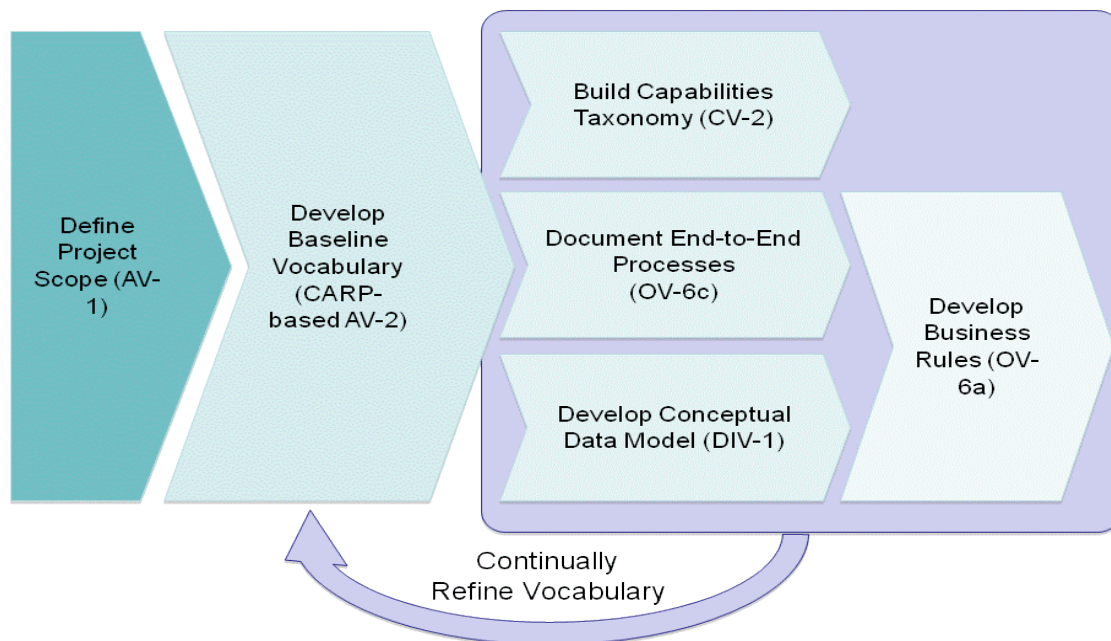
2.1.1 Procedural Model for Architecture Development

The C.A.R.P. method suggests a simple progression of model development for vocabulary-driven enterprise architecture focused on a minimal set of DoDAF-described models. This procedure starts by capturing basic overview and summary information represented in the AV-1 DoDAF-described Model describing the vision, goals and scope of the project.

The next step is development of a baseline vocabulary driven by the C.A.R.P. method. This baseline AV-2 provides an initial vocabulary used to ‘bootstrap’ and drive the development of subsequent DoDAF-described models. Terms and definitions recorded in the baseline AV-2 are used to describe the Capability Taxonomy (CV-2), the end-to-end business process that is the Event-Trace Description (OV-6c), the Conceptual Data Model (DIV-1), and the Operational Rules Model (OV-6a). Additional Operational Viewpoint (OV) models may be created as needed, e.g. OV-2, OV-5a. Also, certain Systems and Services Viewpoint (SV and ScV) models may be produced as more detailed refinements of OV models, e.g. OV-6c refined to SV-10c.

The initial baseline vocabulary is continually refined throughout the model development process. New terms and definitions beyond those captured in the baseline AV-2 but required to fully represent a DoDAF-described model are added to the AV-2, while terms and definitions already in the baseline AV-2 may be refined and clarified with a better understanding of the concepts achieved through their use in the more detailed DoDAF-described models.

