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Enterprise Architecture Process Guide for the Unified Architecture Framework (UAF)

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Abstract. This paper describes a process for creating Enterprise Architecture (EA) views in accordance with the Unified Architecture Framework (UAF) standard published by the Object Management Group (OMG). This process will be the foundation for a new EA Process Guide to be published as part of the OMG standard. The nine steps of the process are laid out in alignment with the stakeholder domains in the UAF for producing the requisite UAF views in each of those domains. This architecture description process can be used in conjunction with processes for the conceptualization and evaluation of an architecture, and also used as the basis for an EA modeling methodology, architecture development planning, MBSE capability assessment, and modeling project organization. The Guide covers architecting of the enterprise as well as architecting (at a high level) of a major entity within the enterprise. We will provide an understanding of what the Guide will contain and how it could be used.

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1 Introduction

This paper describes a process for creating Enterprise Architecture (EA) views in accordance with the Unified Architecture Framework (UAF) standard [OMG 2020] published by the Object Management Group (OMG). This process will be the foundation for a new EA Process Guide to be published as part of the OMG standard. This architecture description process can be used in conjunction with the processes for conceptualization and evaluation of an architecture, as well as being used in support of architecture governance and management activities [ISO 42020 2019].

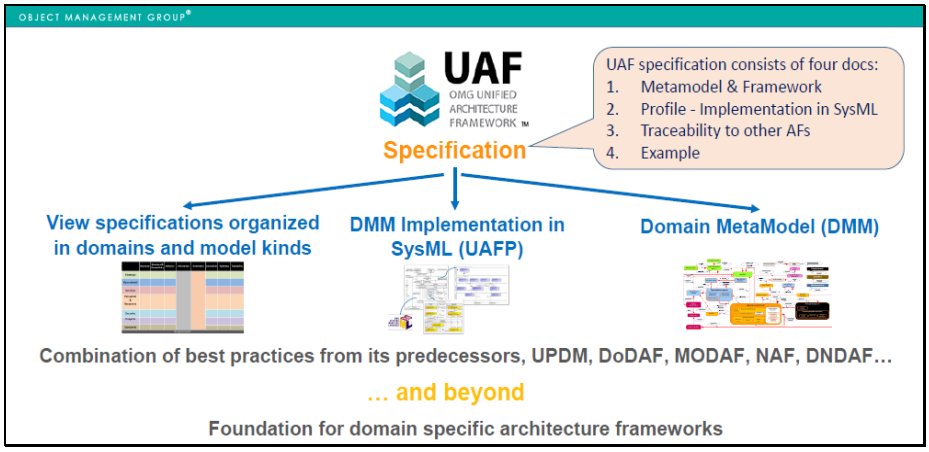
In the context of UAF, an enterprise is a "human undertaking or venture that has a mission, goals and objectives to offer products or services, or to achieve a desired project outcome or business outcome" [ISO 42010 2021]. An enterprise architecture is the "fundamental concepts and properties … and governing principles for the realization and evolution" of the enterprise [ibid.].

2 Background

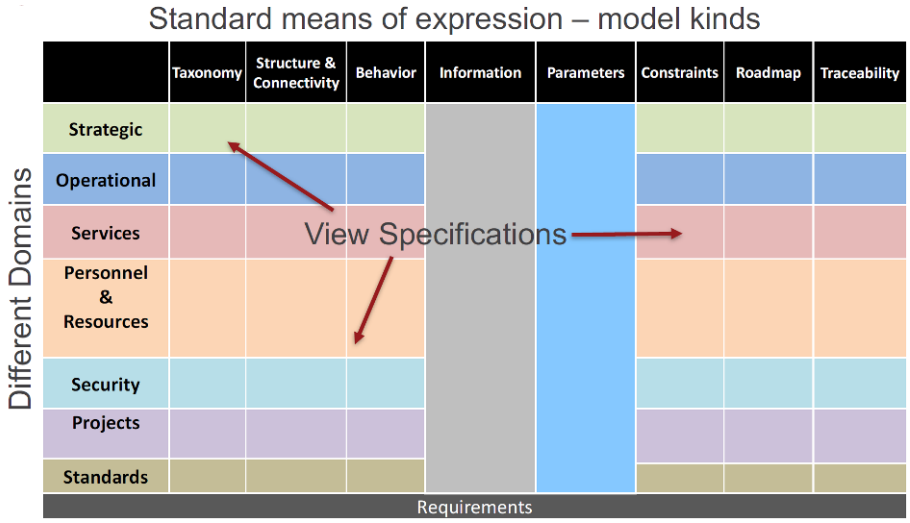
2.1 Unified Architecture Framework

The UAF specification consists of three main components as illustrated below. The Domain Metamodel (DMM) establishes the underlying foundational modeling constructs to be used in modeling an enterprise and major entities within the enterprise. View specifications provide direction to the tool vendors and to those who are creating the architecture views regarding what DMM elements are pertinent to those views. The UAF Profile (UAFP) is an implementation of the DMM that specifies how the UAF views can be modeled using SysML notation.

There is a need for a Process Guide to complement the UAF Profile that defines the steps required to create the UAF views in an orderly and systematic manner. This paper describes the process to be used as the foundation for the UAF Process Guide to be published in 2021.



The UAF Grid (shown below) has rows that represent typical stakeholder domains (or perspectives) that can be used when modeling an enterprise architecture. The Grid has columns that represent the architecture aspects (in UAF these are called 'model kinds') that correspond to "units of modularization of concerns within an architecture description, capturing characteristics or features of the entity of interest" [42010 2021]. This Grid is provided in the UAF standard as a structuring formalism for organizing the 71 view specifications defined within UAF.



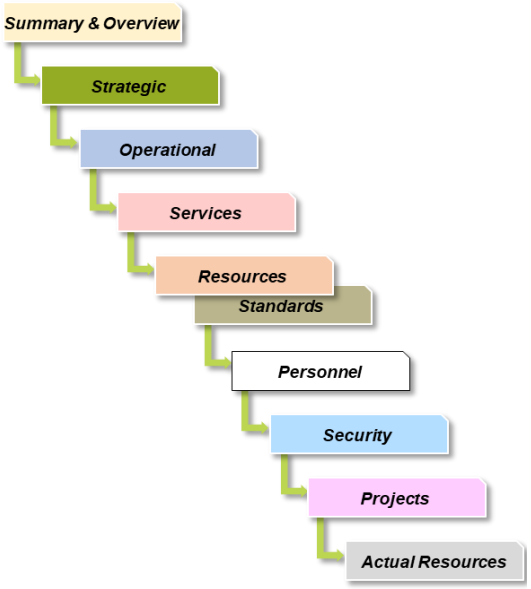
The UAF view specifications are shown in the corresponding "cells" of the Grid below. It is apparent from looking at this large number of potential views that it would be difficult to know where to start and how to proceed in generating these views. First, it is recommended that a Problem Framing approach be used to help identify which views would be most useful in a particular architecture engagement (as described in [Martin 2019]). Second, the process described herein can enable more effective and efficient development of an enterprise architecture.

UAF	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information If	Parameters Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Metadata Md	Metadata Taxonomy Md-Tx	Architecture Viewpoints [a] Md-Sr	Metadata Connectivity Md-Cn	Metadata Processes [a] Md-Pr	-	-			Metadata Constraints [a] Md-Ct		Metadata Traceability Md-Tr
Strategic St	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	-	Strategic States St-St	-			Strategic Constraints St-Ct	Strategic Deployment, St-Rm Strategic Phasing St-Rm	Strategic Traceability St-Tr
Operational 0p	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Interaction Scenarios Op-Is			Operational Constraints Op-Ct	-	Operational Traceability Op-Tr
Services Sv	Service Taxonomy Sv-Tx	Service Structure Sv-Sr	Service Connectivity Sv-Cn	Service Processes Sv-Pr	Service States Sv-St	Service Interaction Scenarios Sv-Is	Conceptual Data Model,	Environment Pm-En	Service Constraints Sv-Ct	Service Roadmap Sv-Rm	Service Traceability Sv-Tr
Personnel Pr	Personnel Taxonomy Pr-Tx	Personnel Structure Pr-Sr	Personnel Connectivity Pr-Cn	Personnel Processes Pr-Pr	Personnel States Pr-St	Personnel Interaction Scenarios Pr-Is	Logical Data Model,		Competence, Drivers, Performance Pr-Ct	Personnel Availability, Personnel Evolution, Personnel Forecast Pr-Rm	Personnel Traceability Pr-Tr
Resources Rs	Resource Taxonomy Rs-Tx	Resource Structure Rs-Sr	Resource Connectivity Rs-Cn	Resource Processes Rs-Pr	Resource States Rs-St	Resource Interaction Scenarios Rs-Is	Physical Data Model	Measurements Pm-Me	Resource Constraints Rs-Ct	Resource evolution, Resource forecast Rs-Rm	Resource Traceability Rs-Tr
Security Sc	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Pr	-	-			Security Constraints Sc-Ct	-	Security Traceability Sc-Tr
Projects Pj	Project Taxonomy Pj-Tx	Project Structure Pj-Sr	Project Connectivity Pj-Cn	Project Processes Pj-Pr	-	-			-	Project Roadmap Pj-Rm	Project Traceability Pj-Tr
Standards Sd	Standard Taxonomy Sd-Tx	Standards Structure Sd-Sr	-	-	-	-			-	Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actual Resources Ar		Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation [b]					Parametric Execution/ Evaluation [b]	-	-
Dictionary * Dc											
Summary & Overview Sm-Ov											
Requirements Rq											

2.2 Layered Progression of Architecture Definition

UAF provides a complete set of stakeholder domains as the basis for defining the variety of necessary architecture views of an Enterprise and these views are specified in the UAF Profile. The domains allow for a logical and systematic flow of architecting activities:

a) Concerns and objectives drive a strategic plan that increases value to enterprise stakeholders
b) The strategic plan deploys capabilities in phases to help address gaps and shortfalls
c) Capabilities are actualized by operational roles, activities and performers
d) Operational concepts are implemented through services, resources and personnel
e) Resources comply with standards
f) Risk and threats are mitigated through necessary security and protection controls
g) Requirements, constraints and concerns are understood and communicated to projects
h) Plans deliver the resources according to project activities and milestones
i) Resources are characterized and verified



Even though these are presented as a "waterfall," this is merely a logical flow rather than a strictly temporal flow. This process can be performed top-down, bottom-up, or middle-out (whatever is needed to meet the objectives) and should be adapted and tailored to fit the situation.

