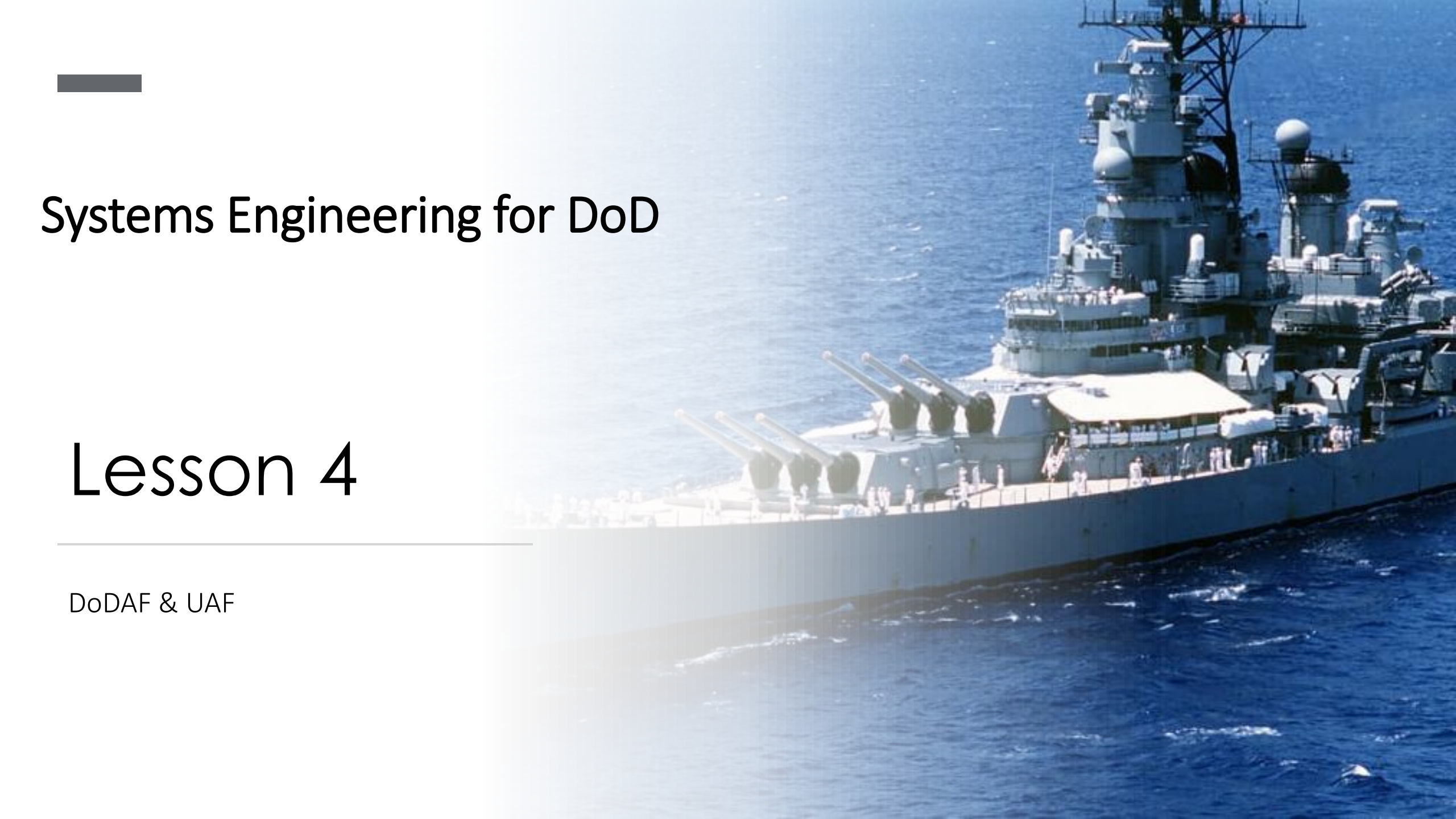
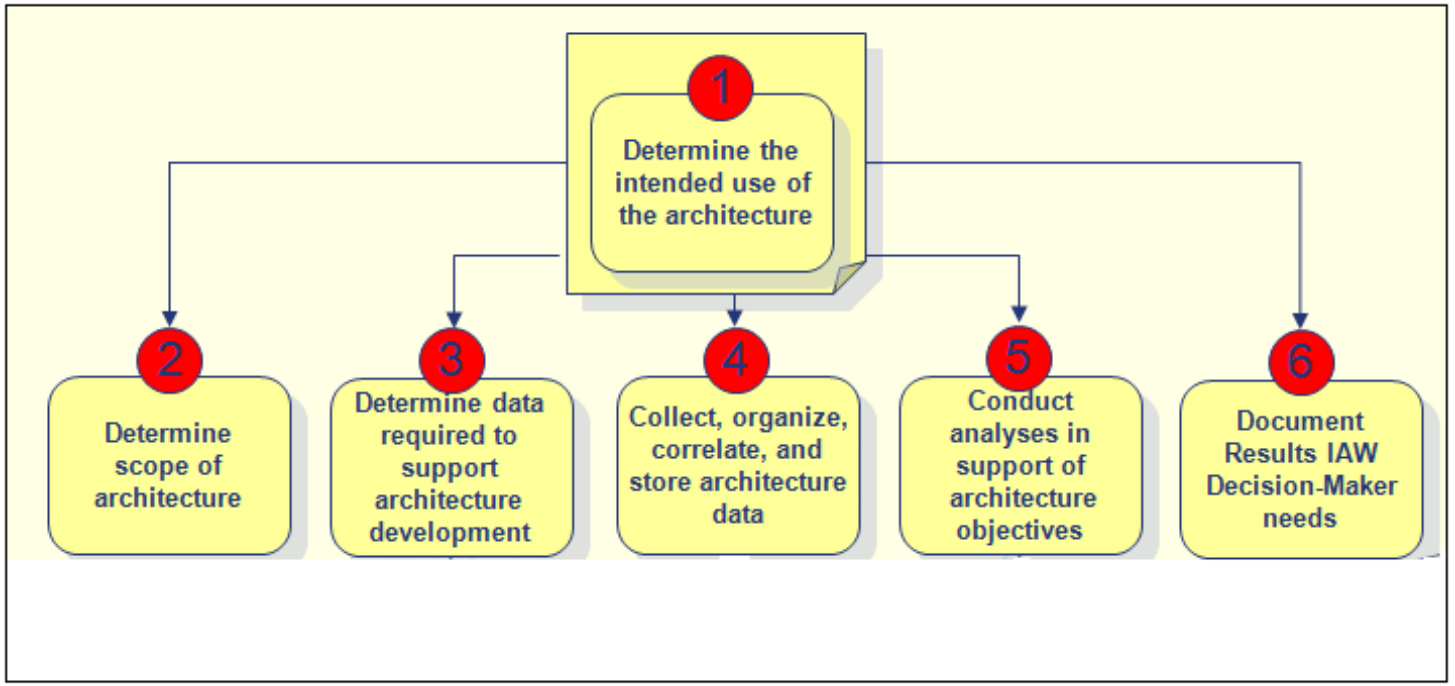
Systems Engineering for DoD



Lesson 4

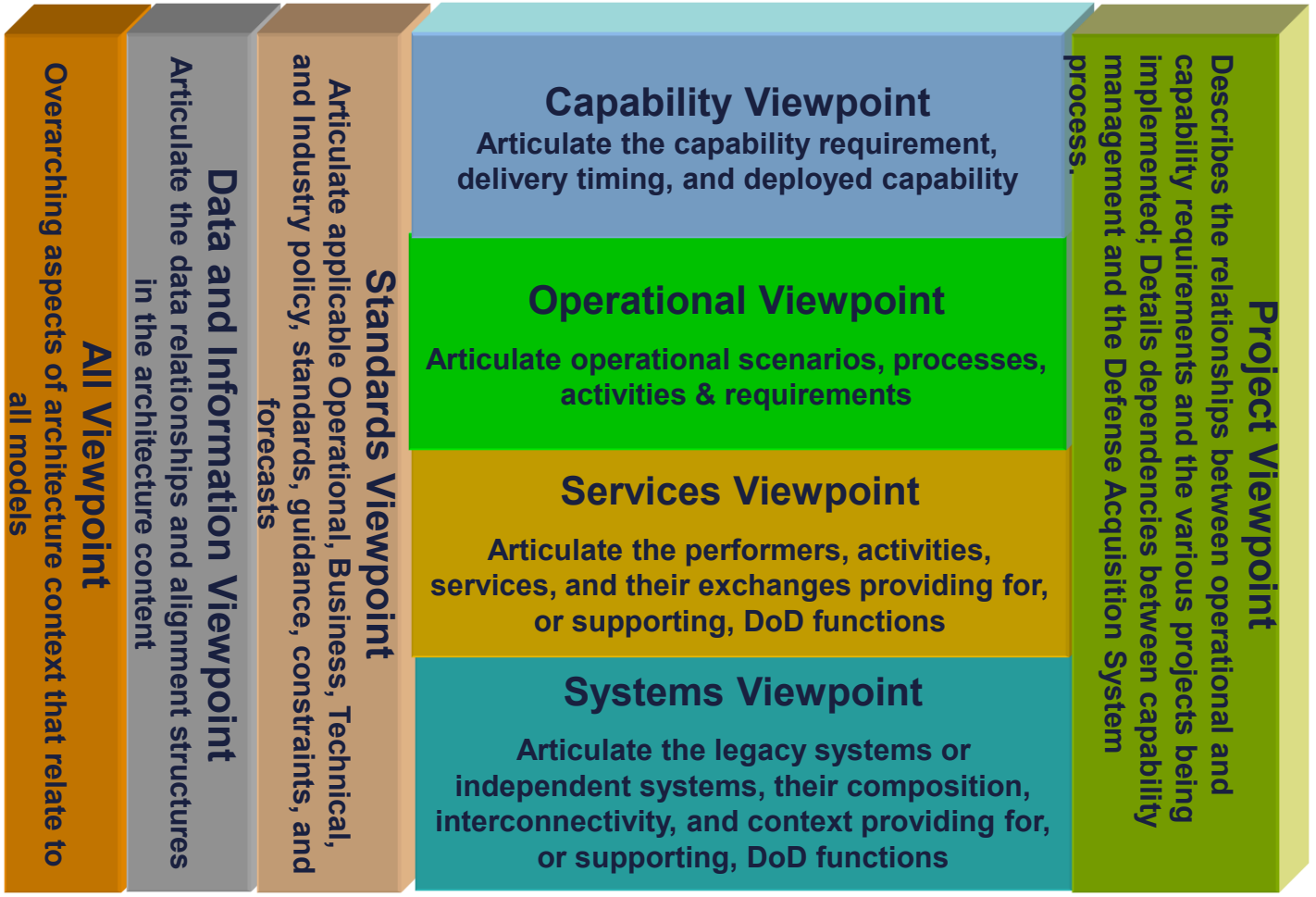
DoDAF & UAF

Methodology: DoDAF V2.0 Six-Step Architecture Development Process



- Determine **Use**, **Scope** and **Data Requirements** of Architecture
- **Architect** (build models), **analyze** and **present** (report)

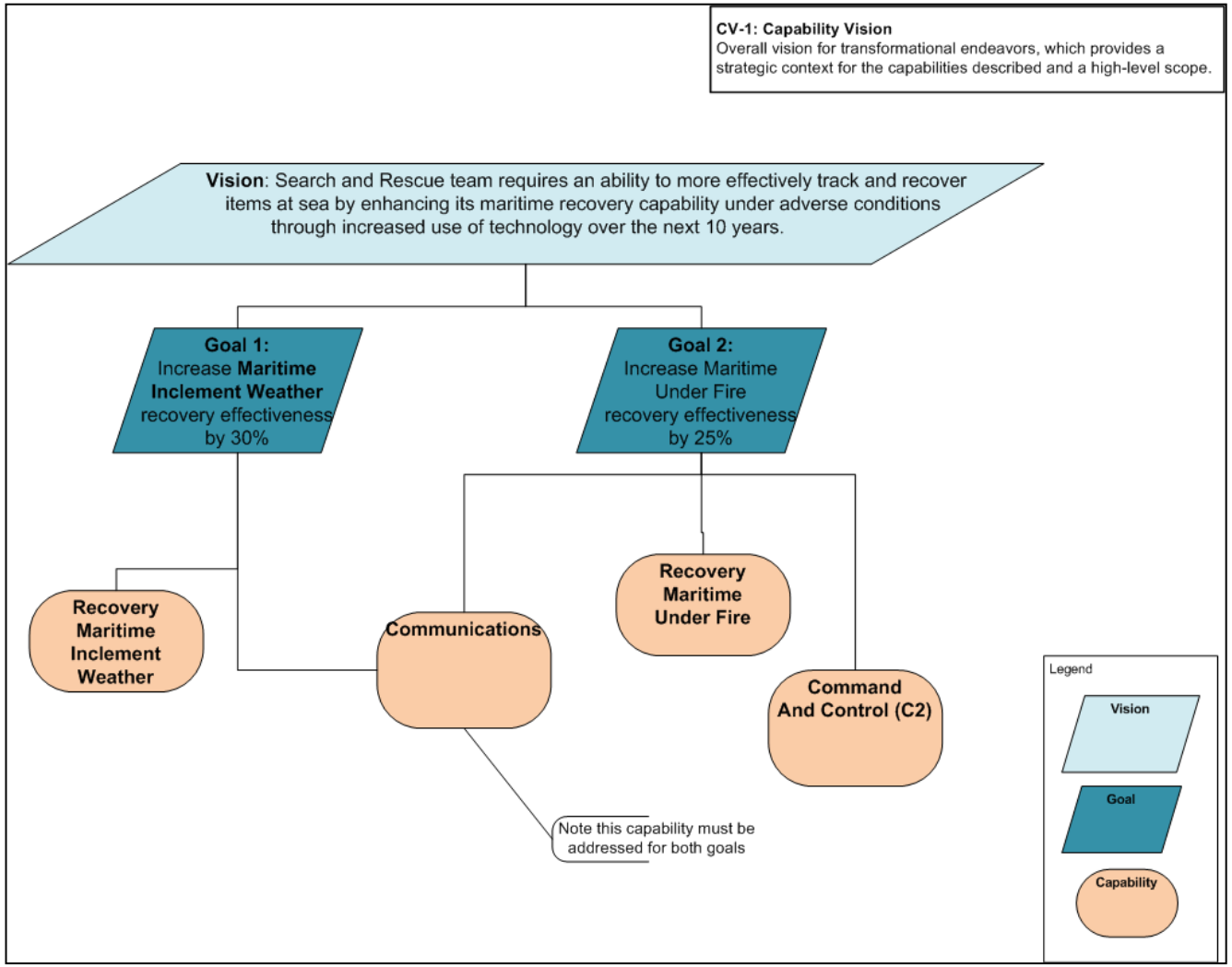
Perspectives:
Viewpoints That Fit-the-Purpose



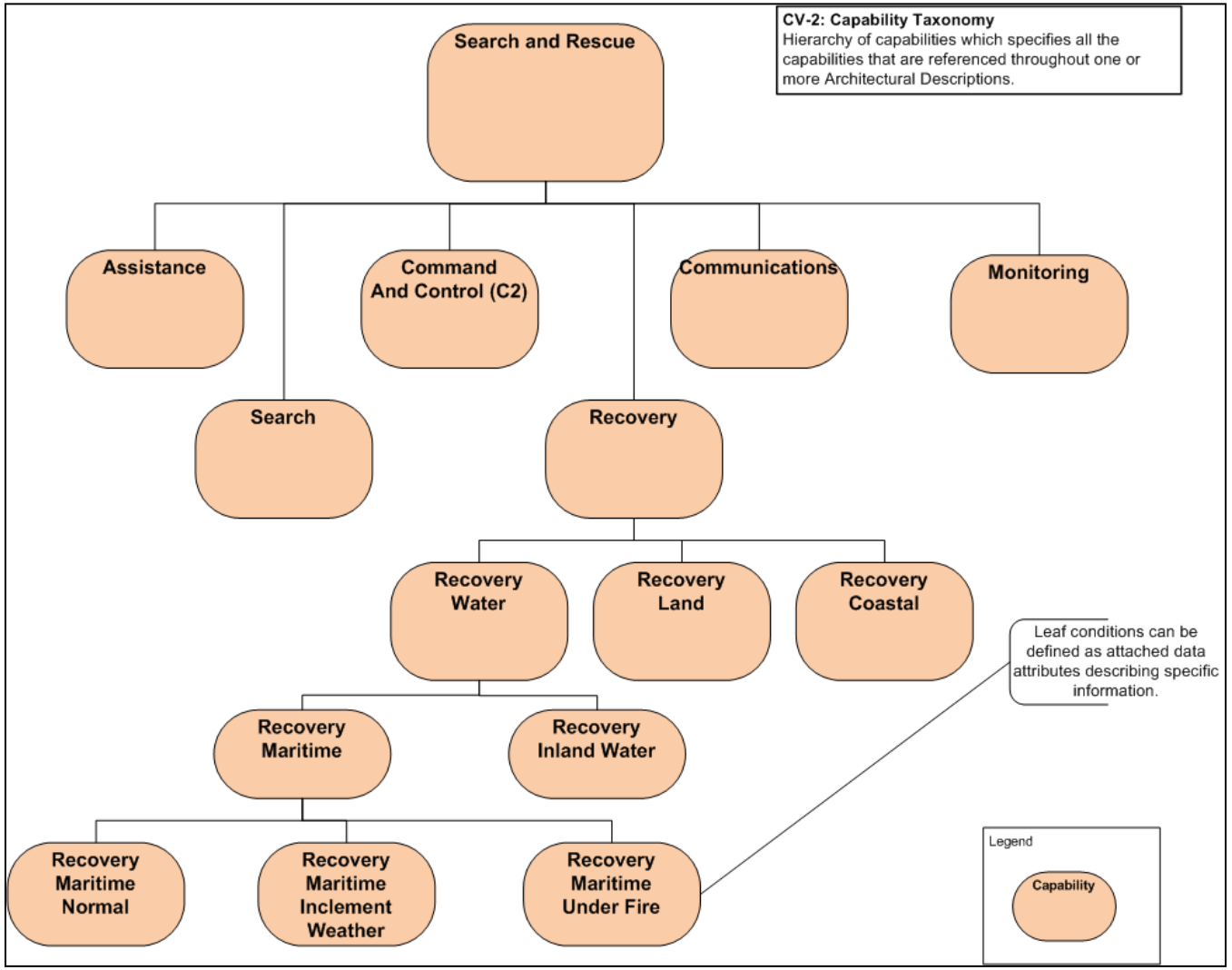
Architectural viewpoints are composed of data that has been organized to facilitate understanding.

CV-1: Vision

The overall vision for transformational endeavors, which provides a strategic context for the capabilities described and a high-level scope.
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 intended usage is communication of the strategic vision regarding capability development
This diagram is meant to capture the relationship between the Vision, the Goals and the Capabilities. It is a decomposition type of a diagram. In this example there is one Vision, two Goals and four Capabilities



CV-2: Capability Taxonomy



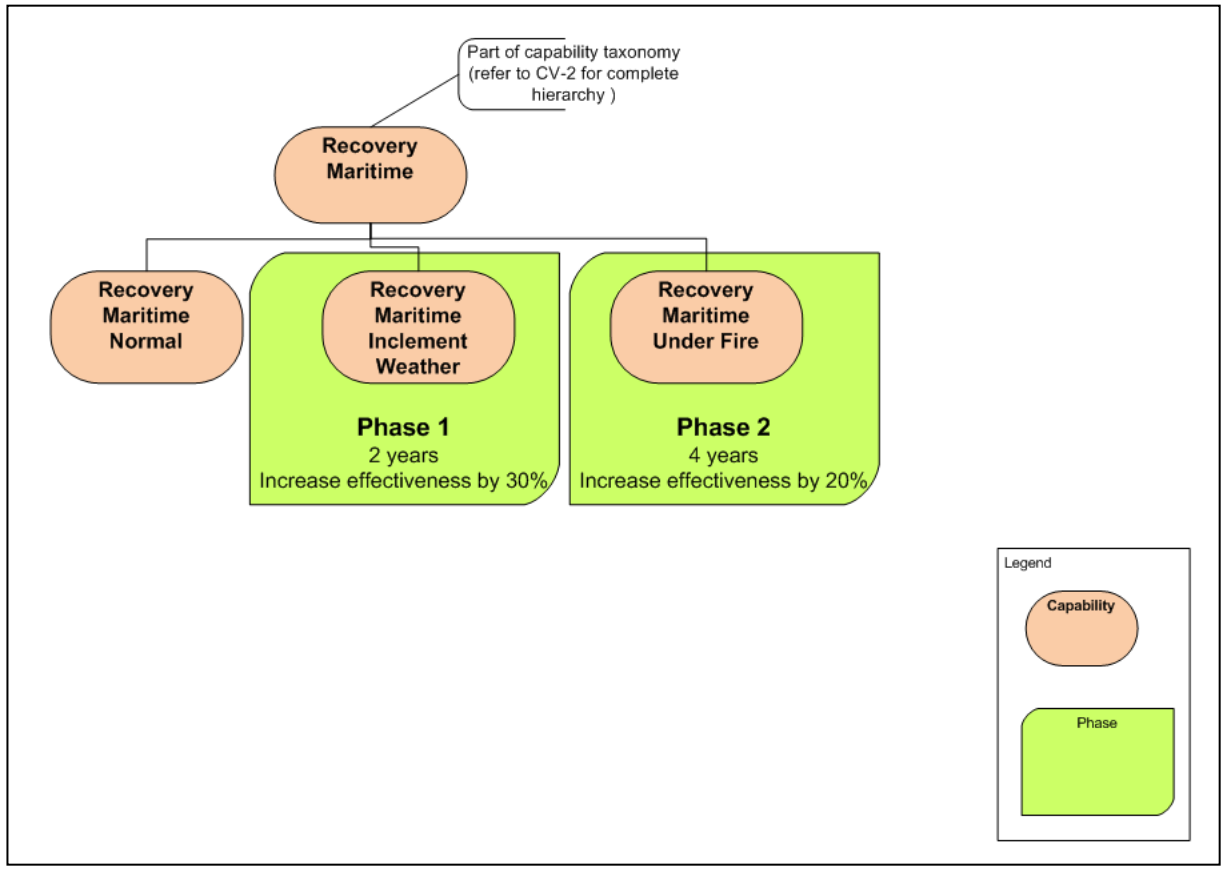
A hierarchy of capabilities which specifies all the capabilities that are referenced throughout one or more Architectural Descriptions.
The CV-2 captures capability taxonomies. The model presents a hierarchy of capabilities.
This diagram is meant to capture this relationship. A Capability should be different that an activity.

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.

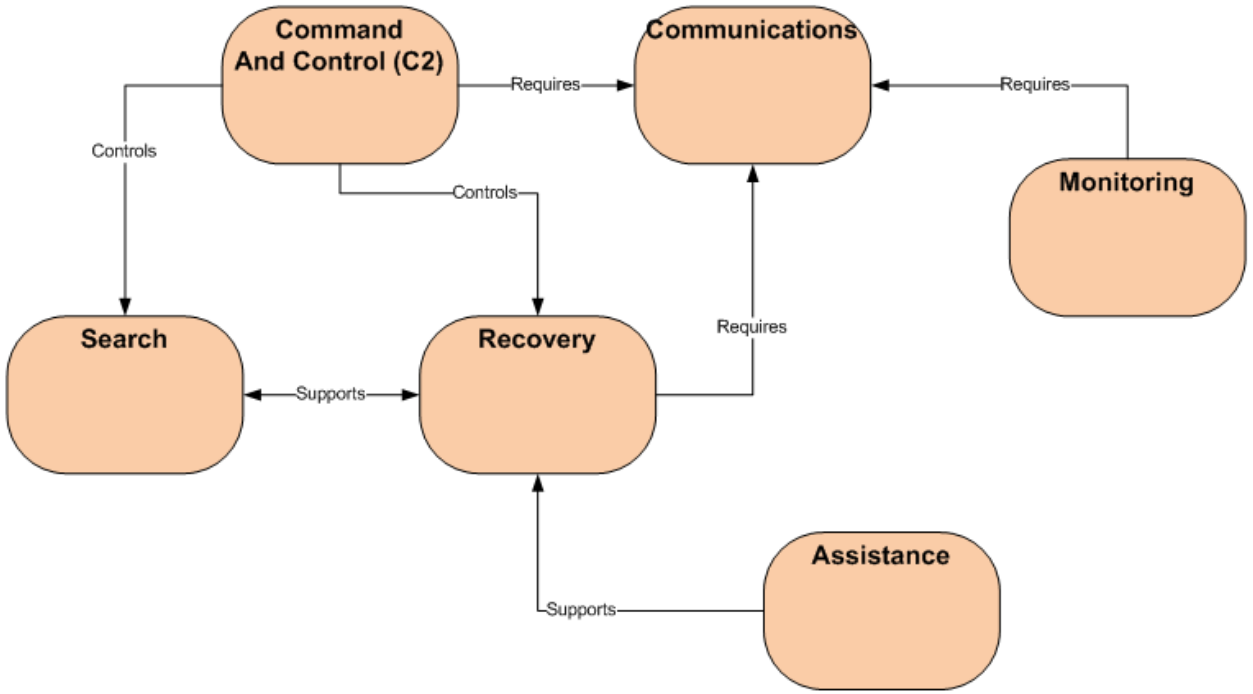
The CV-3 provides a representation of the available capability at different points in time or during specific periods of time

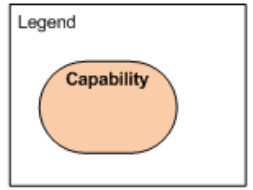
This diagram is meant to capture the time phase of the second and third child capability through the green shape which carries the phase data. Other techniques may be used to capture the phase data as desired.

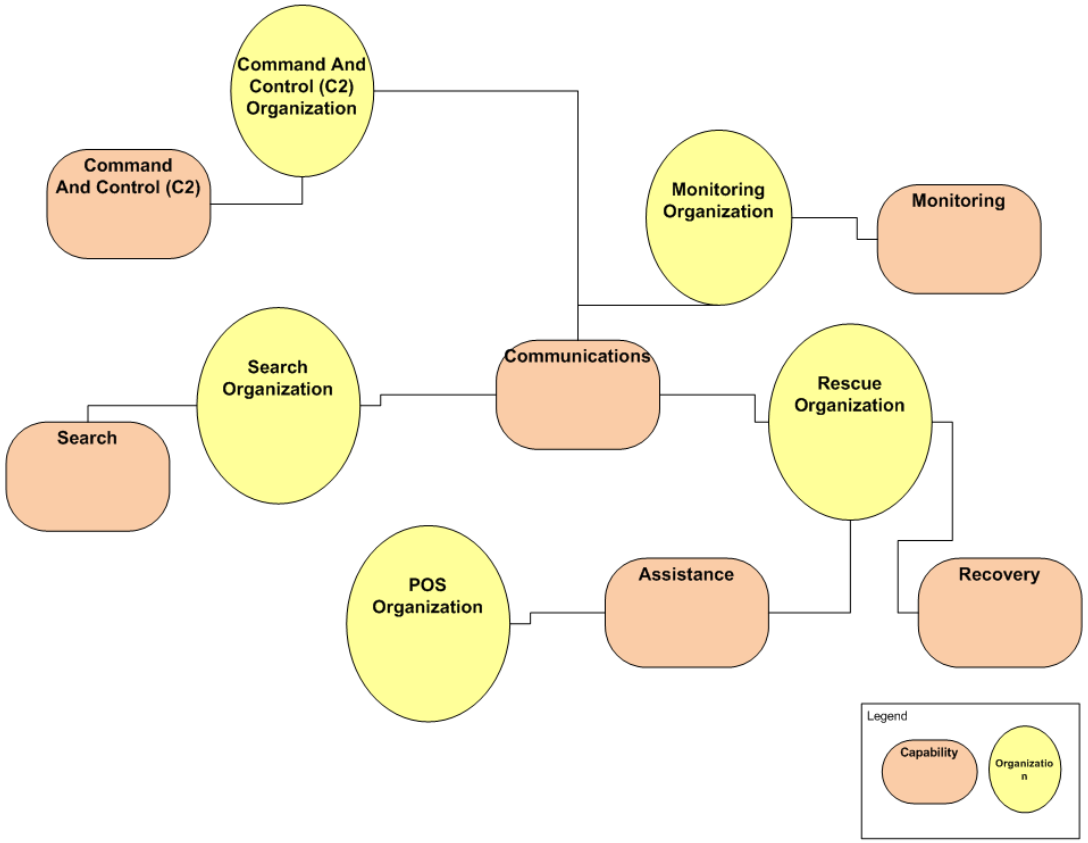


CV-4 Capability Dependencies

- The dependencies between planned capabilities and the definition of logical groupings of capabilities.
- The CV-4 describes the dependencies between planned capabilities.
- This diagram shows relationships (including a relationship label) between six capabilities.

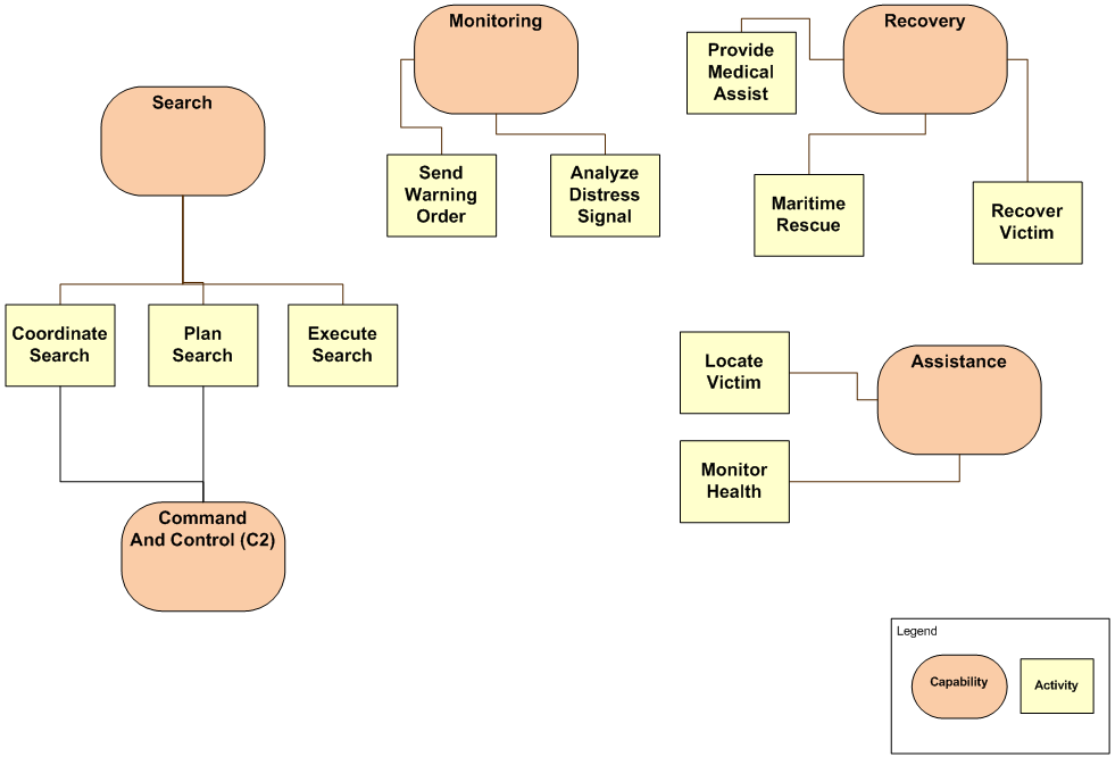






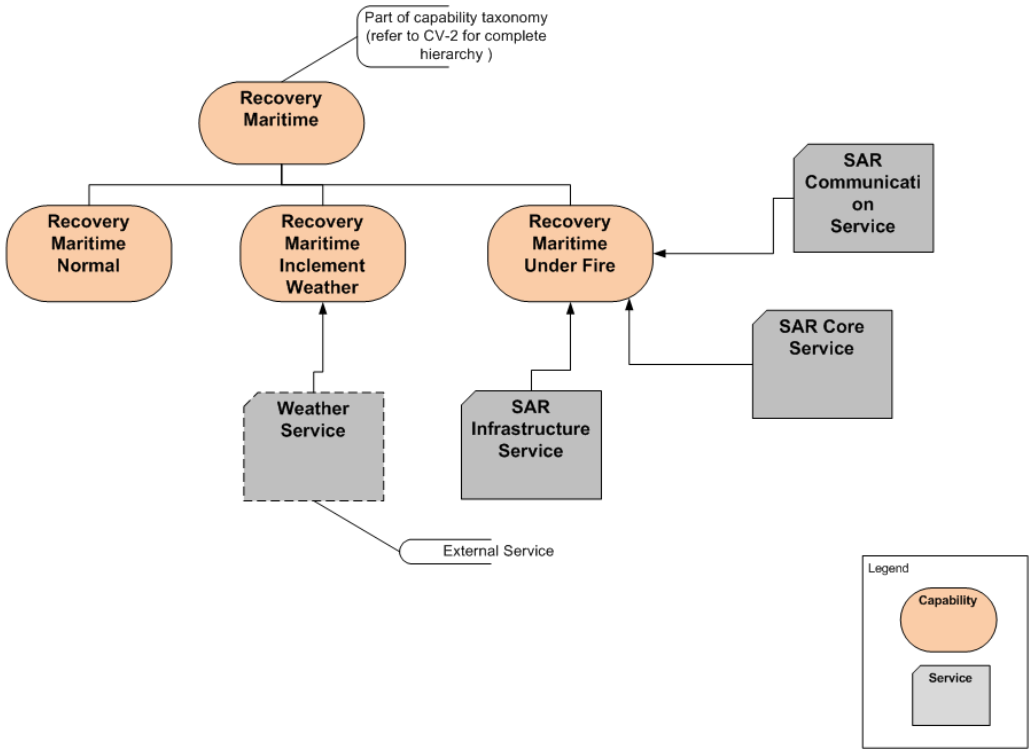
CV-5: Capability to Organizational Development Mapping

- The fulfillment of capability requirements shows the planned capability deployment and interconnection for a particular Capability Phase. The CV-5 shows the planned solution for the phase in terms of performers and locations and their associated concepts.
- The CV-5 shows deployment of Capabilities to specific organizations.
- This diagram shows the relationship between Capability and Organizations



CV-6 Capability to Operational Activities Mapping

- A mapping between the capabilities required and the operational activities that those capabilities support.
- A mapping between the capabilities required and the operational activities that those capabilities support
- This diagram shows the relationship between Capability and Activities. Either style of presentation is acceptable for this model, a graphical mapping or a matrix mapping.