Figure 2-2: Minimal Model Development Procedure



2.1.2 Implications for Other DoDAF Described Models

The content of C.A.R.P. maps directly to several DoDAF-described models. The CV-2 DoDAF-described model is a taxonomy of terms and definitions describing the intended capability. A vocabulary to describe *Capabilities* is essentially the CV-2 capability taxonomy. The OV-5a DoDAF-described model is an activity decomposition providing a taxonomy of terms and definitions for the activities necessary to deliver an intended capability. A vocabulary to describe *Activities* corresponds directly to the OV-5a Operational Activity Decomposition Tree, and influences the complementary OV-2 Operational Resource description. Together with terms and definitions for related *Resources* and *Performers*, this core controlled vocabulary drives coherent development of an integrated OV-

6c DoDAF-described process model, along with the related OV-6a Operational Rules Model and DIV-2 Logical Data Model. Furthermore, a *Resource/Performer* vocabulary defining operational system and service functions corresponds directly to and drives the SV-4 System Functional Description and SvcV-4 Services Functionality Description Models.

2.1.3 DM2 and Architecture Methods

DoDAF v2.0 defines an underlying DoDAF Meta Model (DM2) of concepts, attribute and associations. “The DM2 provides a high-level view of the data normally collected, organized, and maintained in an Architectural Description effort. It also serves as a roadmap for the reuse of data under the federated approach to architecture development and management.” (DoDAF v2.0 Volume I Section 9)

AV-2 terms should be identified with the concept they represent in the DoDAF Meta Model (DM2). Since DoDAF V2.0 provides a mapping of DM2 concepts to DoDAF-described models, the presentation of this mapping in the AV-2 View explicitly relates AV-2 terms to the different DoDAF-described models, i.e. it is useful to locate models that (should) contain a particular term. In following a term to its DM2 concept a user can easily identify which models may contain references to this term, or should re-use this term rather than invent another synonym.

Many different architecture methods may be used to develop an architecture view based on a DoDAF-described model. Ultimately terms in the AV-2 View become labels for rendering core DM2 concepts within a particular architecture method/technique. The same DM2 concept could be rendered differently in different architectural methods/techniques. For example, a DM2 *performer* would be rendered as an entity in an organization chart, an actor in a UML use case diagram, and as a swimlane in a BPMN diagram. Table 2-1 shows an example of such a trace.

Table 2-1: Sample AV-2 Concept Relationships

AV-2 Term	DoDAF v2.0 Meta Model Concept	Example Architecture Methods				...
		Organization Hierarchy	Activity Decomposition	BPMN Process Model	UML Class Diagram	
Intermediate C2	Performer	Organization	N/A	Swimlane	Class	...
Coordinate CAS	Activity	N/A	Entity	Task	N/A	...
...

In this example, the term ‘Intermediate C2’ is a specific instance of the DM2 concept ‘performer’ depicted as an organization in an organizational hierarchy (typical representation for an OV-4 Organizational Relationships Chart), a lane in a BPMN diagram (representation for OV-6c Event-Trace Description) and a class in a UML Class Diagram (common representation for DIV-1 Conceptual Data Model). The term ‘Coordinate CAS’, an instance of the DM2 concept ‘activity’, is rendered as a task in a BPMN process models and an entity in a typical rendering of the OV-5a Operational Activity Decomposition Tree.

2.2 C.A.R.P. and the DoDAF 6-Step Architecture Development Process

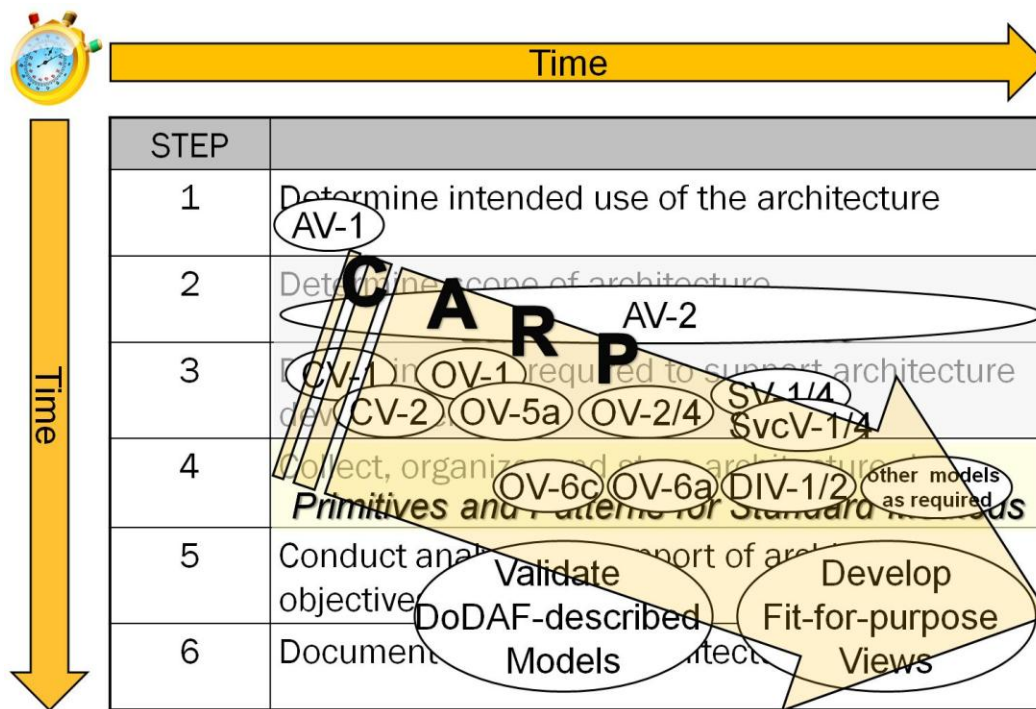
DoDAF v2.0 (Volume 1, Section 7.1.1) provides a high-level, six-step architecture development process. The six basic steps described for this process are:

