The MODAF System Viewpoint

Viewpoint Summary

The System Viewpoint provides a perspective that describes the resources (see section below) that realise capability and/or implement services. It can also be thought of as a Solution or Specification Viewpoint as it specifies a requirement for a system or presents a solution without delving too deep into the design elements of the system.

The System Viewpoint consists of 17 System Views (SVs) that describe resource functions, interactions between resources, and system interfaces. In addition, SVs depict the involvement of humans in the operation of systems, and as resources that carry out functions.

One of the primary uses of the SVs is in the development of system requirements that satisfy user requirements; i.e. the SVs can be used to specify solutions to requirements identified in the Operational Views (OVs). They can alternatively be used to provide more detail to the logical architecture depicted by the OVs.

Introduction to Resources in MODAF

Since version 1.1 of MODAF, the SVs have included aspects of human factors – i.e. the views are not limited to just depicting technical systems. In this sense, the SVs depict "Systems" in the broadest sense of that term.

The SVs are primarily concerned with the MODAF Meta Model (M3) concept of *Resource* and *Functions* that resource performs. Resources may be one of:

- Artefact – a physical resource that is man-made or manufactured.
- Software – executable computer code or a fragment thereof.
- Organisational Resource – a human resource, which may be one of:
    - Organisation Type – a type of organisation, where organisation is defined to be any group of people brought together for a purpose.
    - Post Type – a type of responsible office within an organisation which may be occupied by a person or another organisation.
    - Role Type – a type of role a human resource may have in an organisation or function.
- Physical Architecture – a composite of any of the above resources that forms a re-usable architecture. This may also be:
    - Capability Configuration – a composite of resources that, with the appropriate doctrine, can deliver a capability.
    - Service Implementation – a composite of resources that can deliver a Service.

These resources can be assembled, and re-used from architecture to architecture. When one resource is part of another, MODAF requires that the architect specifies the context in which it is a part:

- Artefacts may be *parts* or *systems* in another Artefact.
- Artefacts may be *platforms*, *systems,* or simply *physical assets* (i.e. serving no function) in a Physical Architecture.
- Software may be *hosted software* on an Artefact, or a *software component* in other Software.
- Physical Architectures may be *used configurations* in other Physical Architectures.
- Organisational Resources may be *human resources* in a Physical Architecture.
- Organisation Types may be *sub-organisations* in other Organisation Types.
- Post Types may be *posts* in Organisation Types.

- Role Types may be *roles* in Post Types.

Views

There are seventeen views, including sub-views, which make up the System Viewpoint:

SV-1 – Resource Interaction Specification

An SV-1 specifies the composition and interaction of resources[1].

Background

The SV-1 links together the operational and systems architecture views by depicting how resources are structured and how they interact in order to realise the logical architecture specified in an OV-2, Operational Node Relationship Description. An SV-1 may represent the realisation of a requirement specified in an OV-2 (i.e. in a to-be architecture) and, consequently, there may be many alternative SV suites that provide candidate solutions that realise the operational requirement.

The SV-1 depicts interactions between resources. A resource interaction is a simplified representation of a pathway or network, usually depicted graphically as a connector (i.e. a line that can be labelled with supporting information). Note that interactions between systems (Artefacts used as systems) may be further specified in detail in the SV-2, Systems Communications Description series, and SV-6, Systems Data Exchange Matrix.

Resources may be decomposed in SV-1 to any level (i.e. depth) that the architect sees fit. When one resource is part of another, the architect must specify the context in which the part is used.

Usage

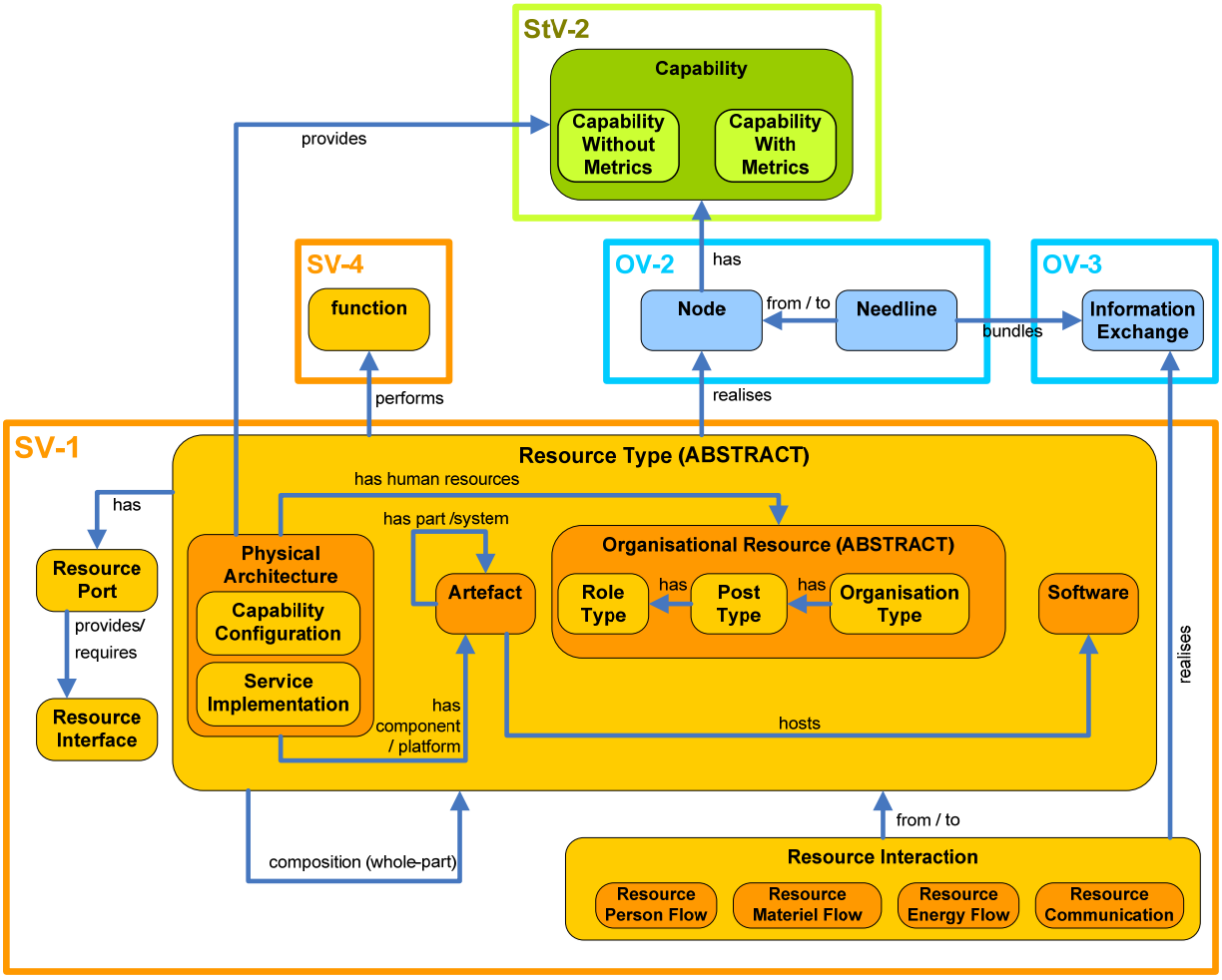
- Solution specification.
- Definition of solution options.
- System Requirements specification.
- Interface requirements capture.
- Capability integration planning.
- System integration management.
- Operational planning (capability configuration definition).