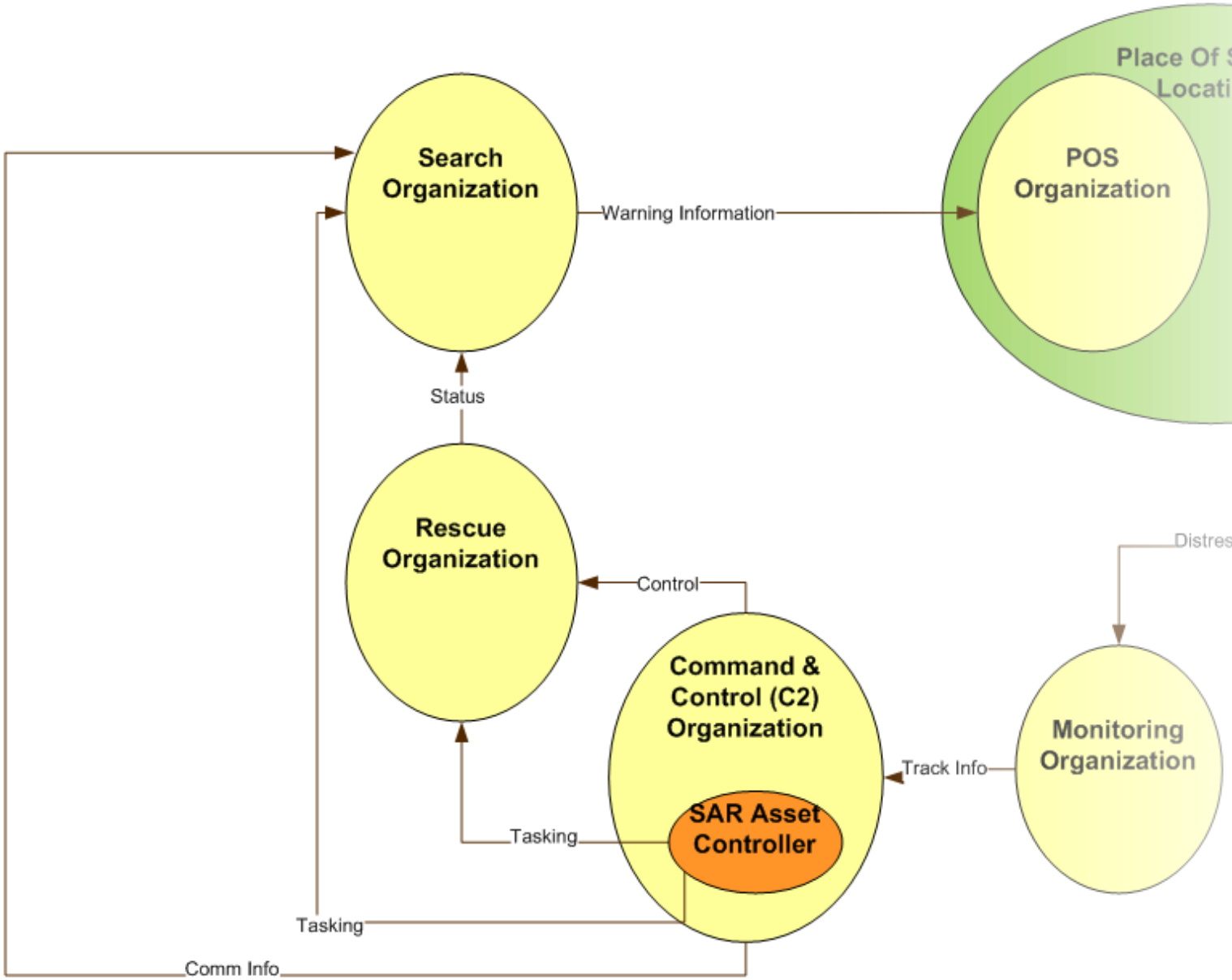


CV-7: Capability to Services

- A mapping between the capabilities and the services that these capabilities enable.
- The CV-7 describes the mapping between the capabilities required and the services that enable those capabilities.
- This diagram shows the relationship between Capability and Activities. Either style of presentation is acceptable for this model, a graphical mapping or a matrix mapping.

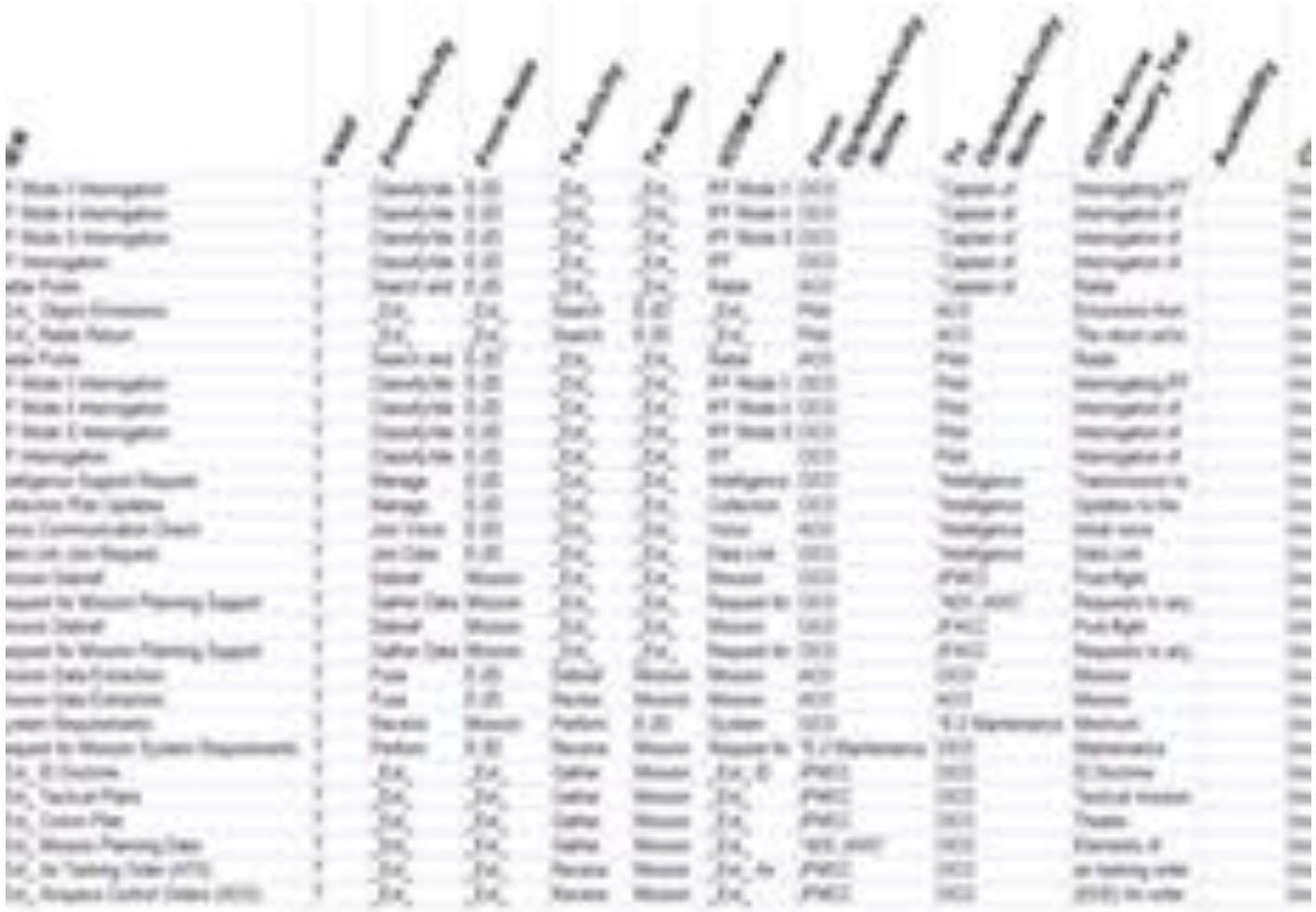
OV-1: High-Level Operational Concept Graphic

- The high-level graphical/textual description of the operational concept
- The OV-1 is the pictorial representation of the written content of the AV-1 Overview and Summary Information.
- This diagram is meant to convey the general, high level, description of the systems that may perform in this mission, and that there may be some form of communication between them. This is a pictorial representation only.



OV-2: Operational Resource Flow Description

- A description of the Resource Flows exchanged between operational activities.
- The OV-2 depicts Operational Needlines that indicate a need to exchange resources. 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
- This diagram is meant to capture the needlines between the different Organizations [Locations] that are key to this sample architecture description.

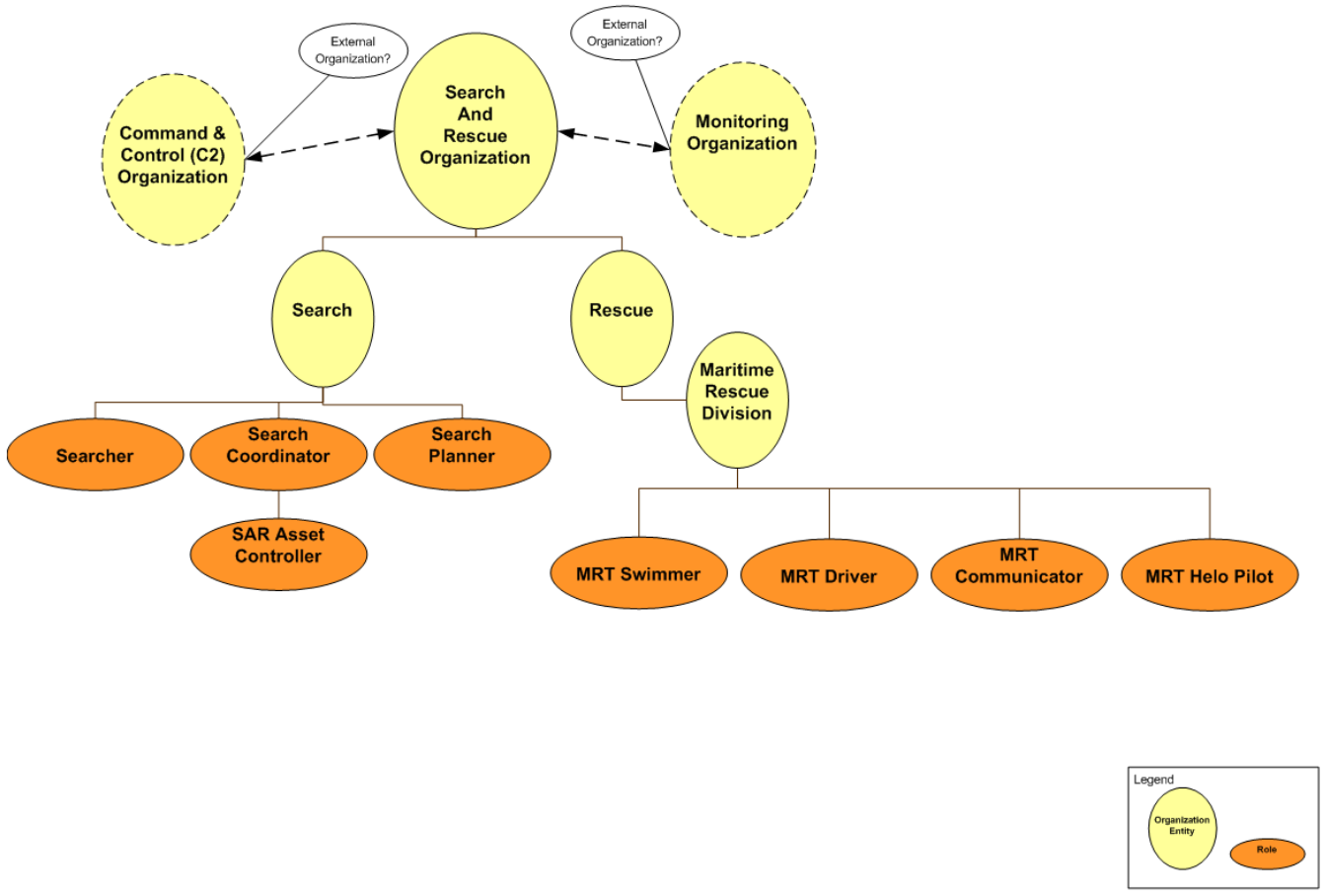


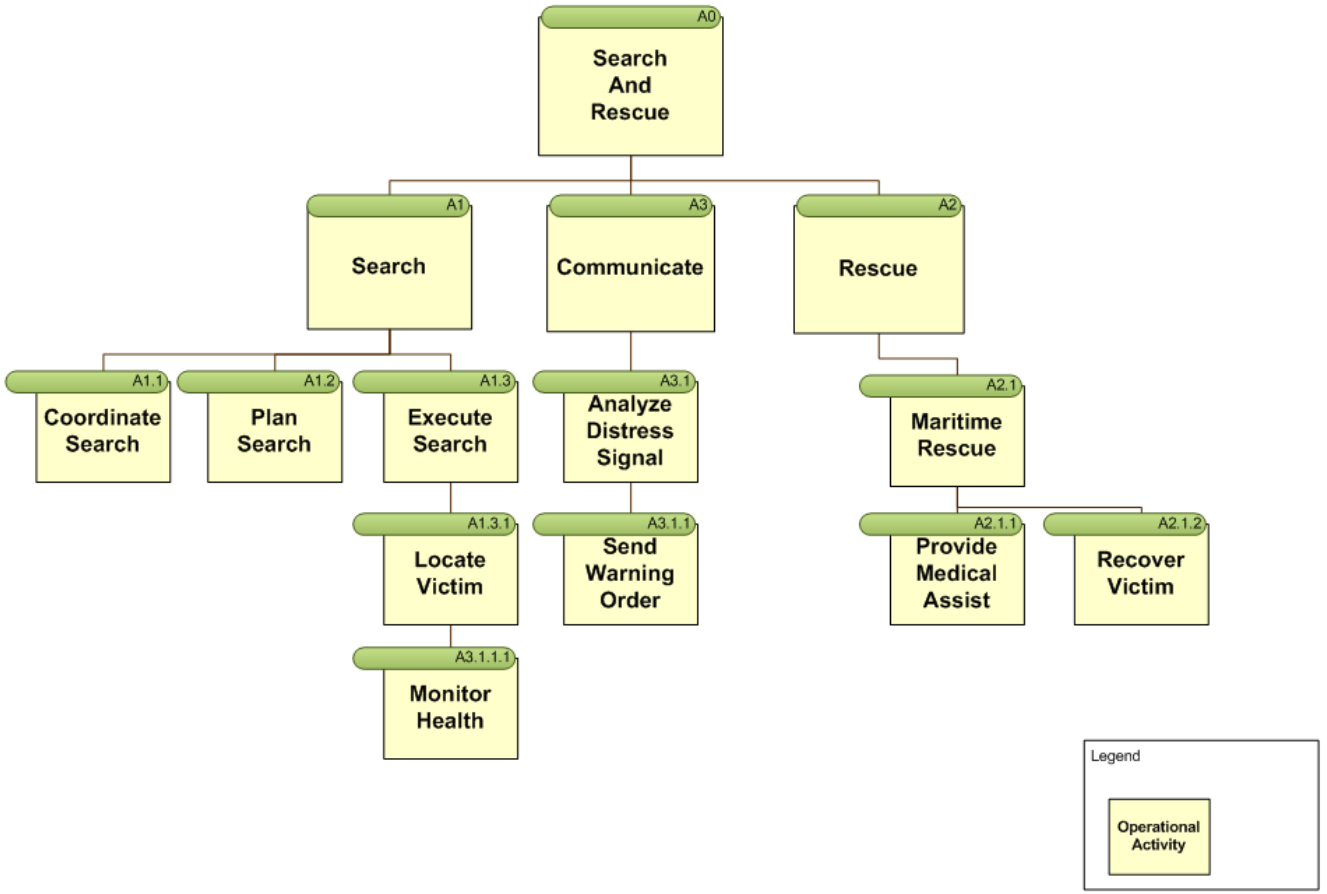
OV-3: Operational Resource Flow Matrix

- A description of the resources exchanged and the relevant attributes of the exchanges.
- 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.
- This matrix is a list of Resource Flows and the key attributes of the associated Resources. One or more rows of this matrix are associated with a Needline in the OV-2: Operational Resource Flow Description

OV-4: Organizational Relations Chart

- The organizational context, role or other relationships among organizations.
- The OV-4 addresses the organizational aspects of an Architectural Description.
- This diagram is meant to show the hierarchical relationships between the organizations involved in Search and Rescue



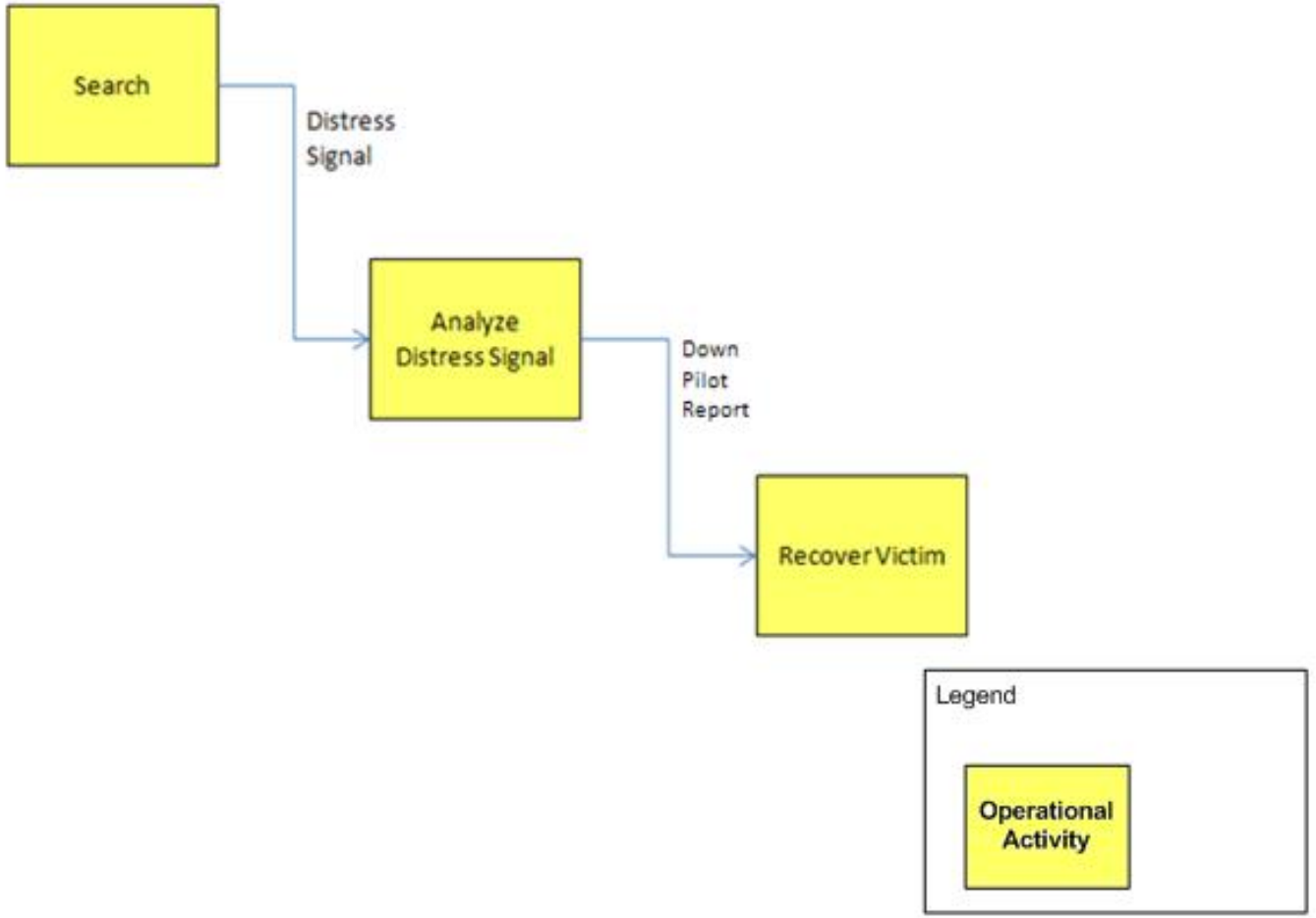


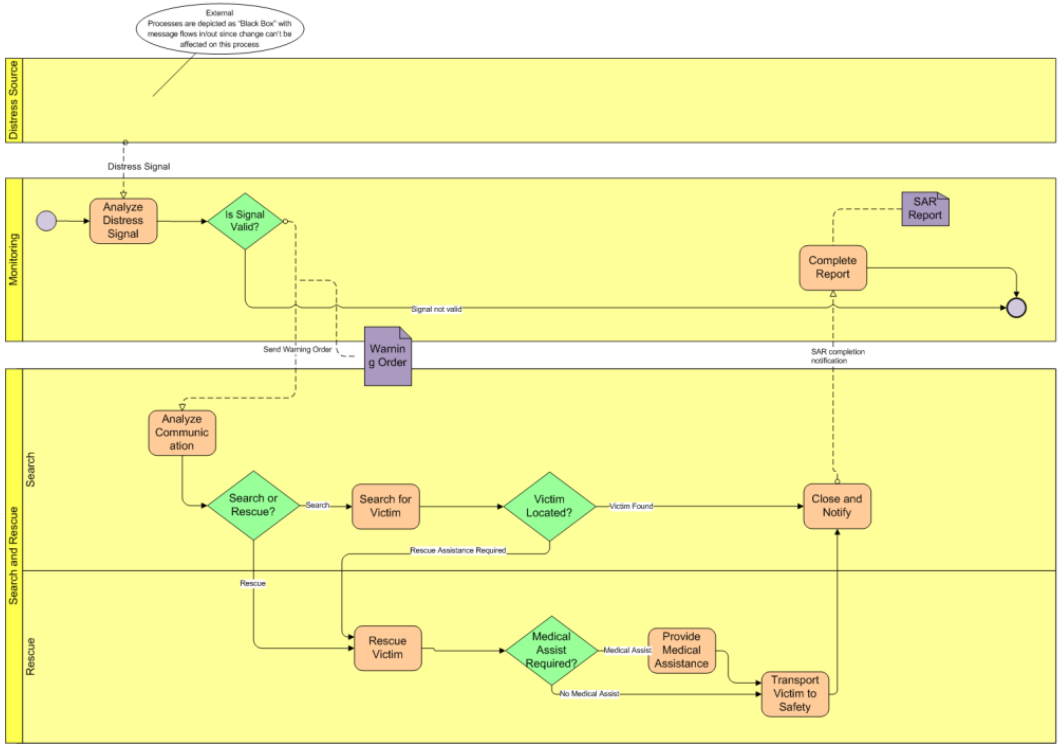
OV-5a: Operational Activity Decomposition Tree

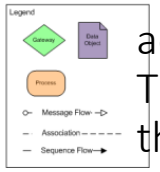
- The capabilities and activities (operational activities) organized in a hierarchical structure.
- The OV-5a helps provide an overall picture of the activities involved and a quick reference for navigating the OV-5b
- This diagram shows the hierarchical representation of the Search and Rescue activities. These will be used in the OV-5b Operational Activity Model

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.
- The Activity Model shows activities connected by Resource Flows; it supports development of an OV-3 Operational Resource Flow Matrix.
- This diagram shows an example of Operational Activities that produce and consume Resource Flows. These Resource Flows and related Operational Activities are related to the Resource Flows identified in both the OV-2 Operational Resource Flow Description and the OV-3 Operational Resource Flow Matrix.







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.
- The OV-6c provides a time-ordered examination of the Resource Flows as a result of a particular scenario.
- This diagram is meant to show the sequence of activities and the data that flows between them. The lanes in this diagram are the Organizations that are used in the OV-2 Operational Resource Flow Diagram.

PV1: Project Portfolio Relationships

- It describes the dependency relationships between the organizations and projects and the organizational structures needed to manage a portfolio of projects.
- 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.
- This diagram is meant to show Programs and how they are organized by increment, JCAs and total cost.

PV-1 Project Portfolio Relationships

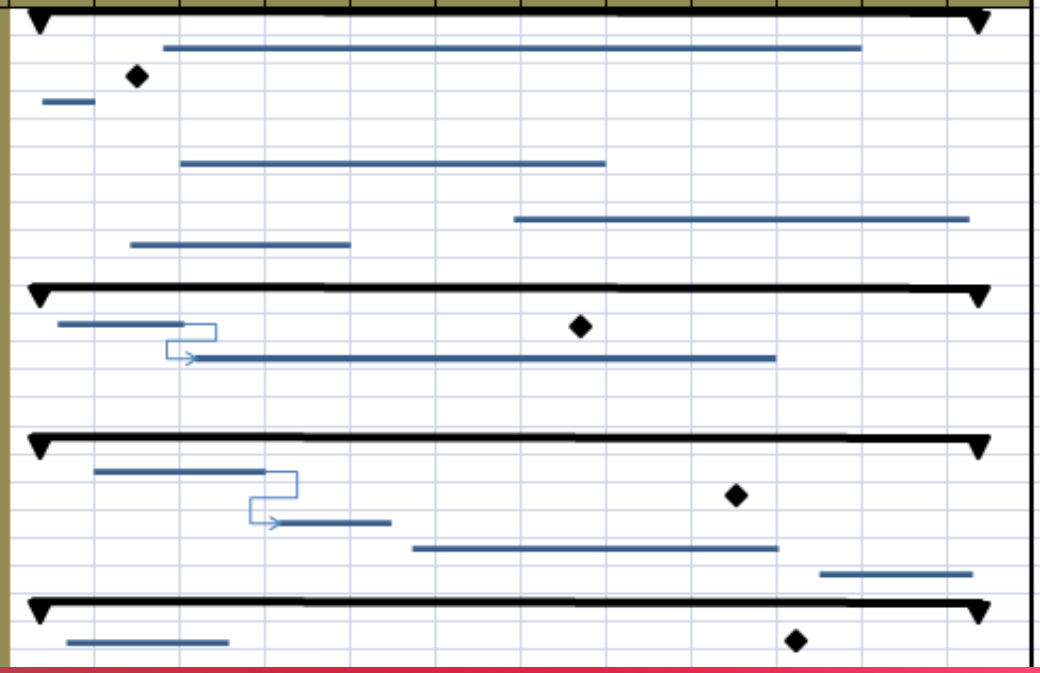
Project	Total Lifecycle Cost	Executive Agent/ Organization	Joint Capability Area		Jan xx	Feb xx	Mar xx	Apr xx	May xx	Jun xx	Jul xx	Sep xx	Oct xx	Nov xx	Dec xx
JOPES	$300M	JFCOM	Command and Control				3/14			6/6		9/8	10/25		
Event							MS-B			IOC		MS-C	FOC		
SINGARS	$15M	DISA	Command and Control			2/14						9/18			12/30
Event						Incre I						Incre II			Disposal
JTRS	$200M	US Marines	Command and Control					4/8							12/12
Event								MS-A							MS-B
GCCS-J	$150M	US Army	Battlespace Awareness		1/15					6/4		9/9			
Event					MS-A					MS-B		IOC			

PV2: Project Timelines

- A timeline perspective on programs or projects, with the key milestones and interdependencies.
- The PV-2 provides an overview of a program or portfolio of individual projects, or initiatives, based on a timeline
- This diagram is meant to show Programs and how they are organized on a timeline.

PV-2 PROJECT TIMELINES

	Task Name	Duration	Start	Finish	Predecessors	Resource Names	% Complete
1	**DoDAF v2.0 Development**	367.5 days	6/7/2007	11/3/2008			52%
2	Project Planning	367.5 days	6/7/2007	11/3/2008			52%
3	Conduct Kickoff Meeting	0 days	6/7/2007	6/7/2007		GTL	100%
4	Develop Statement of Objectives (SOO)	2 days	6/7/2007	6/8/2007	3	GTL,DEV-T	100%
5	Review DoDAF v1.5 Lessons Learned	1 day	6/11/2007	6/11/2007	4	DEV-T	100%
6	Develop Planned Approach	2 days	6/12/2007	6/13/2007	5	GTL,DEV-T	100%
7	Develop Master Schedule	13 days	6/12/2007	6/28/2007	4	GTL,DEV-T	100%
8	Identify Requirements Workshops	2 days	6/7/2007	6/8/2007	4	DEV-T	100%
9	Develop Work Packages	1 day	6/7/2007	6/7/2007	7	DEV-T	100%
10	**Develop Outreach Plan**	355 days	6/22/2007	10/30/2008	6	DEV-T	85%
11	Coordinate DoDAF meetings	202.3 days	6/8/2007	3/18/2008	3	DEV-T,	81%
12	Provide Scribe for CMGs and TWGs	264.5 days	6/8/2007	6/12/2008	3	DEV-T,	85%
13	Publish Minutes	266.35 days	6/8/2007	6/16/2008	3	DEV-T,	85%
14	Track Action Items	264.5 days	6/11/2007	10/31/2008	3	DEV-T,	85%
15	Maintain and Publish Attendance Rosters	264 days	6/8/2007	6/11/2008	3	DEV-T,	100%
16	**Establish DoDAF Organizational**	6.03 days	6/7/2007	6/15/2007	6	GTL,DEV-T,	99%
17	Establish Development Team (DEV-T)	1 day	6/7/2007	6/7/2007	6	GTL,	100%
18	Establish Core Management Group	0.75 days	6/7/2007	6/7/2007	6	GTL,	100%
19	Establish Technical Working Groups	0.78 days	6/7/2007	6/7/2007	6	GTL,	100%
20	Establish & Implement TWG Sync Plan	0.83 days	6/7/2007	6/13/2007	34	DEV-T,	100%
21	Coord Journal Content w/DARS	3.75 days	6/7/2007	6/15/2007	34	DEV-T,	100%
22	**Develop Risk Management Plan**	13 days	6/7/2007	6/25/2007		DEV-T	99%
23	Identify Risks	2 days	6/14/2007	6/15/2007	6	DEV-T,	100%
24	Establish Risk Mitigation	3 days	6/14/2007	6/25/2007	6	DEV-T	100%



PV3: Project to Capability Mapping

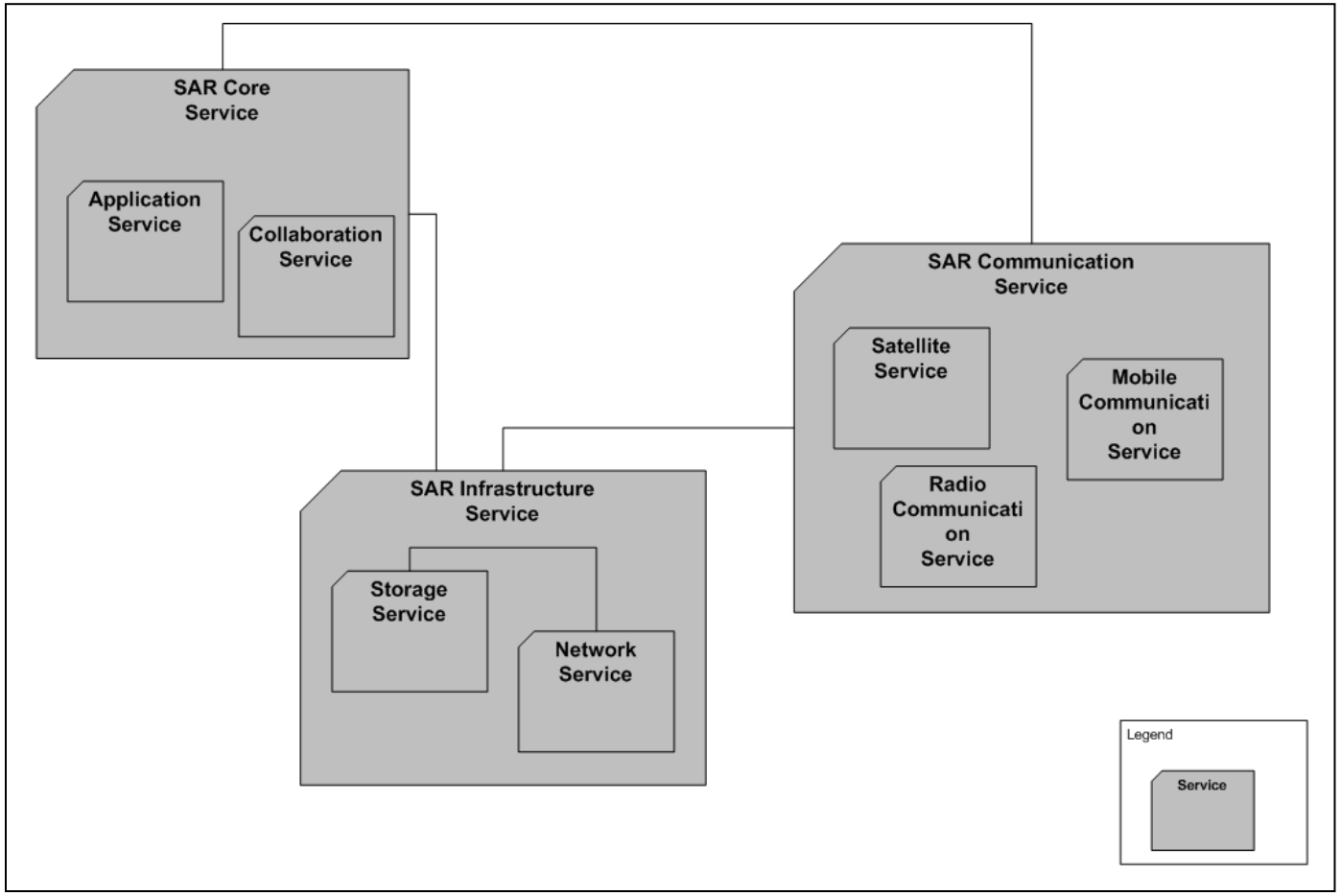
The PV-3 maps programs, projects, portfolios, or initiatives to capabilities to show how the specific elements help to achieve a capability.
The PV-2 provides an overview of a program or portfolio of individual projects, or initiatives, based on a timeline.
This diagram is meant to the mapping of Projects to the Capability by tracing through the dependent relationship.
This shows the relationship is not direct but dependent on other relationships.