1. Determine Intended Use of the Architecture
2. Determine Scope of Architecture
3. Determine Data Required to Support Architecture Development

4. Collect, Organize, Correlate, and Store Architecture Data
5. Conduct Analyses in Support of Architecture Objectives
6. Document Results in Accordance with Decision-Maker Needs

The C.A.R.P approach for AV-2 development fits neatly into this six-step architecture development process. This relationship is illustrated in Figure 2-3. The important concept for all steps of this architecture development process is the establishment of an initial AV-2 up-front, which then drives the continual collection, recording, and reuse of a consistent harmonized vocabulary.

Figure 2-3: DoDAF Architecture Development Roadmap



2.2.1 Steps 1 and 2: Establish AV-2 Baseline

Steps 1 and 2 of the six-step process are the beginning activities for architecture development and characterize the intended use, purpose, and scope of the architecture effort. This information is generally provided by the architecture owner describing some aspect of their area of responsibility (process, activity, etc.) undergoing review, and is intended to insure the resulting architecture is “Fit for Purpose”.

2.2.1.1 Start at the Beginning

Collection of glossary terms and definitions begins at Step 1 and should continue throughout the architecture development process. As initial architecture data is identified to help clarify the appropriate scope of the architecture effort, vocabulary terms and definitions should be disambiguated, harmonized and recorded in a consistent format in the AV-2. (See Appendix B: Template for AV-2 Development).

2.2.2 Steps 3 and 4: Proceed with C.A.R.P.

Steps 3 and 4 of the six-step process are the core activities in developing the architecture models and views, and thus produce the bulk of the terms and definitions required for the AV-2. Step 3 is a ‘top-down’ approach to data and vocabulary identification guided by controlled vocabularies within the C.A.R.P. method, while Step 4 is a more ‘bottom-up’ approach for data capture usually based on architecture methods and tools focused on development of specific DoDAF-described models. Architecture development typically iterates over these two steps. Terms

and definitions recorded in the AV-2 should be related to elements of the DM2. In turn, these DM2 elements are associated with other architecture models that suggest additional data content to be collected and recorded.

2.2.2.1 Central Points in the DM2

Architects typically collect and organize data through the use of architecture methods that produce architecture models, e.g. activity, process, organization and data models. Data collection should be guided by controlled vocabulary terms and definitions that are correlated, harmonized and recorded in a consistent format in the AV-2 (see Appendix B: Template for AV-2 Development). The starting points are central key elements of the DM2 prescribed by the C.A.R.P. method as described in Section 2.1. Additional guidance for the AV-2 representation of these central DM2 elements is provided in Appendix A.

2.2.3 Steps 5 and 6: Validate and Iterate

Steps 5 and 6 of the six-step process test the architecture for completeness, accuracy, and sufficiency. Decision points related to including an architecture view, model, or even a term and definition are based on the intended use, purpose, and scope of the architecture effort determined in the first steps of development.