This architecture description process can be used in conjunction with the processes for conceptualization and evaluation of an architecture. The underlying architecture description process is consistent with the Architecture Elaboration process in the Architecture Processes standard [ISO 42020 2019] and it has the following intended uses:

— Process reference model for Enterprise Architecture (EA) Process Guide to be included in the OMG standard for the Unified Architecture Framework (UAF),

— Reference model as the basis for an EA Modeling Methodology that defines associated methods, patterns, templates, tools and techniques for each process step,

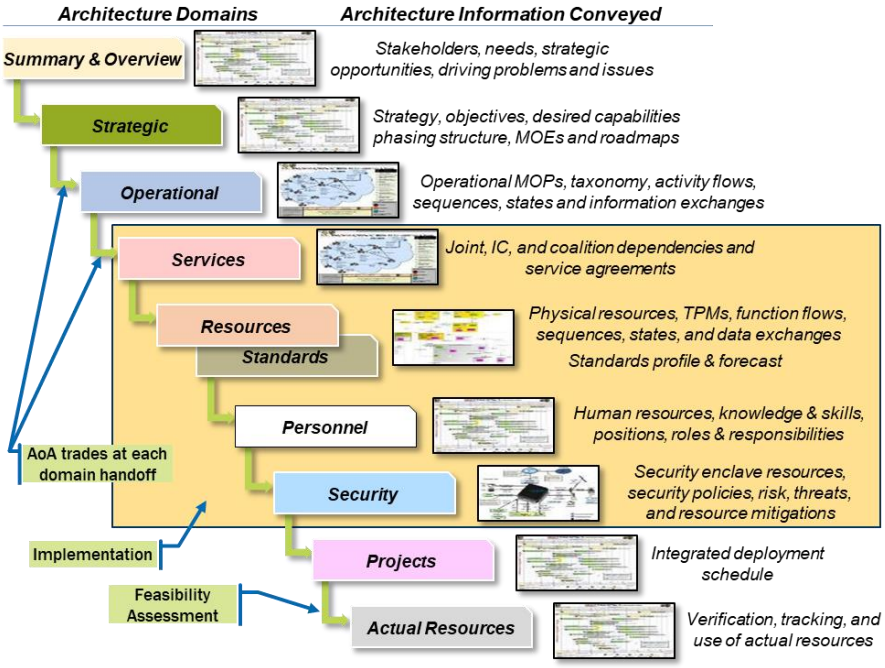
— Process framework for project planning and architecture definition activities, and

— Training and certification on architecture frameworks and modeling approaches.

2.3 General Workflow of Process Steps

The general workflow to implement these architecting activities is illustrated below. Each step in the process conveys the architecture information to iteratively produce a definition of the problem space along with a definition of the solution space (i.e., implementation and instantiation). Tradeoffs are identified along the way and architectural decisions are captured in the architecture views as they are fleshed out. There will be some repetition back and forth between the steps to

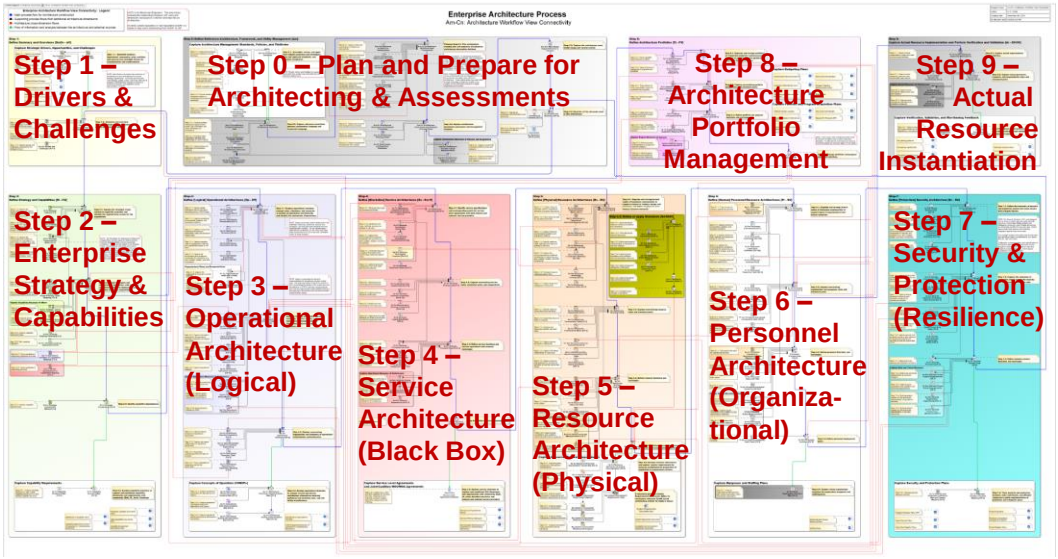
ensure a complete and coherent depiction of the architecture as it unfolds. It is not necessary that it must be implemented in a top-down fashion.



3 Process Guide Overview

3.1 Architecture Description Workflow Steps

The process defines "what" to do when creating the UAF views but does not identify or define methods (the "how") or tools needed for each step (since this is methodology dependent). The nine steps follow the basic flow illustrated earlier and these steps are decomposed to the third level to get to the point where individual UAF views are generated for each of the sub-steps. These steps are not necessarily done in this order and are often done simultaneously with much iteration.



3.2 Process Guide Purpose and Expected Uses

The purpose of the UAF Process Guide is to define what steps to take when creating UAF views for and the underlying models of an enterprise architecture. The Guide covers architecting of the enterprise as well as architecting (at a high level) of a major entity within the enterprise. There are a number of potential ways the process guide can be used:

1) **Basis for creating a Unified Modeling Methodology**
   (where Methodology = Process + Methods + Tools + Techniques + Templates…)
2) **Basis for building Architecture Views and Models**
   a) Agreement between an upper enterprise and lower enterprise(s) on division of responsibility and dependencies between models
   b) Agreement between acquisition office and prime contractor
   c) Agreement between prime contractor and suppliers
   d) Organization of training for architecture modeling classes and workshops
   e) Assessment of EA modeling capabilities and competencies
3) **Basis for a Process Guide template instantiated in UAF plug-ins for MBSE tools**
   a) Navigation Panel, Dashboard, Landing Page (or similar item) within the model
   b) Model Management Work Breakdown Structure and resource planning

3.3 Plan and Prepare for the Architecture Effort (Step 0)

Step 0 deals with planning and preparing for the particular architecture engagement in terms of defining the reference architecture(s) to be used, tailoring the architecture framework to suit the situation, and defining the utilities for managing the architecture development progress. The basic activities for Step 0 are listed below. This step generates a number of special Architecture Management (Am) views that go beyond those (currently) provided by UAF.

1	**Step 0: Plan and Prepare for the Architecture Effort [Am]**
2	**Step 0.1: Assemble, review, and apply best industry practices and techniques, open and approved standards, and maintain compliance**
3	Step 0.1.1: Capture the strategic drivers and represent drivers structure
4	Step 0.1.2: Provide feedback to standards bodies on modifications and extensions of standards
5	Step 0.1.3: Establish authoritative data environment and sources
6	**Step 0.2: Capture reference translation between architecture language and framework language**
7	Step 0.2.1: Conduct problem framing and capture intent, scope, use, information and views necessary for architecture
8	Step 0.2.2: Prototype basic architecture elements and relationships to verify framing
9	Step 0.2.3: Capture types and categories of architecture elements
10	Step 0.2.4: Document and maintain architecture management and user guidance
11	**Step 0.3: Plan architecture standup plan and sequence of enterprise architecture description buildout**
12	Step 0.3.1: Capture reference connectivity in framework connectivity
13	Step 0.3.2: Capture architecture domain and view structure
14	Step 0.3.3: Capture architecture viewpoint structure
15	Step 0.3.4: Capture Governance process use of (and connection to) views
16	Step 0.3.5: Capture information exchanges supporting architecting decision making
17	Step 0.3.6: Capture data exchanges for architecting activities
18	Step 0.3.7: Capture data exchanges for authoritative data flow in data environment
19	**Step 0.4: Capture architecture governance processes and management methods**
20	Step 0.4.1: Capture governance and management processes
21	Step 0.4.2: Capture planning effectivity states
22	Step 0.4.3: Capture management process and view guides

23	Step 0.4.4: Capture overarching architecting MOPs by type and category
24	Step 0.4.5: Capture architecture diagnostic measures by type and category
25	**Step 0.5: Capture the architecture meta-model usage and version control**
26	**Step 0.6: Describe all the elements used in the architecture**
27	Step 0.6.1: Manage all architecture term definitions and acronyms
28	Step 0.6.2: Manage and publish all architecture element descriptions