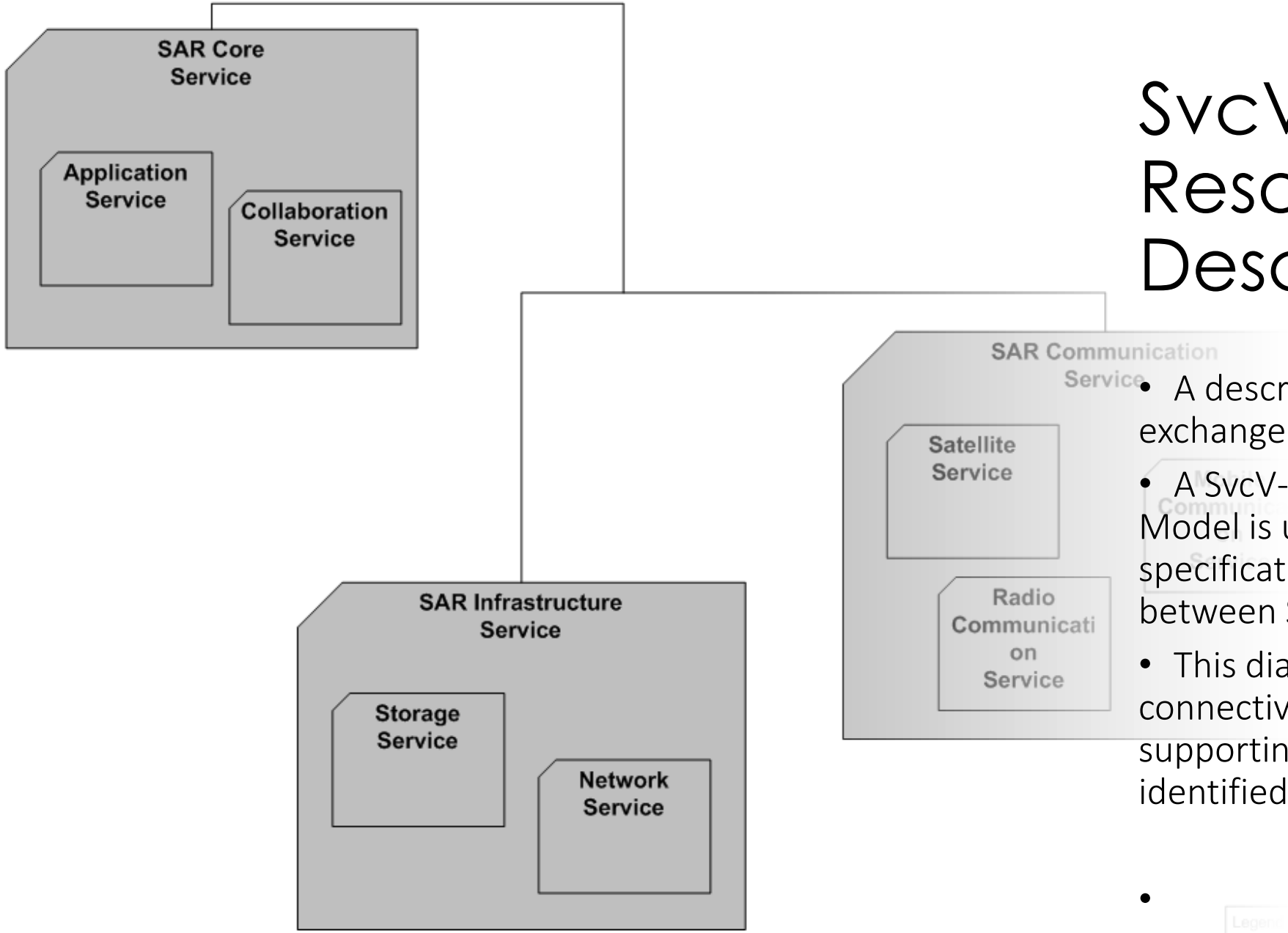
PV-3 Project to Capability Mapping

Force Application	Battlespace Awareness	Net-Centric	Building Partnerships	Protection	Logistics	Command and Control	Force Support	Corporate Management and Support		System Function 1	System Function 2	System Function 3	System Function 4	System Function 5	System Function 6
X			X					X	UJTL 1	X			X		
	X		X			X			UJTL 2		X		X		X
					X				UJTL 3			X	X		
		X					X		UJTL 4		X				X
X				X					UJTL5...N	X			X		X
									Project/Service I	X					
									Project/Service 2		X				
									Project/Service 3			X			
									Project/Service 4				X		X
									Project/Service...N					X	

SvcV-1: Services Interface Description

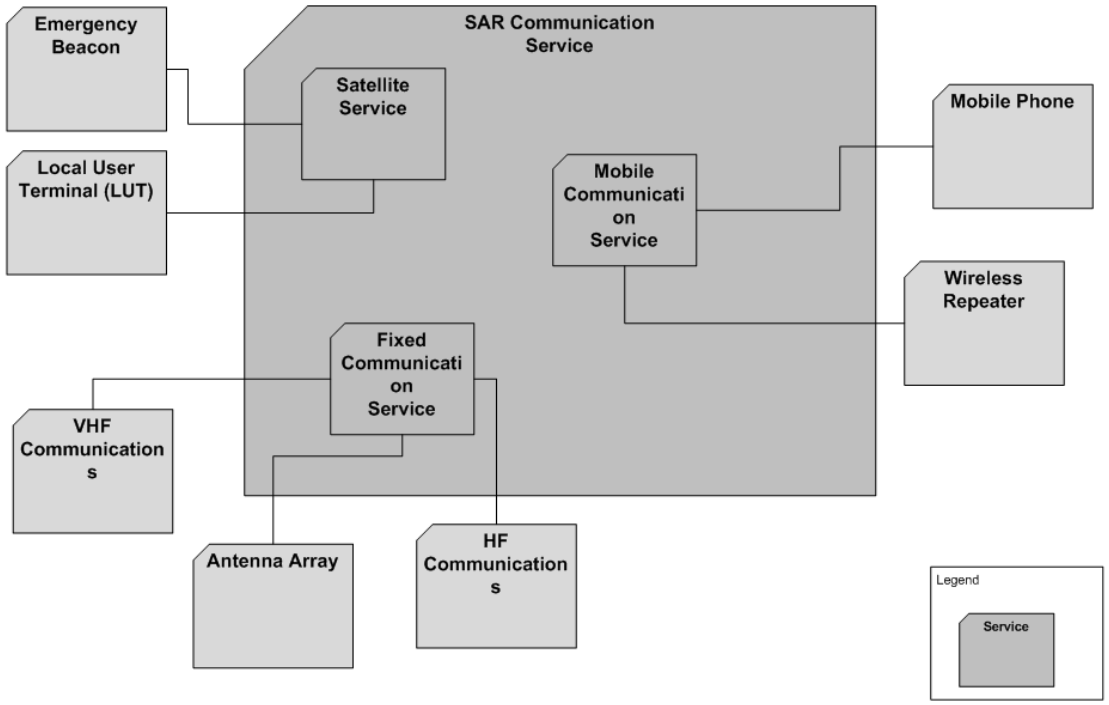
The identification of services, service items, and their interconnections.
The SvcV-1 addresses the composition and interaction of Services. A SvcV-1 can be used simply to depict services and sub-services and identify the Resource Flows between them. This diagram is meant to show the Resource Flow between the Services used in the Search and Rescue architecture description





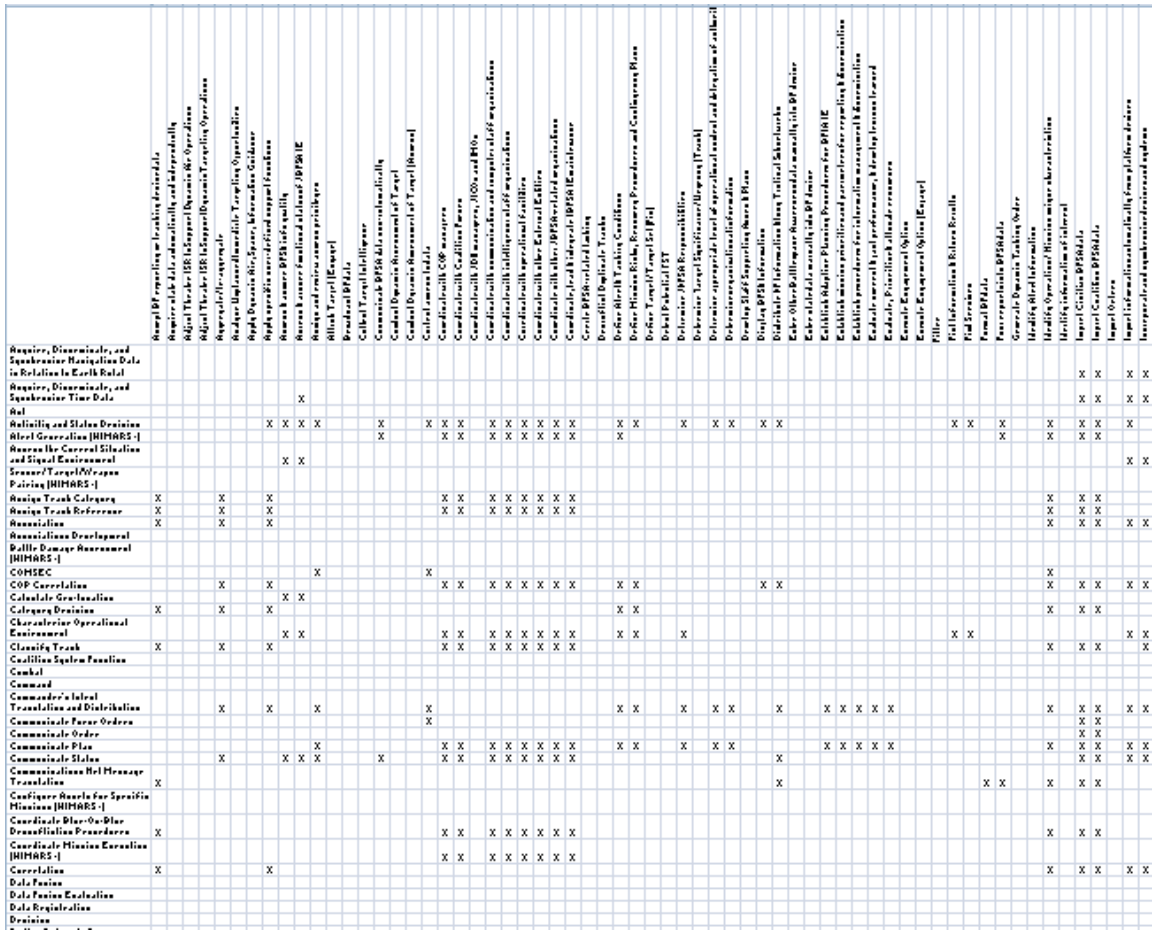
SvcV-2: Services Resource Flow Description

- A description of Resource Flows exchanged between services.
- A SvcV-2 DoDAF-described Model is used to give a precise specification of a connection between Services.
- This diagram depicts the physical connectivity between the Services supporting the Resource Flows identified in the SvcV-1 diagram.
-



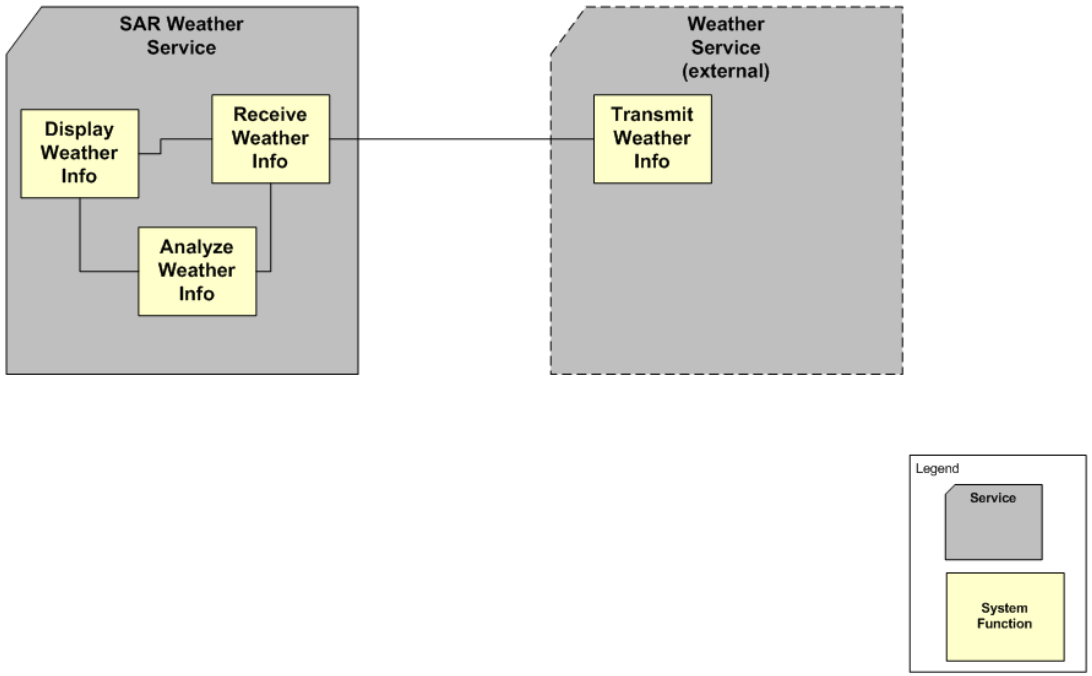
SvcV-3a Systems-Services Matrix

- The relationships among or between systems and services in a given Architectural Description.
- 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.
- This diagram depicts the system to service dependencies



SvcV-3b: Services-Services Matrix

- The relationships among services in a given Architectural Description.
- The SvcV-3b provides a tabular summary of the services interactions specified in the SvcV-1 Services Context Description for the Architectural Description.
- This diagram depicts the Service to Service interactions in a matrix format.

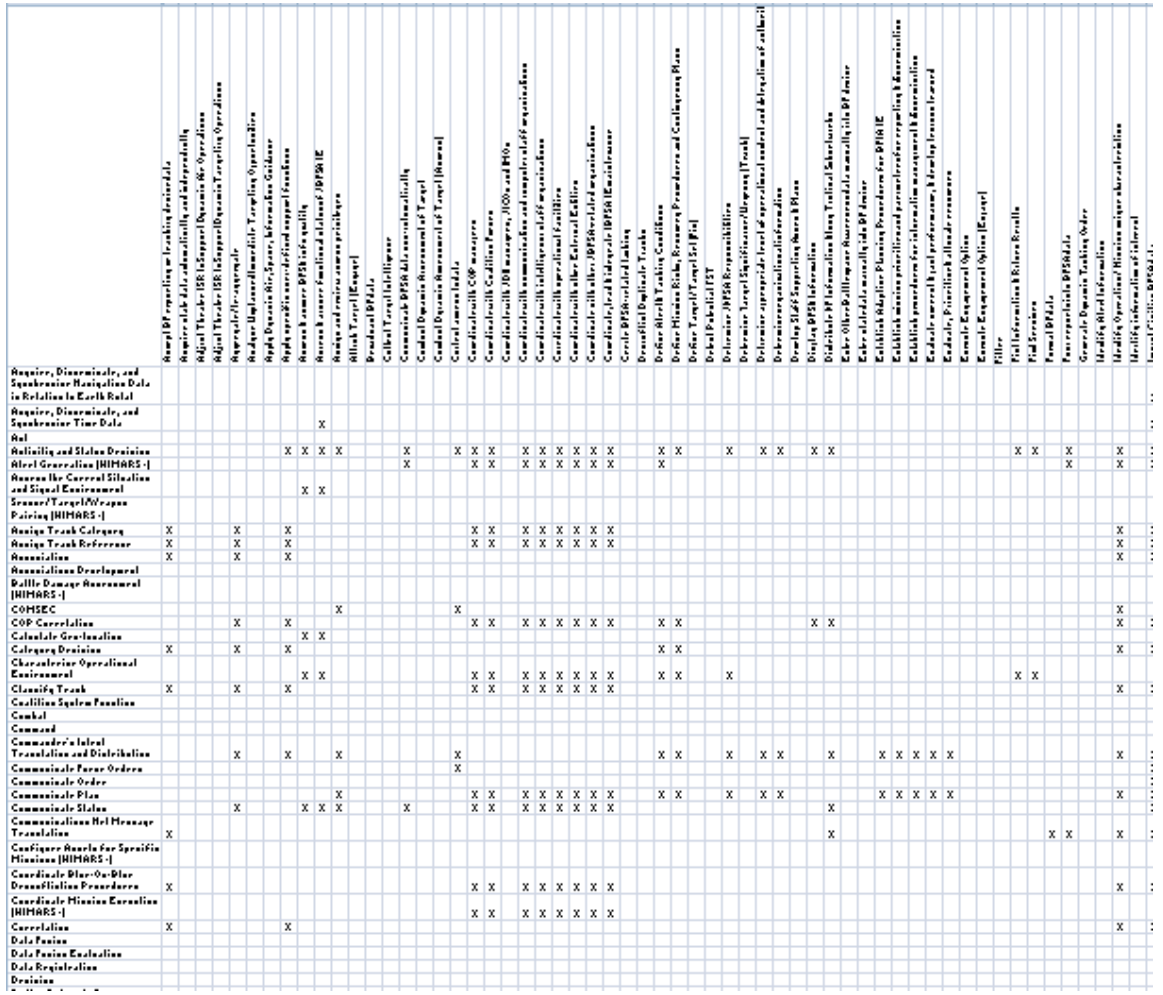


SvcV-4: Services Functionality Description

- The functions performed by services and the service data flows among service functions (activities).
- 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.
- This diagram depicts the data flows that flow between the services of the architecture.

SvcV-5: Operational Activity to Services Traceability Matrix

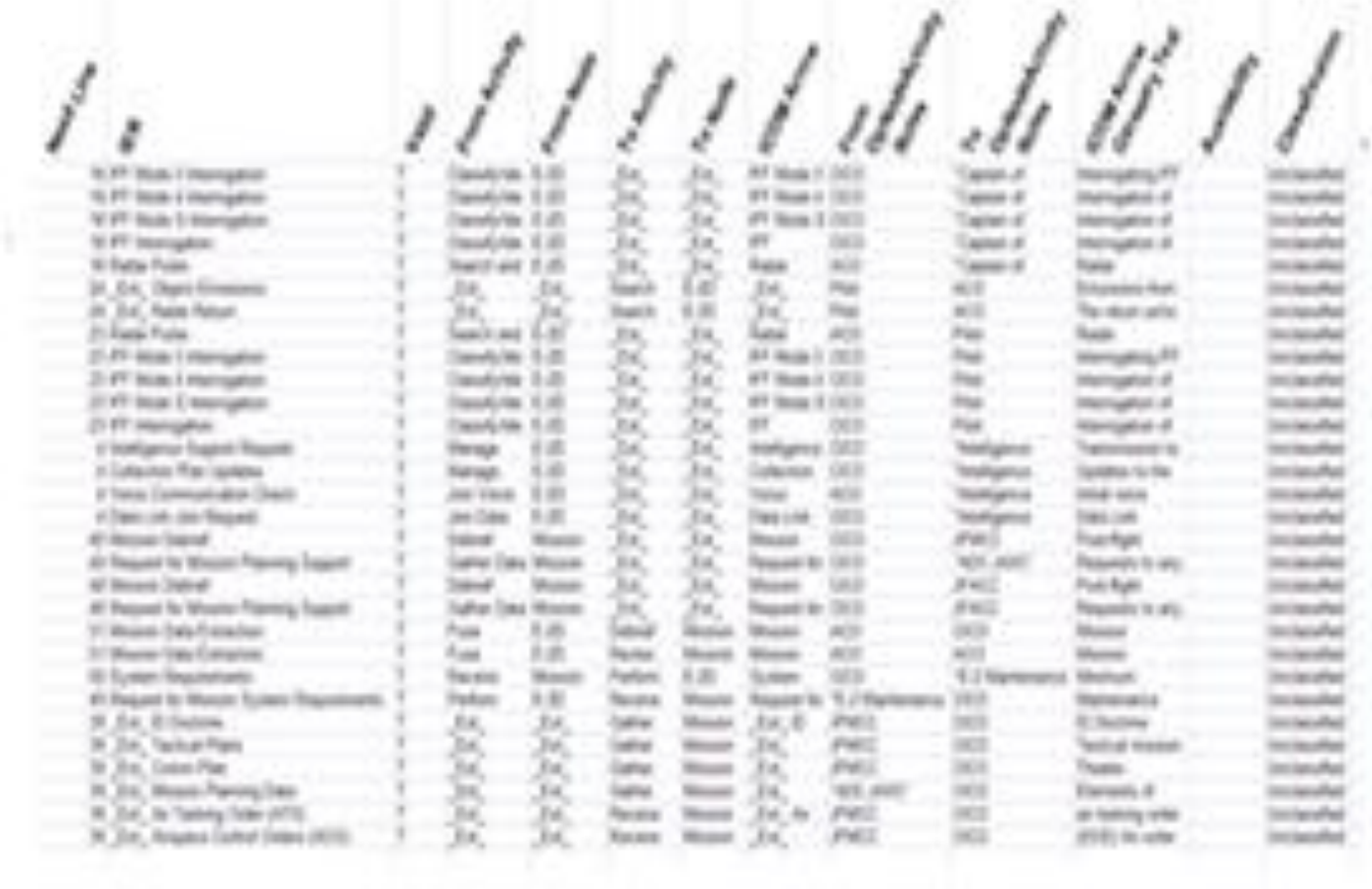
- A mapping of services (activities) back to operational activities (activities).
- The SvcV-5 depicts the mapping of service functions to operational activities and thus identifies the transformation of an operational need into a purposeful action performed by a service solution.
- This matrix depicts the relationships between the set of Operational Activities and the set of Service Functions applicable to an Architectural Description.



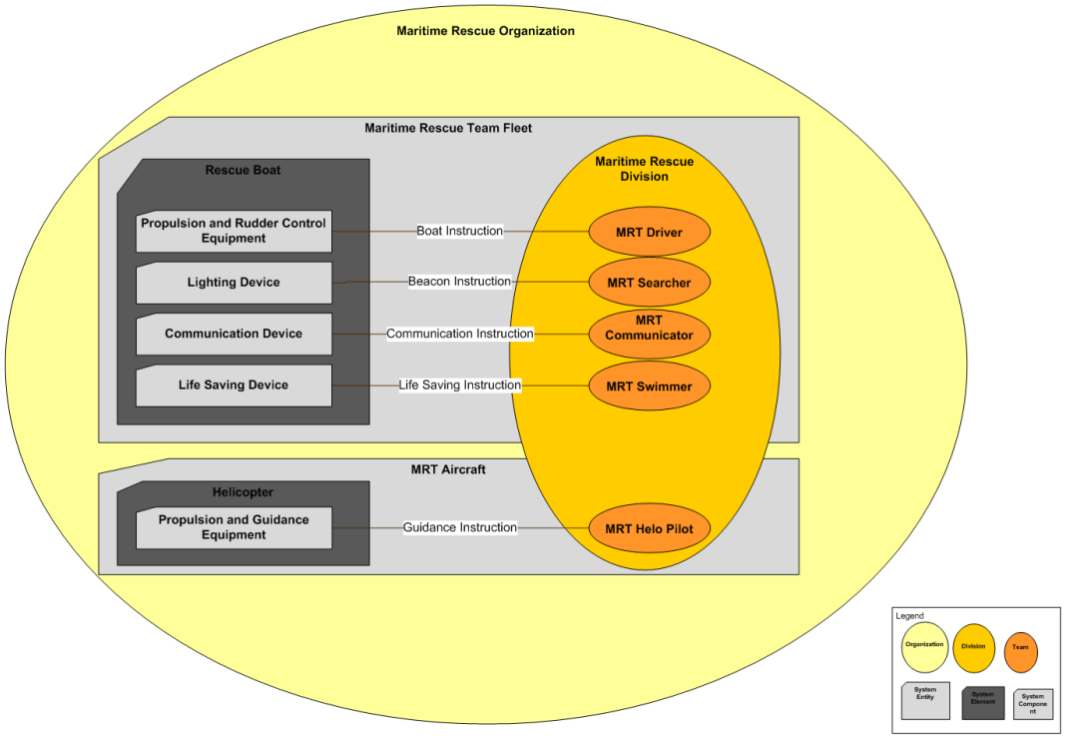
SvcV-6: Services Resource Flow Matrix

- A description of the resources exchanged and the relevant attributes of the exchanges.
- The SvcV-6 specifies the characteristics of the Service Resource Flows exchanged between Services.
- The SvcV-6 identifies resource elements and relevant attributes of the Resource Flows and associates the exchange to the producing and consuming Services
-

This matrix is a list of Resource Flows and the key attributes of the associated Resources.



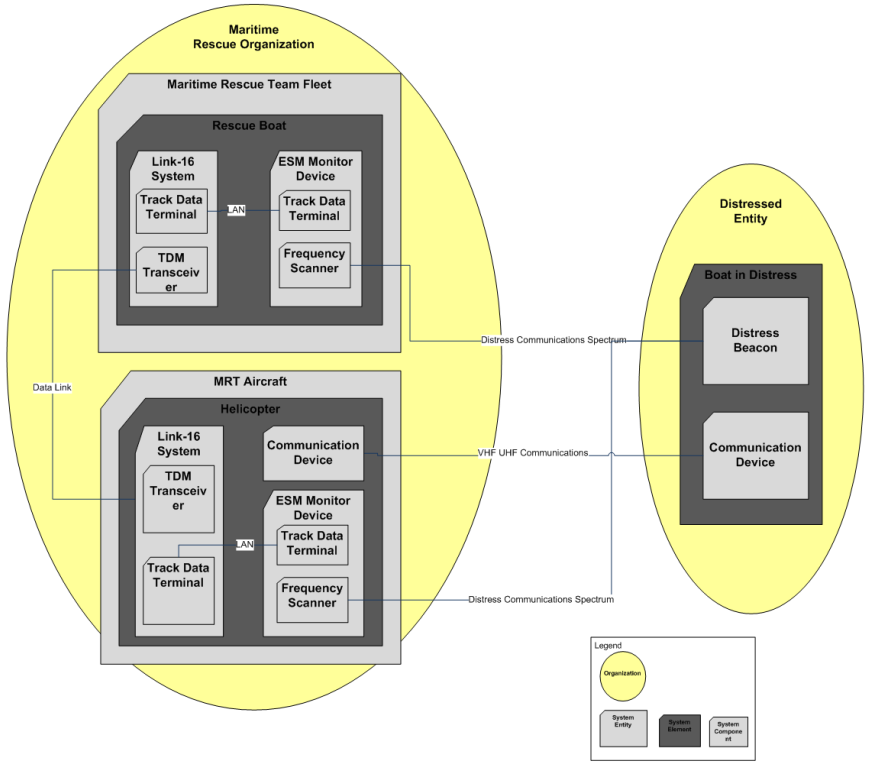
SV-1: Systems Interface Description



- The identification of systems, system items, and their interconnections.
- 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. The SV-1 depicts all System Resource Flows between Systems that are of interest.
- This diagram is meant to show the Resource Flows between a Person Type and a System (both are types of Performer). The diagram also shows the grouping of Performer Types.

Name:	Orders
Description:	Orders that could be used in CSAR domain
Related Reference Flow:	Approved Plans and Orders
	Configuration Orders
	Draft Effects Based Tasking Orders
	Effects Based Tasking Orders
	Effects Based Tasking Orders Annex K
	Effects Based Tasking Orders - Targeting
	Executed Plans and Orders
	Current OPLAN/ Effects Tasking Orders
	Operations Orders
	Plans and Orders

SV-2: Systems Resource Flow Description

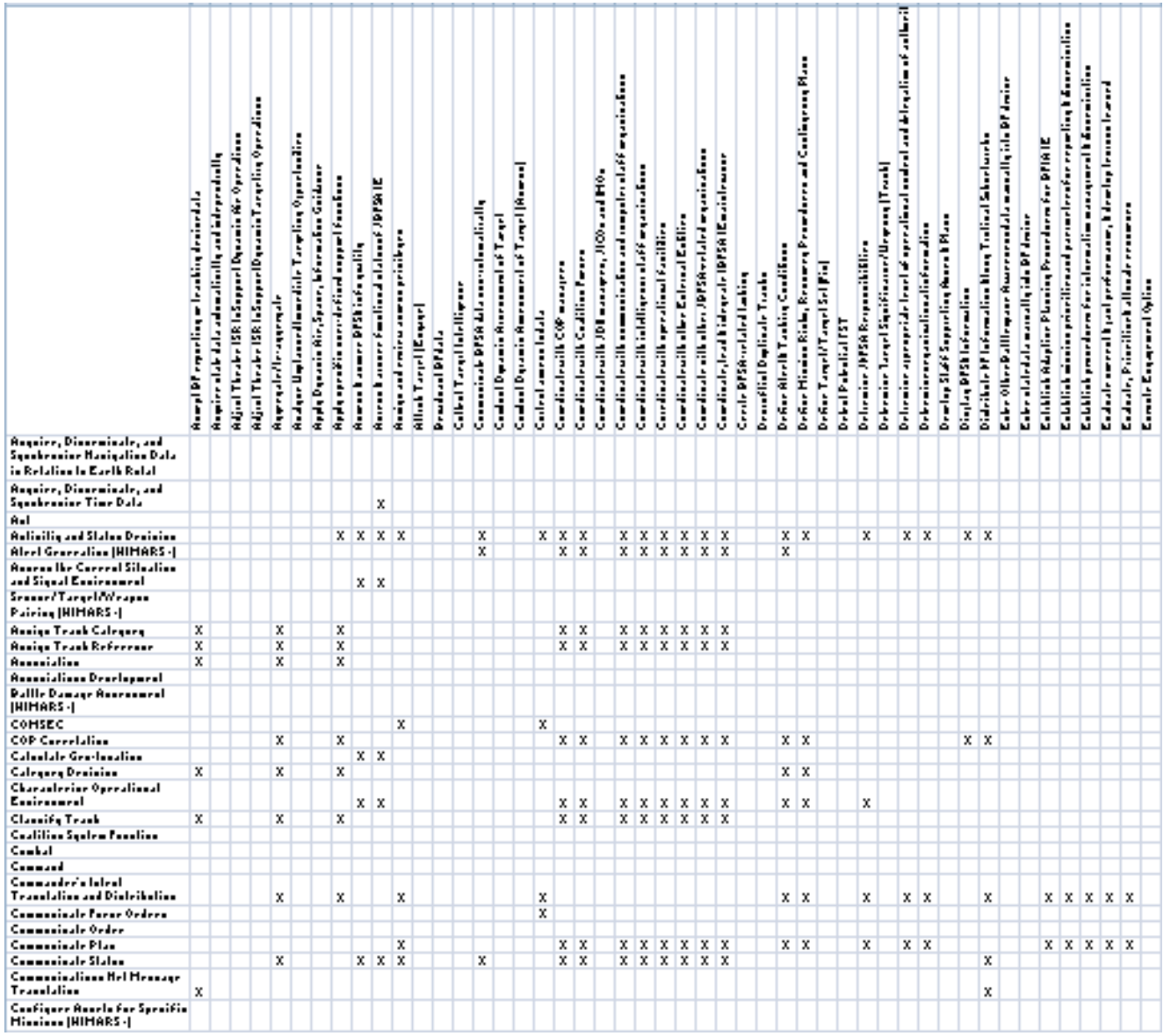


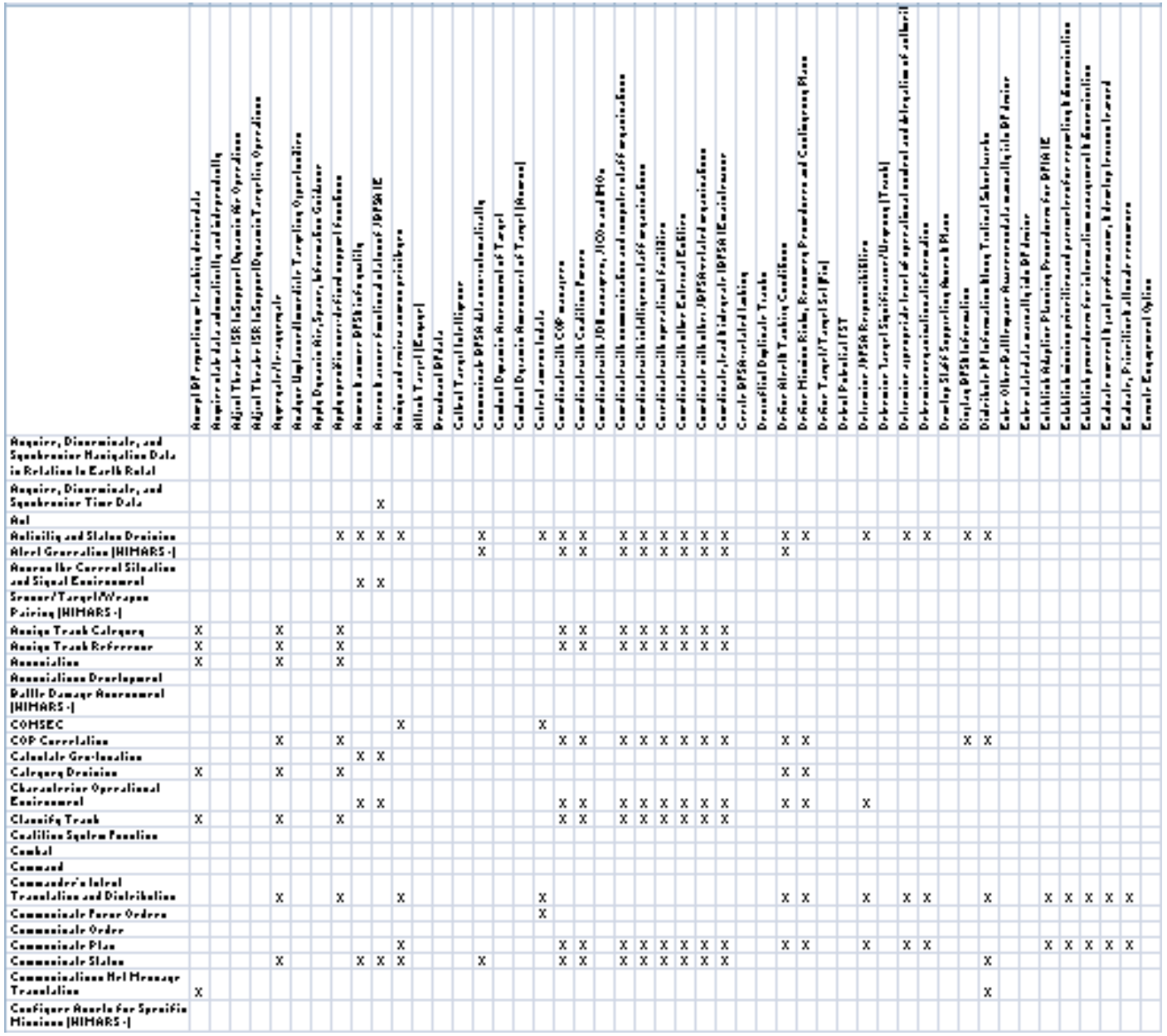
- A description of Resource Flows exchanged between systems.
- A SV-2 DoDAF-described Model is used to give a precise specification of a connection between Systems. This may be an existing connection, or a specification for a connection that is to be made
- This diagram is meant to show a representation of the primary physical connection between the systems of interest.

Name:	VHF/UHF Communication
Description:	Description of VHF/UHF Communication Connection
Connection Type:	VHF/UHF Frequency Modulation
Link Designator:	1A
Link Description:	Connection between 2 sites for purpose of conduction SAR
Link Type:	VHF/UHF
Link Max Data Rate:	5M / second

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).
- The SV-3 provides a tabular summary of the system interactions specified in the SV-1 Systems Interface Description model for the Architectural Description.
- This matrix is used to identify the association between Systems in context with the architecture's purpose.