2.2.3.1 Appropriate Completeness and Coverage

Architectures that conform to DoDAF consist of multiple models, covering different aspects of the system that is being described. These descriptions reflect DM2 concepts that occur in one or more DoDAF-described models. Specific terms are defined in the AV-2 and classified according to the DM2 concept. The AV-2 should be assessed for adequate coverage of appropriate DM2 concepts and completeness against project requirements.

3 Federated Vocabulary and AV-2 Development

The DoD is migrating to the concept of a set of Federated architectures and vocabularies based on Communities of Interest (COI). These individual COI vocabularies capture and define terms specific to the particular community domain. Within a COI development of a common vocabulary requires:

- focused consistent new vocabulary development for architecture, e.g. C.A.R.P. method
- legacy vocabulary (system) alignment: Vocabulary comparison/mapping/mediation
- domain-level governance: and conflict resolution

Terms and definitions necessary to describe architecture are identified and recorded in the AV-2. This can often be simplified through reuse of data previously collected by others that is relevant to the current effort. Access to appropriate COI data and other architecture information, discoverable via DARS and the DoD Metadata Registry (DMR) can provide information on data and other architecture artifacts and products that may prove useful in a current effort, and ultimately support the federation of related architectures.

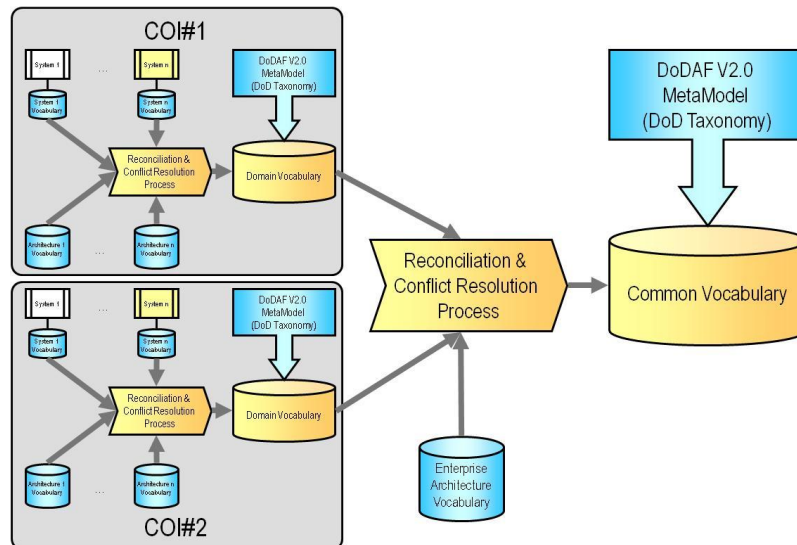
Analysis of common vocabulary across different architectures with similar scope helps to clarify and determine appropriate architecture scope, and ultimately support the goal of architecture federation. For example, all CV-2 DoDAF-described models should be rooted in or linked to the authoritative source Joint Capability Area (JCA) taxonomy to support federation and interoperability. Likewise, all OV-5 DoDAF-described models should be rooted in or linked to appropriate authoritative sources such as the Universal Joint Task List (UJTL) to support federation, interoperability and reuse.

Across COI boundaries, broader more enterprise-level common vocabularies capture and harmonize terms common across community domains. These vocabularies result from the resolution of a common intersection of concepts, terms, and definitions in the individual COI vocabularies. Development of an enterprise-wide common 'core' vocabulary requires:

- focused consistent new vocabulary development for architecture, e.g. C.A.R.P. method
- cross-COI vocabulary alignment: Vocabulary comparison/mapping/harmonization/mediation
- enterprise-level governance, in coordination with the COI domain-level governance

Figure 3-1 illustrates federated vocabulary development and enterprise-level governance across multiple COIs, each with domain-level governance for both architecture vocabulary development for new systems and existing vocabulary alignment for legacy systems.