4 Process Details

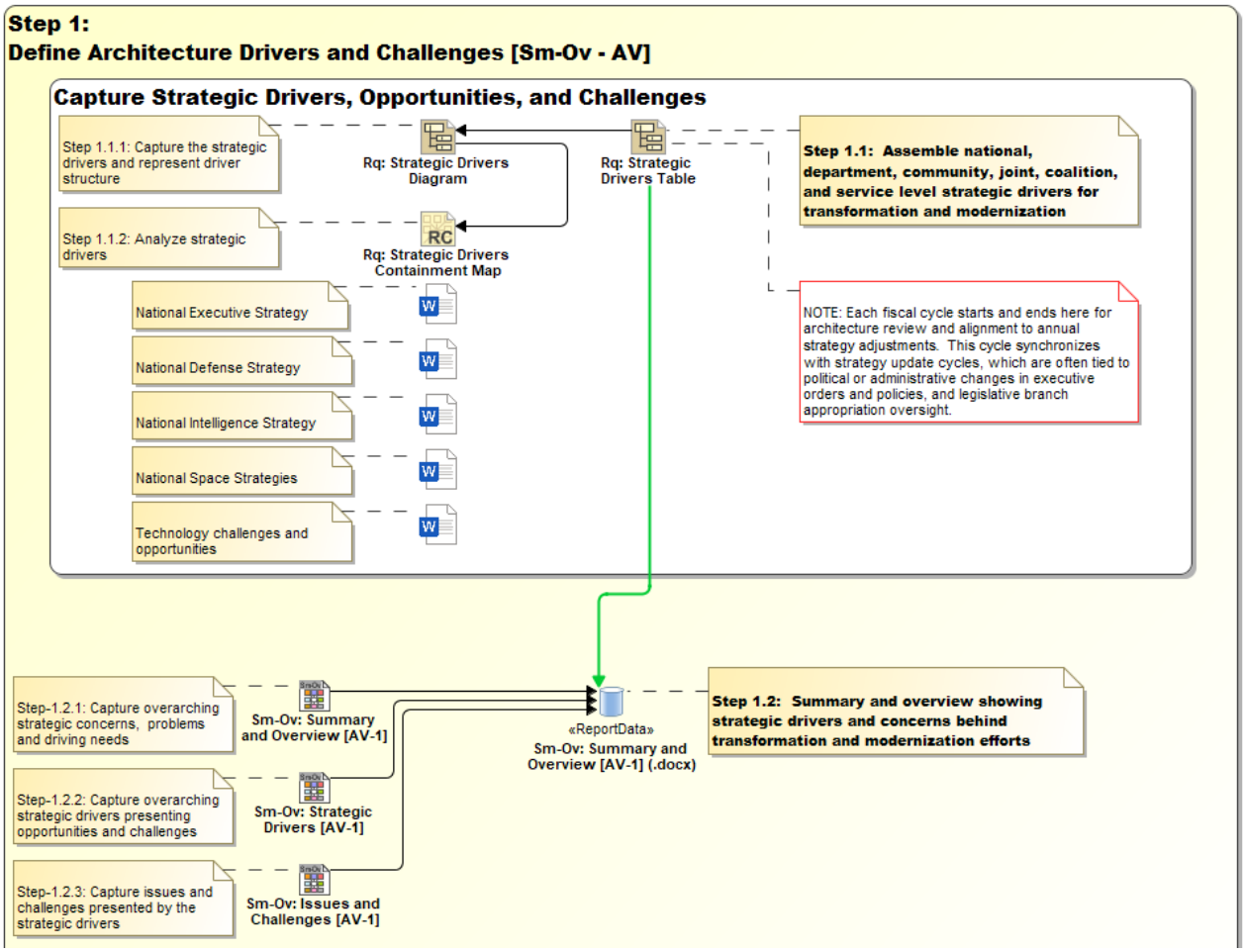
The basic steps in the process are listed below with the UAF Domain (or DODAF Viewpoint) that corresponds to each step. The details of each step are laid out with decomposition down to the level where each of the lower level steps generates one of the UAF views.

Step	Step Name	UAF Domain	DODAF Viewpoint
Step 0	Plan and Prepare for the Architecture Effort	Am	n/a
Step 1	Define Architecture Drivers and Challenges	SmOv	AV
Step 2	Define Strategy and Capabilities	St	CV
Step 3	Define (Logical) Operational Architectures	Op	OV
Step 4	Define (Black Box) Service Architectures	Sv	SvcV
Step 5	Define (Implementation) Resource Architectures	Rs	SV
Step 6	Define (Human) Personnel Architectures	Pr	OV, SV
Step 7	Define (Resilience) Security & Protection Architecture	Sc	SV+
Step 8	Define Architecture Portfolios	Pj	PV
Step 9	Capture Actual Resource Instantiation and Perform V&V	Ar	SV/OV

4.1 Step 1 – Architecture Drivers and Challenges

The purpose of this step is to capture the strategic drivers, opportunities and challenges that need to be addressed in the enterprise architecture. The basic activities for Step 1 are illustrated below in graphic form and as a list of activities and generated UAF views for that step.

29	Step 1: Define Architecture Drivers and Challenges [Sm-Ov - AV]	
30	**Step 1.1: Assemble national, department, community, joint, coalition, and service level strategic drivers for transformation and modernization**	Rq: Strategic Drivers Table
31	Step 1.1.1: Capture the strategic drivers and represent driver structure	Rq: Strategic Drivers Diagram
32	Step 1.1.2: Analyze strategic drivers	Rq: Strategic Drivers Containment Map
33	**Step 1.2: Summary and overview showing strategic drivers and concerns behind enterprise transformation efforts**	Sm-Ov: Summary and Overview [AV-1]
34	Step 1.2.1: Capture overarching strategic concerns, problems and driving needs	Sm-Ov: Summary and Overview [AV-1]
35	Step 1.2.2: Capture overarching strategic drivers presenting opportunities and challenges	Sm-Ov: Strategic Drivers [AV-1]
36	Step 1.2.3: Capture issues and challenges presented by the strategic drivers	Sm-Ov: Issues and Challenges [AV-1]

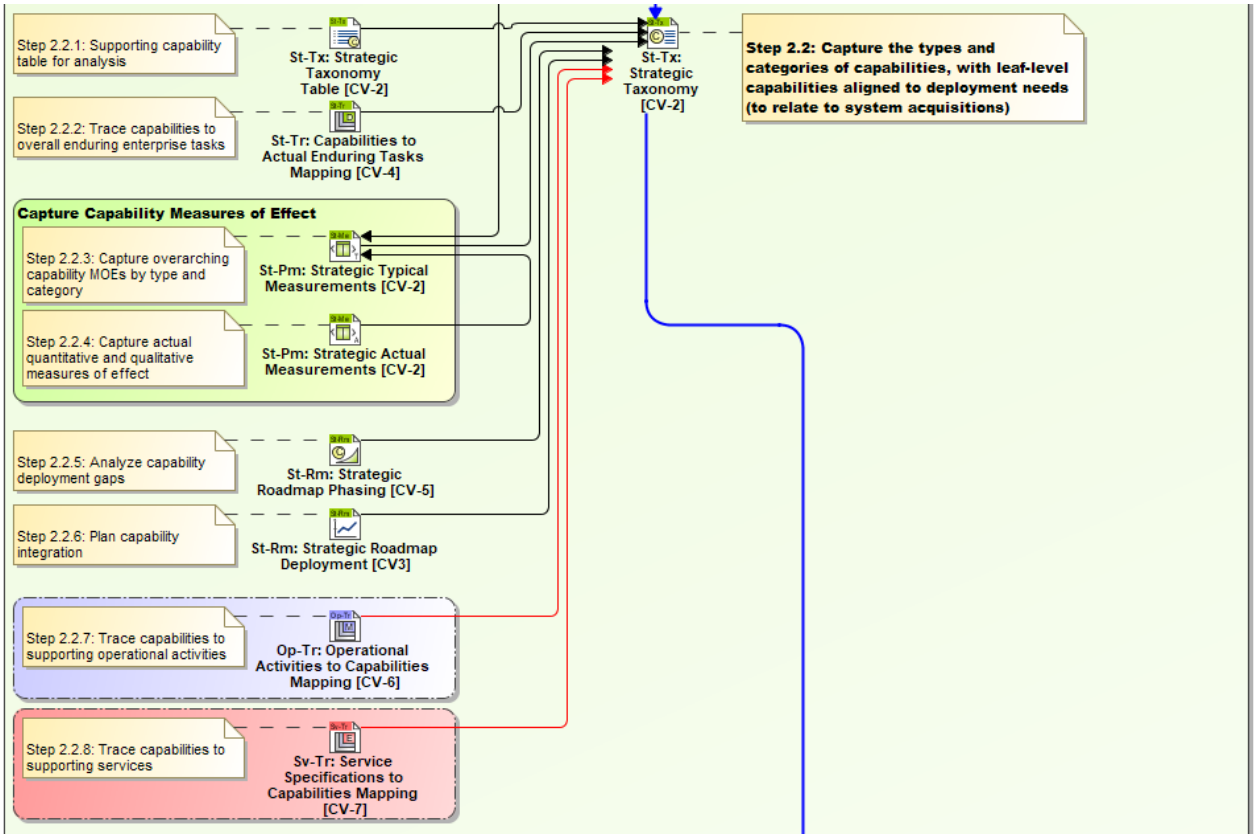


4.2 Step 2 – Enterprise Strategy and Capabilities

The purpose of this step is to define the strategic goals for the enterprise and to identify the capability gaps and shortfalls to be addressed by the architecture. The basic activities for Step 2 are illustrated below in graphic form (partial view) and as a list of activities for that step.

37	Step 2: Define Strategy and Capabilities [St - CV]	
38	**Step 2.1: Capture the strategic vision related to capability evolution and identify the required time scales for the capabilities**	St-Sr: Strategic Vision [CV-1]
39	Step 2.1.1: Capture the relationships between visions (desired effects) and high-level CONOPS outcome states	St-St: Strategic States [CV-1]
40	Step 2.1.2: Capture the environment for capability employment (e.g. theaters, defense planning scenarios, threats, locations, etc.)	St-Pm: Strategic Environment [CV-1]
41	Step 2.1.3: Capture the environment and conditional constraints for capabilities (e.g. joint, coalition, theater, and other constraints)	St-Cn: Strategic Constraints for MOEs [CV-1]
42	Step 2.1.4: Capture the required capability deployment plans to support the strategic vision	St-Tx: Strategic Actual Enterprise Phase Taxonomy Table [CV-1]
43	**Step 2.2: Capture the types and categories of capabilities, with leaf-level capabilities aligned to deployment needs (to relate to system acquisitions)**	St-Tx: Strategic Taxonomy [CV-2]
44	Step 2.2.1: Supporting capability table for analysis	St-Tx: Strategic Taxonomy Table [CV-2]