	Accept BM reporting on tracking deviations	Acquire data automatically and independently	Adjust Threshold ISR to Support Dynamic War Operations	Adjust Threshold ISR to Support Dynamic Targeting Operations	Aggregate/Disaggregate	Analyze Unplanned/Immediate Targeting Opportunities	Apply Dynamic Air Space Information Guidance	Apply operation coordinated support functions	Assess kinematic BPSA info quality	Assess kinematic functional status of JBPSA IE	Assign and review mission priorities	Attack Target (Engage)	Broadcast BPSAs	Collect Target Intelligence	Communicate BPSA data automatically	Conduct Dynamic Assessment of Target	Conduct Dynamic Assessment of Target (Manual)	Control sensor tasks	Coordinate with COP managers	Coordinate with Coalition Forces	Coordinate with JDN managers, JICOs and MCOs	Coordinate with intelligence staff organizations	Coordinate with operational facilities	Coordinate with other External Entities	Coordinate with other JBPS Overlaid organizations	Coordinate, load hierarchy JBPS IE Maintenance	Create BPSA related tasking	Deconflict Duplicate Tracks	Define Alert & Tracking Conditions	Define Mission Rules, Recovery Procedures and Contingency Plans	Define Target/Target Set (Pid)	Detect Probabilistic FST	Determine JBPSA Responsibilities	Determine Target Significance/Urgency (Track)	Determine appropriate level of operational control and delegation of authority	Determine organizational interfaces	Develop Staff Supporting Search Plans	Display BPSA Information	Distribute BM Information Many Tactical Echelons/Units	Enter Other Battlespace Surveys data manually into BM Joint	Establish Adaptive Planning Procedures for BPIA IE	Establish mission priorities and parameters for reporting & Anomalies	Establish procedures for information management & Anomalies	Evaluate current best performance, develop lessons learned	Evaluate, Prioritize Attack resources	Execute Engagement Option
Acquire, Disseminate, and Synchronize Manipulate Data in Relation to Earth Relat																																													
Acquire, Disseminate, and Synchronize Time Data										X																																				
Aid																																													
Activity and Status Decision								X	X	X	X				X			X	X	X			X	X	X	X	X	X			X	X		X			X	X							
Alert Generation [NIMARS -]															X				X	X			X	X	X	X	X	X			X														
Assess the Current Situation and Signal Environment									X	X																																				
Sensor/Target/Weapon Pairing [NIMARS -]																																														
Assign Track Category	X			X		X													X	X		X	X	X	X	X	X																	
Assign Track Reference	X			X		X													X	X		X	X	X	X	X	X																	
Association	X			X		X																																							
Associations Development																																													
Battle Damage Assessment [NIMARS -]																																													
COMSEC											X							X																											
COP Correlation				X		X													X	X		X	X	X	X	X	X			X	X												
Calculate Geolocation									X	X																																			
Category Decision	X			X		X																								X	X														
Characterize Operational Environment									X	X									X	X		X	X	X	X	X	X			X	X		X											
Classify Track	X			X		X													X	X		X	X	X	X	X	X																	
Coalition System Function																																													
Combat																																													
Command																																													
Commander's Intent Translation and Distribution				X		X					X							X													X	X		X			X	X			X	X	X	X	X
Communicate Force Orders																		X																											
Communicate Order																																													
Communicate Plan											X								X	X		X	X	X	X	X	X							X							X	X	X	X	X
Communicate Status				X			X	X	X						X				X	X		X	X	X	X	X	X																	
Communications Net Message Translation	X																																												
Configure Assets for Specific Missions [NIMARS -]																																													

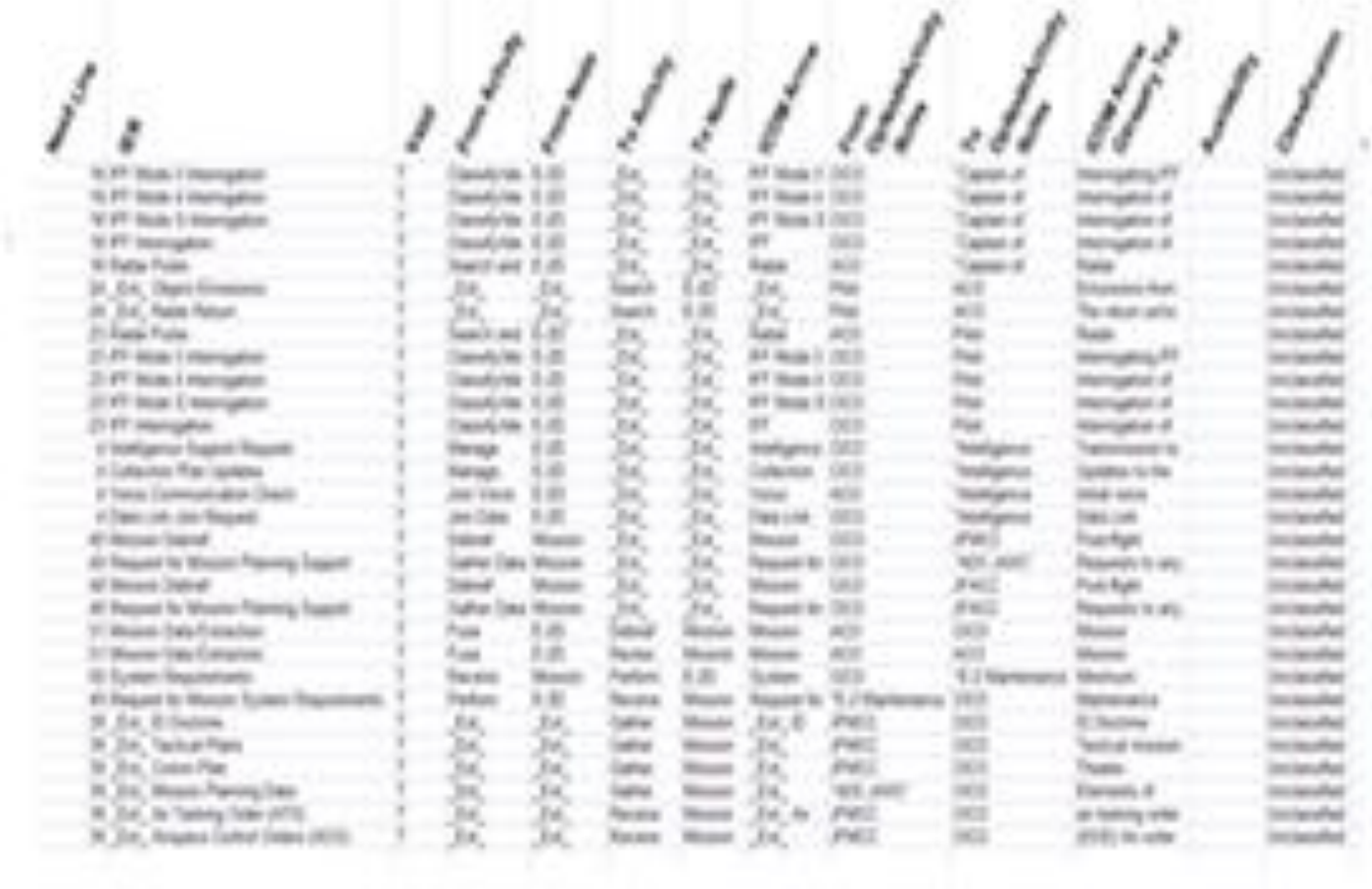
SV-5a: Operational Activity to Systems Function Traceability Matrix

- A mapping of system functions (activities) back to operational activities (activities).
- 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.
- This matrix is used to tie together the logical representation of the Operational Activities of the OV-5a with the System Functions of the SV-4 Systems Functionality Description.

SV-6: Systems Resource Flow Matrix

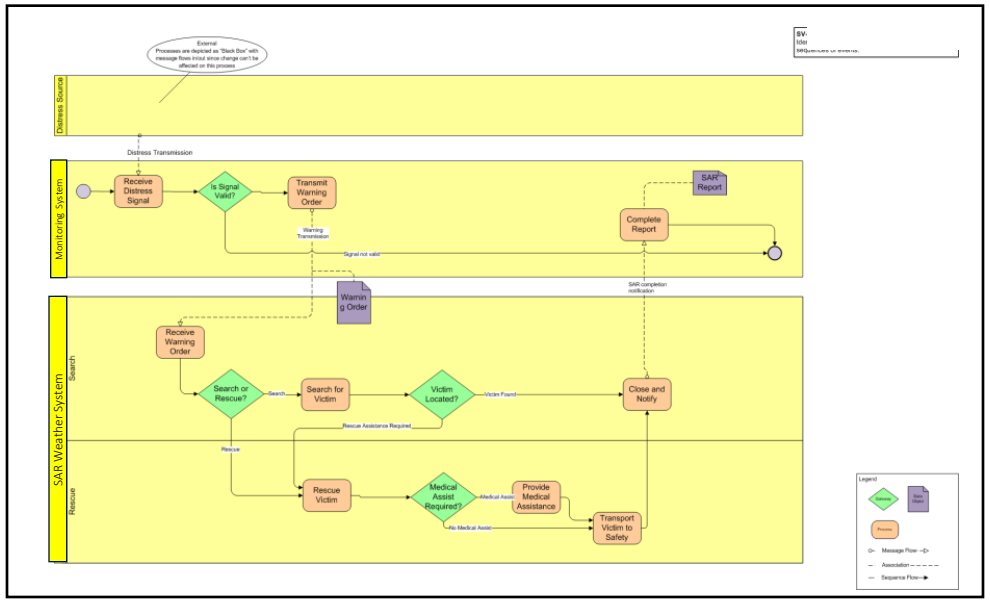
- Provides details of system resource flow elements being exchanged between systems and the attributes of that exchange.
- The SV-6 focuses on the specific aspects of the system Resource Flow and the system Resource Flow content in a tabular format.
- The SV-6 identifies resource elements and relevant attributes of the Resource Flows and associates the exchange to the producing and consuming Systems

This matrix is a list of Resource Flows and the key attributes of the associated Resources.



SV-10c: 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.
The SV-10c provides a sequential examination of the interactions between functional resources.
This diagram is meant to show the sequence of System Functions and the data that flows between them. The lanes in this diagram are the Organizations that are used in the SV-1 Systems Interface Description



- Quick answer:
  - UAF is the next generation of the Unified Profile for DoDAF and MoDAF (UPDM)
  - At one time referred to as UPDM 3
- Longer Answer:
  - An enterprise architecture framework
  - Applicable for domains similar to DoDAF, MoDAF and NAF (NATO Architecture Framework)
  - Flexible enough for non-defense domains
  - Implemented as a UML profile on top of SysML
- Realistic answer:
  - A complicated framework that makes enterprise architecture even harder

What is UAF and How Did It Develop?

UAF evolved from the Unified Profile for DoDAF and MODAF (UPDM), version 2.1. UAF extends the scope of UPDMand generalizes it to make it applicable to commercial as well as military architectures. The intent of UAF is to provide a standard representation for describing enterprise architectures using a Model Based Systems Engineering (MBSE) approach.

The core concepts in the UAF are based upon the DoDAF 2.0.2 Domain Metamodel (DM2) and the MODAF ontological data exchange mechanism (MODEM), Security Views from Canada's Department of National Defense Architecture Framework (DNDAF) and the North Atlantic Treaty Organization (NATO) Architecture Framework (NAF) v 4.

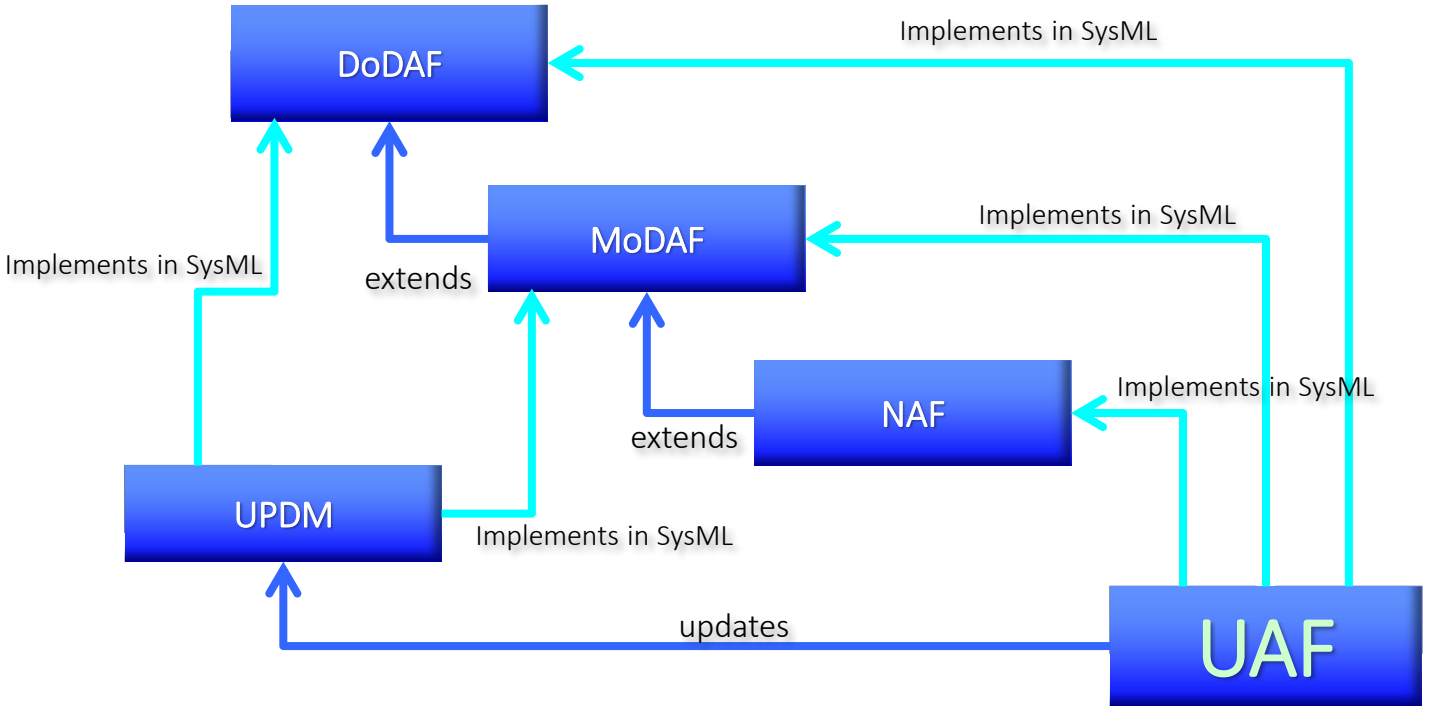
UAF models describe a system1 from a set of stakeholders' concerns such as security or information through a set of predefined viewpoints. Developed models can also reflect custom viewpoints or users can develop more formal extensions for new viewpoints.

1 The The UAFP can be used to develop architectures compliant with:

- Department of Defense Architecture Framework (DoDAF) version 2.02
- Ministry of Defence Architecture Framework (MODAF) version 1.3
- North Atlantic Treaty Organization (NATO) Architecture Framework (NAF) version 3.1
- North Atlantic Treaty Organization (NATO) Architecture Framework (NAF) version 4

UAF v 1.1 supports the capability to:

- model architectures for a broad range of complex systems, which may include hardware, software, data, personnel, and facility elements,
- model consistent architectures for system-of-systems (SoS) down to lower levels of design and implementation,
- support the analysis, specification, design, and verification of complex systems; and
- improve the ability to exchange architecture information among related tools that are SysML based.



UAF continues the effort and modernizes the framework

UAF provides a better model taxonomy than UPDM

- Level 1
  - Actual_Resources
  - Dictionary
  - Metadata
  - Operational
  - Parameters
  - Personnel
  - Project
  - Resources
  - Security
  - Services
  - Standards
  - Strategic
  - Summary_and_Overview
- Level 2
  - Connectivity
  - Constraints
  - Information
  - Interaction_Scenarios
  - Processes
  - Roadmap
  - States
  - Structure
  - Taxonomy
  - Traceability

View Matrix

A better taxonomy provides more logic and order to the set of views available in 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-Tx	Md-Sr	Md-Cn	Md-Pr			Data Models	Environment & Measurements	Md-Ct		Md-Tr
Strategic	St-Tx	St-Sr	St-Cn		St-St				St-Ct	St-Rm	St-Tr
Operational	Op-Tx	Op-Sr	Op-Cn	Op-Pr	Op-St	Op-Is			Op-Ct		
Services	Sv-Tx	Sv-Sr	Sv-Cn	Sv-Pr	Sv-St	Sv-Is			Sv-Ct	Sv-Rm	Sv-Tr
Personnel	Pr-Tx	Pr-Sr	Pr-Cn	Pr-Pr	Pr-St	Pr-Is			Pr-Ct	Pr-Rm	Pr-Tr
Resources	Rs-Tx	Rs-Sr	Rs-Cn	Rs-Pr	Rs-St	Rs-Is			Rs-Ct	Rs-Rm	Rs-Tr
Security	Sc-Tx	Sc-Sr	Sc-Cn	Sc-Pr					Sc-Ct		
Projects	Pj-Tx	Pj-Sr	Pr-Cn							Pj-Rm	Pj-Tr
Standards	Sd-Tx	Sd-Sr								Sd-Rm	Sd-Tr
Actual Resources		Ar-Sr	Ar-Cn								

Example: suppose you want to look at Operational Information for your problem domain

UAF provides view definitions for:

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)

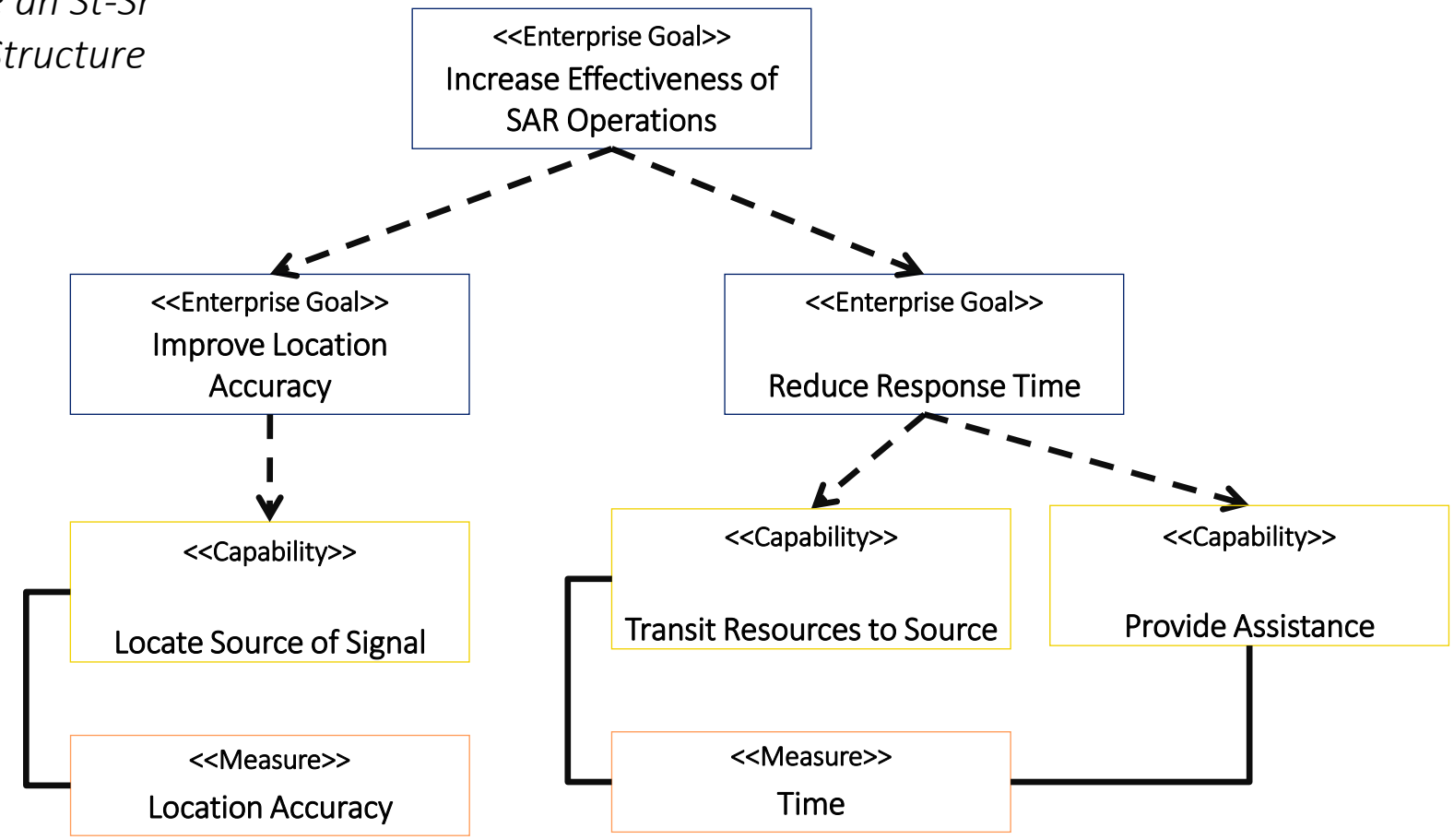
Choose what makes sense for your needs

Pattern is replicated across entities as appropriate

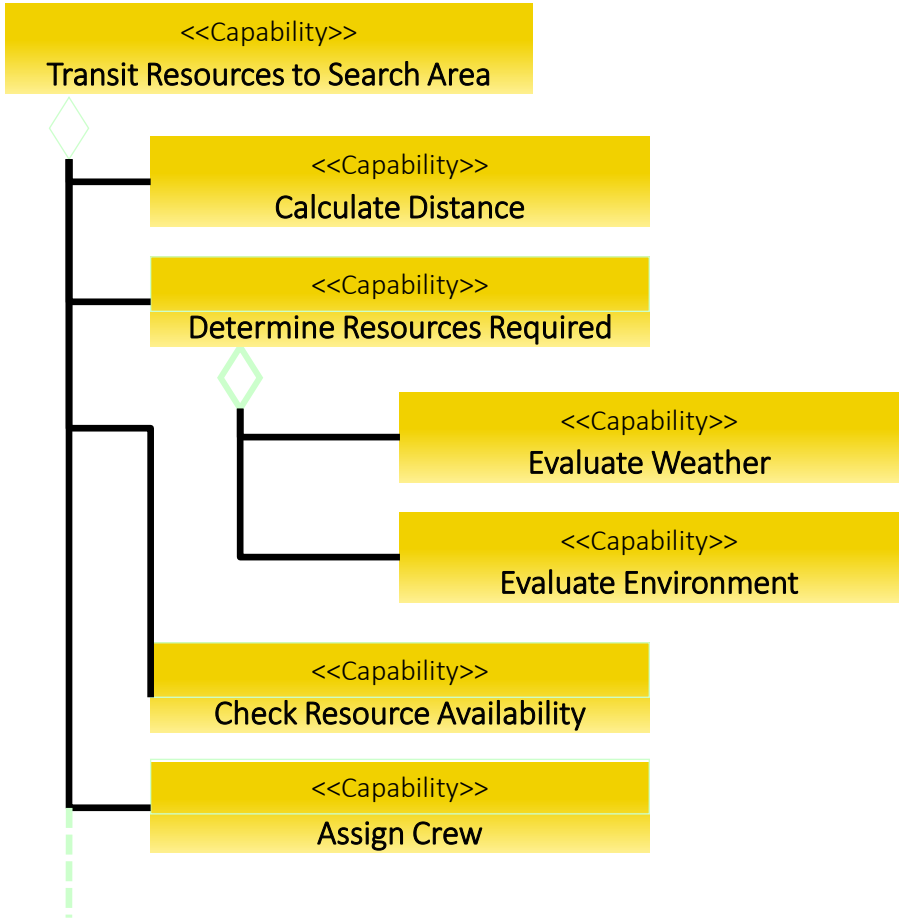
Numbered views (OV-1, OV-2, OV-5 etc) are replaced with more meaningful and consistent views

Capabilities

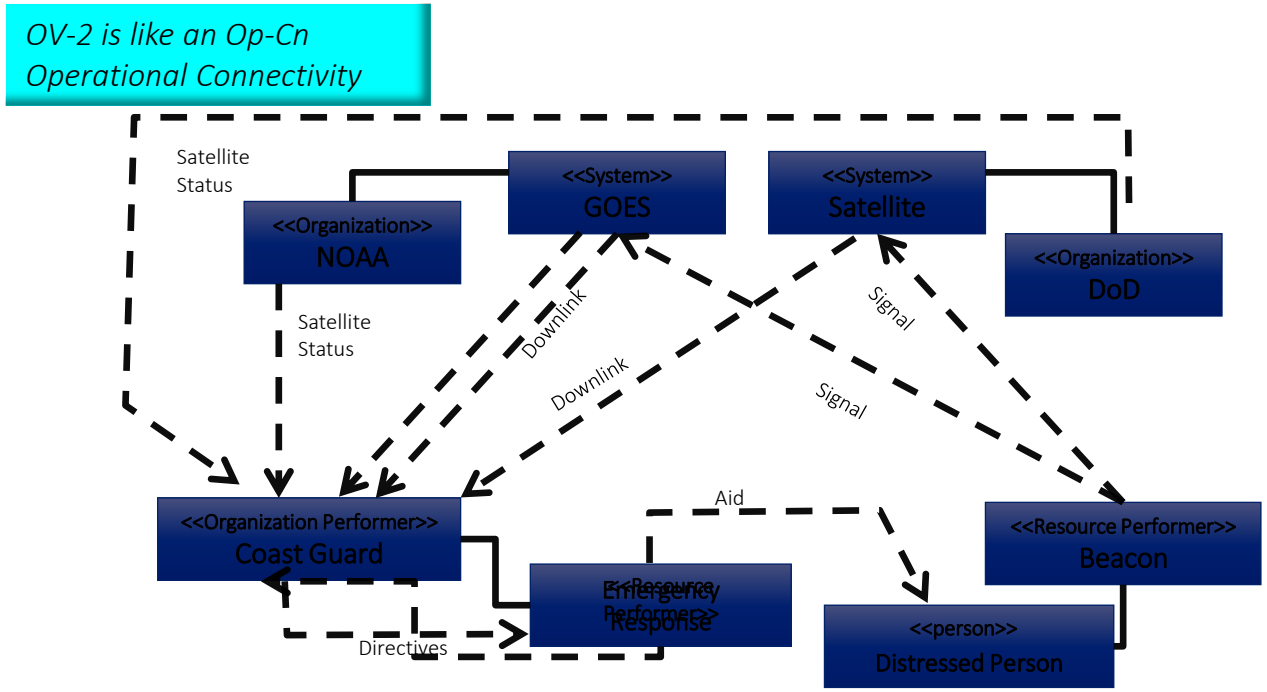
CV-1 is like an St-Sr Strategic Structure



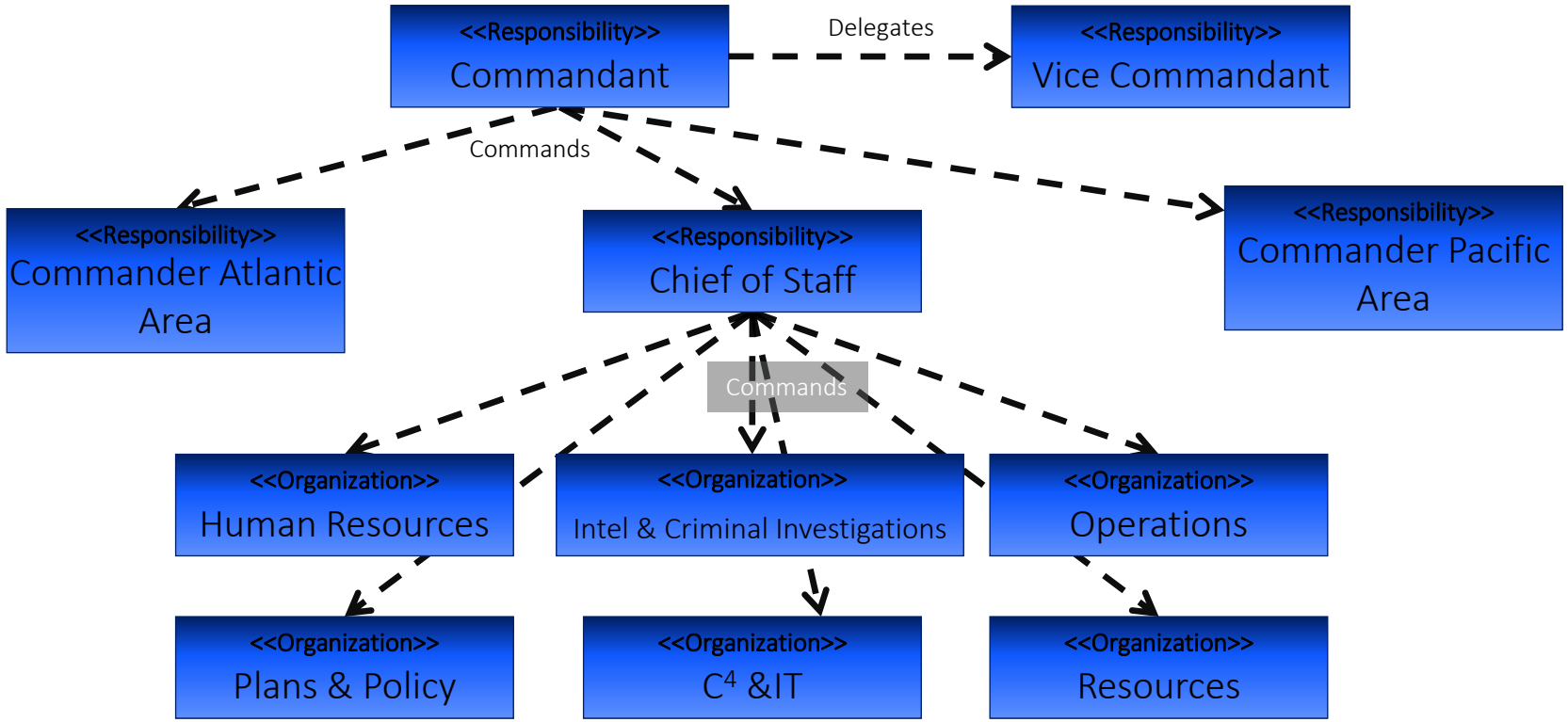
CV-2 is like an St-Tx Strategic Taxonomy



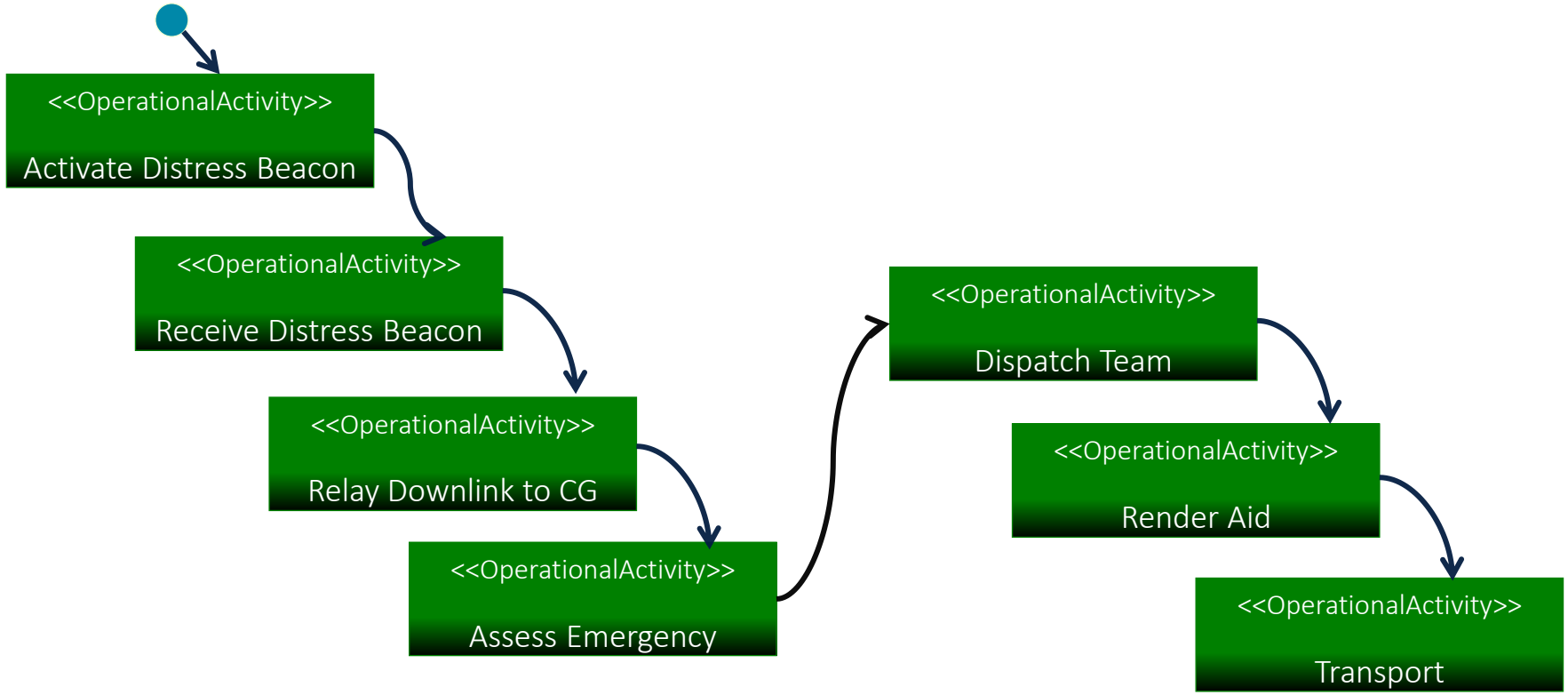
Operational Views

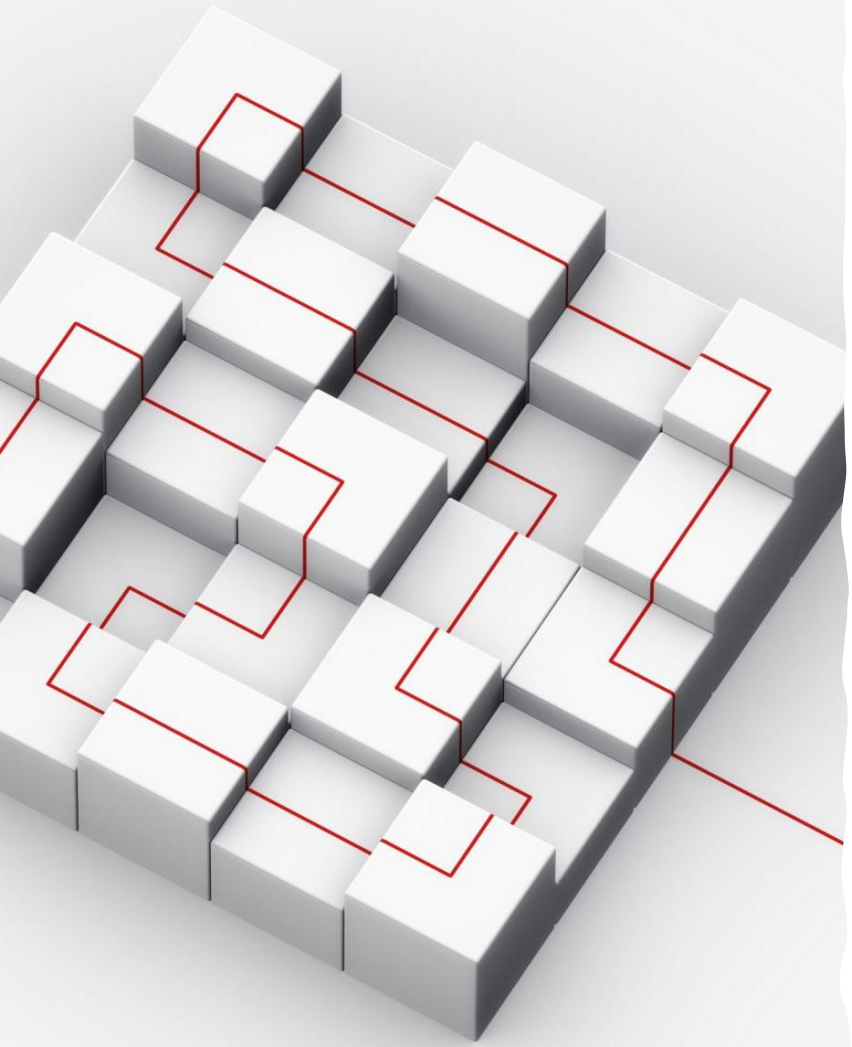


Personnel


<<Responsibility>>
Commandant
Delegates
<<Responsibility>>
Vice Commandant
Commands
<<Responsibility>>
Commander Atlantic Area
<<Responsibility>>
Chief of Staff
<<Responsibility>>
Commander Pacific Area
Commands
<<Organization>>
Human Resources
<<Organization>>
Intel & Criminal Investigations
<<Organization>>
Operations
<<Organization>>
Plans & Policy
<<Organization>>
C4 &IT
<<Organization>>
Resources

Operational





UAF Basics

The Unified Architecture Framework (UAF) published by the Object Management Group (OMG) defines a complete set of stakeholder domains as the basis for creating the variety of necessary architecture views of an enterprise, as well as the systems that make up the enterprise.