Data objects

The data in an SV-1 can include:

- Artefact.
- Organisational Resource (Organisation Type, Post Type, Role Type).
- Software.
- Physical Architecture (Capability Configuration, System Implementation).
- Resource Composition.
- Resource Interaction (flows of data, materiel, human resources or energy).
- Traceability to Nodes (OV-2) and Capabilities (StV-2)

[1] See Introduction to Resources in MODAF on page 1



Relationships between Key Data Objects (Simplified from M3)

Representation

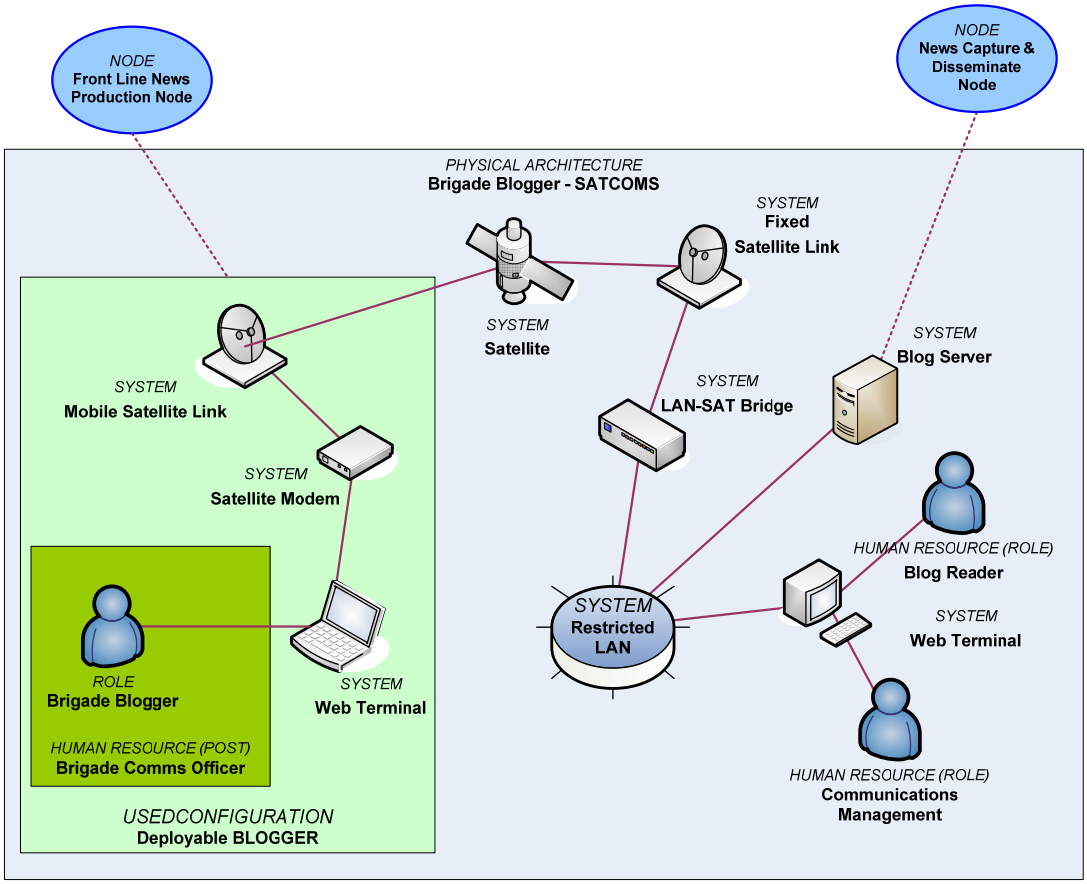
- Topological (connected shapes).
- UML composite structure diagram.
- SysML blocks diagram.

Detailed Product Description

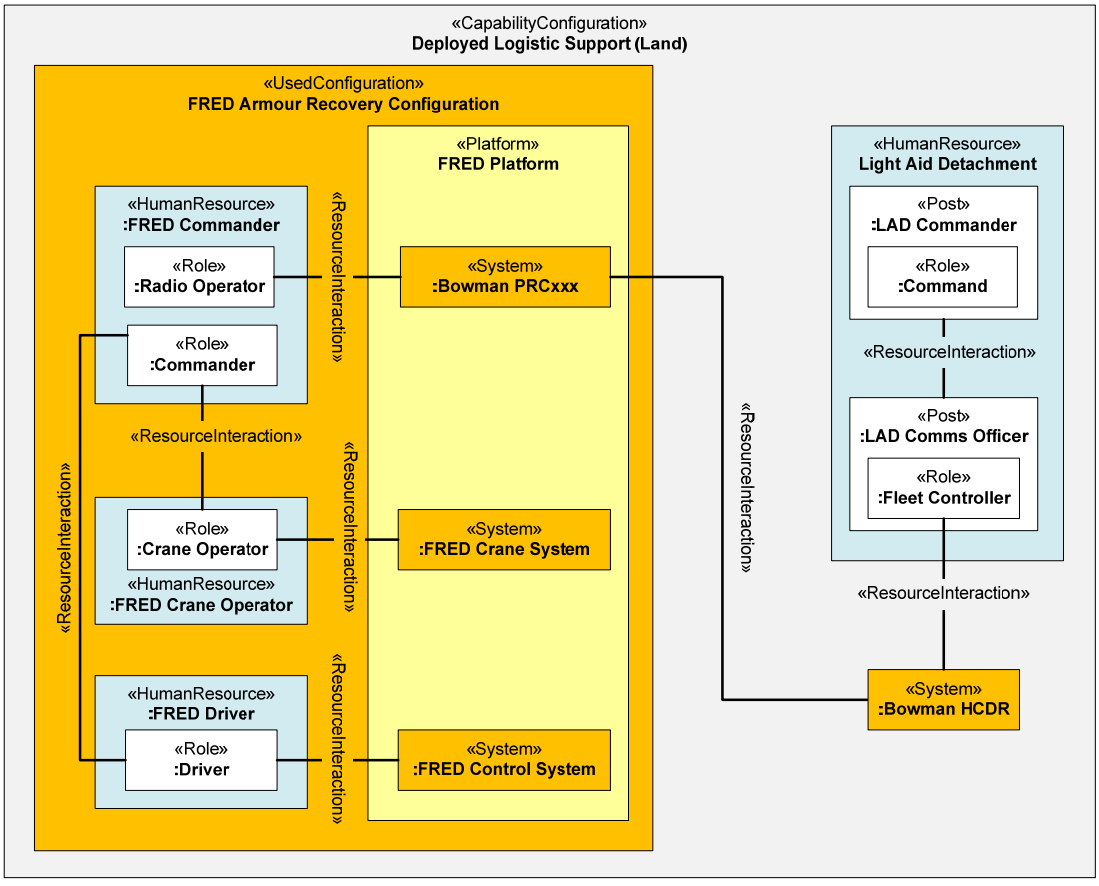
The primary purpose of an SV-1 is to show resource structure; i.e. to identify the primary sub-systems, posts and roles and their interactions. SV-1 contributes to user understanding of the structural characteristics of the capability. Resource structures may be identified in SV-1 to any level (i.e. depth) of decomposition the architect sees fit. An SV-1 may be adorned with nodes originally specified in OV-2. In this way, traceability can be established from the logical OV structure to the physical SV structure.