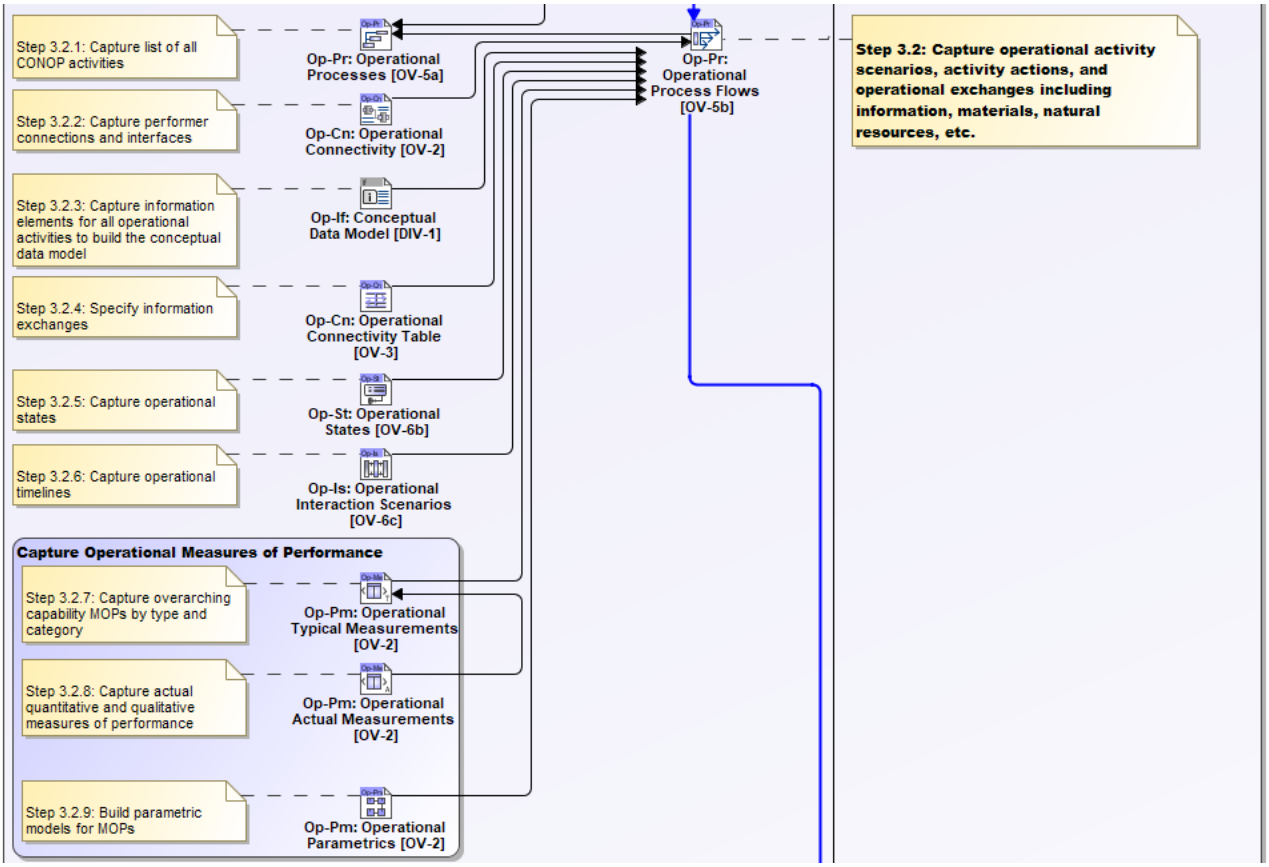
45	Step 2.2.2: Trace capabilities to overall enduring enterprise tasks	St-Tr: Capabilities to Actual Enduring Tasks Mapping [CV-4]
46	Step 2.2.3: Capture overarching capability MOEs by type and category	St-Pm: Strategic Typical Measurements [CV-2]
47	Step 2.2.4: Capture actual quantitative and qualitative measures of effect	St-Pm: Strategic Actual Measurements [CV-2]
48	Step 2.2.5: Analyze capability deployment gaps	St-Rm: Strategic Roadmap Phasing [CV-5]
49	Step 2.2.6: Plan capability integration	St-Rm: Strategic Roadmap Deployment [CV3]
50	Step 2.2.7: Trace capabilities to supporting operational activities	Op-Tr: Operational Activities to Capabilities Mapping [CV-6]
51	Step 2.2.8: Trace capabilities to supporting services	Sv-Tr: Service Specifications to Capabilities Mapping [CV-7]
52	**Step 2.3: Identify capability dependencies**	St-Cn Strategic Connectivity [CV-4]
53	Step 2.3.1: Analyze capability dependencies	St-Cn: Strategic Connectivity Matrix [CV-4]
54	**Step 2.4: Analyze capability structure to capture and coordinate capability documents and requirements with community (DoD, IC, Joint, Coalition)**	St-Tr: Capability Structural Map [CV-6]
55	Step 2.4.1: Analyze capability behaviors to plan overall capability structure of in multi-domain capability structure	St-Tr: Capability Behavioral Map [CV-6]



4.3 Step 3 – Operational Architectures (Logical)

The purpose of this step is to define the operational architecture in terms of the operational performers and their operational activities (with associated operational concepts, partially captured in Concept of Operations documents). The basic activities for Step 3 are illustrated below in graphic form (partial view) and as a list of activities for that step.

56	Step 3: Define [Logical] Operational Architectures [Op - OV]	
57	**Step 3.1: Capture operational concepts, concept roles, situations, and scenarios in context of operational environments and identify the constraints of operations.**	Op-Tx: High Level Operational Concepts [OV-1]
58	Step 3.1.1: Capture simple operational views with users describing all key CONOPS ideas	Op-Tx: Operational Free Form Taxonomies [OV-1]
59	Step 3.1.2: Capture operational environments, theaters, and operating conditions	Op-Pm: Operational Environment [OV-1]
60	Step 3.1.3: Capture overarching operational architecture performers, roles, and structural relationships	Op-St: Operational Structure [OV-2]
61	Step 3.1.4: Capture operation rules of engagement, methods, and operational policies in rule form	Op-Ct: Operational Constraints [OV-6a]
62	Step 3.1.5: Capture the environment and conditional constraints for operations (e.g. joint, coalition, theater, and other constraints)	Op-Ct: Operational Constraints Definition [OV-6a]
63	Step 3.1.6: Capture the organizations involved in overall CONOPS	Pr-Tx: Organizational Roles and Context [OV-4]
64	Step 3.1.7: Capture the responsibilities of the organizations involved in the CONOPS relative to their roles	Pr-St: Organizational Responsibilities [OV-4]
65	**Step 3.2: Capture operational activity scenarios, activity actions, and operational exchanges including information, materials, natural resources, etc.**	Op-Pr: Operational Process Flows [OV-5b]
66	Step 3.2.1: Capture list of all CONOPS activities	Op-Pr: Operational Processes [OV-5a]
67	Step 3.2.2: Capture performer connections and interfaces	Op-Cn: Operational Connectivity [OV-2]
68	Step 3.2.3: Capture information elements for all operational activities to build the conceptual data model	Op-If: Conceptual Data Model [DIV-1]
69	Step 3.2.4: Specify information exchanges	Op-Cn: Operational Connectivity Table [OV-3]
70	Step 3.2.5: Capture operational states	Op-St: Operational States [OV-6b]
71	Step 3.2.6: Capture operational timelines	Op-Is: Operational Interaction Scenarios [OV-6c]
72	Step 3.2.7: Capture overarching capability MOPs by type and category	Op-Pm: Operational Typical Measurements [OV-2]
73	Step 3.2.8: Capture actual quantitative and qualitative measures of performance	Op-Pm: Operational Actual Measurements [OV-2]
74	Step 3.2.9: Build parametric models for MOPs	Op-Pm: Operational Parametrics [OV-2]
75	**Step 3.3: Capture overarching organization and taxonomy of operational architectures and performers**	Op-Tx: Operational Taxonomy [OV-2]
76	Step 3.3.1: Capture internal structure of operational performers	Op-Cn: Operational Internal Connectivity [OV-2]
77	Step 3.3.2: Capture role-based relationships of operational performers	Op-Cn: Operational Role-based Connectivity Table [OV-2]
78	Step 3.3.3: Supporting operational performer table for analysis	Op-Tx: Operational Taxonomy Table [OV-2]
79	Step 3.3.4: Trace capabilities to supporting operational performers	Op-Tr: Operational Performers to Capabilities Mapping [CV-6]
80	**Step 3.4: Analyze operational structure to analyze overall operational architecture alternatives between performer and activities sets, and role utility of performers**	Op-Tr: Opnl Performer Implementation Map [OV-2] Op-Pr: Opnl Activity Implementation Map [SV-5a]
81	Step 3.4.1: Analyze operational performers for alternatives and options	Op-St: Operational Performer Impact Analysis Map [OV-2]
82	Step 3.4.2: Analyze operational role-based impacts for alternatives and options	Op-Pr: Operational Role Impact Analysis Map [OV-2]
83	Step 3.4.3: Capture operational activity structure for alternatives and options	Op-Pr: Operational Activity Decomposition Map [OV-5a]

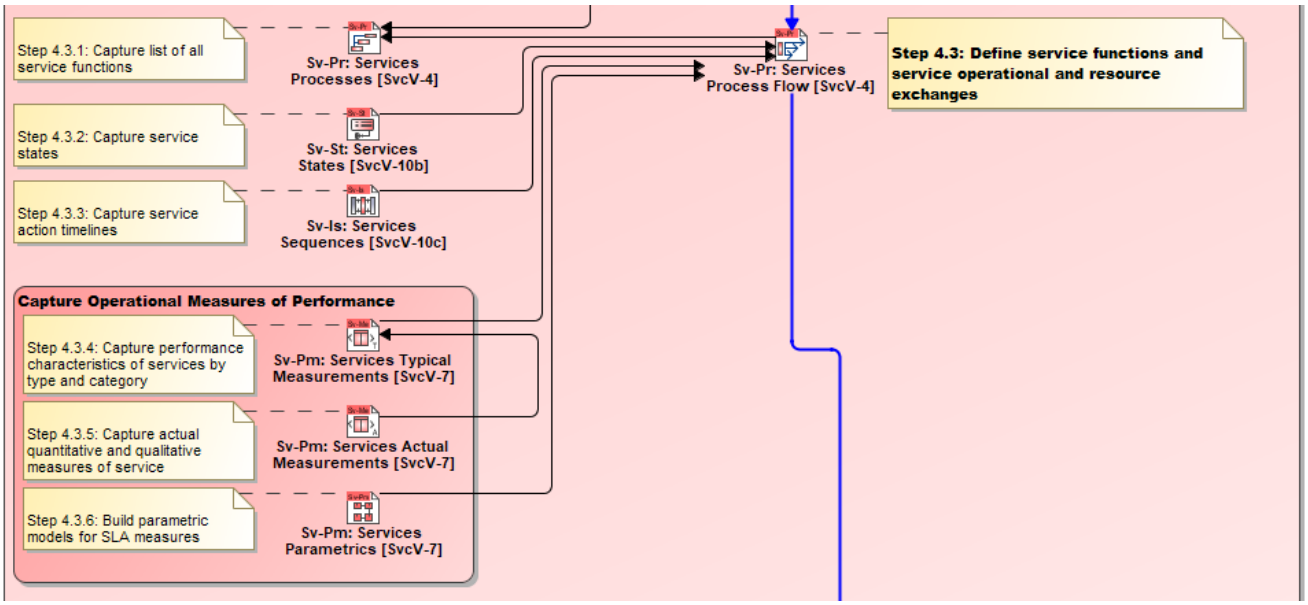


4.4 Step 4 – Service Architectures (Black Box)

The purpose of this step is to define the enterprise services needed to support the operational architecture along with specification of required service features and qualities. The basic activities for Step 4 are illustrated below in graphic form (partial view) and as a list of activities for that step.