Figure 3-1: Federated Vocabulary Development



3.1 AV-2 Registration and Discovery

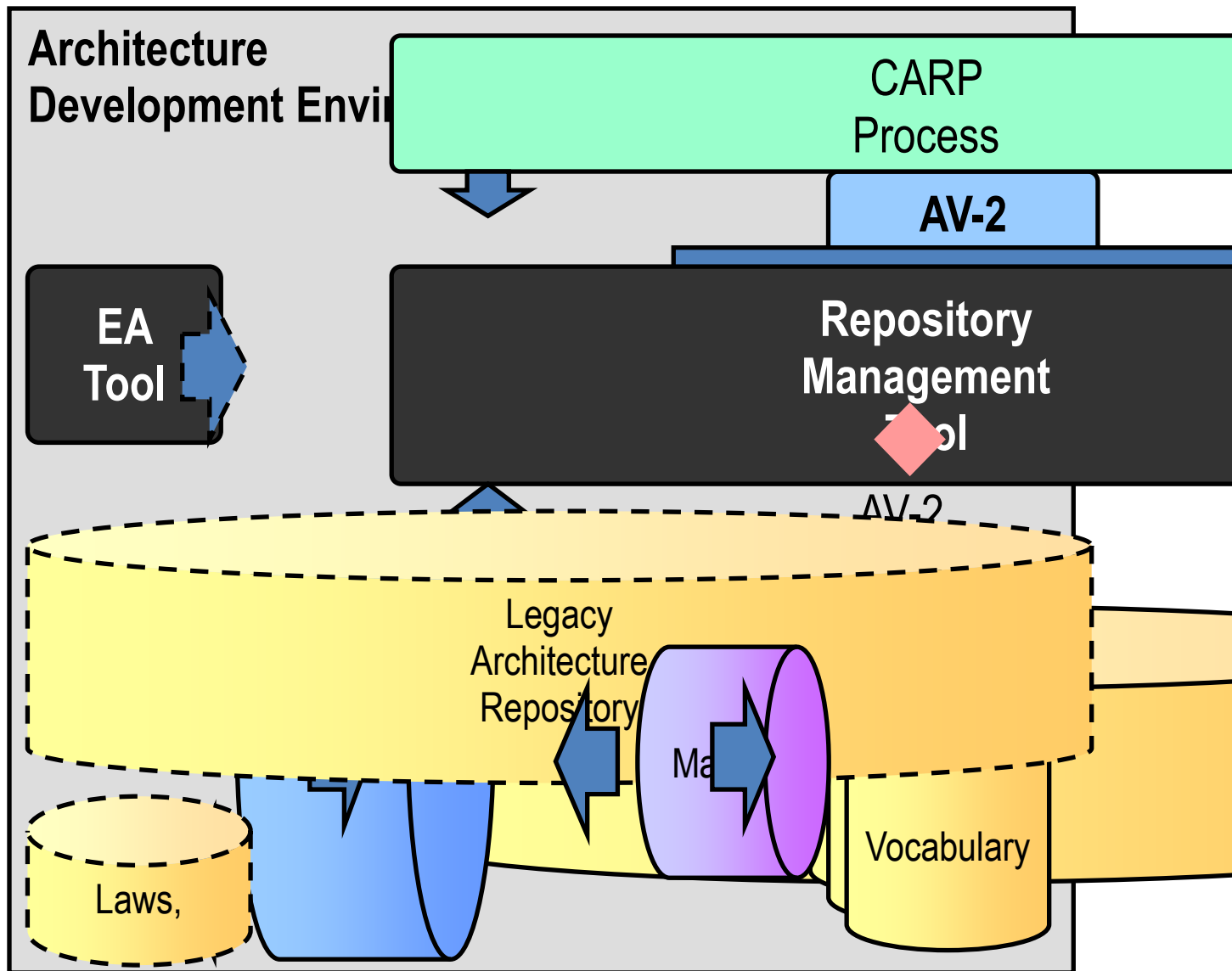
DoDAF architectures with consistent and harmonized AV-2 Integrated Dictionaries are necessary for effective architecture federation, interoperability, and reuse across the enterprise. The development of DoDAF architectures with consistent AV-2s requires that architects have ready access to the approved AV-2 Integrated Dictionaries from other related architectures for comparison and potential reuse, as well as access to any authoritative common 'core' vocabularies which may be mandated.