In its simplest form, an SV-1 can be used to depict systems and sub-systems, and identify the interfaces between them; however, this rarely adds more to that which can be shown in an SV-2, product. The real benefit of an SV-1 is its ability to show the human aspects of an individual architecture, and how these interact with systems. In addition, MODAF has the concept of a ‘capability configuration’ which is used to gather together systems, assets and people into a configuration which can meet a specific capability.

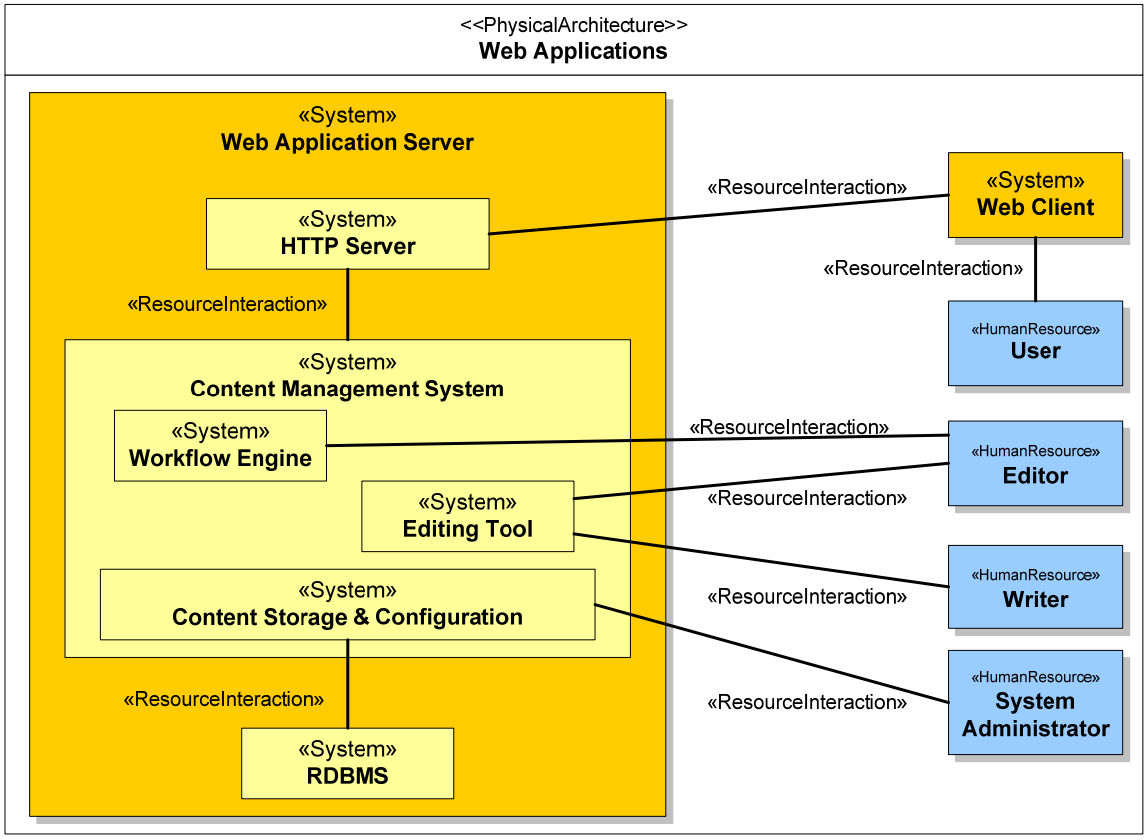
If possible, an SV-1 will show resources and their interactions for the entire architecture on the same diagram. If a single SV-1 is not possible, the structure should be decomposed into multiple SV-1s.



SV-1 Example with elements traced back to logical nodes



SV-1 Example Showing Capability Configuration



SV-1 Example (UML Composite Structure Model)

Functions

MODAF adopts a simplified model where any resource may perform functions. SV-1 and SV-4, Functionality Description, provide complementary representations (structure and function). The functions from an SV-4 can optionally be overlaid on an SV-1.

Interactions in SV-1

In addition to depicting resources and their structure, SV-1 addresses interaction relationships between resources. An interaction, as depicted in SV-1, is an indicator that data passes between one resource and another. In the case of systems, this can be described in further detail in an SV-2b, System to System Port Connectivity Description. Interactions provide a specification for how the exchanges specified in OV-2 needlines are realised. A single needline shown in the OV-2 may translate into multiple interactions.

The actual implementation of an interaction may take more than one form (e.g. multiple physical links). Details of the physical links and communications networks that implement the interfaces are documented in SV-2. Resource Interactions are summarised in an SV-3, Resource Interaction Matrix. If SV-1 is developed as a composite structure model (e.g. in SysML, UML), Resource Ports may be used to convey how interactions are dealt with internal to the resource when the resource has parts. Resource Ports may also specify the interfaces they require or provide. Note that when connecting resources via interfaces and ports, the architecture is tight-coupled. For loose-coupled architectures, a service-oriented approach should be taken (see Service Oriented Views and SV-12, Service Provision and Service Composition).

Interactions between resources need not be restricted to communication of data. An SV-1 may also show interactions where materiel, human resources or energy flow from one resource to another.

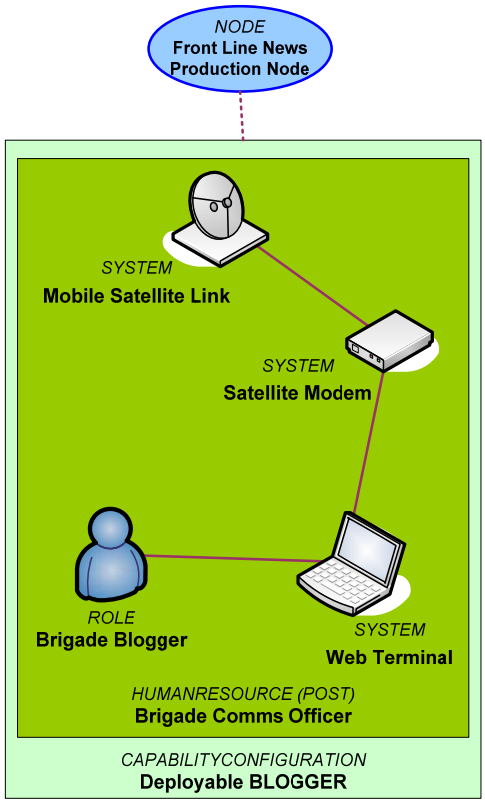
SV-1 in Solution Architecture

A key feature in MODAF is the ability to represent configurations of resources that, when put together with the appropriate functions (e.g. doctrine), provide one or more capability. These are known as 'capability configurations'. A capability configuration is a combination of organisational resources (with their competencies) and equipment (artefacts and software) that combine to provide a capability.

Capability configurations fulfil the operational capability needs and are usually defined to fulfil the requirements associated with nodes (see OV-2). [For more detail, please refer to "MODAF Support to Systems Requirement Definition"[2]].

The example to the right illustrates the relationship between capability configuration and nodes.

Use of capability configurations allows architects to include all of the Defence Lines of Development (DLOD) rather than just systems and platforms. [For more information on this, please refer to the document "MODAF Support to Analysis of Capability Integration in the Context of the Defence Lines of Development" [3].]



Capability Configuration Tracing to OV-2 Node

Fielded Capability

A 'fielded capability' is a particular instance of a capability configuration. For example, a capability configuration may be a Type 45 destroyer configured for an anti-air role, of which HMS Daring will be a fielded capability. Fielded capabilities should be used only when a specific instance of a Capability Configuration is required.