84	Step 4: Define [Black Box] Service Architectures [Sv - SvcV]	
85	**Step 4.1: Identify service specifications and corresponding points for service level agreements with both internal and external service providers**	Sv-Tx: Services Taxonomy [SvcV-1]
86	Step 4.1.1: Trace services used by operational activities	Sv-Tr: Operational Activities to Service Specifications Mapping [SvcV-5]
87	Step 4.1.2: Specify service rules, methods, and service policies in rule form	Sv-Ct: Services Constraints [SvcV-10a]
88	Step 4.1.3: Capture the environment and conditional constraints for services (e.g. joint, coalition, theater, and other constraints)	Sv-Ct: Services Constraints Definition [SvcV-10a]
89	Step 4.1.4: Forecast resource (used by future services) technology readiness against time	Rs-Rm: Services Technologies Forecast [SvcV-9]
90	Step 4.1.5: Capture types and categories of services (both internal and external)	Sv-Tx: Services Taxonomy Table [SvcV-1]
91	**Step 4.2: Capture overarching service roles, structural parts, and connectivity**	Sv-Sr: Services Structure [SvcV-2]

92	Step 4.2.1: Specify service connections and interfaces	Sv-Cn: Services Flow Connectivity [SvcV-6]
93	Step 4.2.2: Capture internal structure of services	Sv-Cn: Services Internal Connectivity [SvcV-3b]
94	Step 4.2.3: Specify service connections with resources	Sv-Cn: Resources to Services Connectivity [SvcV-3a]
95	Step 4.2.4: Capture service data elements for all service activities to build the logical data model	Sv-If: Services Logical Data Model [DIV-2]
96	**Step 4.3: Define service functions and service operational and resource exchanges**	Sv-Pr: Services Process Flow [SvcV-4]
97	Step 4.3.1: Capture list of all service functions	Sv-Pr: Services Processes [SvcV-4]
98	Step 4.3.2: Capture service states	Sv-St: Services States [SvcV-10b]
99	Step 4.3.3: Capture service action timelines	Sv-Is: Services Sequences [SvcV-10c]
100	Step 4.3.4: Capture performance characteristics of services by type and category	Sv-Pm: Services Typical Measurements [SvcV-7]
101	Step 4.3.5: Capture actual quantitative and qualitative measures of service	Sv-Pm: Services Actual Measurements [SvcV-7]
102	Step 4.3.6: Build parametric models for SLA measures	Sv-Pm: Services Parametrics [SvcV-7]
103	**Step 4.4: Define service deployment plans**	Sv-Rm: Services Roadmap [SvcV-8]
104	Step 4.4.1: Manage service configurations	Sv-Rm: Services Roadmap [SvcV-8]
105	**Step 4.5: Analyze service structure to capture and coordinate SLA documents and requirements with community (DoD, IC, Joint, Coalition) services, and internal and external service providers**	Service Level Agreement Datasets
106	Step 4.5.1: Capture SLA, MOU, and MOA datasets for incoming services, outgoing service offerings, and joint-coalition inbound or outbound service offerings	Service Level Agreement Datasets

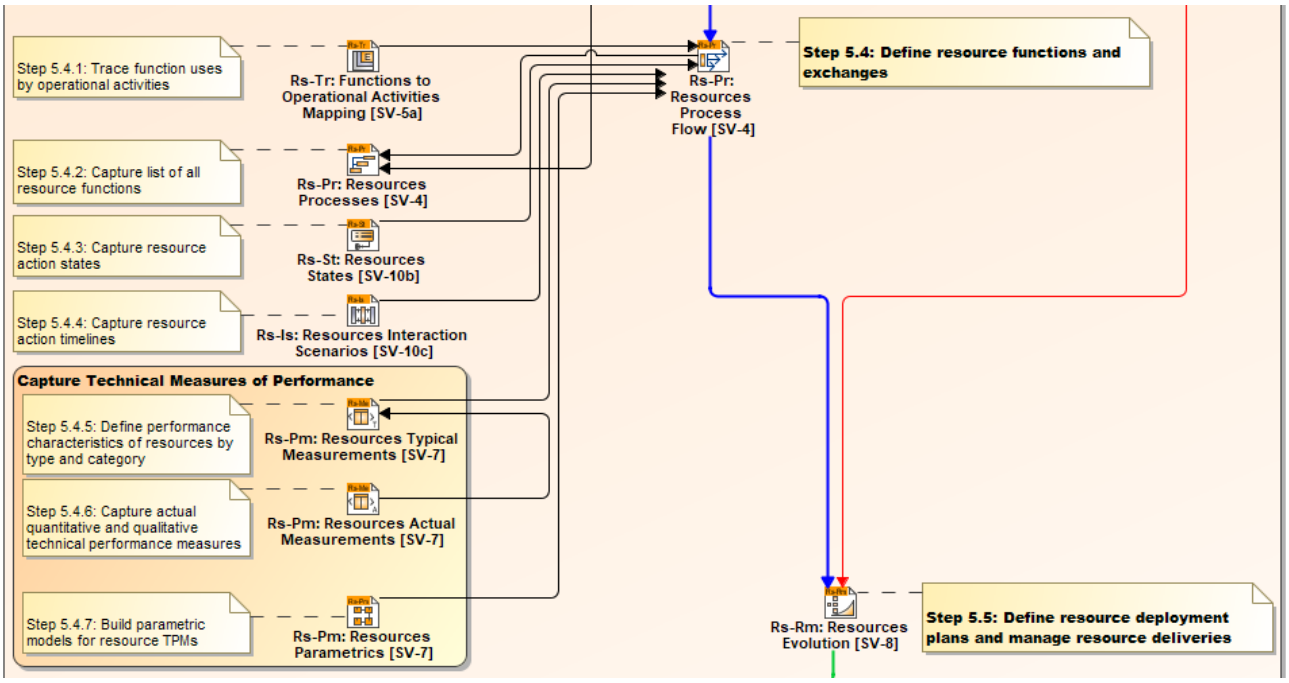


4.5 Step 5 – Resource Architectures (Implementation)

The purpose of this step is to define the resources (e.g., capability configurations, systems, hardware, software, technologies, natural resources) needed to implement the operational and service architectures to realize the desired capabilities in the strategic domain. The basic activities for Step 5 are illustrated below in graphic form (partial view) and as a list of activities for that step.

107	**Step 5: Define [Implementation] Resource Architectures [Rs - SV]**	
108	**Step 5.1: Organize and arrange branch nodes of taxonomic commonality to support common or modular design and structure, and define all physical (non-human) resource elements**	Rs-Tx: Resources Taxonomy [SV-1]
109	Step 5.1.1: Analyze resource elements used for operational elements to prepare alternatives	Rs-Tx: Resources Implementation Matrix [SV-1]
110	Step 5.1.2: Trace resource used by operational activities	Rs-Tr: Resources to Operational Activities Mapping [SV-5b]
111	Step 5.1.3: Capture resource environments, theaters, and operating conditions	Rs-Pm: Resources Environment [SV-1]
112	Step 5.1.4: Specify resource rules, methods, and resource policies in rule form	Rs-Ct: Resources Constraints [SV-10a]
113	Step 5.1.5: Capture the environmental and conditional constraints for resources (e.g. joint, coalition, theater, and other constraints)	Rs-Ct: Resources Constraints Definition [SV-10a]
114	Step 5.1.6: Forecast resource readiness against time.	Rs-Rm: Resource Technology Forecast [SV-9]
115	Step 5.1.7: Capture types and categories of resources	Rs-Tx: Resources Taxonomy Table [SV-1]
116	**Step 5.2: Define or Apply Standards [Sd - StdV]**	
117	Step 5.2.1: Apply standards based on resource conditions and constraints	Sd-Tx: Standards Taxonomy [StdV-1]
118	Step 5.2.2: Trace standards used by resources	Sd-Tr: Standards Traceability [StdV-1]
119	Step 5.2.3: Define performance characteristics of standards by type and category	Sd-Pm: Standards Typical Measurements [StdV-1]
120	Step 5.2.4: Capture actual quantitative and qualitative technical standards measures	Sd-Pm: Standards Actual Measurements [StdV-1]
121	Step 5.2.5: Capture types and categories of standards	Sd-Tx: Standards Taxonomy Table [StdV-1]
122	Step 5.2.6: Capture standards roles and structural parts	Sd-Sr: Standards Structure [StdV-1]
123	Step 5.2.7: Forecast future changes in standards	Sd-Rm: Standards Roadmap [StdV-2]
124	**Step 5.3: Capture overarching resource roles and structural parts**	Rs: Resources Structure [SV-2]
125	Step 5.3.1: Specify resource connections and interfaces	Rs-Cn: Resources Connectivity [SV-1]
126	Step 5.3.2: Supporting resource table for analysis	Rs-Cn: Resources Connectivity Table [SV-3]
127	Step 5.3.3: Analyze how resources interact with each other	Rs-Cn: Resources Connectivity Matrix [SV-6]
128	Step 5.3.4: Capture internal structure of resources	Rs-Cn: Resources Internal Connectivity [SV-2]
129	Step 5.3.5: Capture role-based relationships of resources	Rs-Cn: Resources Role-based Connectivity [SV-2] Table
130	Step 5.3.6: Capture resource data elements for all resource activities to build the logical data model	Rs-If: Resources Logical Data Model [DIV-2]
131	**Step 5.4: Define resource functions and exchanges**	Rs-Pr: Resources Process Flow [SV-4]
132	Step 5.4.1: Trace function uses by operational activities	Rs-Tr: Functions to Operational Activities Mapping [SV-5a]
133	Step 5.4.2: Capture list of all resource functions	Rs-Pr: Resources Processes [SV-4]
134	Step 5.4.3: Capture resource action states	Rs-St: Resources States [SV-10b]
135	Step 5.4.4: Capture resource action timelines	Rs-Is: Resources Interaction Scenarios [SV-10c]
136	Step 5.4.5: Define performance characteristics of resources by type and category	Rs-Pm: Resources Typical Measurements [SV-7]
137	Step 5.4.6: Capture actual quantitative and qualitative technical performance measures	Rs-Pm: Resources Actual Measurements [SV-7]
138	Step 5.4.7: Build parametric models for resource TPMs	Rs-Pm: Resources Parametrics [SV-7]
139	**Step 5.5: Define resource deployment plans and manage resource deliveries**	Rs-Rm: Resources Evolution [SV-8]
140	**Step 5.6: Analyze resource alternatives and capture system requirements for resource components for preparation of acquisition or procurement actions.**	Rq: System (Component) Requirement Table Rs-Ct: Resource Performer Structural Decomposition [SV-2]