UAF is a successor to the DOD Architecture Framework (DODAF) and will automatically create DODAF-compliant architecture views as well as a few dozen other useful views.

3 Main Components

framework – a collection of domains, model kinds, and viewpoints,

metamodel – a collection of types, tuples, and individuals used to construct views according to the specific viewpoints,

profile – SysML based implementation of the metamodel to apply model-based systems engineering principles and best practices while building the views.

13 Domains

Metadata - captures meta-data relevant to the entire architecture, e.g. principles, metamodel extensions, views to be built, processes of developing architecture, etc.

Strategic - describes capability taxonomy, composition, dependencies and evolution.

Operational - describes the requirements, operational behaviour, structure, and exchanges required to support (exhibit) capabilities.

Services - shows Service Specifications and required and provided service levels of these specifications required to exhibit a Capability or to support an Operational Activity.

Personnel - enables an understanding of the human role in systems/enterprise architectures. It provides a basis for decisions by stakeholders by providing a structured linkage from the engineering community to the manpower, personnel, training, and human factors communities.

Resources - captures a solution architecture consisting of resources, e.g. organizational, software, artefacts, capability configurations, natural resources that implement the operational requirements.

Security - illustrates the security assets, security constraints, security controls, families, and measures required to address specific security concerns.

13 Domains

Projects - describes projects and project milestones, how those projects deliver capabilities, the organizations contributing to the projects and dependencies between projects.

Standards - shows the technical, operational, and business Standards applicable to the architecture.

Actual Resources - illustrates the expected or achieved individual resource configurations and actual relationships between them.

Dictionary - provides definitions for all elements in the architecture.

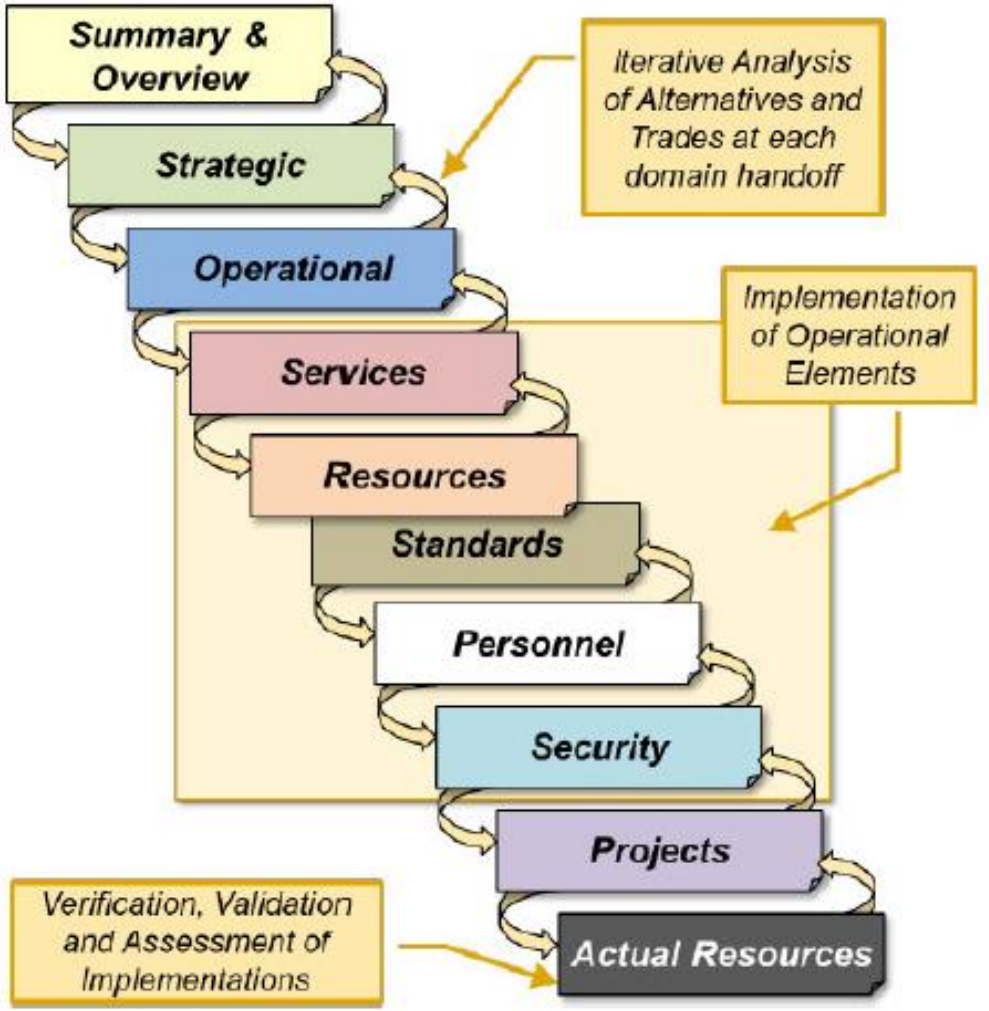
Summary and overview - provides executive-level summary information in a consistent form that allows quick reference and comparison between architectural descriptions.

Requirements - used to represent requirements, their properties, and relationships (trace, verify, satisfy, refine) to each other and to UAF architectural elements of different domains.

Viewpoints

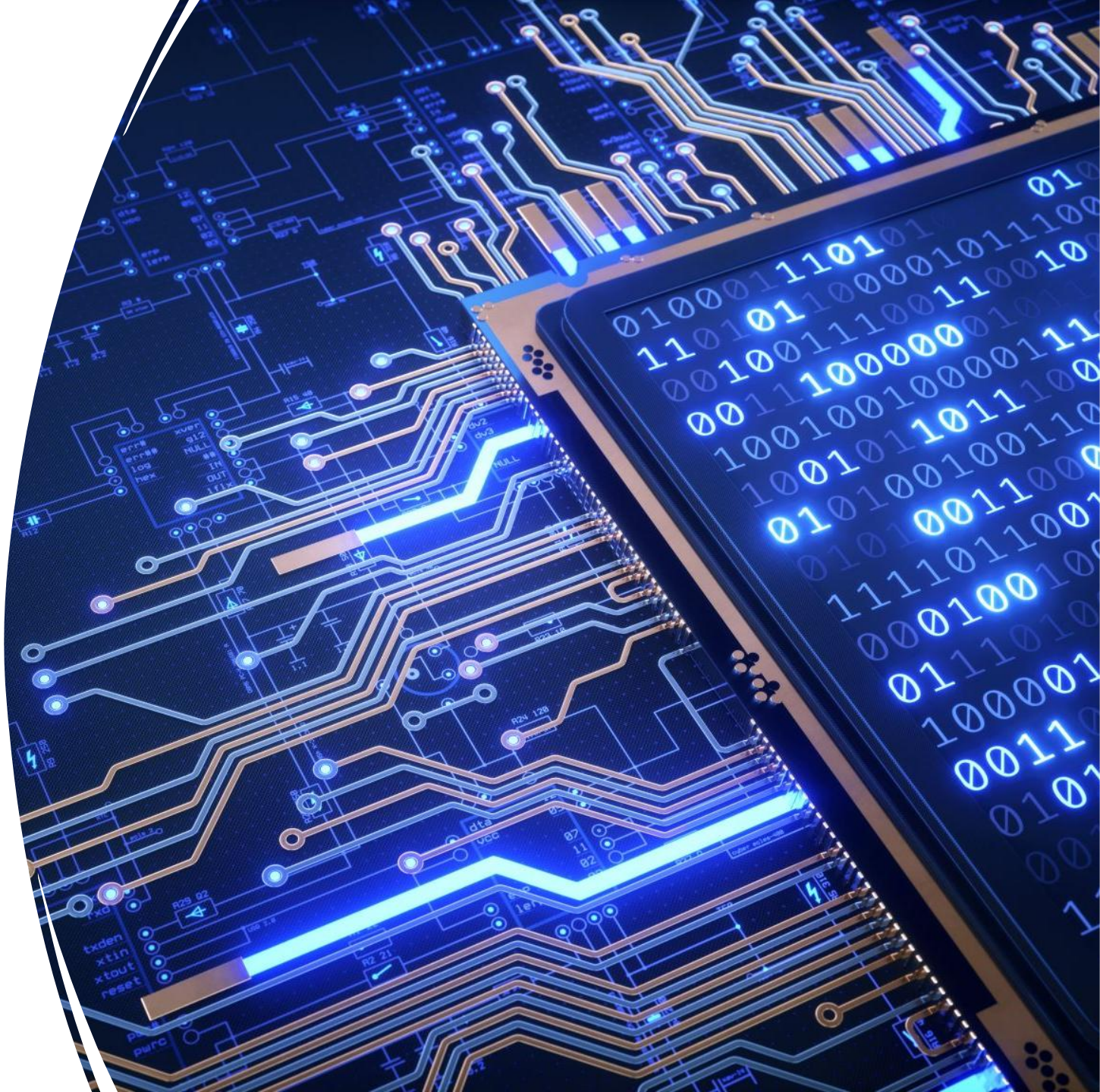
A UAF Domain metamodel (DMM) is organized according to viewpoints. Thus, it is easy to understand which elements (including types, individuals, and tuples) can be used to build a specific view. The categorization of elements into types, individuals, and tuples is taken from IDEAS. In general, a UAF metamodel is a simplified version of complex 4D IDEAS ontology. Although it is simplified, it is still powerful compared to the majority of existing enterprise modeling languages and methodologies.

UAF Viewpoints



Graphical Notation

A UAF metamodel does not define graphical notation. Systems Modeling Language (SysML) is the standard method of representing UAF metamodel elements graphically. SysML defines 9 diagram types, as well as notation for all SysML elements. Because the UAF profile is an extension of SysML, it inherits the same notation. For example, UAF Capability is inherited from SysML block, meaning that UAF Capability inherits SysML block notation



UAF Specification

There are four parts to this specification, two are normative and two informative. The normative parts are:

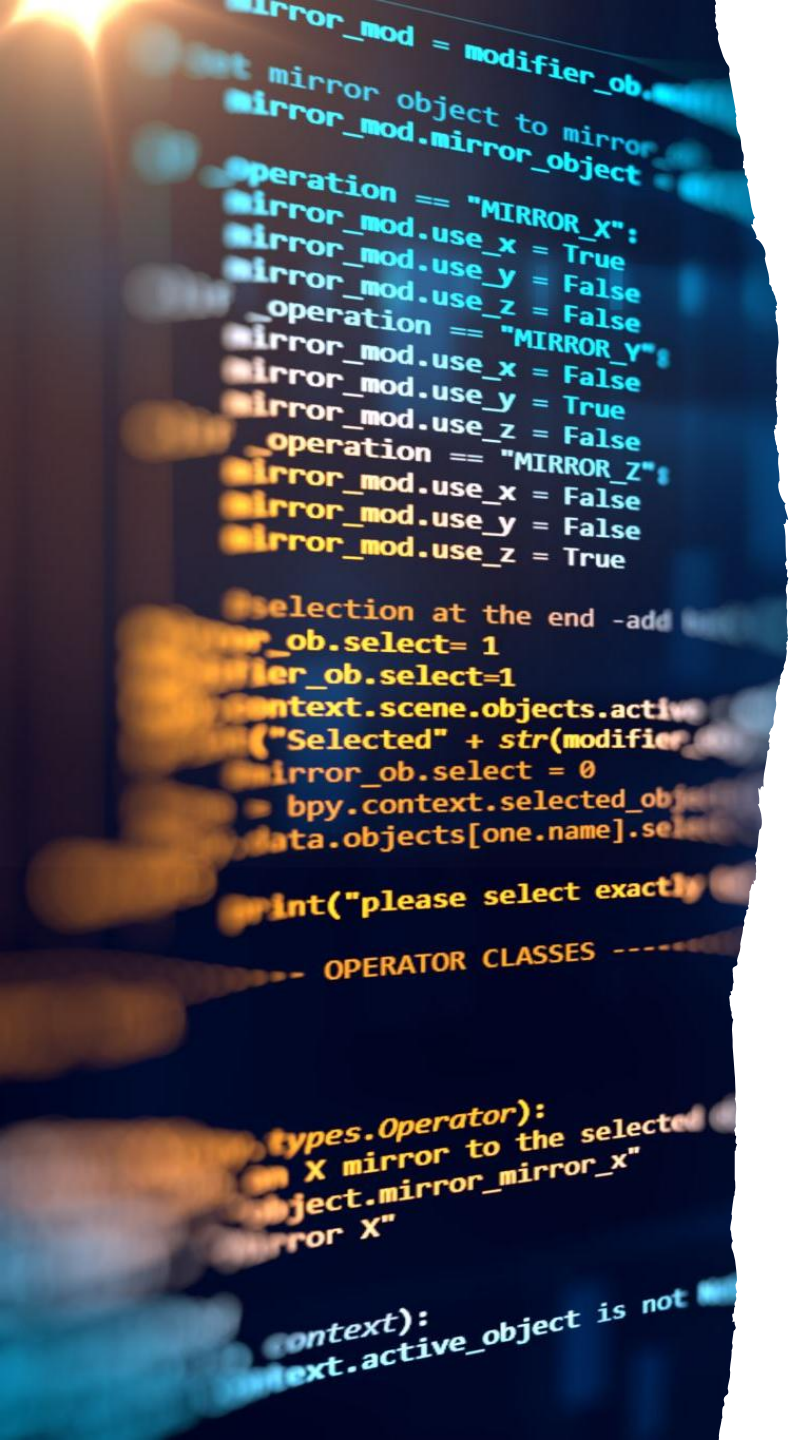
1. The UAF Domain Metamodel (DMM) (this document) that provides the definition of concepts, relationships and viewpoints for the framework. The UAF DMM is the basis for any implementation of UAF including non-UML/SysML implementations.

2. The UAF Profile (UAFP) (see document dtc/19-06-15) is a UML/SysML implementation of the UAF DMM

The informative parts are:

3. The UAF Traceability, Annex A (see document dtc/19-06-17), which details the mappings between the UAF and the various frameworks and languages that contribute to the UAF.

4. The UAF Example Model, Annex B (see document dtc/19-06-18), which illustrates a practical usage of UAF.



UAF Conformance

UA specifies four types of conformance.

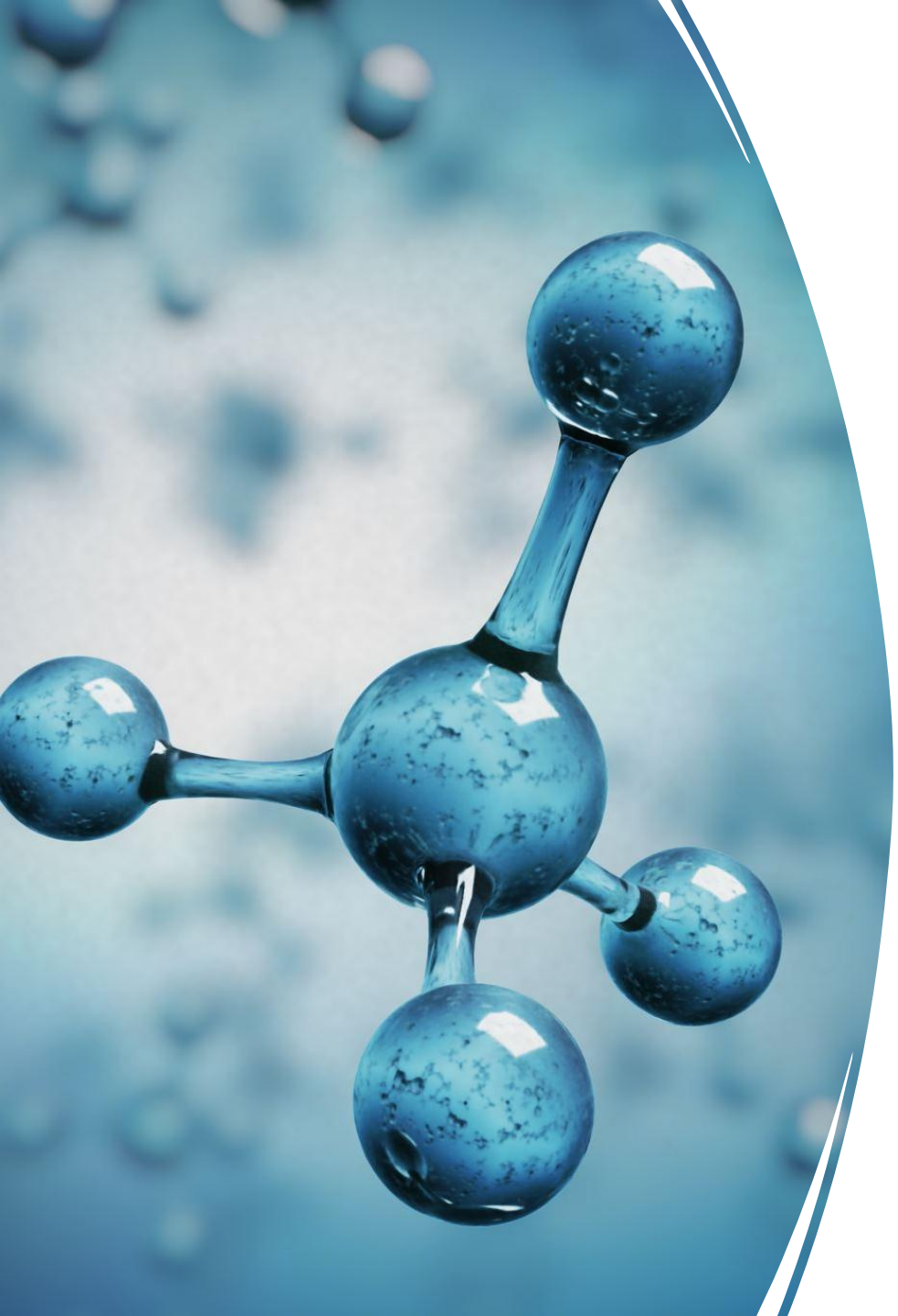
- *Type 1 Conformance: - UAF View specification conformance.* A tool demonstrating view specification conformance shall implement a version of all the view specifications defined in the UAF Grid, with the exception of the view specifications in the Metadata Domain. Optionally the tool vendor can implement other donor framework viewpoints, for instance DoDAF, MODAF or NAF based upon the mapping between them and UAF provided in Appendix A (dtc/19-06-17)
- *Type 2 Conformance: - UAF Conceptual Syntax Conformance.* A tool demonstrating conceptual syntax conformance is consistent with the concepts, relationships and constraints defined in the UAF DMM (this document). UAF Conceptual Syntax Conformance implies Type 1 Conformance.
- *Type 3 Conformance: - UAF Formal Syntax Conformance.* A tool demonstrating formal syntax conformance:
  - enables instances of concrete UAFP stereotypes defined in the UAFP (dtc/19-06-15)
  - complies with the constraints defined in the UAFP (dtc/19-06-15)
  - complies with the SysML version 1.5 Concrete Syntax Conformance (formal/17-05-01)

UAF Formal Syntax Conformance implies Type 2 Conformance.

- *Type 4 Conformance: - UAF Model interchange conformance*. A tool demonstrating model interchange conformance can import and export conformant XMI for all valid UAFP models. Model interchange conformance implies Type 3 Conformance.

Grid

	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information[c] If	Parameters[d] Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Metadata[a] Md	Metadata Taxonomy Md-Tx[f]	Metadata Structure Md-Sr	Metadata Connectivity Md-Cn	Metadata Processes Md-Pr	Metadata States Md-St	-			Metadata Constraints Md-Ct	Metadata Roadmap Md-Rm	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 Op	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 schema[e], real world results	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 Req											



Model Example: Terms

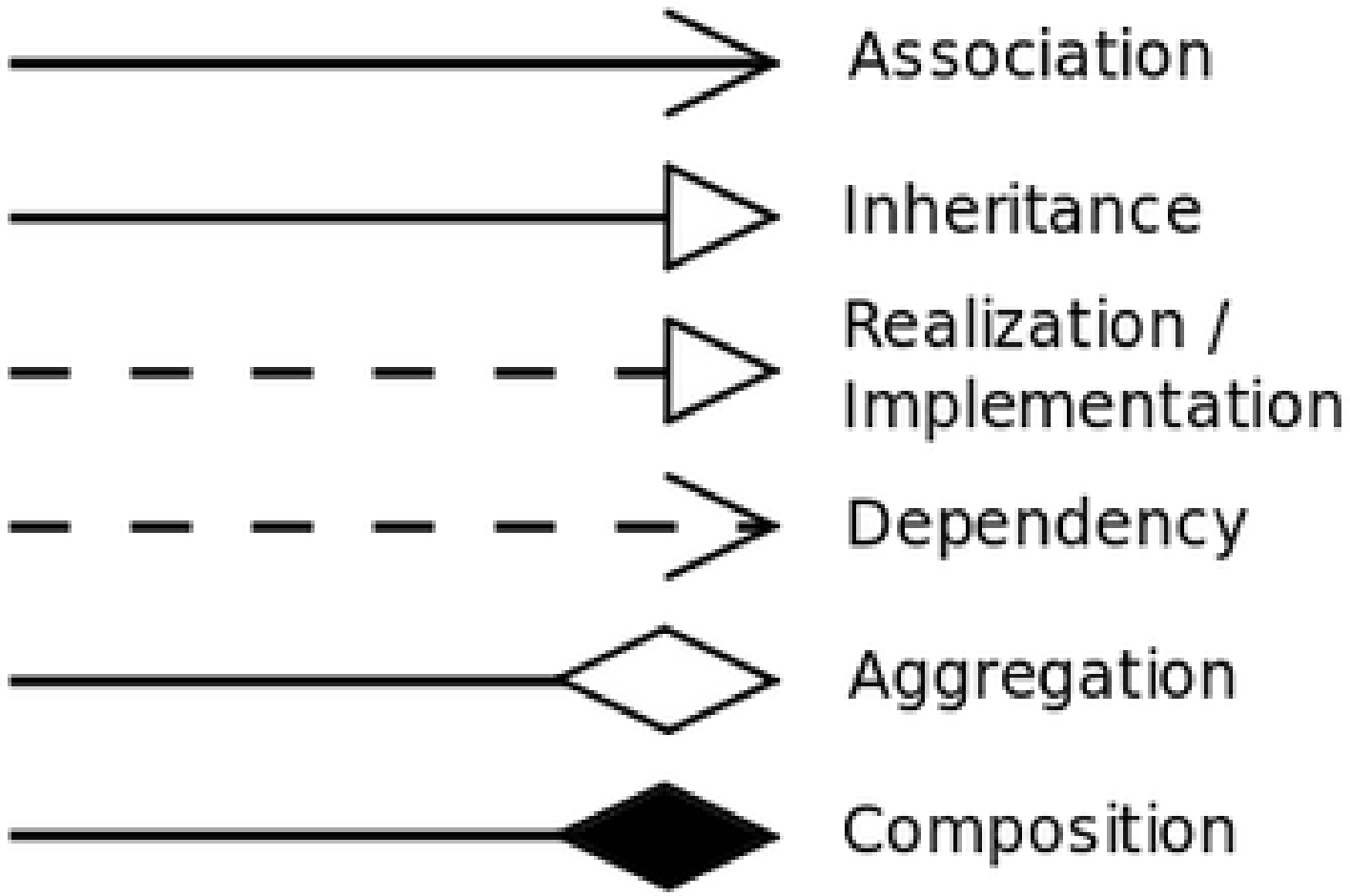
- Stereotype: a *stereotype* is a model element that identifies the purpose of other model elements.
- Constraint: a *constraint* is an extension mechanism that enables you to refine the semantics of a model element. A constraint refines a model element by expressing a condition or a restriction to which the model element must conform.
- Profile: a *profile* is a package that identifies a particular subset of a base metamodel and defines stereotypes and constraints that can be applied to the model.

Model Example: Stereotypes

This was adapted from UML

Stereotype	Relationship	Description
«call»	Dependency	This stereotype is applied to an operation in the consumer class that invokes an operation in the supplier class. A call dependency can connect a consumer operation to any supplier operation that is within scope.
«create»	Dependency	This stereotype is applied to a consumer model element that creates instances of the supplier model element.
«derive»	Abstraction	This stereotype is applied to a consumer abstraction that is computed from the supplier model element.
«instantiate»	Dependency	This stereotype is applied to operations in the consumer model element that create instances of the supplier model element.
«refine»	Abstraction	This stereotype is applied to a model element that is a finer degree of abstraction than the supplier model element.
«send»	Dependency	This stereotype is applied to an operation that sends a target signal.
«trace»	Abstraction	This stereotype is applied to track changes to model elements when the model elements represent the same concept in different models.

ELEMENTS


Association
Inheritance
Realization /
Implementation
Dependency
Aggregation
Composition

UAF – SWOT analysis

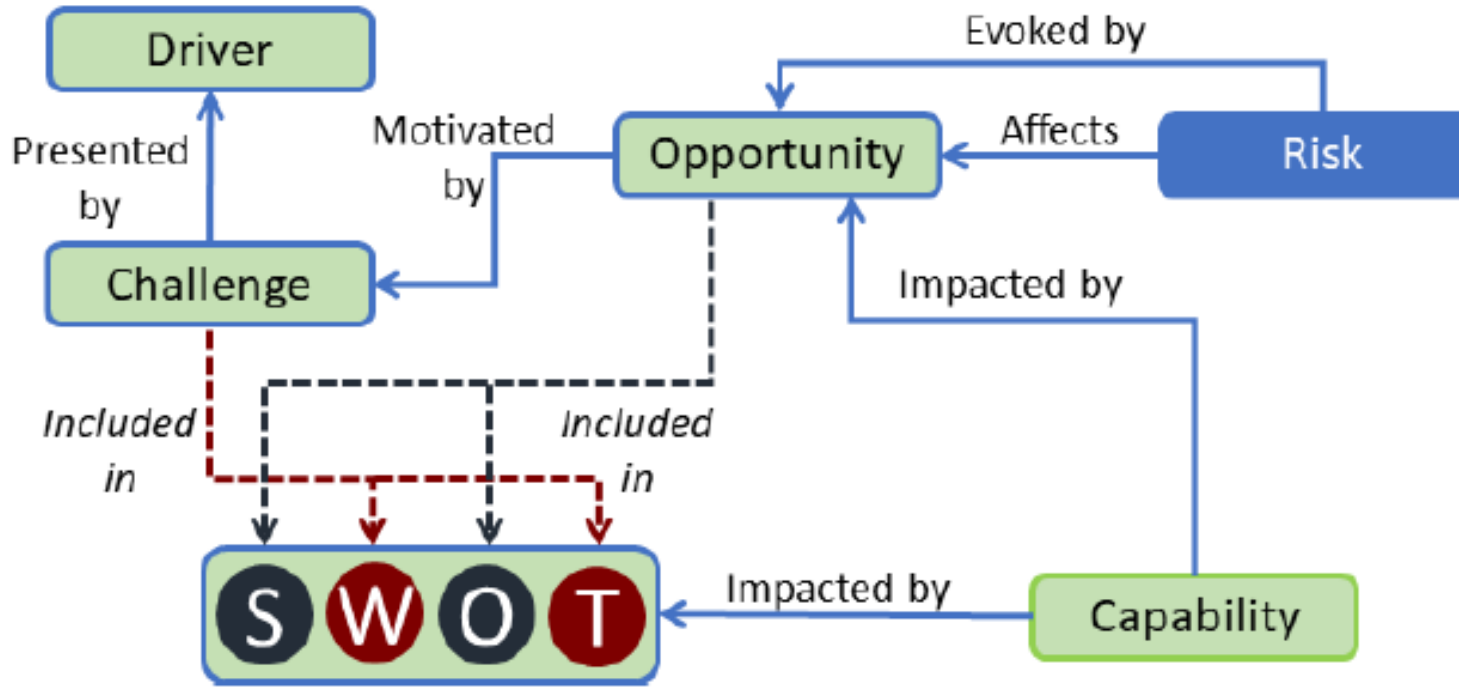


FIGURE 4. UAF elements included in SWOT analysis.

-UAF Strategic Planning for Enterprises MOHAMMADREZA TORKJAZI , (Member, IEEE), ARTURO J. DAVILA-ANDINO, (Member, IEEE), AHMAD ALGHAMDI , (Member, IEEE), AND ABBAS K. ZAIDI, (Senior Member, IEEE) Department of Systems Engineering and Operations Research, George Mason University, Fairfax, VA 22030, USA

UAF – SWOT analysis

- -UAF Strategic Planning for Enterprises MOHAMMADREZA TORKJAZI , (Member, IEEE), ARTURO J. DAVILA-ANDINO, (Member, IEEE), AHMAD ALGHAMDI , (Member, IEEE), AND ABBAS K. ZAIDI, (Senior Member, IEEE) Department of Systems Engineering and Operations Research, George Mason University, Fairfax, VA 22030, USA

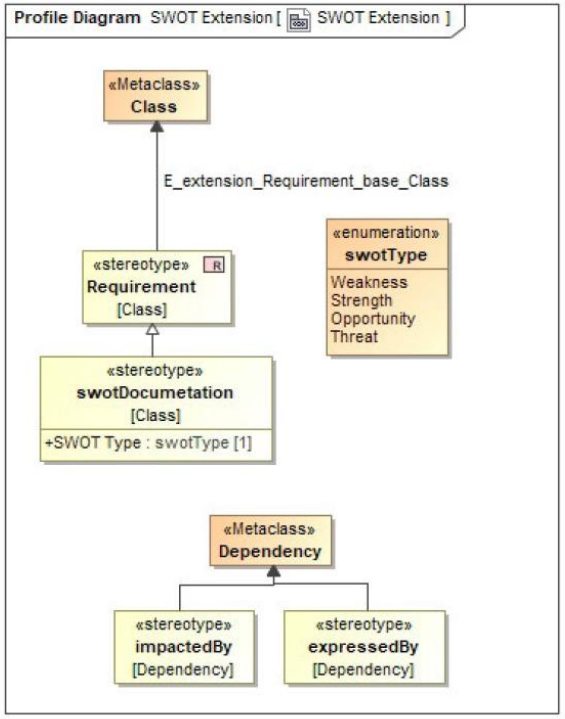
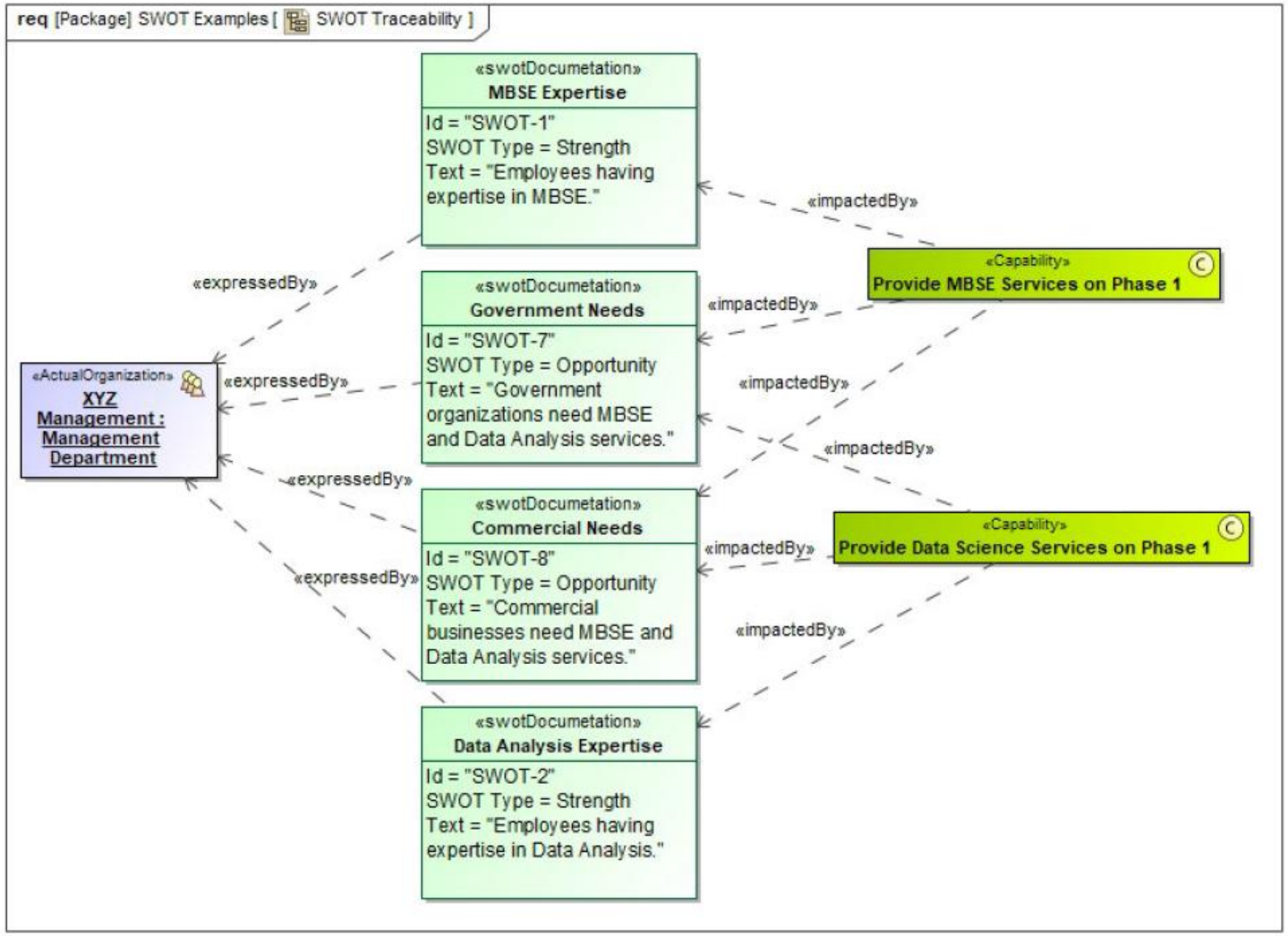


FIGURE 5. Profile diagram for the proposed SWOT extension.

UAF – SWOT Table

#	Id	Name	SWOT Type	Text
1	SWOT-1	MBSE Expertise	Strength	Employees having expertise in MBSE.
2	SWOT-2	Data Analysis Expertise	Strength	Employees having expertise in Data Analysis.
3	SWOT-3	Expertise in UAF	Strength	The experts are proficient in UAF.
4	SWOT-4	Expertise in System Trade Studies	Strength	The experts are proficient in executing trade studies and have proven experience in the area.
5	SWOT-5	Expert Availability Constraints	Weakness	The time of our personnel interested is limited due to academic responsibilities.
6	SWOT-6	Budgeting Constraints	Weakness	As a start-up, there is limited funding for tools and salaries.
7	SWOT-7	Government Needs	Opportunity	Government organizations need MBSE and Data Analysis services.
8	SWOT-8	Commercial Needs	Opportunity	Commercial businesses need MBSE and Data Analysis services.
9	SWOT-9	Scarcity of Experts	Opportunity	There are few qualified professionals in the field of Digital Engineering.
10	SWOT-1(	Competitors	Threat	Other competitors entering the market and established competitors bidding for the same work.
11	SWOT-11	Expensive Tools	Threat	The cost for modeling tools are expensive for a start-up.