[2] http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/InformationManagement/MODAF/UseAndExamplesOfModaf.htm

[3] http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/InformationManagement/MODAF/UseAndExamplesOfModaf.htm

An Introduction to SV-2a, SV-2b and SV-2c v1.2

The SV-2 Systems Communications Description is comprised of a set of 3 views that can provide representation of the communications networks and pathways that link communications systems[4], and provides details regarding their configuration.

The networks and pathways documented through these views represent the physical implementation of the SV-1, Resource Interaction Specification, and the information needlines identified in an OV-2, Operational Node Relationship Description.

The SV-2 view comprises of three views which define the communications links between systems:

- SV-2a System Port Specification – defines the ports on each system, and the communication protocol / hardware stack that is specified or implemented for each of those ports.
- SV-2b System to System Port Connectivity – defines the connections between individual ports and shows the communication protocols and hardware spec used for each connection.
- SV-2c System Connectivity Clusters – defines the bundles of system to system connections that go to make up a connection between the Artefacts that host the connected systems (see SV-1).

The purpose of these views is to provide a comprehensive specification of how systems are connected, what interfaces each system exposes (ports), the hardware interface used and the protocols transmitted across the interface. Key elements are repeated from view to view and are also common to the SV-1. These key elements are:

- Artefacts (used as Systems and Platforms).
- Ports.
- Protocols.
- System Port connections.

SV-2 differs from SV-1 in that it only features Physical Architectures, Software and Artefacts (as systems) – i.e. SV-2 does not feature any organisational resources. SV-2 also provides a great deal more technical detail than SV-1, specifying the protocols implemented by systems and used by the connections between those systems.

It is important to understand the differences between SV-1 and SV-2 to ensure that the correct detail is captured in each view. In essence, the SV-2 expands on the SV-1 by providing more detail of the physical characteristics of interactions between systems. For example, the SV-1 interaction perspective shows a single-line representation of interfaces between nodes, whereas the SV-2 would show a more detailed representation of the communications infrastructure that provides the connections.

[4] Formally, in M3, these are Artefacts that are being used as systems in the context of a given Physical Architecture

SV-2a System Port Specification v1.2

An SV-2a specifies the ports provided by a system, and the protocols used by those ports when communicating with other systems.

Background

An SV-2a provides a specification for each system port that is modelled in the architecture.

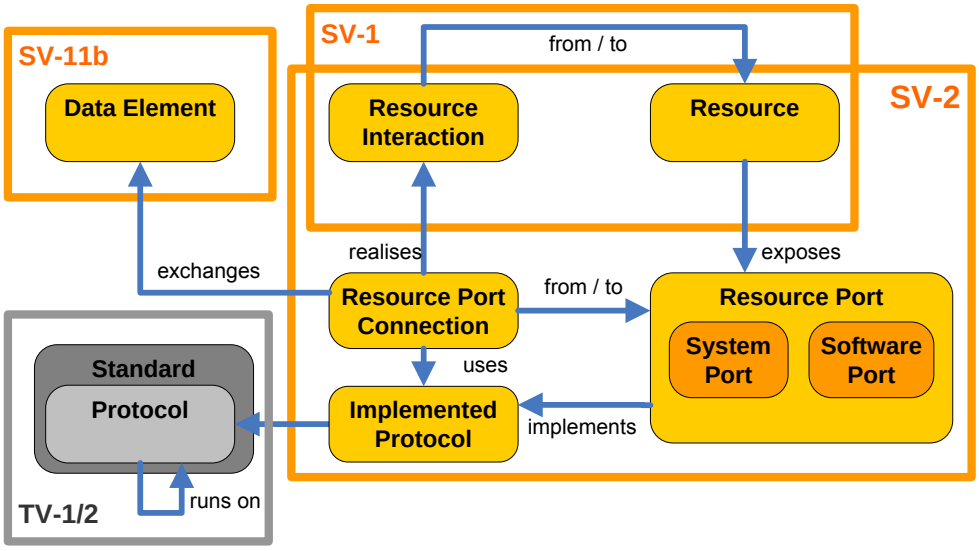
Usage

- Interface specification.
- Identification of applicable protocols.
- Description of system communication paths.

Data objects

The data in an SV-2a can include:

- System.
- System port.
- Protocol.



Relationships between Key Data Objects (Simplified from M3)

Representation

- Topological (connected shapes).
- UML composite structure diagram.
- SysML structural diagram.

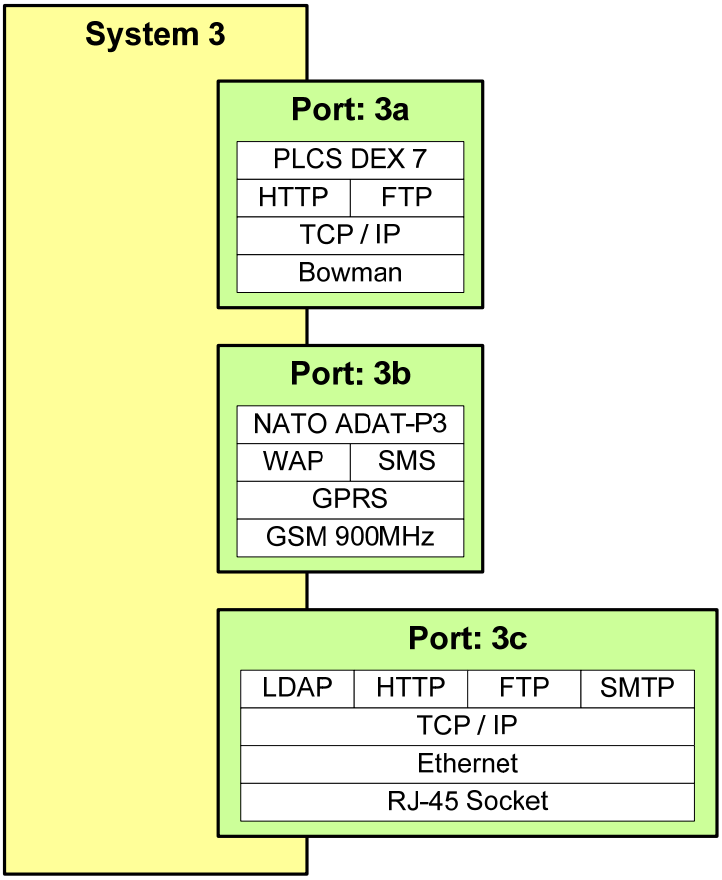
Detailed Product Description

An SV-2a is used to describe the interface protocols and hardware specifications of each port on a system. The view comprises of one diagram for each system in the architecture. Each port on the system is specified in terms of:

- Its name.
- The interface protocols used (e.g. OSI Stack).
- The physical port specification (e.g. the physical element of the stack).

In many cases, a physical port may support more than one protocol in parallel (e.g. a TCP/IP network supporting http, ftp, telnet, etc.). All supported protocols relevant to the architecture shall be shown through the SV-2a for the various systems.