141	Step 5.6.1: Capture system (component) specialization configurations	Rs-St: Resource Performer Specialization Variant Map [SV-2]
142	Step 5.6.2: Analyze function impacts based on resource alternatives	Rs-Tr: Resource Impact Analysis Map [SV-4]
143	Step 5.6.3: Analyze capability impacts based on resource role alternatives	Rs-Tr: Resource Role Impact Analysis Map [SV-4]
144	Step 5.6.4: Capture system (component) requirements and represent requirements structure	Rq: System (Component) Requirement Diagram
145	Step 5.6.5: Analyze system (component) requirements	Rq: System (Component) Requirement Containment Map
146	Step 5.6.6: Analyze system (component) black box interfaces	Rq: System (Component) Black box ICD Analysis
147	Step 5.6.7: Analyze sub-system (sub-component) internal interfaces	Rq: System (Component) White box ICD Analysis

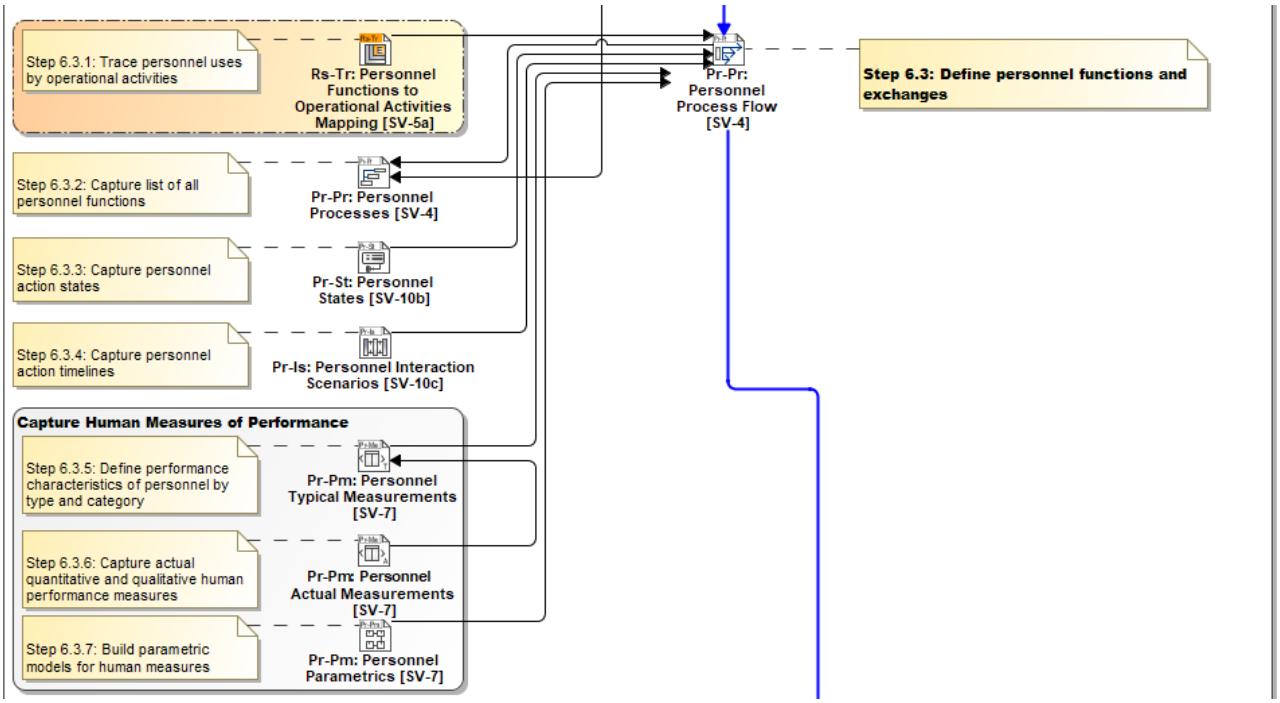


4.6 Step 6 – Personnel Architectures (Organizational)

The purpose of this step is to identify the personnel characteristics (e.g., organizations, persons, responsibilities, posts) needed to participate in the operational architecture. The basic activities for Step 6 are illustrated below in graphic form (partial view) and as a list of activities for that step.

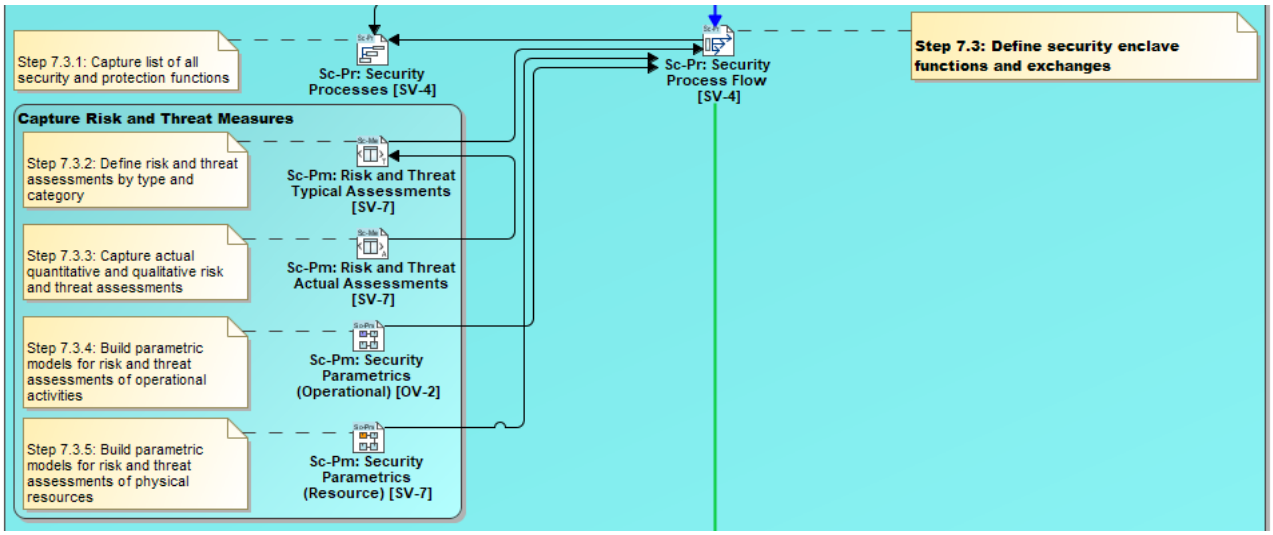
148	**Step 6: Define [Human] Personnel Architectures [Pr - SV]**	
149	**Step 6.1: Organize and arrange branch nodes of taxonomic commonality to support types of organizational and human resources**	Pr-Tx: Personnel Taxonomy [OV-4]
150	Step 6.1.1: Trace personnel uses by operational activities	Rs-Tr: Personnel Resources to Operational Activities Mapping [SV-5b]
151	Step 6.1.2: Capture personnel environments, theaters, and operating conditions	Pr-Pm: Personnel Environment [SV-1]
152	Step 6.1.3: Specify personnel rules, methods, and personnel policies in rule form	Pr-Ct: Personnel Constraints [SV-10a]

153	Step 6.1.4: Capture the environmental and conditional constraints for personnel (e.g. joint, coalition, theater, and other constraints)	Pr-Ct: Personnel Constraints Definition [SV-10a]
154	Step 6.1.5: Forecast personnel readiness against time	Pr-Pm: Personnel Forecast [SV-9]
155	Step 6.1.6: Capture types and categories of personnel	Pr-Tx: Personnel Taxonomy Table [OV-4]
156	**Step 6.2: Capture overarching organization and manpower roles and structural parts**	Pr-St: Personnel Structure [OV-4]
157	Step 6.2.1: Specify personnel connections and interfaces	Pr-Cn: Personnel Connectivity [SV-6]
158	Step 6.2.2: Supporting personnel table for analysis	Pr-Cn: Personnel Connectivity Table [SV-6]
159	Step 6.2.3: Capture internal structure of organization	Pr-Cn: Personnel Internal Connectivity [SV-6]
160	Step 6.2.4: Capture role-based relationships of personnel	Pr-Cn: Personnel Role-based Connectivity Table [SV-6]
161	Step 6.2.5: Capture personnel data elements for all personnel activities to build the logical data model	Pr-If: Personnel Logical Data Model [DIV-2]
162	**Step 6.3: Define personnel functions and exchanges**	Pr-Pr: Personnel Process Flow [SV-4]
163	Step 6.3.1: Trace personnel uses by operational activities	Rs-Tr: Personnel Functions to Operational Activities Mapping [SV-5a]
164	Step 6.3.2: Capture list of all personnel functions	Pr-Pr: Personnel Processes [SV-4]
165	Step 6.3.3: Capture personnel action states	Pr-St: Personnel States [SV-10b]
166	Step 6.3.4: Capture personnel action timelines	Pr-Is: Personnel Interaction Scenarios [SV-10c]
167	Step 6.3.5: Define performance characteristics of personnel by type and category	Pr-Pm: Personnel Typical Measurements [SV-7]
168	Step 6.3.6: Capture actual quantitative and qualitative human performance measures	Pr-Pm: Personnel Actual Measurements [SV-7]
169	Step 6.3.7: Build parametric models for human measures	Pr-Pm: Personnel Parametrics [SV-7]
170	**Step 6.4: Define personnel deployment plans**	Pr-Rm: Personnel Evolution [SV-8]
171	Step 6.4.1: Manage personnel availability	Pr-Rm: Personnel Availability Gantt Chart [PV-2]
172	**Step 6.5: Capture actual organization structure for preparation manpower and staffing plans**	Ar-St: Actual Organization Structure Map [SV-2]
173	Step 6.5.1: Analyze organizational alternatives to plan overall organization within multi-domain organization	Ar-St: Actual Organization Structure Map [SV-2]



4.7 Step 7 – Security and Protection (Resilience)

The purpose of this step is to identify the security risks and the necessary mitigation elements and associated security processes and controls for protecting operational and resource assets. The basic activities for Step 7 are illustrated below in graphic form (partial view) and as a list of activities for that step.