UAF – SWOT Traceability Diagram



Terminology

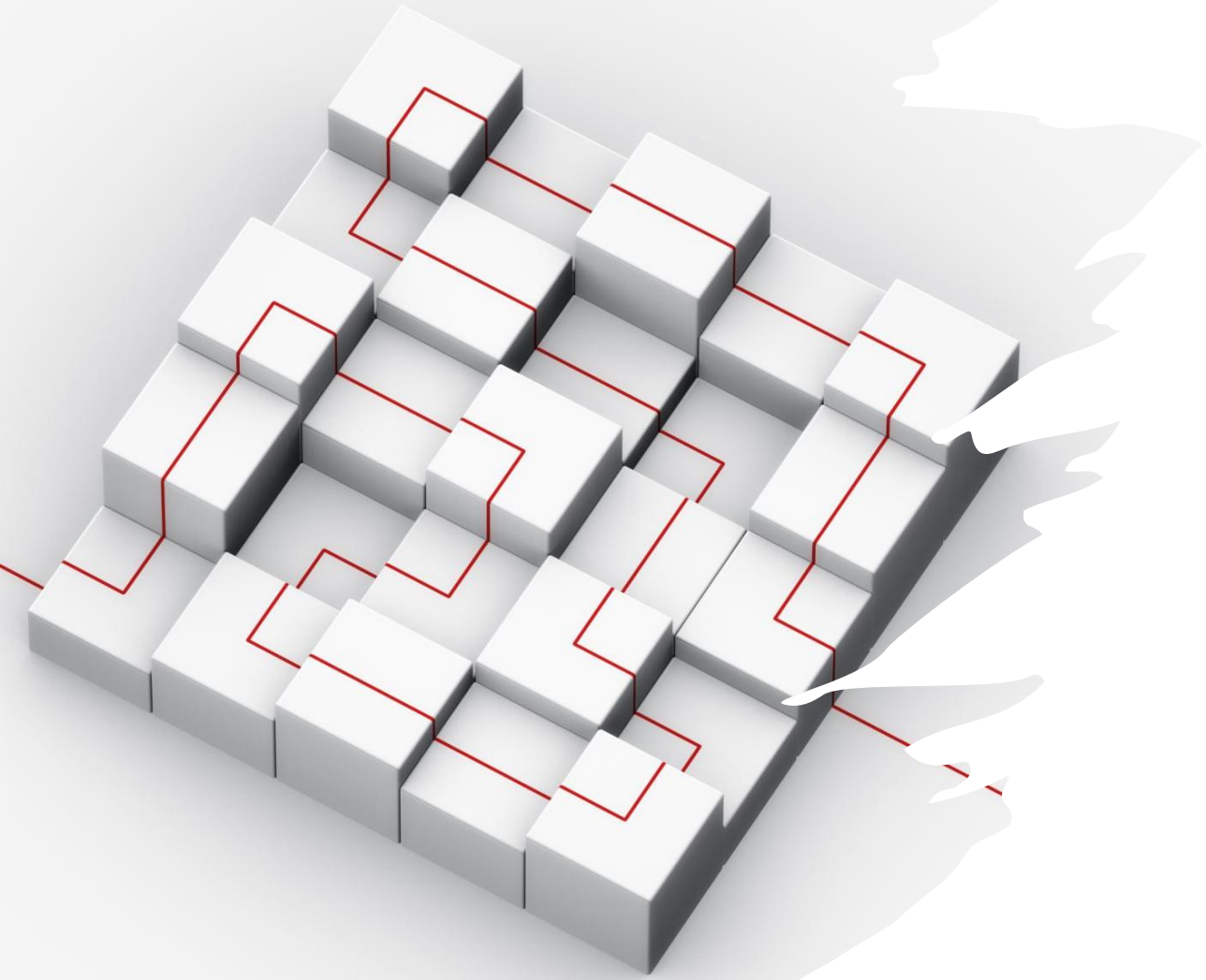
AcV-*2	Acquisition View
AD	Architecture Description
AV-*	All View
BMM	Business Motivation Model
BPMN	Business Process Modeling Notation
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CaT	Capability Team
COI	Communities of Interest
CV-*	Capability View
DIV-*	Data and Information Views
DLOD	Defence Lines of Development
DM2	DoDAF Meta Model
DMM	Domain Meta Model
DNDAF	Department National Defence and Canadian Forces (DND/ CF) Architecture Framework
DoD	United States Department of Defense
DoDAF	Department of Defense Architecture Framework
DOTMLP	Doctrine, Organization, Training, Material, Leadership, Personnel, Facilities
EIE	Enterprise Information Environment
IDEAS	International Defense Enterprise Architecture Specification for Exchange
IDEF	Integrated DEFinition Methods
INCOSE	International Council Of Systems Engineering
JCIDS	Joint Capabilities Integration and Development System
MISIG	Model Interchange Special Interest Group
MOD	United Kingdom Ministry of Defence

Terminology

MODAF	Ministry of Defence Architecture Framework
MODEM	MODAF Ontological Data Exchange Mechanism
NAF	NATO Architecture Framework
OASIS	Organization for the Advancement of Structured Information Standards
OSLC	Open Services for Lifecycle Collaboration
OV-*	Operational View
PES	DoDAF Physical Exchange Specification
POC	Proof of Concept
PV-*	Project View
RDF	Resource Description Framework
SoaML	Service orientated architecture Modeling Language
SoS	System of Systems
SOV-*	Service Oriented View
StdV-*	Standards View in DoDAF 2.02 compare TV-* in UAF
STV-*	Strategic View
SV-*	System View
SvcV-*	Service View
TEPID OIL	Training, Equipment, Personnel, Information, Concepts and Doctrine, Organisation, Infrastructure, Logistics
TOGAF	The Open Group Architectural Framework©
TPPU	Task, Post, Process, and Use
TV-*	Technical View
UAF	Unified Architecture Framework
UAFP	Unified Architecture Framework Profile
UPDM	Unified Profile for DoDAF/MODAF

STEP 4 – Service Architectures

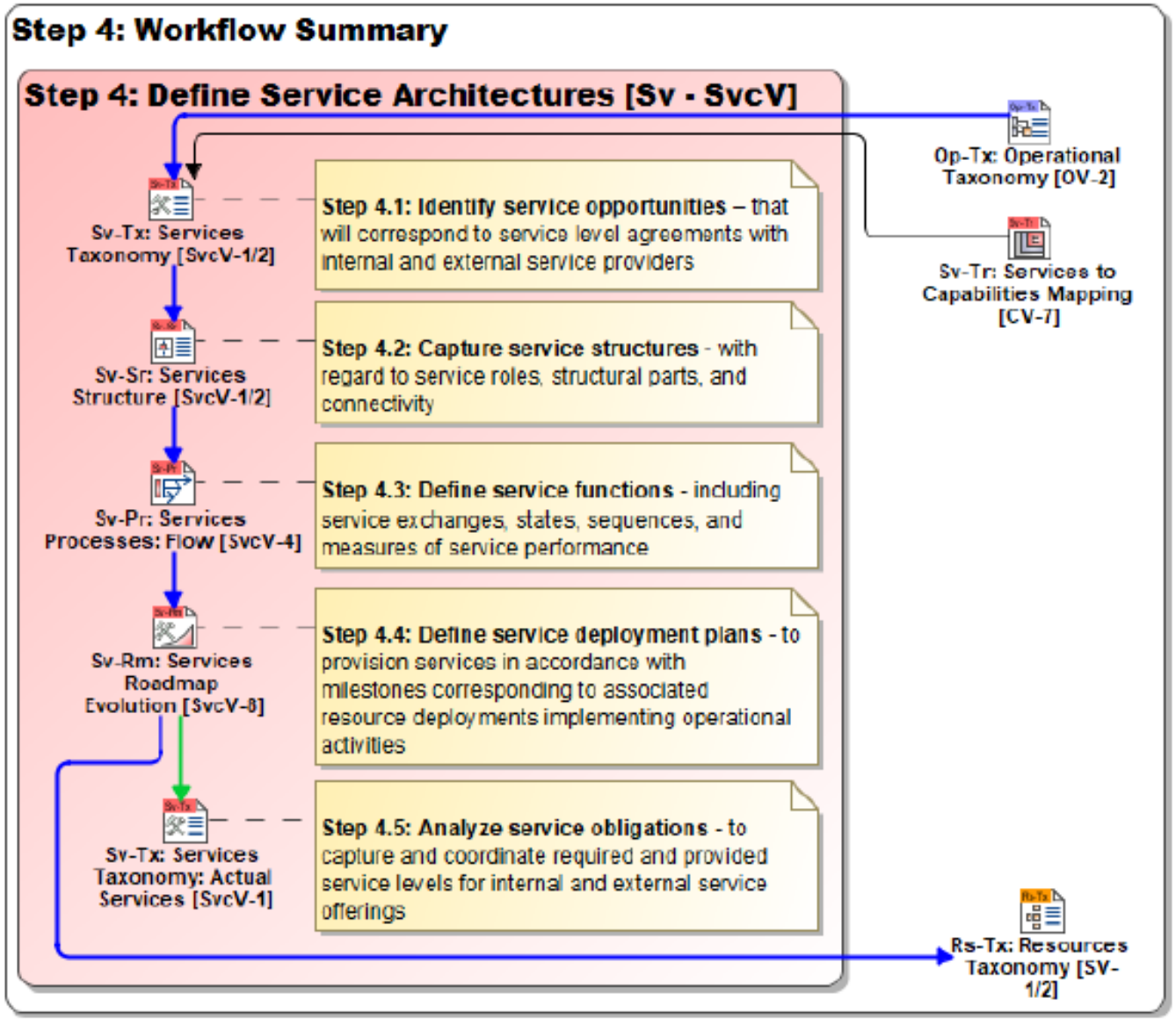
- **Purpose.** The purpose of this step is to define services and to specify required and provided service levels for the services needed to exhibit capabilities and to support operational activities. Key stakeholders for this step are Enterprise Architects, Solution Providers, Systems Engineers, Software Architects and Business Architects. Their concerns are mainly about what are the specifications of services required to exhibit capabilities.
- **Conceptual Schema.** The key concepts in the Services Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:24. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships shown in the conceptual schema are provided in the UAFML specification document.



STEP 4 – Service Architectures

- The main entry criterion for this Step is bringing forward the ***operational activities*** from Step 3 with associated ***performers***, ***operational exchanges***, ***measures*** and their operational context. These are used to define potential or actual opportunities for service use, i.e., identification of services to be used by ***operational activities*** that support operational needs for information or resources that can be provided on the basis of a ***service*** specification**.** These services can also be used as the components of a designated ***service architecture***.
- • **Service** – the specification of a set of functionalities provided by one element for the use of others (Note: this is often a set of functionalities that can be provided for the use of operational activities)
- • **Service Architecture** – an element used to denote a model of the Architecture, described from the **Services** perspective (Note: this

STEP 4 – Workflow



STEP 4 – Workflow

99	**Step 4: Define Service Architectures [Sv - SvcV]**	**Views**
100	**Step 4.1: Identify service opportunities** – that will correspond to service level agreements with internal and external service providers	Sv-Tx: Services Taxonomy [SvcV-1]
107	**Step 4.2: Capture service structures** - with regard to service roles, structural parts, and connectivity	Sv-Sr: Services Structure [SvcV-1/2]
111	**Step 4.3: Define service functions** - including service exchanges, states, sequences, and measures of service performance	Sv-Pr: Services Processes: *Flow* [SvcV-4]
118	**Step 4.4: Define service deployment plans** - to provision services in accordance with milestones corresponding to associated resource deployments implementing operational activities	Sv-Rm: Services Roadmap-Evolution [ScvV-8]
120	**Step 4.5: Analyze service obligations** - to capture and coordinate service level agreements and requirements for internal and external service providers and consumers	Sv-Tx: Services Taxonomy: *Actual Services* [SvcV-1]

Step 4 – Service Structures

- Service Role – a behavioral feature of a Service whose behavior is specified in a Service Function
- Service Interface – a contract that defines the Service Methods and Service Signals that the Service realizes (Note: this may be for a formal declaration of a contractual level interface with a Service)
- Implements – a tuple that defines how an element in the upper layer of abstraction is implemented by a semantically equivalent element (for example tracing the Functions to the Operational Activities) in the lower level of abstraction (Note: in this case a relationship between a Resource Interface that will outfit or equip a Service Interface, or between a Service Interface or Service Function that will outfit or equip an Operational Interface or Operational Activity)

Step 4 – Service Structures

- **Service Exchange** – asserts that a flow can exist between **Services** (i.e., flows of information, people, materiel, or energy)
- **Service Exchange Item** – an abstract grouping for elements that defines the types of elements that can be exchanged between **Services** and conveyed by a **Service Exchange** (Note: this may be one of several **Service Exchange Kinds** such as a Material Exchange, Organizational Exchange, Energy Exchange, Information Exchange, or a Configuration Exchange).

STEP 5 – Resource Architectures

- **Purpose.** The purpose of this step is to capture a solution architecture consisting of various resources, such as software, artifacts, capability configurations and natural resources that implement the operational elements and requirements in the operational architecture. Further design of a resource is typically detailed in SysML or UML. Key stakeholders for this step are Systems Engineers, Resource Owners, Implementers, Solution Providers, and Information Technology (IT) Architects. Their concerns are mainly about definition of solution architectures to implement operational elements and requirements.
- **Conceptual Schema.** The key concepts in the Resources Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:31. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships shown in the conceptual schema are provided in the UAFML specification document.

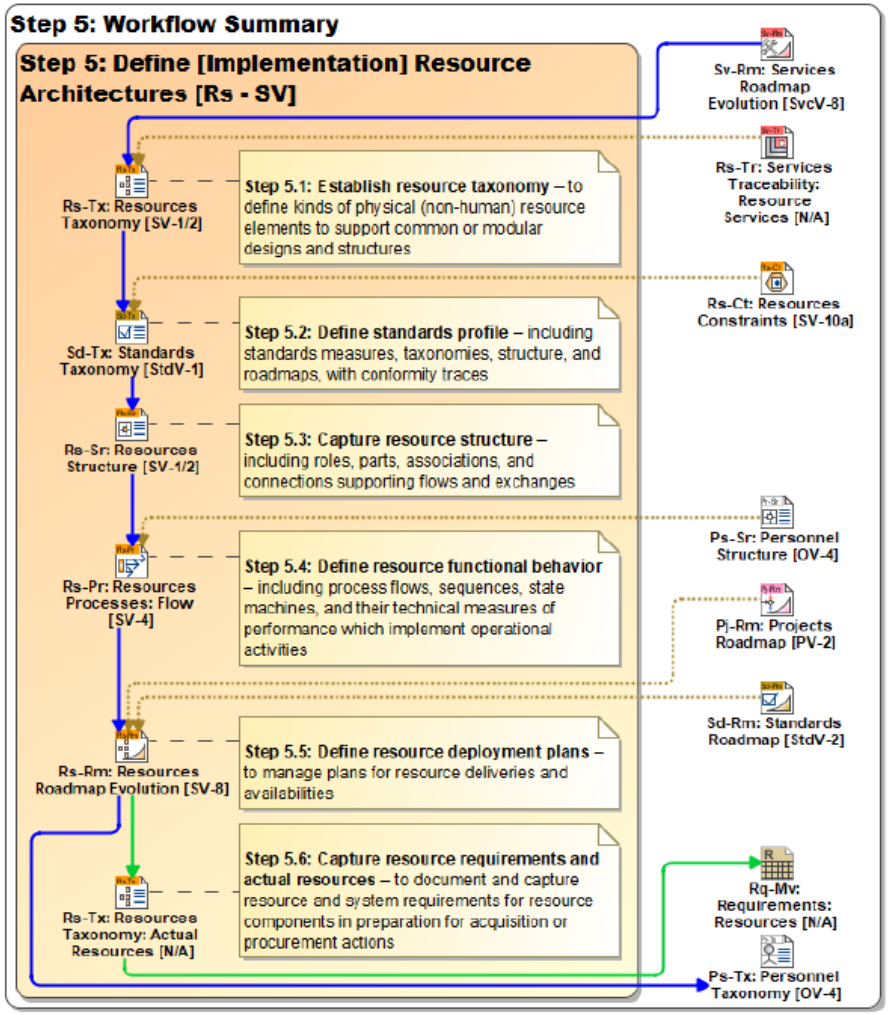
STEP 5 – Resource Architectures

Define [Implementation] Resource Architectures – The main entry criterion for this Step is bringing forward the ***operational activities*** from Step 3 with associated ***performers***, ***operational exchanges***, ***measures*** and their operational context. These are used to define potential or actual ***resources*** for operational use, i.e., identification of resource ***functions*** to be used by ***operational activities*** that support operational needs for information or resources that can be provided on the basis of a ***resource architecture*** specification**.** These ***resources*** can also be used as the components of a designated ***resource architecture***.

STEP 5 – Resource Architectures

- **Resource Performer** – an abstract grouping of elements that can perform **Functions** (Note: this is an entity that is capable of interacting with other resource performers to perform resource **Functions** and may include **Resource Architectures** and **Resource Artifacts**, among other things. See conceptual schema above.)
- **Resource Architecture** – a type used to denote a model of the Architecture, described from the **Resource Performer** perspective (Note: this typically represents a large composition or aggregation of resource performers (which is itself a resource performer) that can interact with other resources and perform functions)
- **Implements** – a tuple that defines how an element in the upper layer of abstraction is implemented by a semantically equivalent element (for example tracing the **Functions** to the **Operational Activities**) in the lower level of abstraction (Note: in this case these include implements relationships between resource elements that outfit or equip operational elements)

STEP 5 – Workflow



Step 5 – Resource Taxonomy

- **Capability Configuration** – a composite structure representing the physical and human resources (and their interactions) in an enterprise, assembled to meet a capability
- **System** – An integrated set of elements, subsystems, or assemblies that accomplish a defined objective, including products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements (INCOSE SE Handbook V4, 2015)
- **Resource Artifact** – a type of man-made object that contains no human beings (e.g., satellite, radio, petrol, gasoline, etc.) (Note: this includes subtypes such as **Software** and **Technology**)
- **Natural Resource** – a type of physical resource that occurs in nature such as oil, water, gas or coal (Note: this may also include other natural resources such as solar energy, ballast rock and electromagnetic spectrum)
- **Known Resource** – asserts that a known resource performer constrains the implementation of the **Operational Performer** that plays a particular role in the **Operational Architecture** (Note: a **Known Resource** may be a pre-existing entity, such as a physical resource or other operational agent which participates in an operational scenario and is already known and described outside the context of the **Operational Architecture**)
- **Resource Service** – a service that a Resource Performer provides to support higher level **Service** or **Operational Activity** (Note: employee provisioning, backup and recovery, storage, and self-service help desk are examples of **Resource Services** which are a set of functionalities that can be provided for the use of resource functions, which can implement an enterprise **Service** in the Services Viewpoint)

Step 5 – Standards Profile

- **Define standards profile** – A standards profile is created to define the technical ***standards*** applicable to the ***resource architecture***, identifying and listing applicable portions of existing or emerging standards, including ***protocols*** and ***protocol stacks***. Standards may also apply to any element in the architecture as necessary, but should not be used in lieu of a ***rule kind***, including policies, or ***standard operational activities***. ***Mandate*** and ***retirement dates*** should be included for all existing or anticipated standards, and the actual organization that ***ratifies*** the standard.
- **Standard** – a ratified and peer-reviewed specification that is used to guide or constrain the architecture. A **Standard** may be applied to any element in the architecture. (Note: a Standard may have a Mandated Date, a Retired Date, and may be Ratified By and **Actual Organization**)
- **Protocol** – a **Standard** for communication over a network, which may be composite, represented as a **Protocol Stack** made up of **Protocol Layers**
- **Protocol Stack** – a sub-type of **Protocol** that contains the **Protocol Layers**, defining a complete stack (Note: of protocols used in a communications network configuration)

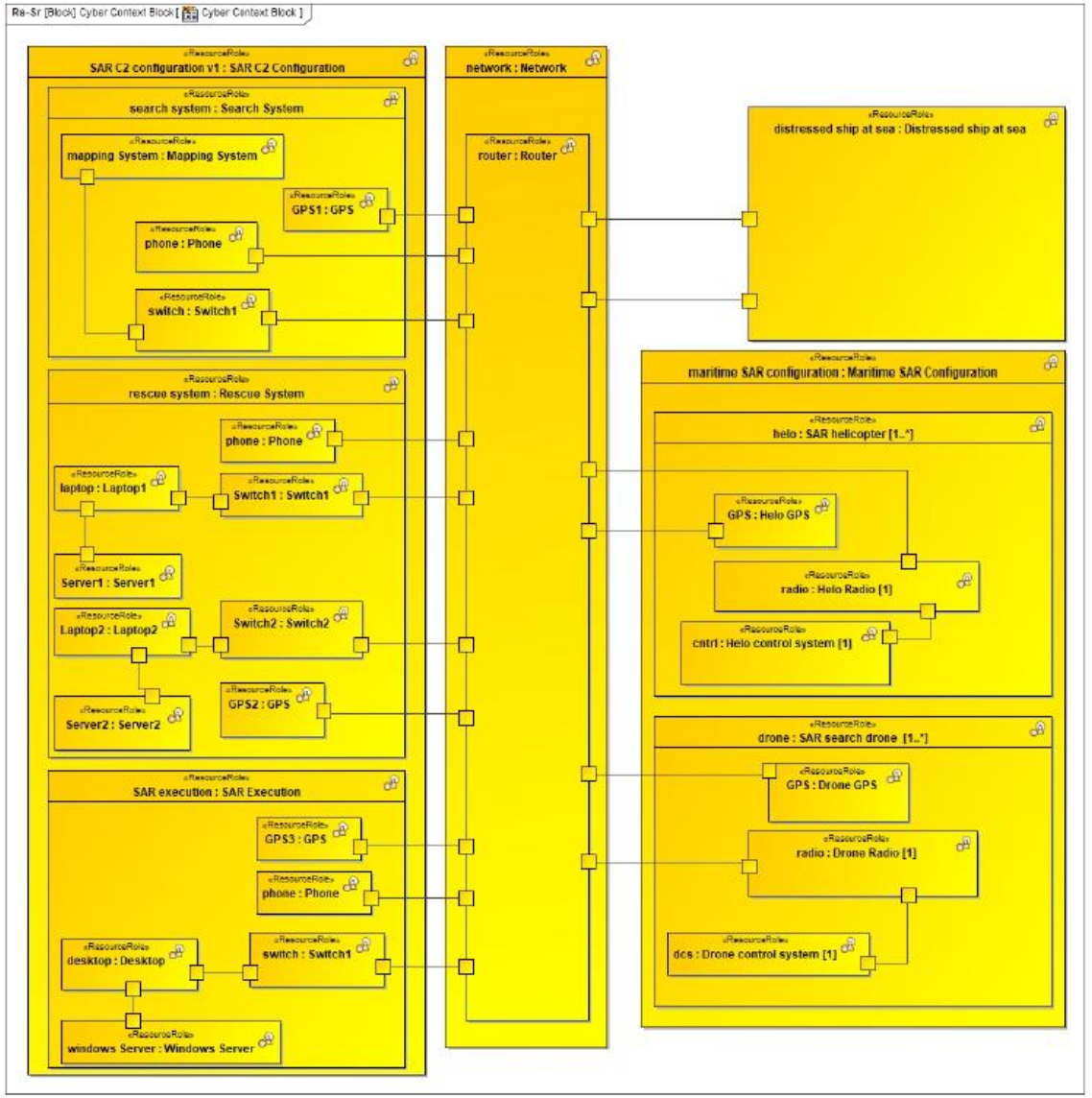
Step 5 – Resource Structure

- **Capture Resource Structure** – Internal structure of resource performers within the taxonomy is developed with internal features and characteristics, including ***resource roles*** they will have as part of a greater resource performer. One resource may perform different resource roles, and one resource role may be performed by different resource performers. Examination of this is necessary to scope and perform assessment of the trade space and conduct an analysis of alternatives, including differences between composition and aggregation in resource performer structure. Formal ***resource interfaces*** may be defined and declared for interface points of any resource performer port, which implement service or operational interfaces.
- **Resource Role** – usage of a Resource Performer in the context of another Resource Performer creating a whole-part relationship (Note: this is an element representing the part played by one resource in a particular context, governed by a **Role Kind**, such as Part, Component, Used Configuration, Human Resource, Platform, System, Sub Organization, Post Role, Responsibility Role, Equipment, Sub System Part, Hosted Software, Artifact Component, Natural Resource Component, or Other kind of role)
- **Resource Interface** – a declaration that specifies a contract between the Resource Performers it is related to and any other Resource Performers it can interact with. It is also intended to be an implementation of a specification of an Interface in the Business and/or Service layer. (Note: this may include the idea of a formal declaration of a contractual level interface)

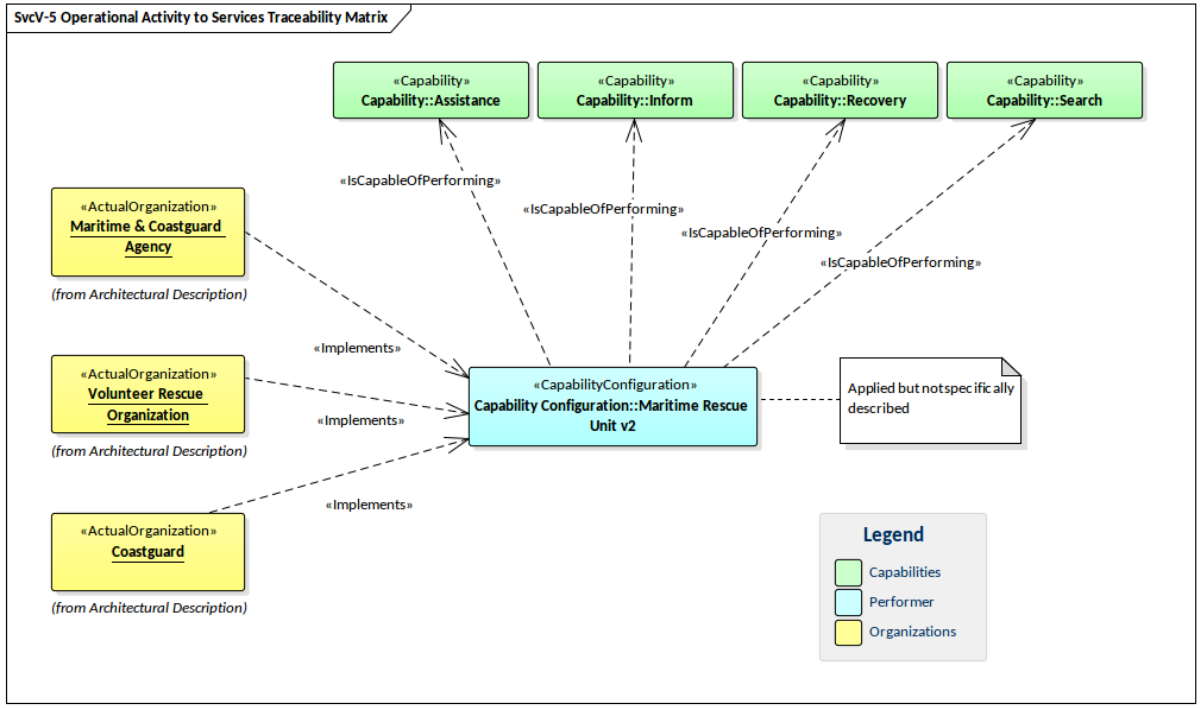
All of the resource performers are associated with each other to identify resource performer relationships which will support ***resource exchanges***, and ***resource connections***.

- **Resource Exchange** – asserts that a flow can exist between Resource Performers (i.e., flows of data, people, material, or energy)
- **Resource Exchange item** – an abstract grouping for elements that defines the types of elements that can be exchanged between Resource Performers and conveyed by a **Resource Exchange** (Note: these may be a Resource Performer, **Resource Information**, or a **Geopolitical Extent Type**)
- **Resource Connector** – a channel for exchange between two **Resource Roles**