While the DoD Architecture Registry System (DARS) provides a central point for registration and discovery of architecture AV-1 Overview and Summary Information, there is currently no consistent way to discover and access the AV-2 Integrated Dictionary associated with a registered architecture. Net-centric principles (discovery, accessibility, understandability, and trust) drive requirements for a DoD AV-2 Registration and Discovery Service that allows users to search and download dictionaries of architecture terms and definitions (AV-2s) and provide:

- Discovery metadata, e.g. creator, publisher, and version
- Level of approval and source of authority, e.g. approval authority, approval status, and date
- Associated Architecture AV-1 Information
- Access to authoritative common 'core' vocabularies, e.g. JCA

Figure 3-2 illustrates an example Architecture development environment (e.g. BEA, JACAE ...) interacting with a notional service for registration and discovery of architecture AV-2 Integrated Dictionaries.

Figure 3-2: AV-2 Registration and Discovery



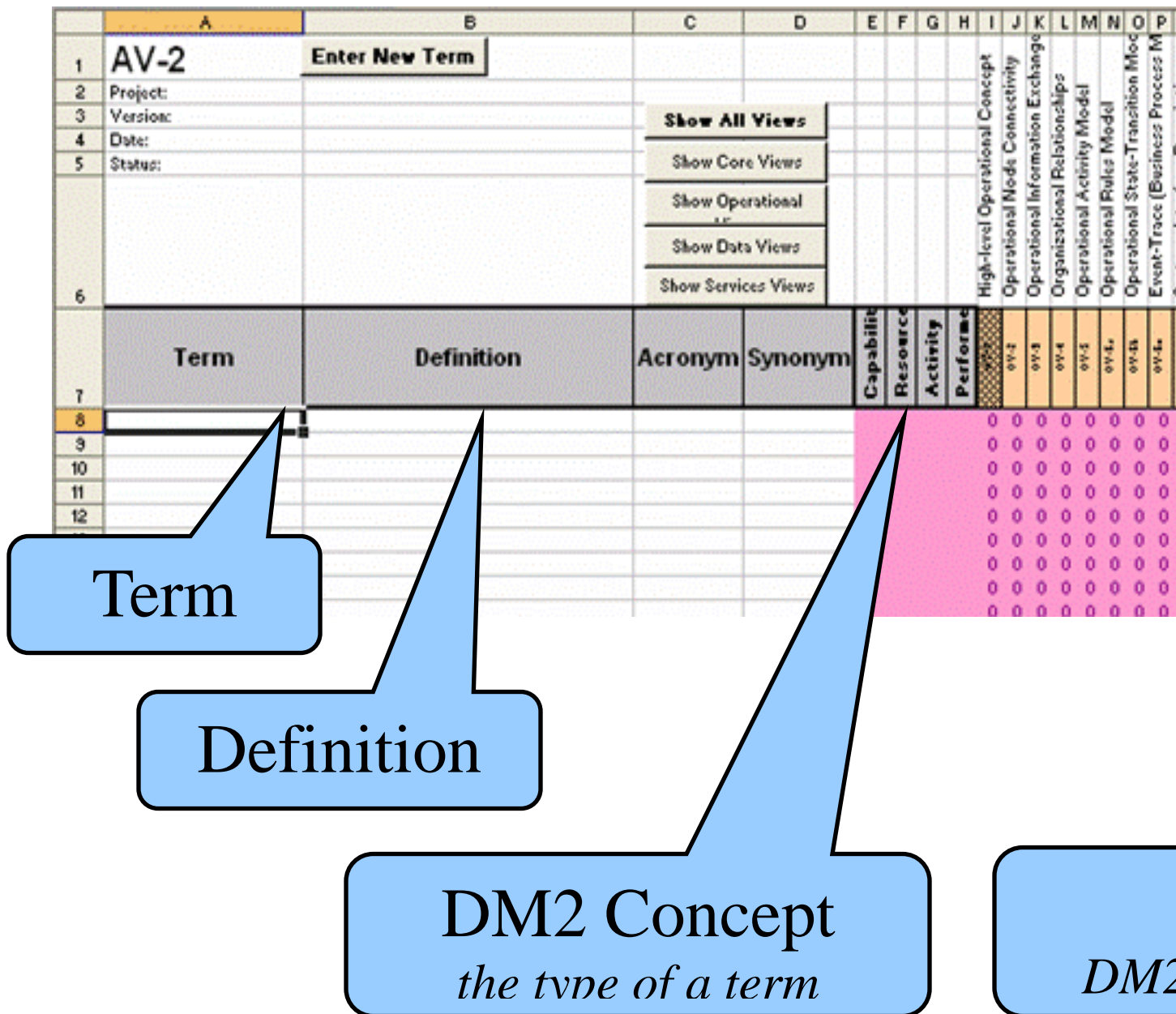
4 Appendix A: C.A.R.P. Process Guidesheet