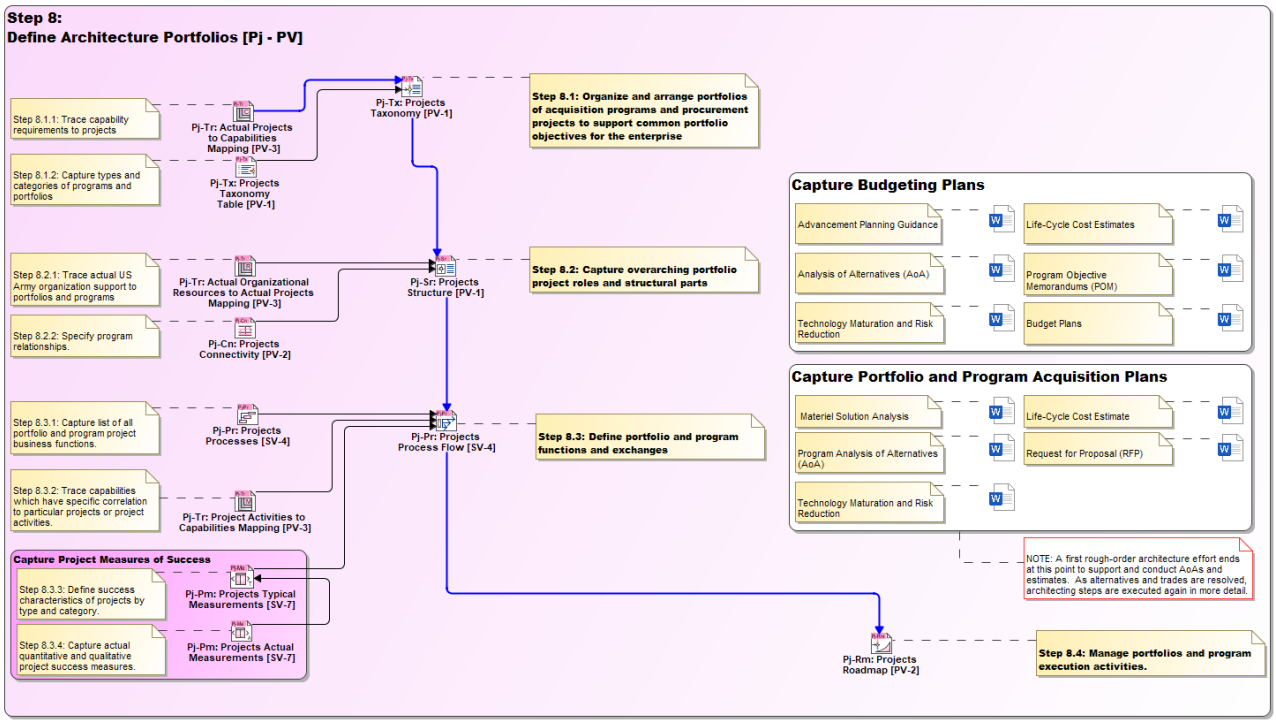


174	Step 7: Define [Protection] Security Architecture [Sc - SV]	
175	**Step 7.1: Define the hierarchy of security and protection assets and asset owners that mitigate threats**	Sc-Tx: Security and Protection Taxonomy [SV-1]
176	Step 7.1.1: Capture threat environments and conditions	Sc-Pm: Threat Environment [SV-1]
177	Step 7.1.2: Specify security and protection rules, methods, and policies in rule form	Sc-Ct: Security and Protection Constraints [SV-10a]
178	Step 7.1.3: Capture the environmental and conditional constraints for security and protection (e.g. joint, coalition, theater, and other constraints)	Sc-Ct: Security and Protection Constraints Definition [SV-10a]
179	Step 7.1.4: Capture types and categories of threat mitigations	Sc-Tx: Security and Protection Taxonomy Table [SV-1]
180	**Step 7.2: Capture the allocation of mitigation assets across the security and protection enclaves and cells**	Sc-Ct: Security Structure [SV-2]
181	Step 7.2.1: Specify security and protection enclave structure and interfaces	Sc-Cn: Security Connectivity [SV-1]
182	Step 7.2.2: Specify security and protection table for analysis	Sc-Cn: Security Connectivity Table [SV-3]
183	Step 7.2.3: Capture internal structure of security and protection enclaves for operational activities	Sc-Cn: Security Internal Connectivity (Operational) [OV-2]
184	Step 7.2.4: Capture internal structure of security and protection enclaves for resource actions	Sc-Cn: Security Internal Connectivity (Resource) [SV-2]
185	Step 7.2.5: Capture role-based relationships of security and protection enclaves	Sc-Cn: Security Role-based Connectivity Table [SV-2]
186	Step 7.2.6: Capture security and protection enclave data elements for all security actions and activities to build the logical data model	Sc-If: Security and Protection Logical Data Model [DIV-2]
187	**Step 7.3: Define security enclave functions and exchanges**	Sc-Pr: Security Process Flow [SV-4]
188	Step 7.3.1: Capture list of all security and protection functions	Sc-Pr: Security Processes [SV-4]
189	Step 7.3.2: Define risk and threat assessments by type and category	Sc-Pm: Risk and Threat Typical Assessments [SV-7]

190	Step 7.3.3: Capture actual quantitative and qualitative risk and threat assessments	Sc-Pm: Risk and Threat Actual Assessments [SV-7]
191	Step 7.3.4: Build parametric models for risk and threat assessments of operational activities	Sc-Pm: Security Parametrics (Operational) [OV-2]
192	Step 7.3.5: Build parametric models for risk and threat assessments of physical resources	Sc-Pm: Security Parametrics (Resource) [SV-7]
193	**Step 7.4: Trace security and protection controls, risks and threats, and affected resources to guide implementation of protection and mitigation plans**	Sc-Tr: Risks and Threats to Assets Mapping [SV-5]
194	Step 7.4.1: Manage security risks and controls.	Sc-Tr: Security and Protection Controls to Risk and Threats Mapping [SV-5]

4.8 Step 8 – Architecture Portfolio Management

The purpose of this step is to define portfolios of programs and projects that are involved in developing resource solutions that will be incorporated into capability configurations. The basic activities for Step 8 are illustrated below in graphic form and as a list of activities for that step.