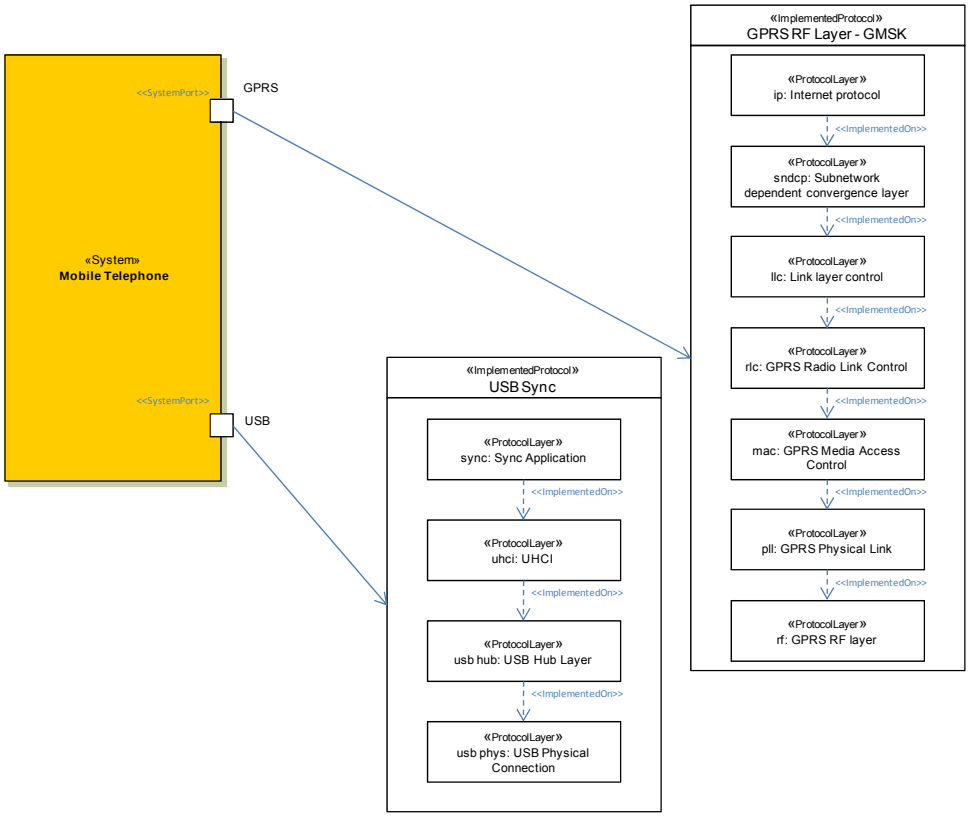
The figure below shows an example port specification port 3a uses a physical port to support HTTP and FTP over TCP/IP.



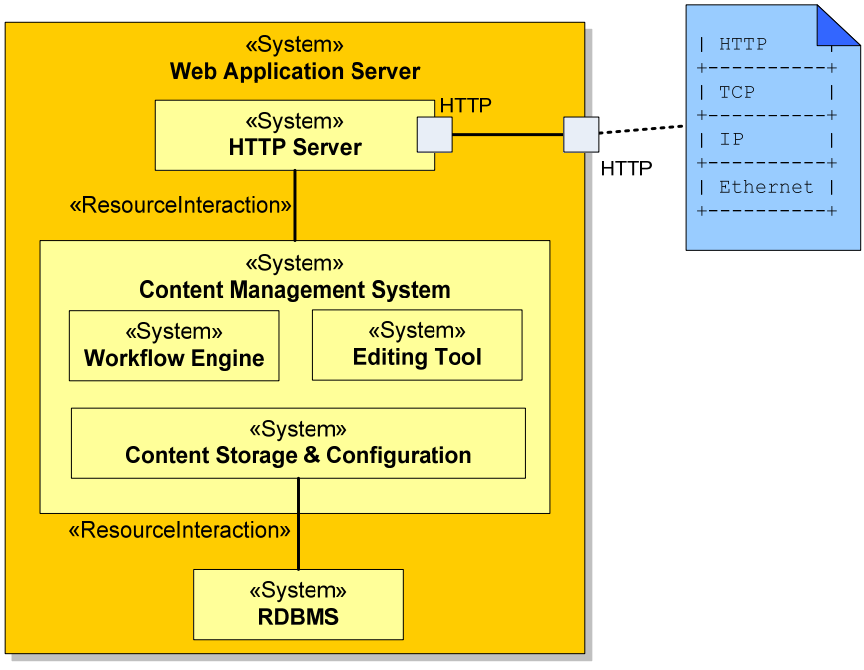
Non-UML Example Showing Alternative Protocols at Different Levels in the Stack

If a port supports a particular data protocol that is in it's self supported by a physical data model (from SV-11, Physical Schema), then this will also be specified. In the above figure, Port 3a supports the PLCS DEX 7 XML Schema definition for in-service feedback.

Any protocol referred to in an SV-2a diagram must be listed and defined in the TV-1 Technical Standards View.



Example SV-2a in UML – Mobile Phone



Example SV-2a in UML Using Simplified Stack Notation

SV-2b - System Port Connectivity Description

An SV-2b specifies the communications links between systems and may also list the protocol stacks used in connections.

Background

An SV-2b is used to give a precise specification of a connection between systems.

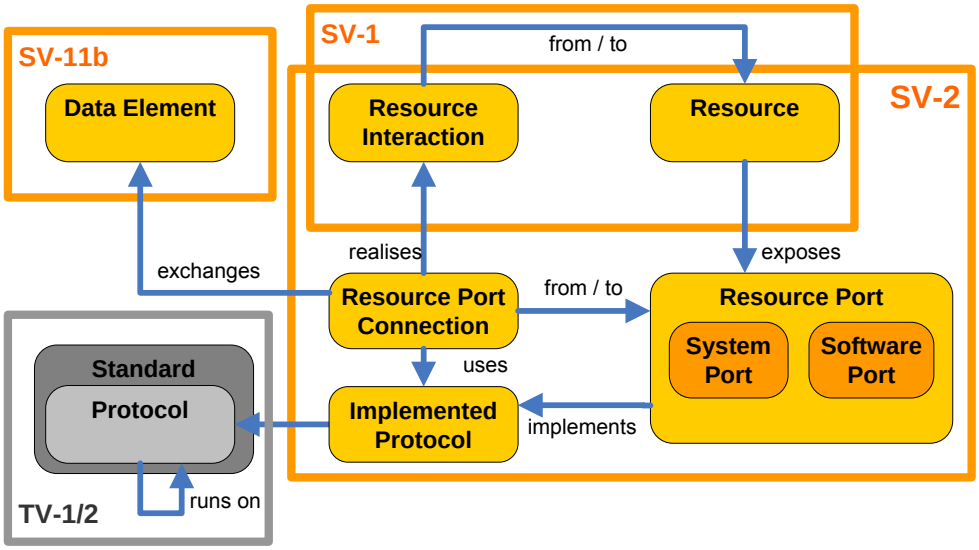
Usage

- Interface specification.

Data objects

The data in an SV-2b can include:

- System.
- System and software ports.
- Port connection.
- Protocol.