Step	Definition	Procedure/ Typical Questions	Linkage to other DODAF-described Models
1. Define Capabilities	Capabilities describe the desired functionality of a system and serve as a set of top-level objectives. A capability is the ability to achieve a desired effect under specified [performance] standards and conditions through the combination of ways and means [activities and resources] in order to perform a set of activities.	<ul style="list-style-type: none"> Identify overall objectives of the system What are the goals of the system? What are the major design constraints? What is the major functionality to be offered by the resulting system? 	AV-1 Overview and Summary Information: The capabilities identified in this step should occur in the AV-1 architecture description document. Initial basis for CV-1, CV-2, CV-3, CV-4. Can be used later on to define CV-5, CV-6, CV-7.
2. Define Activities	Work, consisting of atomic or composite steps, that transforms resources to achieve an objective. Activities describe the processes and procedures carried out to actively change an EffectObject, i.e., a target resource.	<ul style="list-style-type: none"> Identify the major processes of the system that are needed to provide the desired capabilities. Break the major processes into those activities necessary to achieve the objectives of each process. Describe Activities in “Verb-Object” format (e.g.: write report). Avoid unspecific verbs such as “manage” or “oversee” Do not use “and” in activity labels: Break complex activities into individual steps 	CV-6: Linkage between Activities and the Capabilities that they support OV-5a: Operational Activity Decomposition Tree The results of this step become the activities in a hierarchical functional decomposition diagram OV-6c Event-Trace Description: The results of this step become the activities in an eventual process model Constraints among the activities can be used as the basis for OV-6a (Operational Business Rules)
3. Define Resources	Data, Information, Performers, Materiel, or Personnel Types that are produced or consumed by the resulting system.	<ul style="list-style-type: none"> Identify the major objects and data elements (entities) of the system. Identify the relationships among the resources (Structural Business Rules) 	DIV-1/2: Data Model The results of this step become classes/tables in an eventual conceptual data model, which forms the basis for DIV-1 and DIV-2 DoDAF-described models. OV-2/OV-3: Operational Resource Flow Description and Matrix
4. Define Performers	Any entity - human, automated, or any aggregation of human and/or automated - that performs an activity and provides a capability.	<ul style="list-style-type: none"> Revisit the list of resources identified in step 2 and identify those that actively contribute toward the completion of activities or the achievement of an objective 	OV-4: Organizational Relationship Chart OV-6c Event-Trace Description: The result of this step defines the swimlanes in an eventual process model. S(vc)V-4 System(Service) Functionality Description

5 Appendix B: Template for AV-2 Development

In order to support the development of AV-2 views an Excel template is provided, as illustrated in Figure 5-1. This template can be used for data capture. Given the DoDAF mapping of Meta Model concepts to architecture models that contain them, the template can help identify the set of architecture models within which the defined term is relevant. By mapping the terms in an AV-2 to the concepts of the underlying DoDAF Meta Model it is possible to trace the relationship between a term and the different architecture models in which this term occurs. In the future this template could be replaced by a web-based form that is linked to a database for easier storage, manipulation and rendering of AV-2 content or integrated as part of an architecture tool.