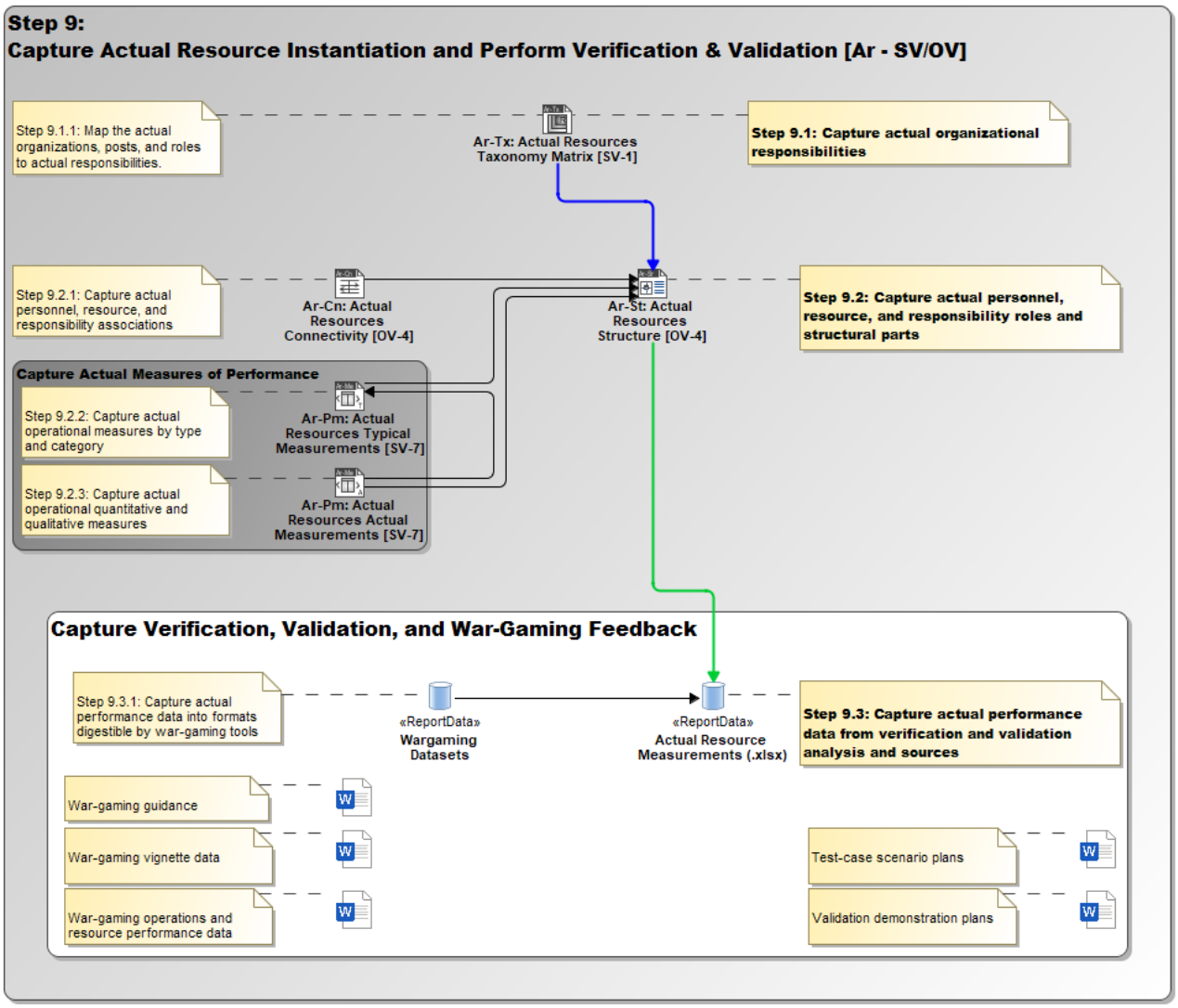


195	**Step 8: Define Architecture Portfolios [Pj - PV]**	
196	**Step 8.1: Organize and arrange portfolios of acquisition programs and procurement projects to support common portfolio objectives for the enterprise**	Pj-Tx: Projects Taxonomy [PV-1]
197	Step 8.1.1: Trace capability requirements to projects	Pj-Tr: Actual Projects to Capabilities Mapping [PV-3]
198	Step 8.1.2: Capture types and categories of programs and portfolios	Pj-Tx: Projects Taxonomy Table [PV-1]
199	**Step 8.2: Capture overarching portfolio project roles and structural parts**	Pj-Sr: Projects Structure [PV-1]
200	Step 8.2.1: Trace actual organization support to portfolios and programs	Pj-Tr: Actual Organizational Resources to Actual Projects Mapping [PV-3]
201	Step 8.2.2: Specify program relationships.	Pj-Cn: Projects Connectivity [PV-2]

202	**Step 8.3: Define portfolio and program functions and exchanges**	Pj-Pr: Projects Process Flow [SV-4]
203	Step 8.3.1: Capture list of all portfolio and program project business functions.	Pj-Pr: Projects Processes [SV-4]
204	Step 8.3.2: Trace capabilities which have specific correlation to particular projects or project activities.	Pj-Tr: Project Activities to Capabilities Mapping [PV-3]
205	Step 8.3.3: Define success characteristics of projects by type and category.	Pj-Pm: Projects Typical Measurements [SV-7]
206	Step 8.3.4: Capture actual quantitative and qualitative project success measures.	Pj-Pm: Projects Actual Measurements [SV-7]
207	**Step 8.4: Manage portfolios and program execution activities**	Pj-Rm: Projects Roadmap [PV-2]

4.9 Step 9 – Actual Resource Instantiation and V&V

The purpose of this step is to define organizational responsibilities along with associated services, resources, and other structural elements, as well as verification and validation results. The basic activities for Step 9 are illustrated below in graphic form and as a list of activities for that step.



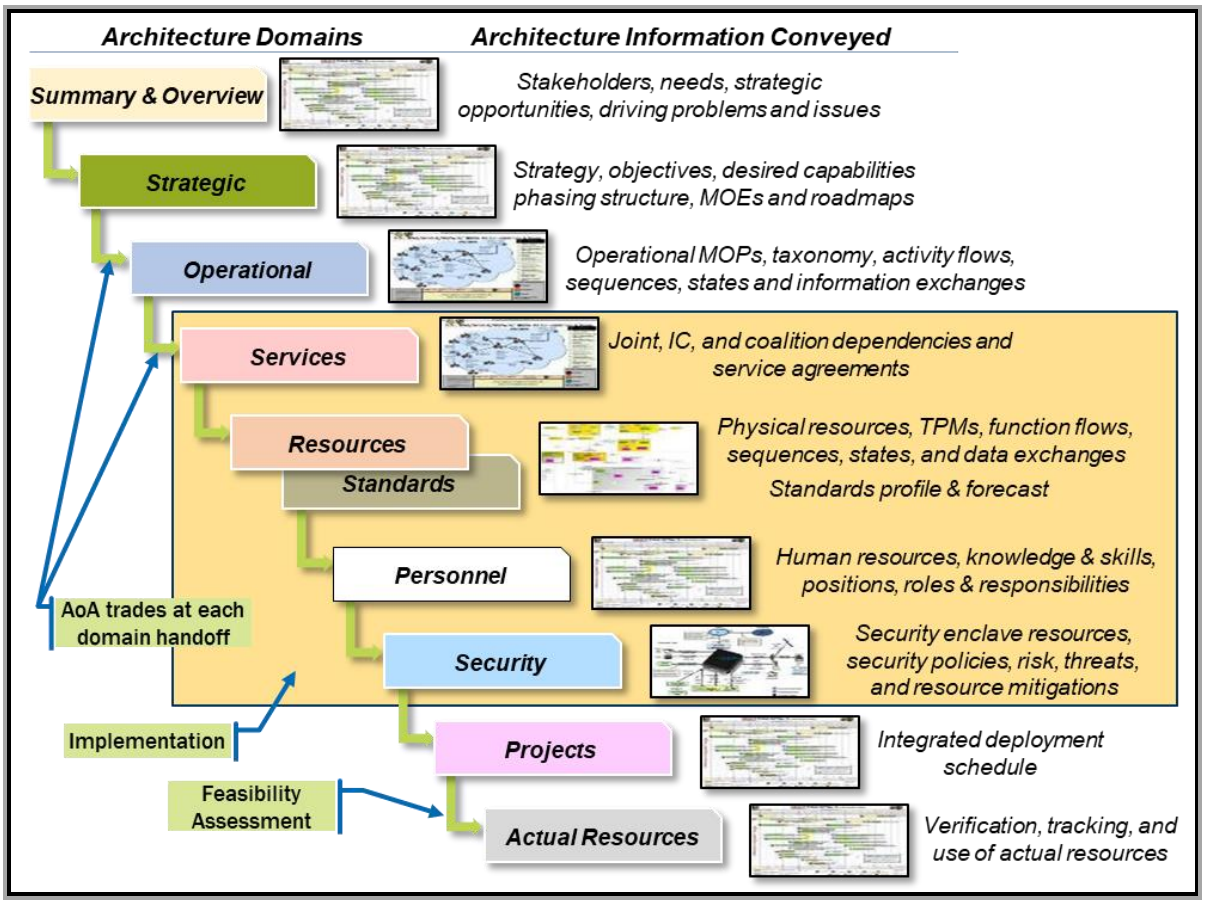
208	**Step 9: Capture Actual Resource Instantiation and Perform Verification & Validation [Ar - SV/OV]**	
209	**Step 9.1: Capture actual organizational responsibilities**	Ar-Tx: Actual Resources Taxonomy Matrix [SV-1]
210	Step 9.1.1: Map the actual organizations, posts, and roles to actual responsibilities.	Ar-Tx: Actual Resources Taxonomy Matrix [SV-1]
211	**Step 9.2: Capture actual personnel, resource, and responsibility roles and structural parts**	Ar-St: Actual Resources Structure [OV-4]
212	Step 9.2.1: Capture actual personnel, resource, and responsibility associations	Ar-Cn: Actual Resources Connectivity [OV-4]
213	Step 9.2.2: Capture actual operational measures by type and category	Ar-Pm: Actual Resources Typical Measurements [SV-7]
214	Step 9.2.3: Capture actual operational quantitative and qualitative measures	Ar-Pm: Actual Resources Actual Measurements [SV-7]
215	**Step 9.3: Capture actual performance data from verification and validation analysis and sources**	Actual Resource Measurements (.xlsx)
216	Step 9.3.1: Capture actual performance data into formats digestible by war-gaming tools	Wargaming Datasets

5 Conclusion

The process described in this paper provides a systematic and structured way to generate the architecture views defined in the Unified Architecture Framework. This process can be performed top-down, bottom-up, or middle-out, and should be tailored to fit the situation. In practice, many of these activities are done concurrently with the aim of achieving convergence towards an agreed upon target architecture with various roadmaps toward achieving the intended outcomes.

The process can be used as the basis for developing a modeling methodology, or as the basis for planning an architecture engagement with a potential client or builder. It can be used to assess MBSE capabilities of an organization, or in training personnel in the necessary knowledge and skills for modeling an enterprise. The EA description process provided here will be incorporated into the UAF standard as part of an "EA Process Guide for UAF" that facilitates application of the UAF Profile and Domain Metamodel components.

The basic structure of the process is illustrated below, showing the key architectural information that is produced out of each major step. Analysis of alternatives will be performed to identify the tradeoffs that should be examined and considered when proposing major changes to the architecture. These changes will drive decisions that affect how the enterprise will pursue opportunities to most effectively meet its enterprise goals and objectives.



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7 Biography

James N Martin is the INCOSE representative to the UAF Revision Task Force with OMG and was lead editor for the ISO 42020 standard on Architecture Processes. He is an Enterprise Architect and a Principal Systems Engineer at The Aerospace Corporation developing solutions for information systems and space system enterprises. He was a key author on the BKCASE project in development of Enterprise Systems Engineering articles for the SE Body of Knowledge (SEBOK). Dr. Martin led the working group responsible for developing ANSI/EIA 632, a US national standard that defined the processes for engineering a system. He previously worked for Raytheon Systems Company and AT&T Bell Labs on airborne and underwater systems and on communication systems. His book, Systems Engineering Guidebook, was published by CRC Press in 1996. Dr. Martin is an INCOSE Fellow and was leader of the Standards Technical Committee. He was founder and was until recently leader of the Systems Science Working Group. He received from INCOSE the Founders Award for his long and distinguished achievements in the field.

David P. O'Neil is an Enterprise Architect and Chief Systems Engineer at Science Applications International Corporation, developing and managing the architecture development and strategic planning for space systems enterprises. He authored and published "The Rapid Deployment Digital Satellite Network" in IEEE Communications Magazine (Jan 1992), and has been a guest lecturer at George Mason University's masters program in telecommunications, and AFCEA Professional Development Courses. He previously worked for Lockheed Martin on development and operation of satellite systems and engineering technical services, as well as the Unites States Marine Corps, where he was an instructor at the Command & Control System School, Marine Corps University. He received his ME in System Engineering from Old Dominion University, and his BS in Naval Architecture from the United States Naval Academy.