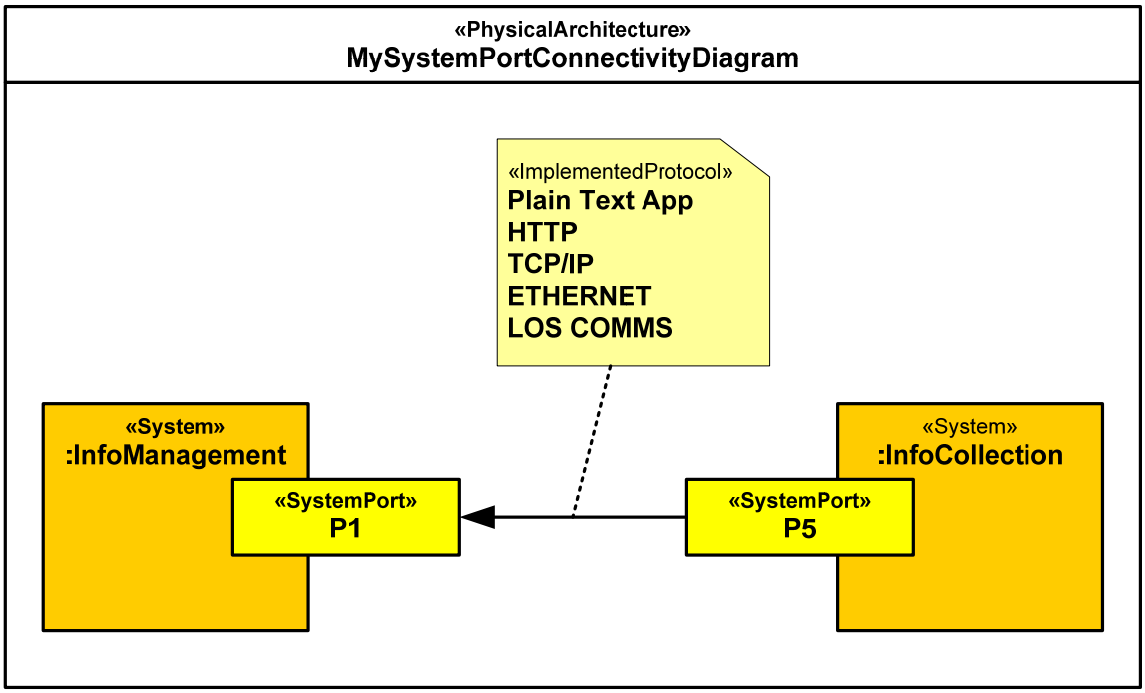
Relationships between Key Data Objects (Simplified from M3)

Representation

- Topological (connected shapes).
- UML composite structure diagram.
- SysML block diagram.

Detailed Product Description

An SV-2b is comprised of systems, their communications ports and the connections between those ports. The architect may choose to create a diagram for each pair of connected systems in the architecture or to show all the connections on one diagram if this is possible.

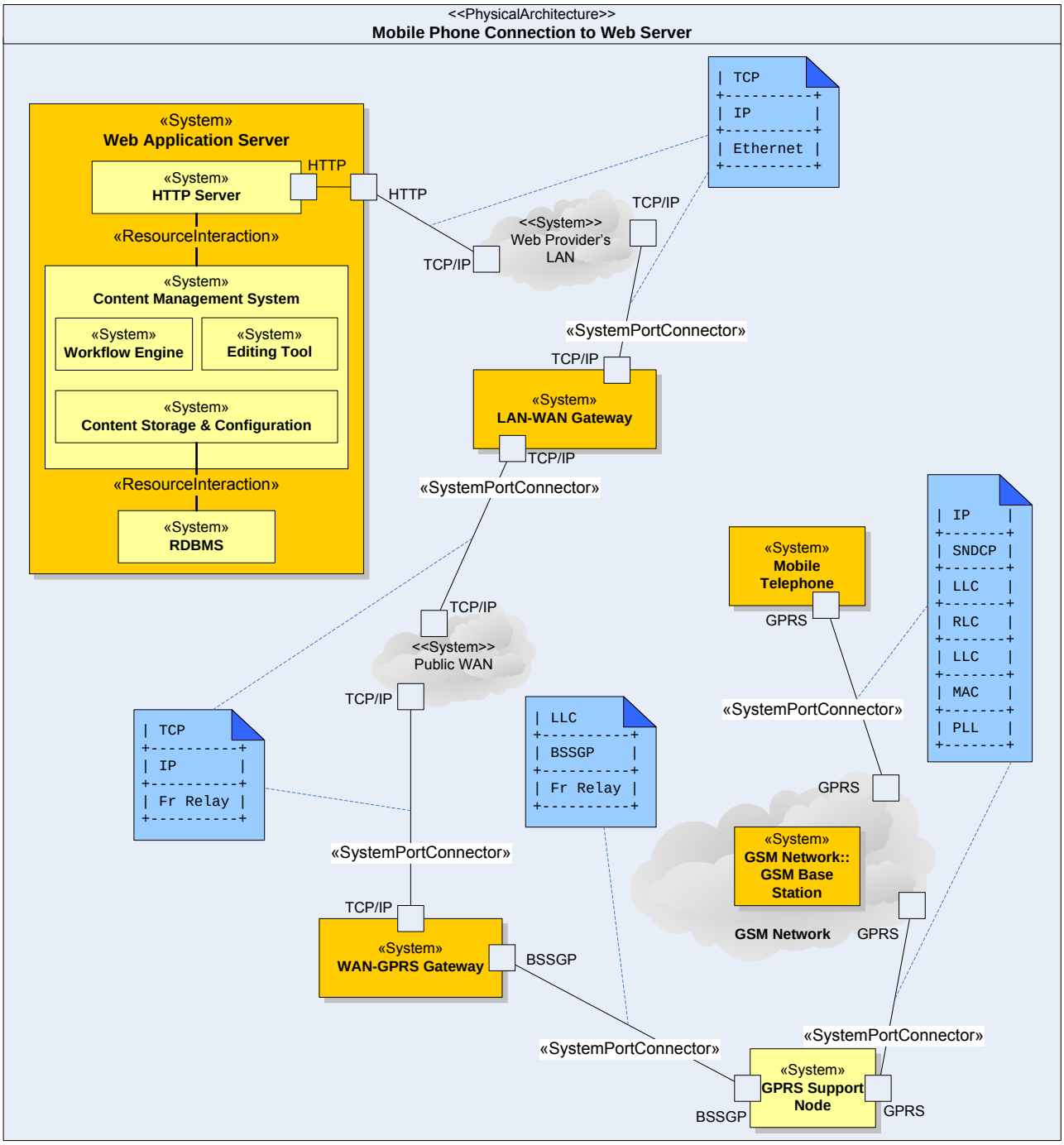


Simple SV-2b Example Showing Pair of Systems

Each diagram shall show:

- Which ports are connected.
- The systems to which the ports belong.
- The definition of the connection in terms of the physical connectivity and any protocols that are used in that connection.

The SV-2b view is closely related to the SV-2a System Port Specification that specifies the available protocols on each port. Any connection specified in an SV-2b view shall conform to the protocols specified on the corresponding port definitions in the SV-2a view.



SV-2b Example based on Mobile Data Communications

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

Any protocol referred to in an SV-2b must be defined in the TV-1 Technical Standards View.

SV-2c - System Connectivity Clusters

An SV-2c defines how individual connections between system ports are grouped when the systems share common parent resources.

Background

An SV-2c defines the connectivity requirements between resources which host one or more systems. Typically the hosting resource will be a physical asset, although it could also be an organisational resource.