Model Example: Resource Network Diagram for Cyber Resiliency

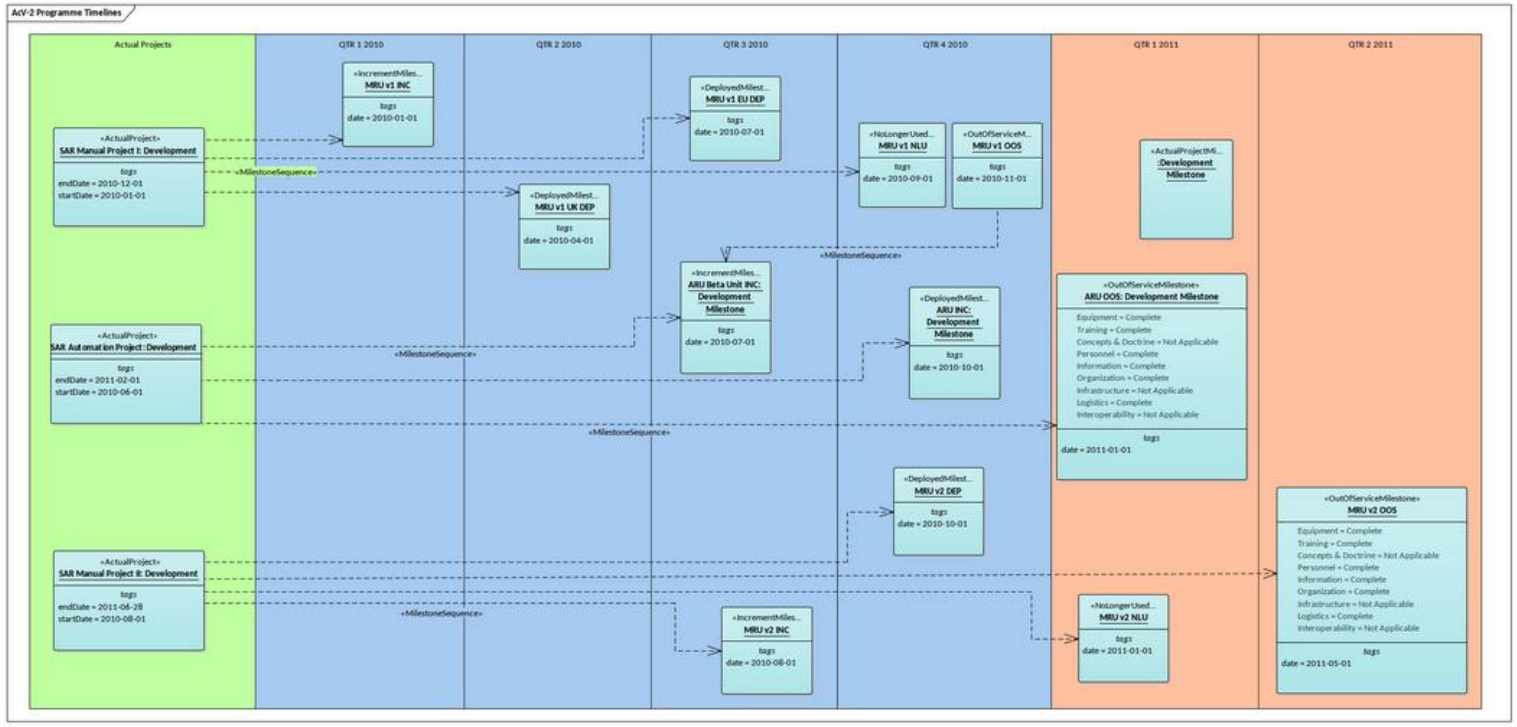


Model Example – Activity to Services Traceability Matrix

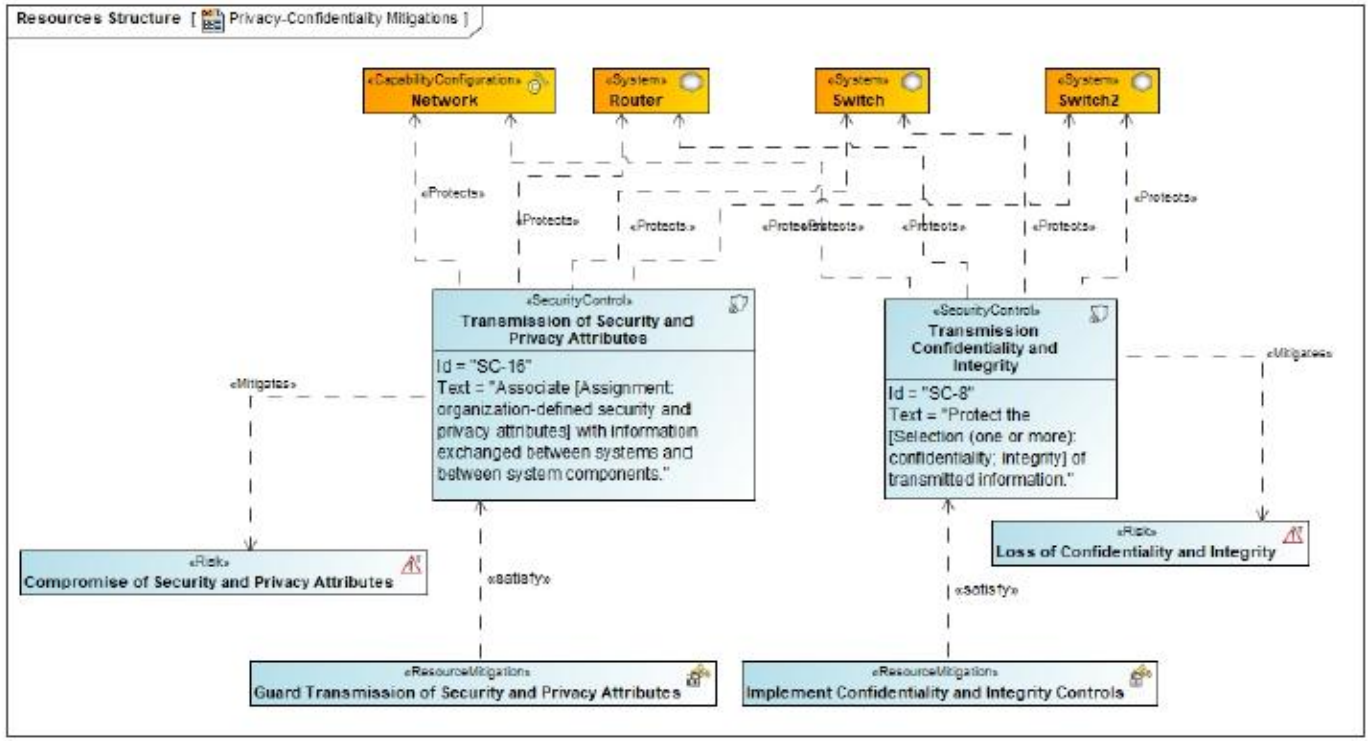


UPDM - Activity to Services Traceability Matrix

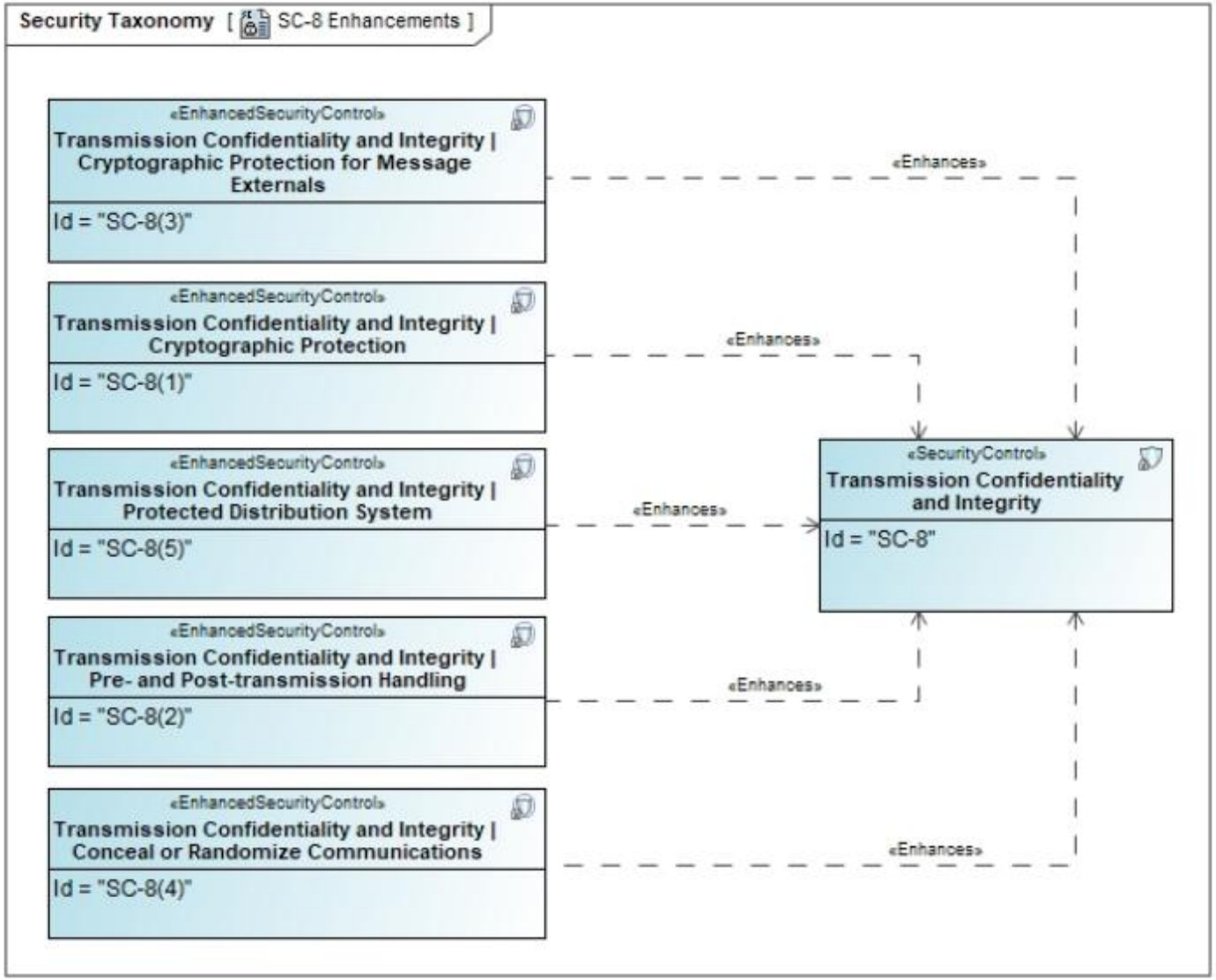
Model Example – Program Timelines



Resources Structure

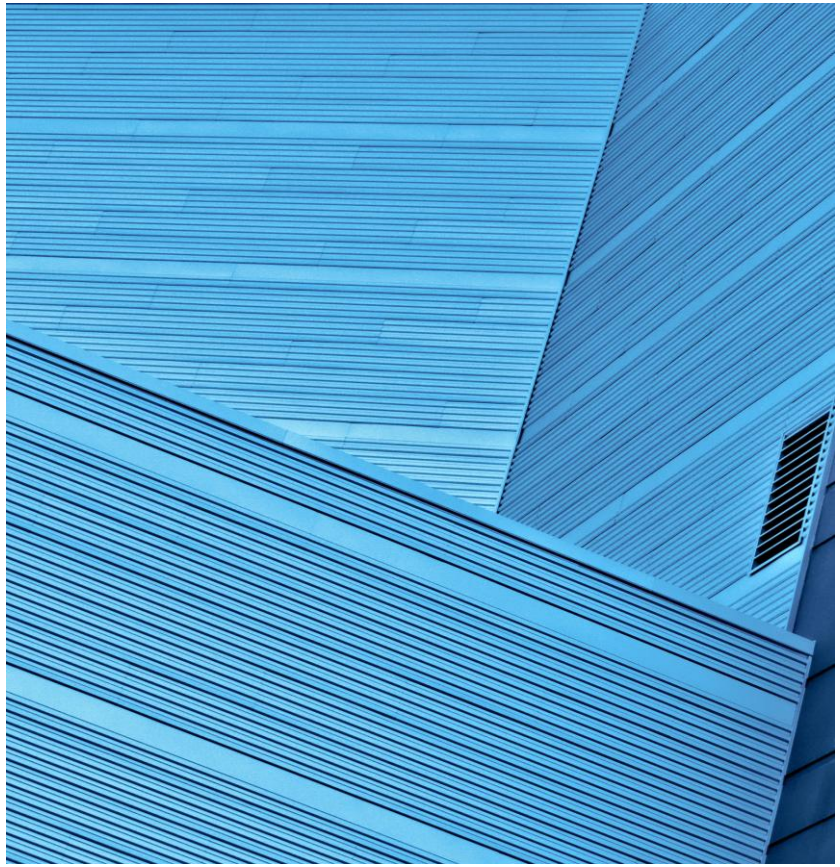


Model Example: Security Taxonomy

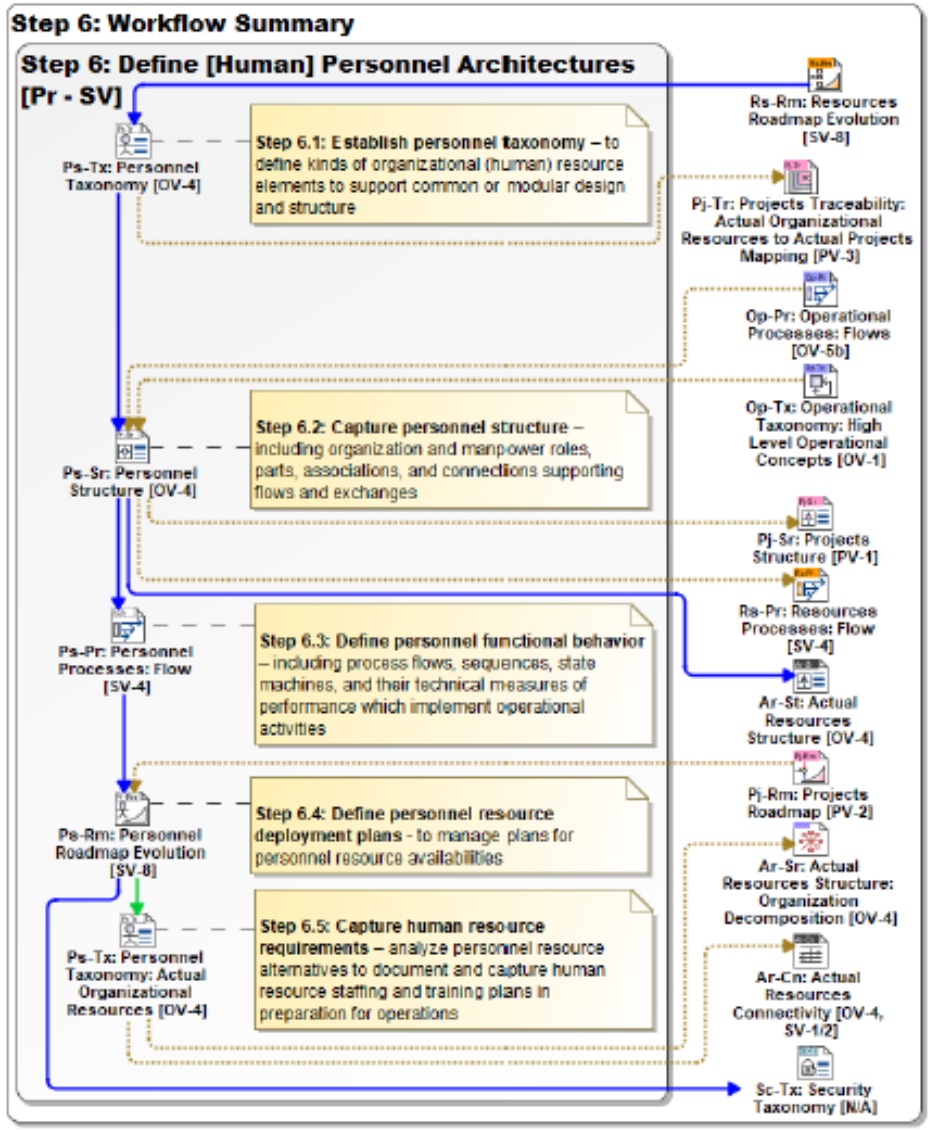


Step 6 – Personnel Architectures

- **Purpose.** The purpose of this step is to clarify the role of Human Factors when creating architectures in order to facilitate both Human Factors Integration and Systems Engineering. Key stakeholders for this step are Personnel involved in operations of the enterprise, Solution Providers and Project Managers. Their concerns are mainly about what are the roles and responsibilities of humans in the enterprise operations and how are those human resources to be organized.
- **Conceptual Schema.** The key concepts in the Personnel Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:39. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships shown in the conceptual schema are provided in the UAFML specification document.



Step 6 - Workflow



Step 6 Personnel Taxonomy

Establish personnel taxonomy – A set of organizational resources are described, including any that have been preliminarily identified from Step 3.2, where organizational resources are needed or anticipated that will ***implement operational agents***. These organizational resource performers are accounted for in a ***personnel taxonomy***, and may include ***organizations***, ***persons***, ***posts***, or ***responsibilities***. This captures the understanding of ***generalizations***, particularly when a reference personnel architecture is setting contextual guidance, organizational resource categories are established, or particular human resource plans are already known.

- **Organization** – a group of organizational resources (**Persons**, **Posts**, **Organizations** and **Responsibilities**) that are associated for a purpose
- **Person** – a type of human being used to define the characteristics that need to be described for **Actual Persons** (e.g., properties such as address, telephone number, nationality, etc.)
- **Post** – a type of job title or position that a **Person** can fill (e.g., Lawyer, Solution Architect, Machine Operator or Chief Executive Officer)
- **Responsibility** – a type of duty required of a **Post**, **Person,** or **Organization**

Step 7 – Security Architectures

- **Purpose.** The purpose of this step is to illustrate security assets, security constraints, security controls, security control families and the measures required to address specific security concerns. Key stakeholders for this step are Security Architects, Security Engineers, Systems Engineers and Operational Architects. Their concerns are mainly about how to address the security constraints and information assurance attributes that exist on exchanges between resources and operational performers.
- **Conceptual Schema.** The key concepts in the Security Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:46. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships shown in the conceptual schema are provided in the UAFML specification document.

Step 7 Security Architectures

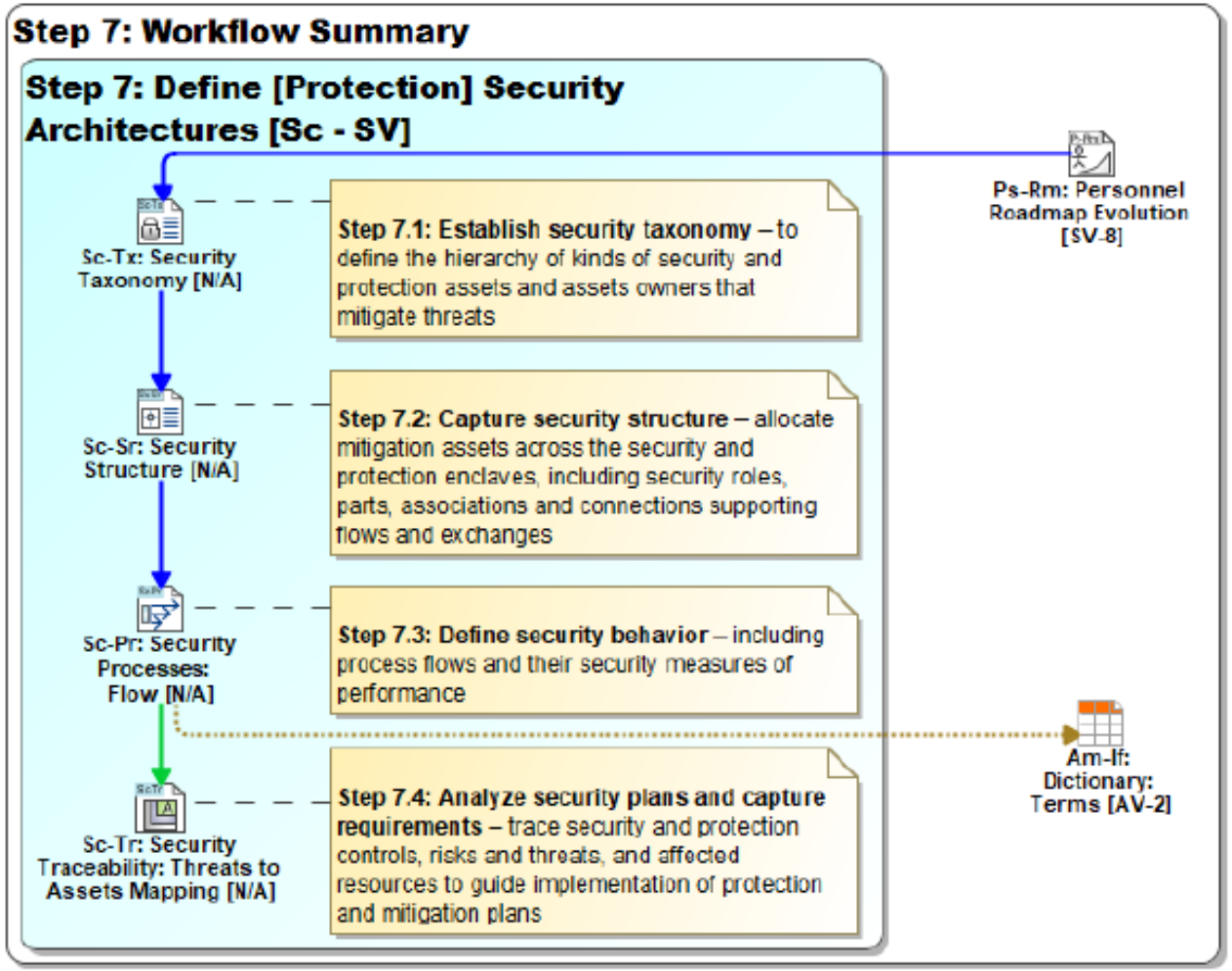
Security can often be addressed by things other than physical and human resources. For example, it is worth considering how other dimensions of the solution space can be put in place, such as doctrine, organization, training, materiel (other than regular resources, systems, or other artifacts), leadership and education, personnel, and facilities (DOTMLPF). Alternatively, you can consider other categories associated with the “defense lines of development” used in the UK: training, equipment, personnel, information, concepts and doctrine, organization, infrastructure, and logistics (TEPIDOIL).

Step 7 0 Security Architectures

These agents and performers along with their associated exchanges and functions will form alternatives that clarify the role of *security controls* to *protect* operational and resource assets by *mitigating* various *risks* that *affect* them.

- Operational – a set of Operational Performers intended to address against specific operational Risks
- Resource Mitigation – a set of Resource Performers intended to address against specific Risk
- Asset – an abstract element that indicates the types of elements that can be affected by Risk. Asset as applied to Security views is an abstract element that indicates the types of elements that can be considered as a subject for security analysis. (Note: types assets can include Operational Agents, Operational Information, Resource Performers, and Resource Information)
- Security Control – the management, operational, and technical control (i.e., safeguard or countermeasure) to Protect the confidentiality, integrity, and availability of the system and its information [NIST SP 800-53]
- Risk – a type that represents a situation involving exposure to danger of Affectable Elements (e.g., Assets, Processes, Capabilities, Opportunities, or Enterprise Goals) where the effects of such exposure can be characterized in terms of the likelihood of occurrence of a given threat and the potential adverse consequences of that threat's occurrence (Note: this is typically expressed as a statement of the impact of an event that Affects an asset representing a constraint in terms of adverse effects with an associated measure)
- Affectable Element – an abstract grouping of elements that can be affected by a Risk (Note: these include Enterprise Goals, Processes, Assets, Opportunities, and Capabilities)
- Security Risk – the level of impact on enterprise operations, assets, or individuals resulting from the operation of an information system given the potential impact of a threat and the likelihood of that threat occurring [NIST SP 800-65]
- Mitigates – a tuple relating a Security Control to a Risk. Mitigation is established to manage risk and could be represented as an overall strategy or through techniques (mitigation configurations) and procedures (Security Processes).

Step 7 - Workflow



Security Taxonomy

Establish security taxonomy – A ***security taxonomy*** of security operational assets and assets roles are described or brought forward from Step 3.2 which could be susceptible to adverse events, along with ***risks*** that affect those ***operational performers***. ***Security controls***, which are types of ***requirements***, are then described which define to the intended result or outcome of ***mitigating*** the ***risks*** affecting the operational performers, and to ***protect*** the resources that implement those operational performers. New ***operational mitigations*** are described, along with new operational performers, which will satisfy the security controls.

- This taxonomy includes understanding of ***generalizations***, particularly when a reference security architecture is setting contextual guidance, security asset categories are predefined, particular security strategies and plans are already known, or when ***enhanced*** or ***families*** of controls are deemed necessary. Step 7.1 and Step 3.2 may be conducted iteratively to adjust both operational performers and security taxonomies and to trade-off designs of the operational and security architectures.
- **Operational Mitigation** - a set of **Operational Performers** intended to address against specific operational **Risks** (Note: these performers are established to manage operational **Risks** which can represented as an overall strategy or through techniques (mitigation configurations) and procedures (**Security Processes**) They are a type of **Operational Architecture** which is used to mitigate a risk through satisfaction of a security control.))
- **Enhanced Security Control** – a statement of security capability to: (i) build in additional but related, functionality to a basic control; and/or (ii)increase the strength of a basic control
- **Security Control Family** – an element that organizes **Security Controls** into a family. Each **Security Control Family** contains **Security Controls** related to the general security topic of the family.

Step 7 - Categorization

The operational assets dealing with information are then categorized with associated security ***measurement*** to measure security impacts, along with features such as ***security availability, security classification***, and ***security integrity***.

- **Security Measurement** – an abstract type grouping all types of security measurements (e.g., **Security Integrity**, **Security Availability**)
- **Security Availability** – details the potential impact on organizations or individuals if the information is not available to those who need to access it
- **Security Classification** – details a classification for the exchange
- **Security Integrity** – details the potential impact on organization or individuals due to modification or destruction of information, and includes ensuring information non-repudiation and authenticity
- **Security Classification Kind** - a type that defines acceptable values for the security category (SC) of an information system, where the acceptable values for potential impact are low, moderate, or high

Step 7 – Assets and Asset Roles

- **Asset** – an abstract element that indicates the types of elements that can be affected by **Risk**. Asset as applied to Security views is an abstract element that indicates the types of elements that can be considered as a subject for security analysis.
- **Asset Role** – an abstract element that indicates the types of elements that can be affected by **Risk** in the particular context. **Asset Role** as applied to Security views, is an abstract element that indicates the type of elements that can be considered as a subject for security analysis in the particular context.
- **Resource Mitigation** – a set of Resource Performers intended to address against specific **Risk** (Note: these performers are established to manage resource **Risks** which can be represented as an overall strategy or through techniques (mitigation configurations) and procedures (**Security Processes**). They are a type of **Resource Architecture** which is a resource or structured resources that are used to mitigate a risk through satisfaction of a security control.)
- **Security Enclave** – a collection of information systems connected by one or more internal networks under the control of a single authority and security policy. The systems may be structured by physical proximity or by function, independent of location. (Note: a **Security Enclave** is a type of **Resource Mitigation**).

Step 7 - Structure and Behavior

- **Capture Security Structure** – Internal structure of operational assets within the taxonomy are developed with internal features and characteristics, including ***operational roles*** they have, in accordance with Step 3.2. Similarly, internal structure of resource assets within the taxonomy are also developed with internal features and characteristics, including the ***resource roles*** they have.
- **Define Security Behavior** – Process flow diagrams are constructed for all ***security processes*** including ***security process actions*** classified by ***security processes*** and process control-flow mechanisms such as decision nodes and forks. When ***operational*** or ***resource mitigations*** are already known or defined in Step 7.1, they are assigned to swim-lanes and the actions they are capable to perform. Otherwise, ***security process actions*** are grouped into swim-lanes to create ***operational*** or ***resource mitigations*** which must be structured in Step 7.1 – 7.2.

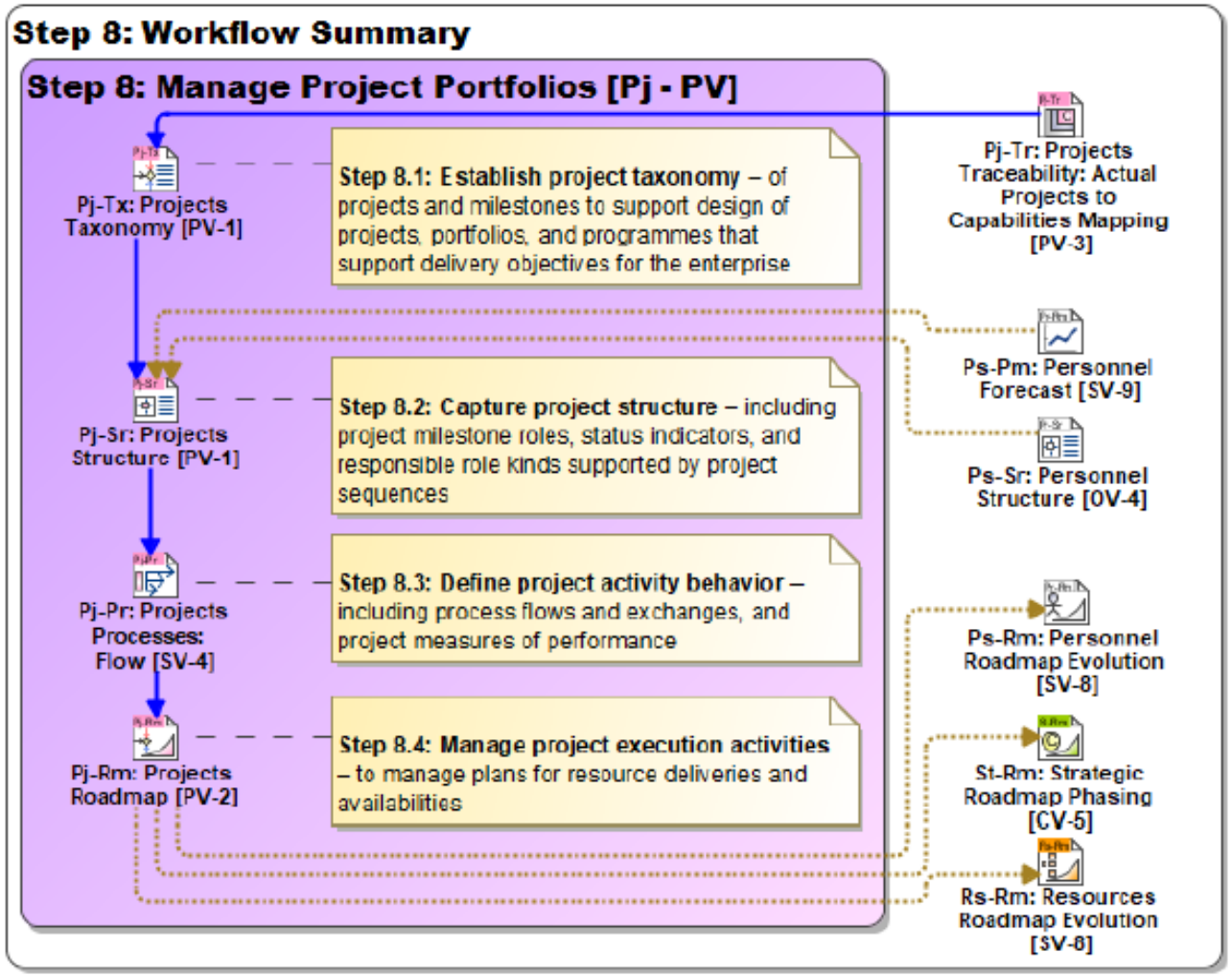
STEP 8 – Projects Portfolio Management

- **Purpose.** The purpose of this step is to describe projects and project milestones, how those projects deliver resources that lead to capabilities, the organizations contributing to the projects and dependencies between projects. Key stakeholders for this step are Project Managers, Project Portfolio Managers and Enterprise Architects. Their concerns are mainly about what are the projects in the project portfolio, what are their project milestones and how are these associated with resources that make up the capability configuration in the capability roadmaps.
- **Conceptual Schema.** The key concepts used in the Projects Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:52. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships

STEP 8 – Projects Portfolio Management

- **Manage Project Portfolios** – The main entry criterion for this Step is bringing forward the planned ***capabilities*** from Step 2 with associated mappings to existing or planned projects. The projects portfolio is developed in parallel with Steps 3 through 7. As ***forecasts***, ***roadmaps***, and ***actual enterprise phases*** are developed, their various use of start and end ***dates***, ***timelines***, and ***actual project milestones*** will affect or be driven by project planning.

STEP 8 – Workflow



STEP 8 – Projects Portfolio Management

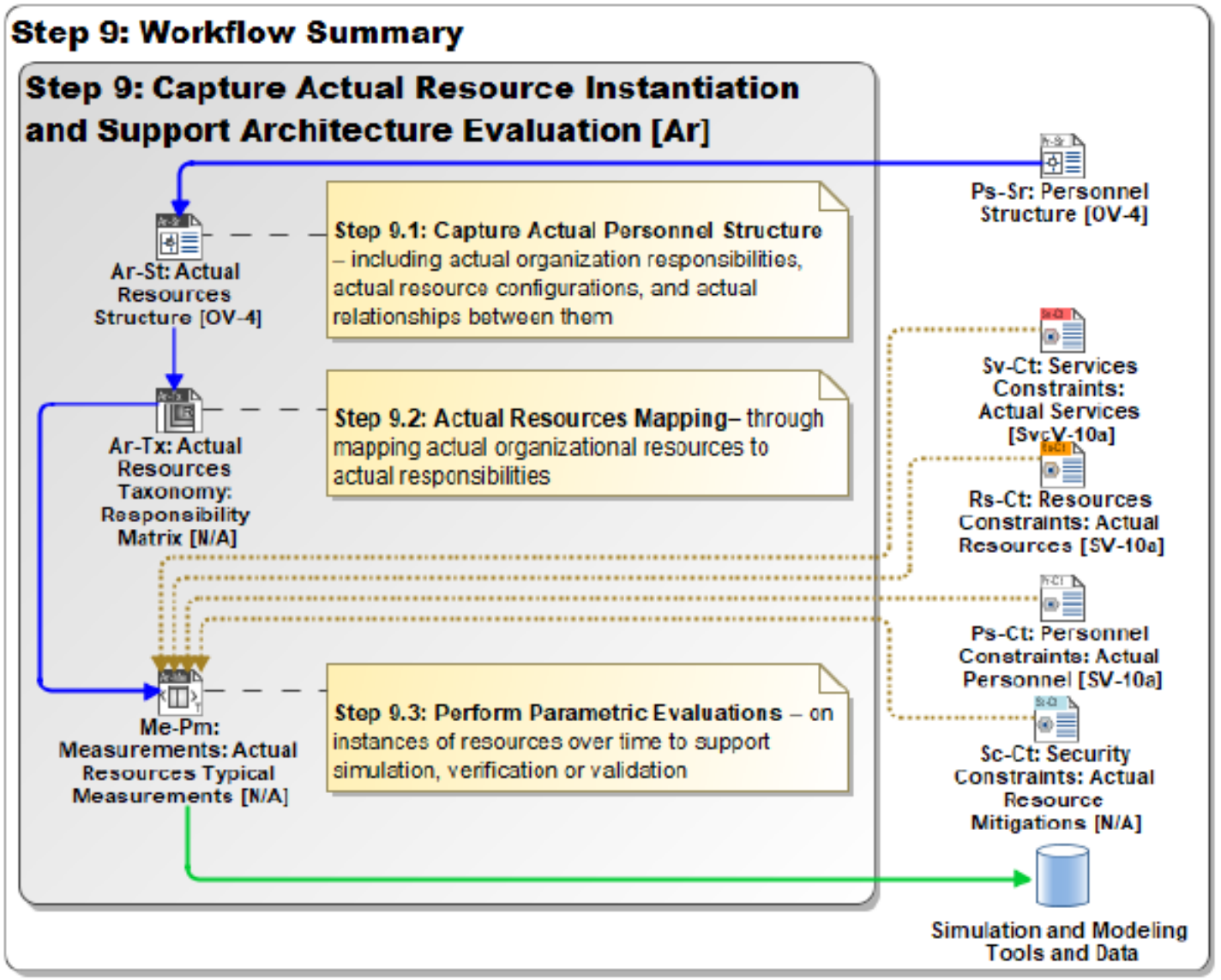
Projects are organized, arranged and grouped into portfolios and programs that will obtain the resources necessary to implement operational activities and provide capabilities. These projects along with their associated exchanges and functions will form alternatives that are compared in trade-offs to support procurement and acquisition decisions.

- Project – a type that describes types of time-limited endeavors that are required to meet one or more Capability needs (Note: these typically represent a planned endeavor executed by an Actual Organization responsible for actions and progress in accordance with Actual Project Milestones)
- ISO 8601 Date Time – a date and time specified in the ISO8601 date-time format including time zone designator (TZD): YYYY-MM-DDThh:mm:ssTZD (Note: it is useful to display elements with date times in a timeline format, as well as organize date times by Projects)
- Actual Project Milestone – an event with a start date in an Actual Project from which progress is measured

STEP 9 – Actual Resources Realization

- **Purpose.** The purpose of this step is to illustrate the expected or achieved actual resource configurations and actual relationships between them. This step also entails the identification of technical, operational, and business standards applicable to the architecture and defining the underlying current and expected standards. Key stakeholders for this step are Solution Providers, Systems Engineers, Business Architects and Human Resources. Their concerns are mainly about the analysis of different alternatives, what-if scenarios, architectural tradeoffs, and the verification and validation of the actual resource configurations. They also have concerns regarding the technical and non-technical standards applicable to the architecture.
- **Conceptual Schema.** The key concepts used in the Actual Resources Viewpoint that can be used as model elements in the architecture views and the relationships between these concepts are illustrated in the conceptual schema shown in Figure 4:58. These ***key concepts*** are highlighted in italics within the Narrative and some of the less obvious concepts are listed with the associated UAF meaning of that concept. Detailed definition of the entities and relationships shown in the conceptual schema are provided in the UAFML specification document.

STEP 9 – Workflow



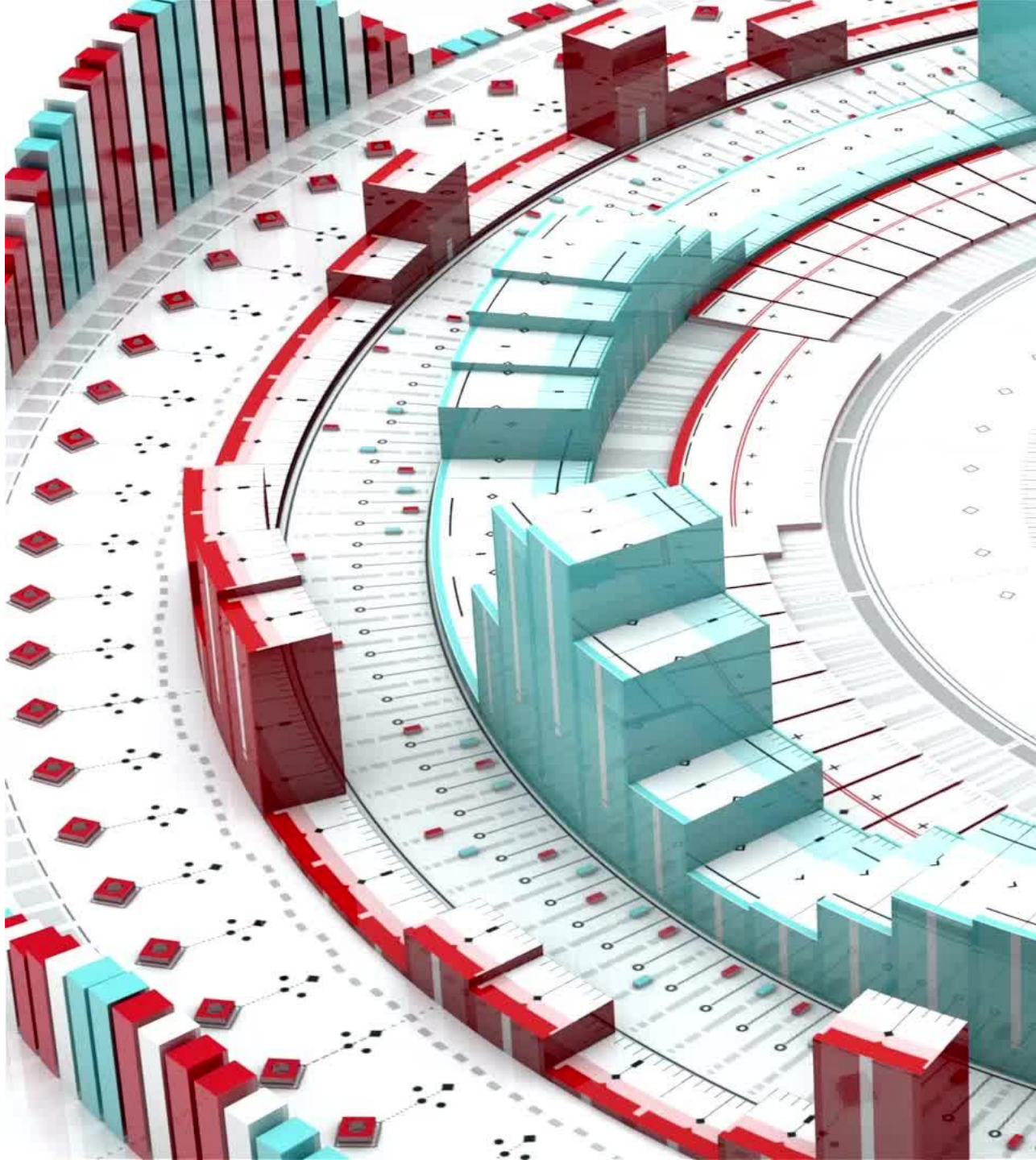
UAF Recommendations

Recommendation 1: Use the architecture model as the overarching model to maintain traceability from system design to cyber resiliency analytical models. Modeling security risks, mitigations, and SCs within the architecture model and relating those elements to other architecture model elements such as requirements and system design, enables a visualization of the essential cyber resiliency components. Visually modeling security risks, mitigations, and SCs within the architecture model moves the record of authority from documents to enable model based traceability and analysis of the models.