Figure 5-1: Example AV-2 Development Template

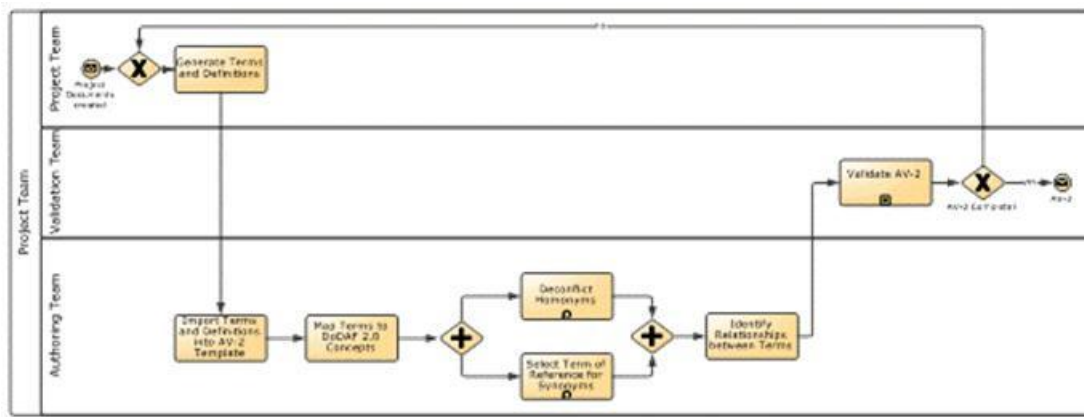


6 Appendix C: General Process for AV-2 Development

The generic process for the development of an AV-2 consists of seven steps and incorporates the C.A.R.P. vocabulary ‘bootstrapping’ method. The process should be initiated after the initial outline of the architecture has been developed, i.e. AV-1 and OV-1 exist, and is consistent with the one described in the “DoDAF Architecture Development Process for the Models” Microsoft Project Plan.

An AV-2 consists of defined terms and derived terms. Defined terms are those specified at the outset of an architecture project, while derived terms emerge during the development of subsequent architecture views. The purpose of this process is to ensure a sufficient set of defined terms at the beginning of an architecture project, and to allow for subsequent expansion and extension of this initial set of terms. It is an iterative process that accompanies the development of other architecture views.

Figure 6-1: General AV-2 Development Process



6.1 Generate Terms and Definitions

During this step the key terms are gathered from domain subject matter experts (SMEs) and a set of definitions is created. An initial vocabulary baseline should be established using the C.A.R.P. method to ‘bootstrap’ an architecture development effort as a first step in defining scope – corresponding to Step 2 of the DoDAF six step development process. At the very start of the architecture development effort, these terms and definitions are typically derived from the AV-1 and related documents, and includes the definition of mandatory architecture components required by project sponsors and architecture users. As development of the architecture progresses, additional terms and definitions are identified and documented during the creation of other architecture models and views and this process repeats until the required completeness, coverage, and level of detail is achieved.

6.2 Import Terms and Definitions into AV-2 Template

Development of the AV-2 is currently supported by a simple template allowing the architect to relate each term and definition to a DoDAF Meta Model (DM2) concept. The AV-2 should initially be focused on what the target architecture should be capable of achieving, not how this functionality should be rendered.

6.3 Map Terms to DoDAF 2.0 Concepts

During this step the existing terms are mapped against the DM2 concepts. The starting point should be the key elements of the DM2: Capabilities, Resources, Activities, and Performers. Note the DM2 contains many additional elements which will be defined and refined in later development cycles.

6.4 Deconflict Homonyms

In order to disambiguate term homonyms the architect should either change one of the homonym terms, or add a suffix that specifies the context of the related definition (e.g. tank[army] vs. tank[air force])

6.5 Set Term of Reference for Synonyms

In case of multiple terms that relate to the same definition the architect should determine one term of reference. Additional terms can be explicitly listed as synonyms, but should not be listed as terms in their own right.

6.6 Define Relationships between Terms

Dependencies between terms (such as generalization/specialization and whole/part relationships) should be documented in this step.

6.7 Evaluate AV-2 Completeness and Coverage

The final step of the development process tests the AV-2 for coverage of the DoDAF Meta Model and completeness against project requirements. If the AV-2 is found to be incomplete a new round of revisions is initiated, otherwise the result of the process is the finished AV-2.

In many cases the content of the AV-2 will emerge throughout an architecture design project. The first occurrence of an AV-2 term will thus be in a particular model that represents a view of the underlying architecture. Similar to the bottom-up validation approach it is possible to trace the model construct containing the term to the underlying DoDAF Meta Model, and determine from there which other model types should be populated with this term. Figure 6-2 shows this validation process formalized in BPMN.

Figure 6-2: General AV-2 Validation Process