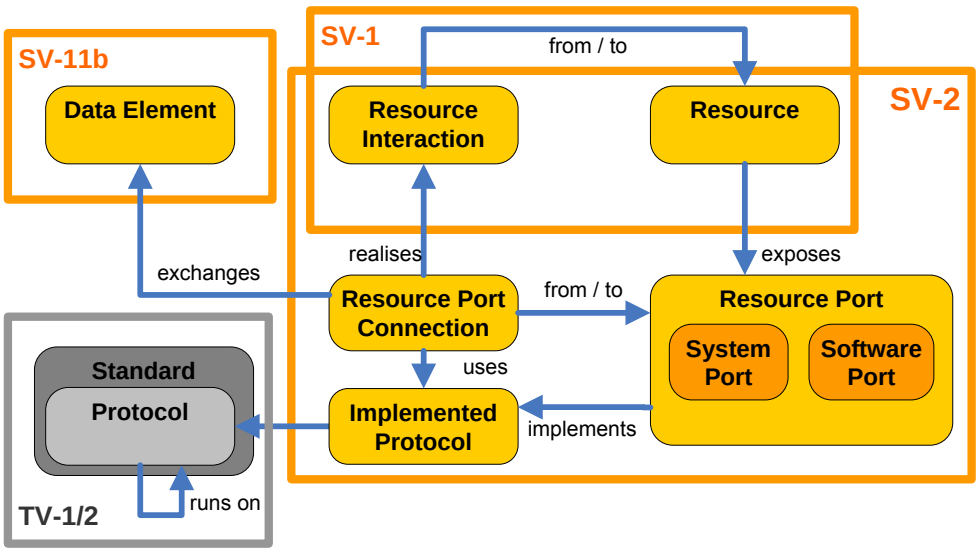
Usage

- Interface specification.
- Bandwidth and capacity analysis.

Data objects

The data in an SV-2c can include:

- Physical asset.
- Organisational resource (post type or organisation type).
- System.
- System port.
- System port connection.



Relationships Between Key Data Objects (Simplified from M3)

Representation

- UML composite structure diagram.
- Topological (connected shapes).

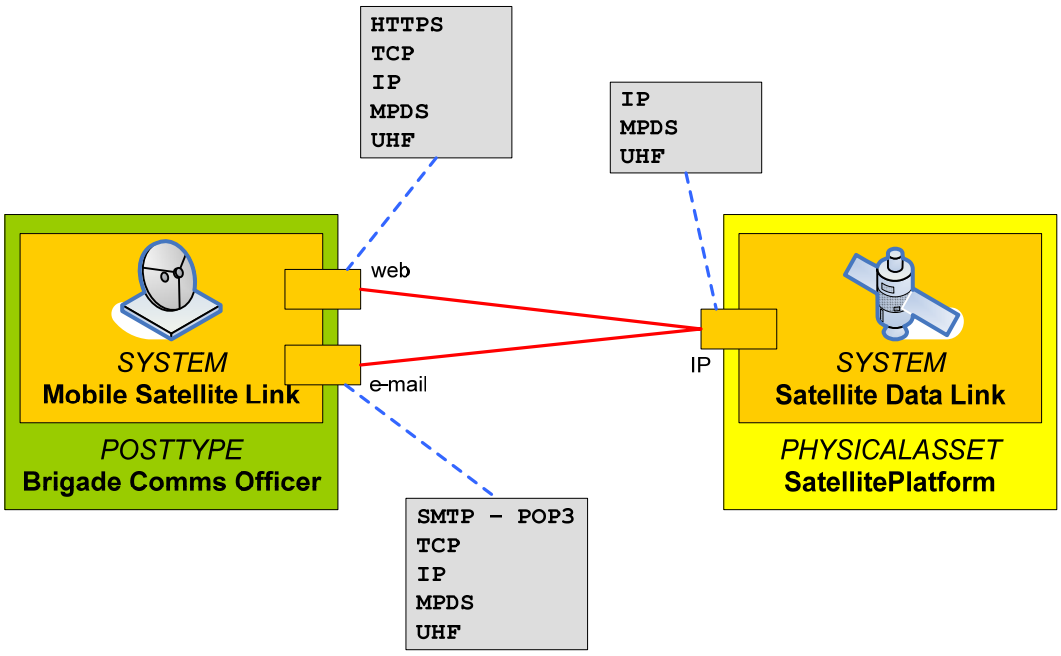
Detailed Product Description

An SV-2c defines the connectivity requirements between resources and may be used for estimating requirements for physical routing and bandwidth, as well as defining the physical architecture within a system or system of systems. An SV-2c view is particularly useful when planning physical connections and routings between physical assets.

The SV-2c is intended to aid analysis of the connectivity between systems that are hosted separately. In particular it is a useful way of highlighting redundancy issues that is, showing when too many or too few connections are used. This could indicate opportunities for cost savings from using a common network, or that there may be a need for redundancy to increase reliability.

An SV-2c consists of a diagram for each connection between assets and shows:

- The hosting resources and their systems (this should be a simple 2-level decomposition).
- The system-to-system connections that run between.
- Which ports are used in which system-to-system connections.



Example SV-2c

SV-3 - Resource Interaction Matrix

The SV-3 provides a summary of the resource interactions specified in the SV-1, Resource Interaction Specification.

Background

An SV-3 allows a quick overview of all the resource interactions specified in one or more SV-1 diagrams. The matrix format supports a rapid assessment of potential commonalities and redundancies or, if fault-tolerance is desired, the lack of redundancies.

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

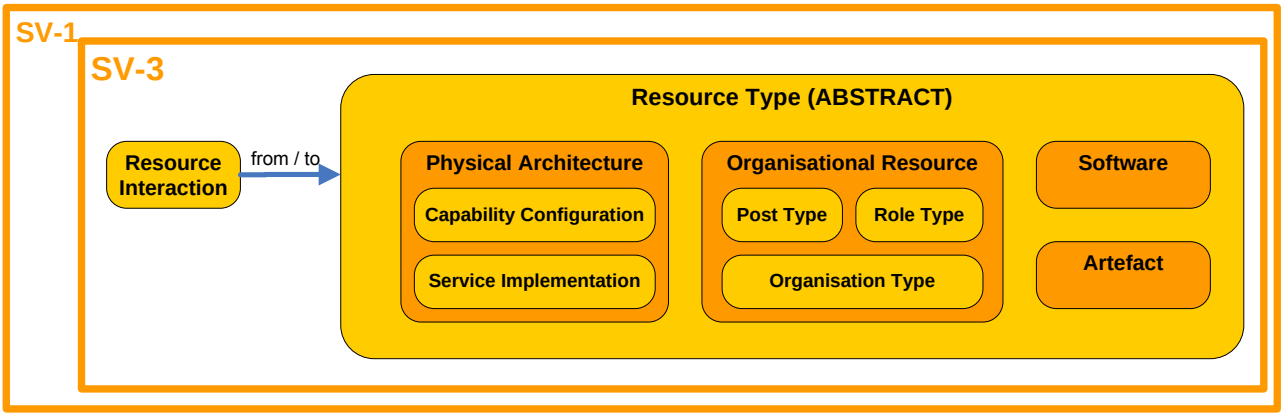
Usage

- Summarising resource interactions.
- Interface management.

Data objects

The data in an SV-3 can include:

- Resource types.
- Resource interactions.



Relationships Between Key Data Objects (Simplified from M3)

Representation

- Tabulation.
- N-squared table.

Detailed Product Description

The SV-3 summarises the resource interactions depicted in the SV-1.

Depending upon the purpose of the architecture, there could be several SV-3 products. The suite of SV-3 products can be organised in a number of ways (e.g. by domain, by operational mission phase or by solution option) to emphasise the association of groups of resource pairs in context with the architecture's purpose.

SV-3 is similar to an N2-type matrix, where the resources are listed in the rows and columns of the matrix and each cell indicates an interaction between resources if one exists.