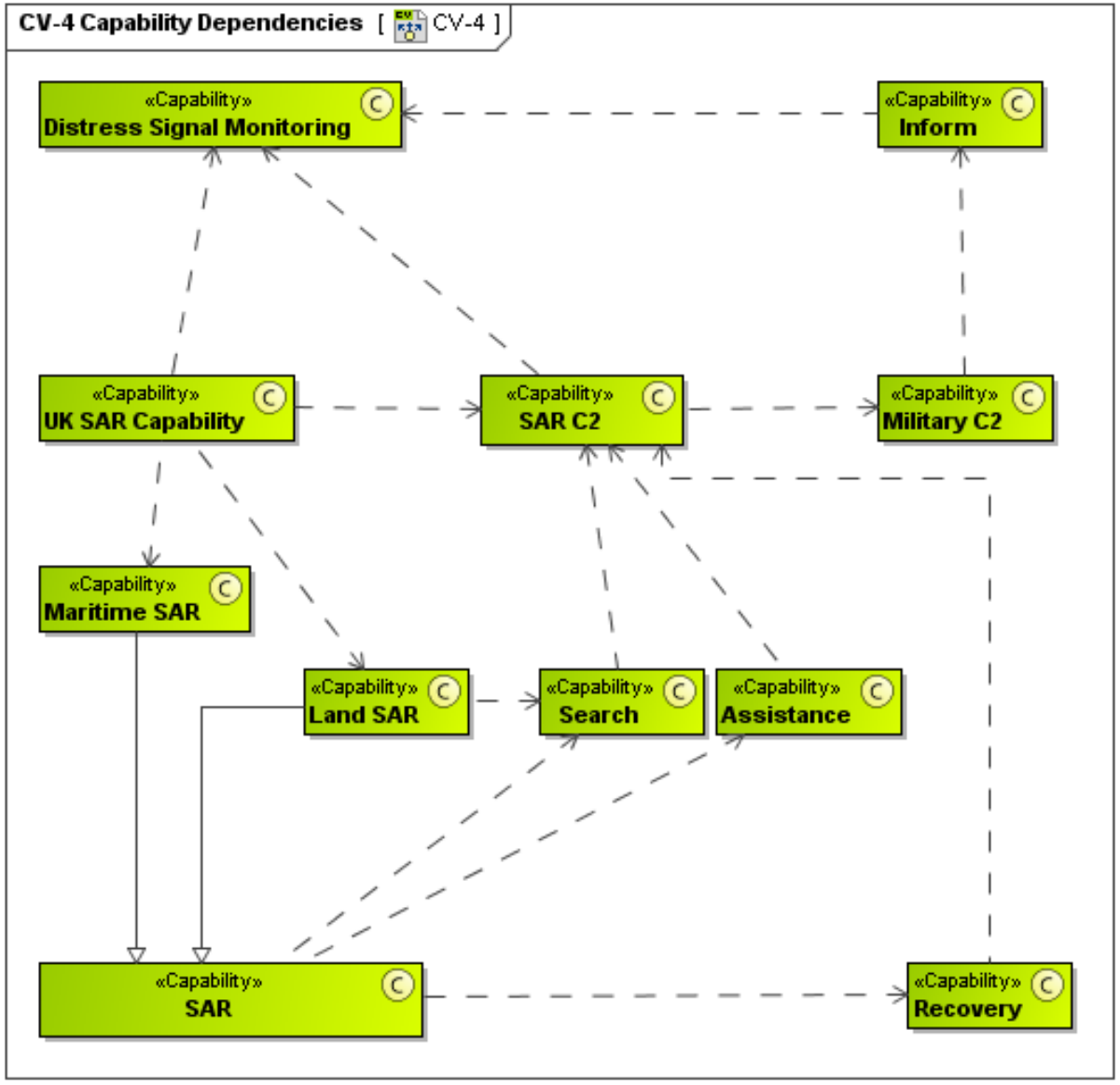
Recommendation 2: Conduct rigorous cyber resiliency analysis using cyber analysis tools. One such tool referenced in this paper is MITRE's TRACE.

Recommendation 3: The architect is responsible for providing the overarching model. The need for additional analytical models may be identified by the architecture team in collaboration with the teams working on various areas of specialization (e.g., cyber security community who gather daily logs). The architect is also responsible for validating that the downstream analytical analyses are interpreting the model as intended. There are cases where the architect has used a certain modeling convention and then the analyst assumed it meant something else. A feedback loop and continuous communication regarding the responsibility for interpretability of the model over its lifecycle goes hand-in-hand with the responsibility for generating the model.

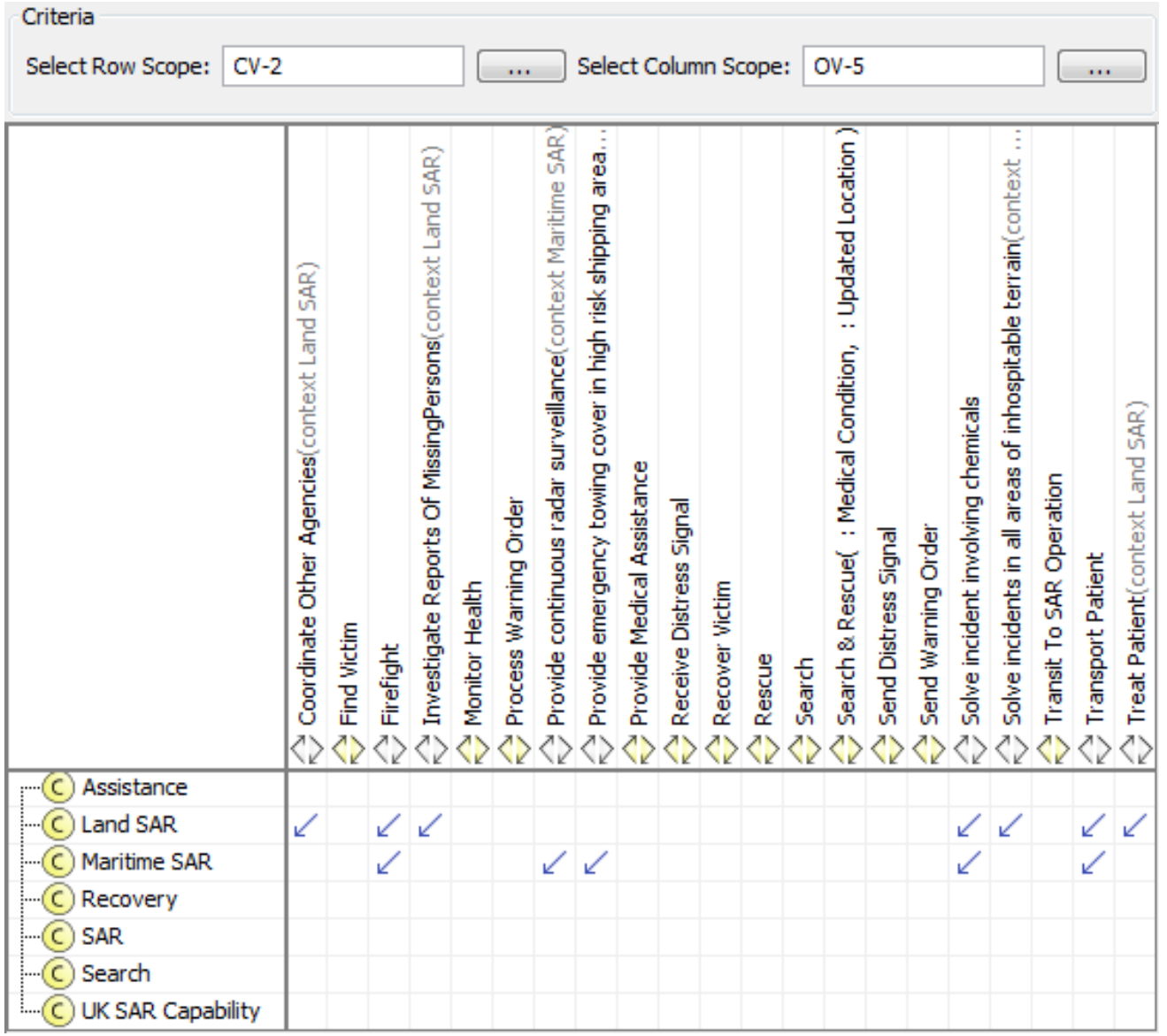
Recommendation 4: The need to maintain traceability to the architecture and to validate that the various teams are working towards a consistent architecture model is the responsibility of the program manager in collaboration with the architecture team. The program manager's leadership can ensure that the architecture team and the cyber security team coordinate and maintain traceability across their models with a feedback loop across models (architectural and analytical).,Empowered by the program manager's support, the architecture team ensures that the cyber resiliency analysis findings trace back to desired capabilities, and that the system design documents security risk mitigations.



CV-4 Capability Dependencies



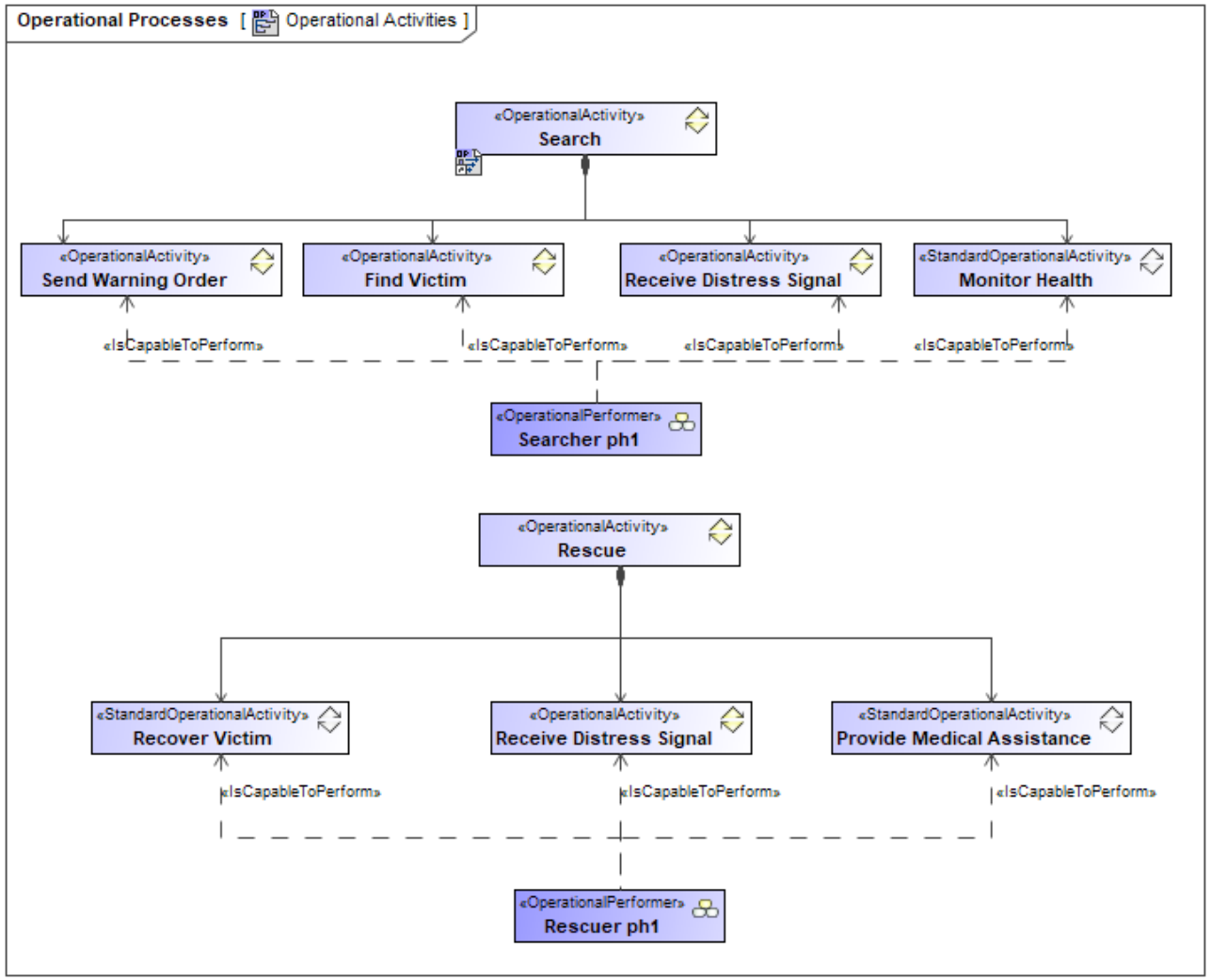
CV-6 Capability to Operational Activities Mapping



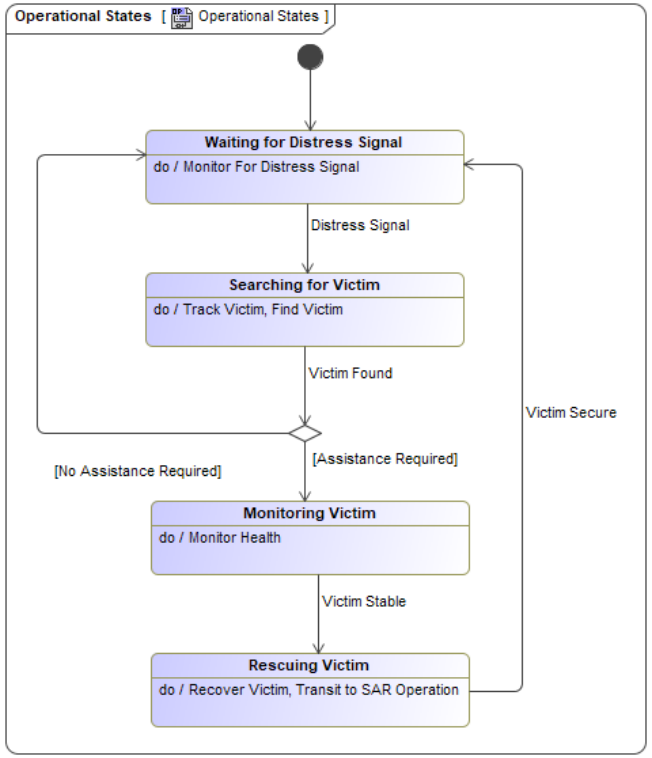
Operational Constraints Op-CT

#	Applies To	Rule Specification	Rule Kind
1	Send Distress Signal	The maximum range for distress signals shall be posted on all ports and marinas	Constraint
2	Search	Search personnel shall operate on a shift system to ensure they can perform to maximum efficiency	Constraint
3	Monitor For Distress Signal	Distress signals shall be monitored 24/7	Constraint

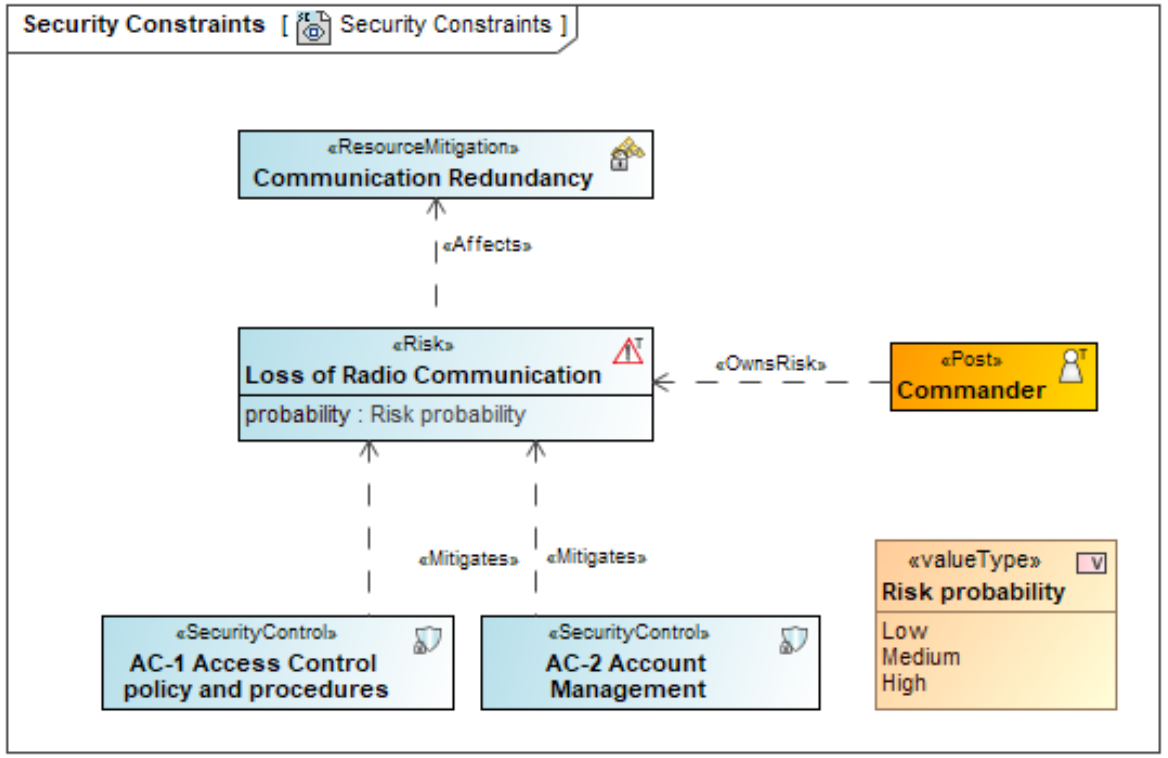
Operational Processes Op-Pr



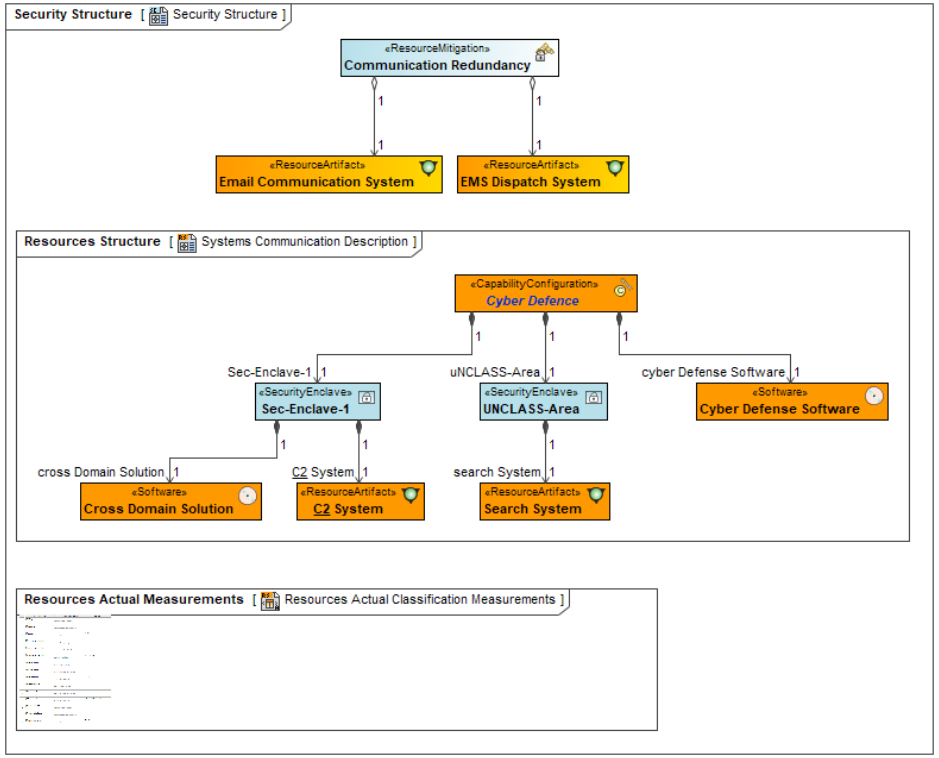
Operational States Op-St



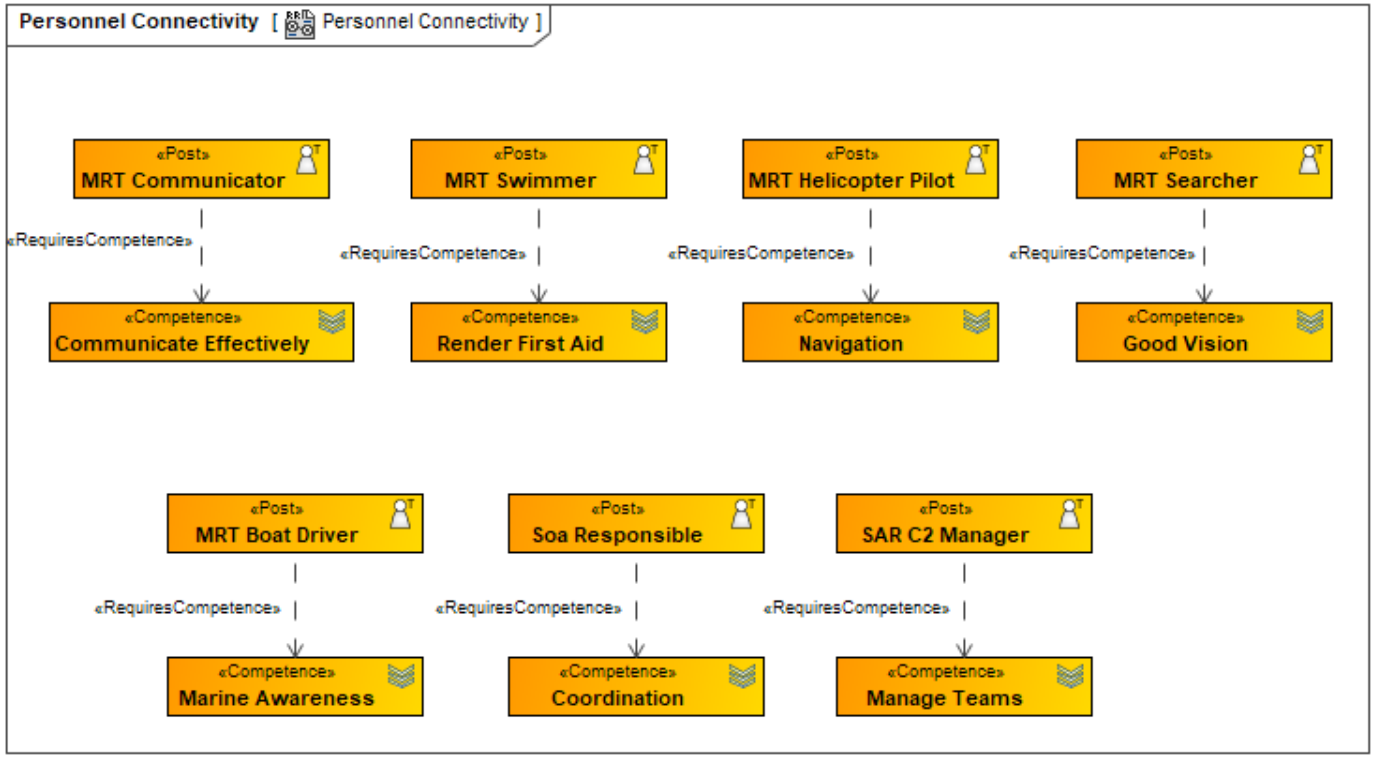
Security Constraints Sc-CT



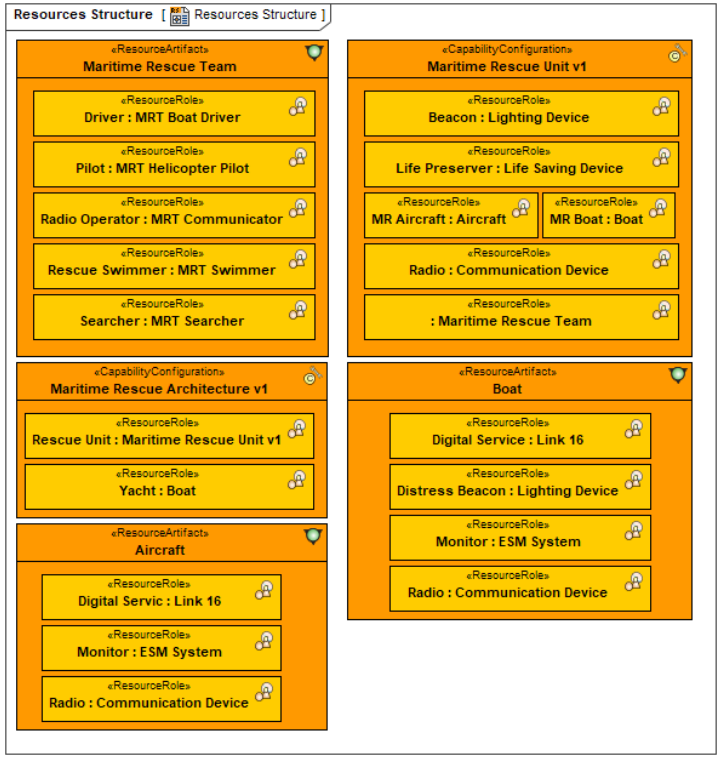
Security Structure Sc-Sr



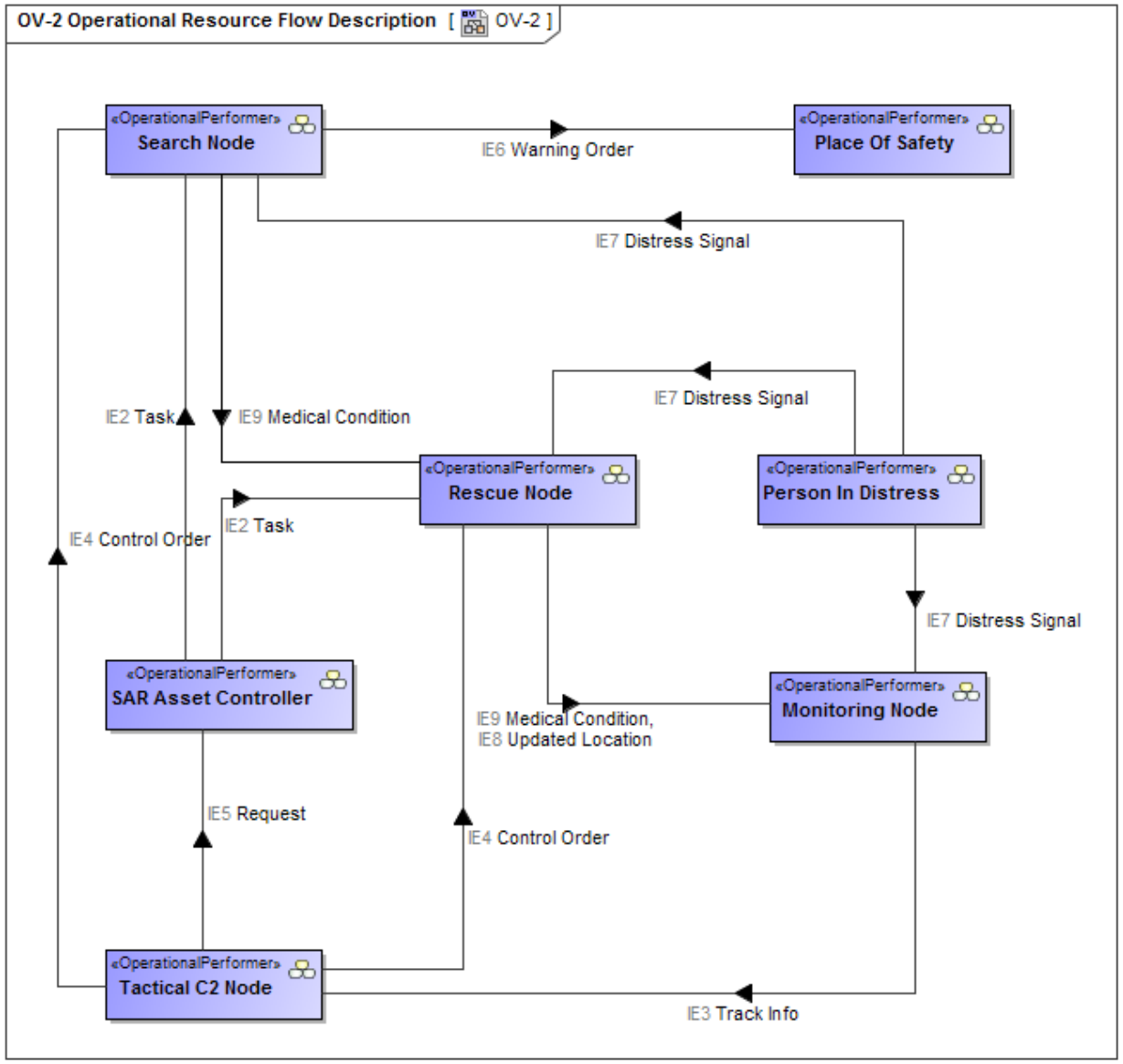
Personnel Connectivity Pr-Cn



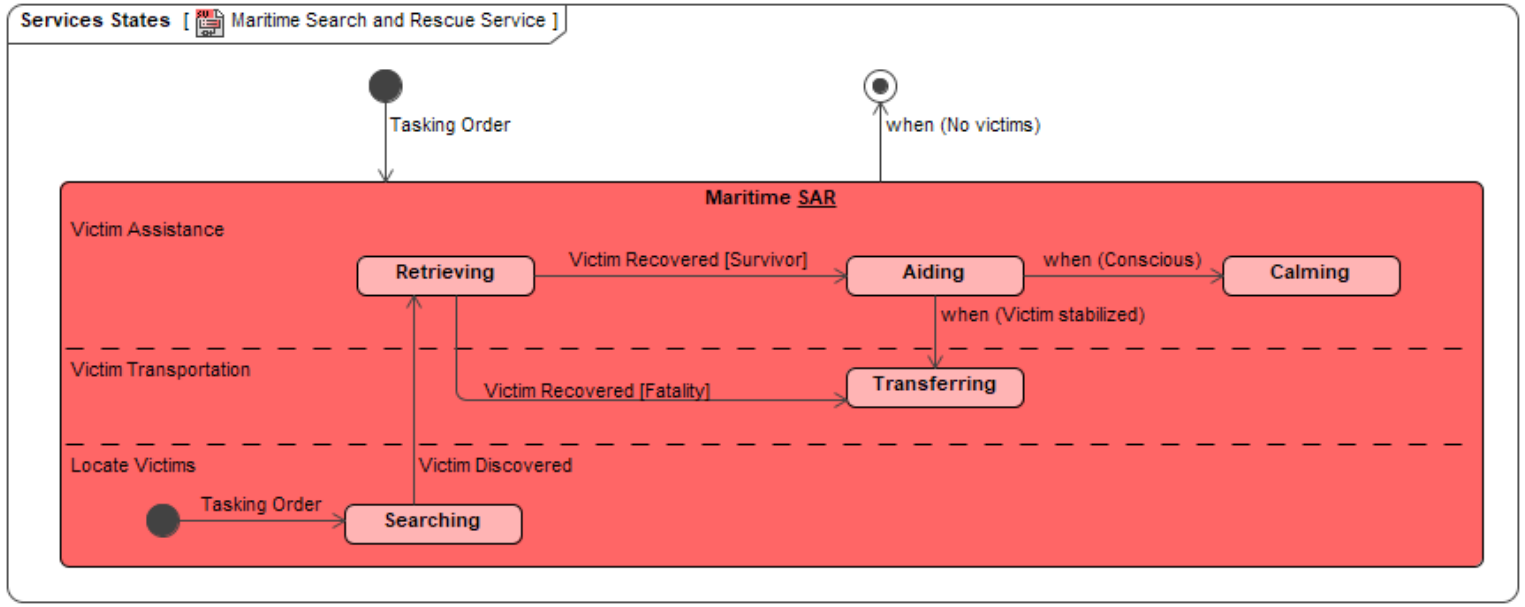
Resource Structure RS-Sr



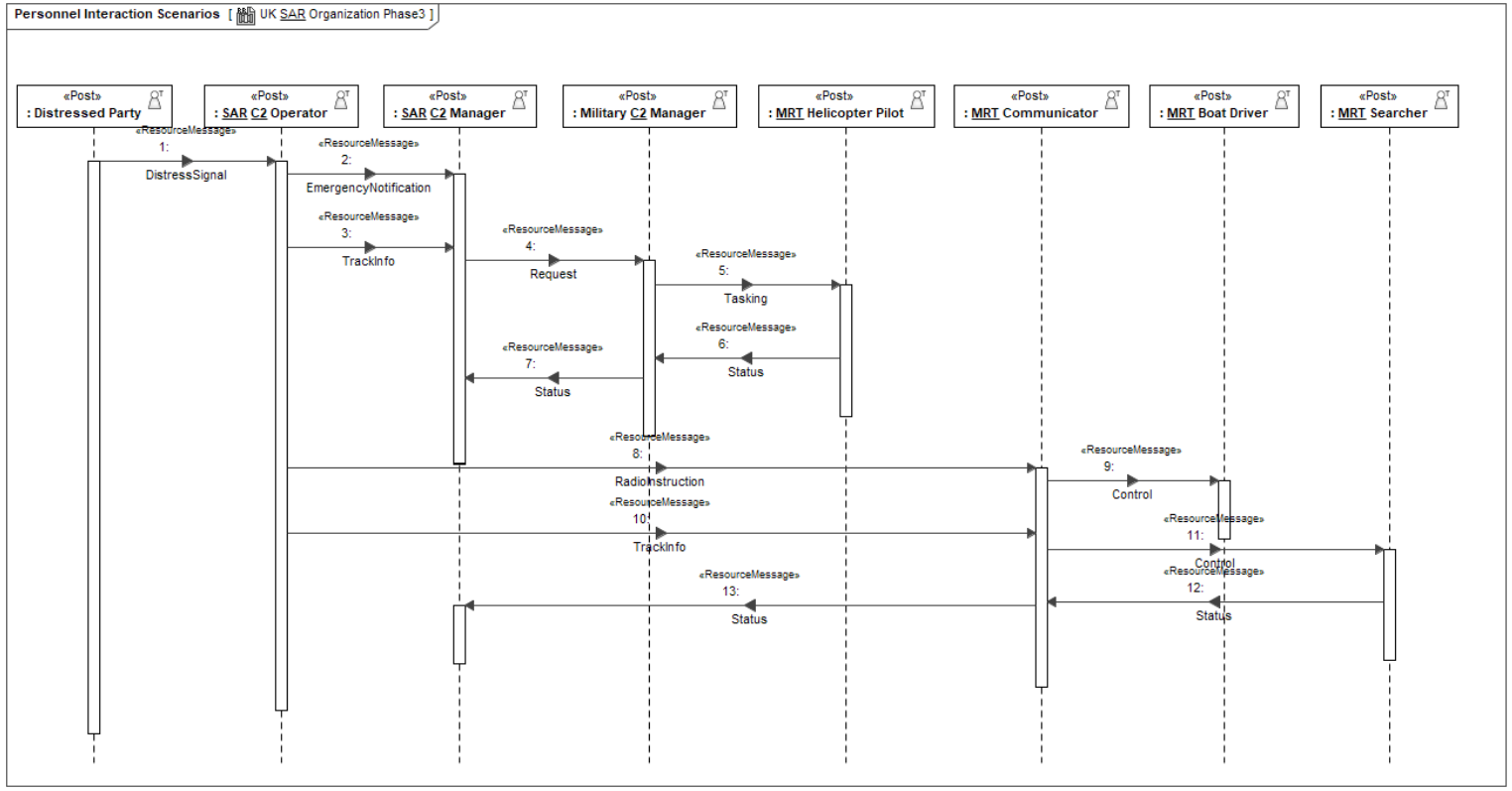
OV-2 Operational Resource Flow Description



Services State Sv-St



Personnel Interaction Scenarios Pr-Is



UAF Elements

- Achiever: An Actual Resource, Actual Project or Actual Enterprise Phase that can deliver a Desired Effect.
- Activity: An abstract element that represents a behavior or process (i.e. a Function or Operational Activity) that can be performed by a Performer
- Activity Performable Under Condition: The environment under which an Activity is performed.
- Capability: A high level specification of the enterprise's ability to execute a specified course of action.
- Operational Performer: Operational Performer denote a logical entity that Is Capable To Perform Operational Activities which produce, consume and process resources.