	Blog Server	Web Terminal	Restricted LAN	LAN-SAT Bridge	Fixed Satellite Link	Satellite	Mobile Satellite Link	Satellite Modem	Web Terminal	Brigade Blogger	BLOG Reader	Comms Management
Blog Server			X									
Web Terminal			X									
Restricted LAN	X	X		X								
LAN-SAT Bridge			X		X							
Fixed Satellite Link				X		X						
Satellite					X		X					
Mobile Satellite Link						X		X				
Satellite Modem							X		X			
Web Terminal								X		X	X	X
Brigade Blogger									X			
BLOG Reader		X										
Comms Management		X										

Example SV-3

SV-4 - Functionality Description

An SV-4 specifies the functions carried out by all types of Resource, including organisational resources.

Background

The primary purposes of the SV-4 are to:

- Specify the behaviour of resources in the architecture.
- Develop a clear description of the necessary data flows that are input (consumed) by and output (produced) by each resource.
- Ensure that the functional connectivity is complete (i.e. that a resource's required inputs are all satisfied).
- Provide implementation-specific realisations of the operational activities specified in OV-5, Operational Activity Model.

The Functionality Description provides detailed information regarding the:

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

The SV-4 is the systems view counterpart to the OV-5.

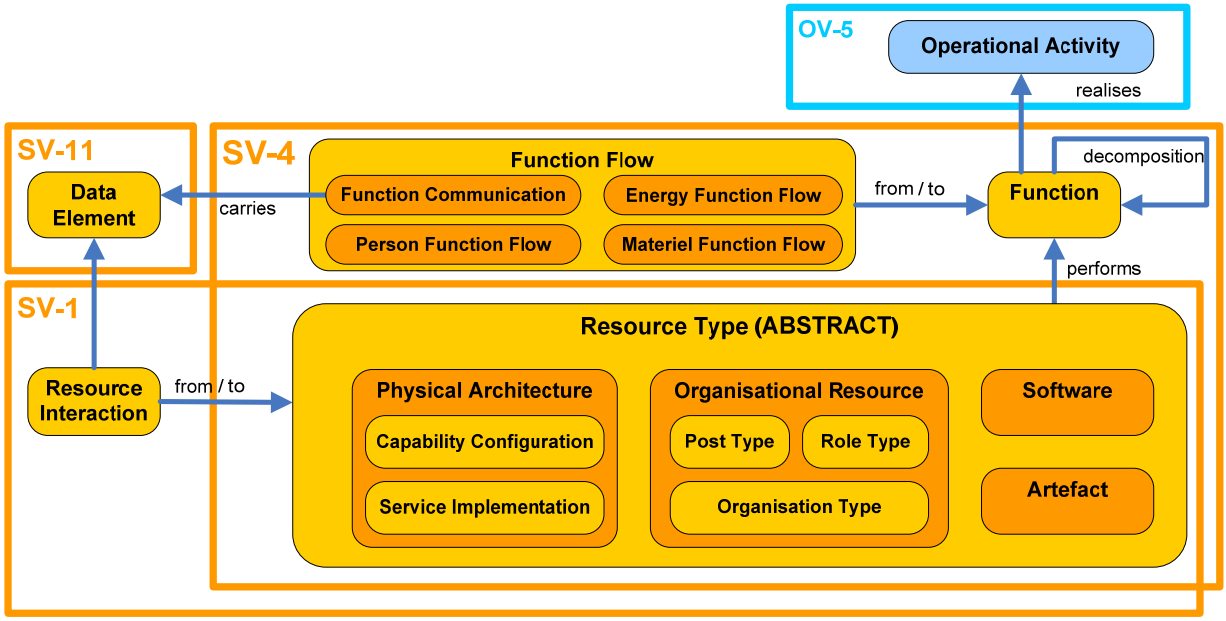
Usage

- Description of task workflow.
- Identification of functional system requirements.
- Functional decomposition of systems.
- Relating human and system functions to provide detail about interactions.

Data objects

The data in an SV-4 can include:

- Function.
- Resource.
- Data Element.



Relationships Between Key Data Objects (Simplified from M3)

Representation

- Topological (connected shapes).
- UML activity diagram.
- UML activity diagram (with swimlanes to represent resources).
- Functional Breakdown (decomposition).
- SysML activity diagram.

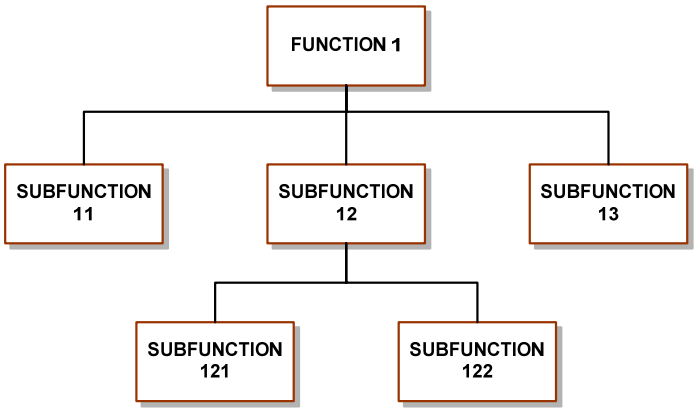
Detailed Product Description

The SV-4 is used to specify the functionality of resources in the architecture. SV-4 is the functional counterpart to the structures specified in SV-1, Resource Interaction Specification, (in the same way that OV-5 is the functional counterpart to OV-2, Operational Node Connectivity Description).

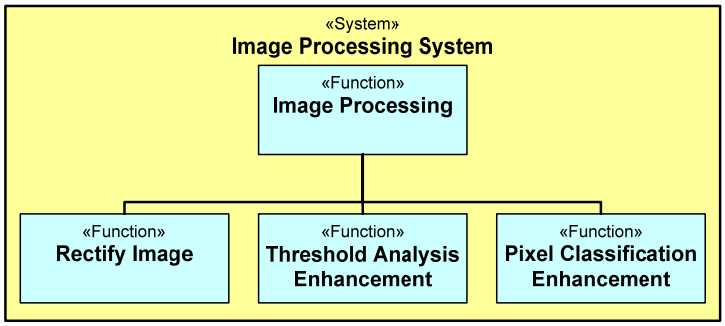
The scope of this view may be capability wide, without regard to which resources perform which functions, or it may be resource-specific (usually with the resources depicted as swimlanes). There are two basic ways to depict SV-4:

- The functional hierarchy shows a decomposition of functions depicted in a tree structure and is typically used where tasks are concurrent but dependent, for example, on a production line.
- The functional flow diagram that shows functions connected by data and control flow arrows.

The functional hierarchy approach may be particularly useful in capability-based acquisition where it is necessary to model the functions that are associated with particular capability configurations depicted in the SV-1.

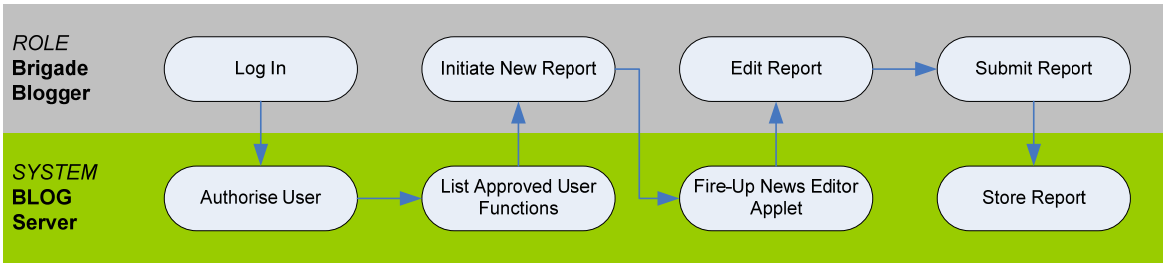


SV-4 Hierarchy Schematic

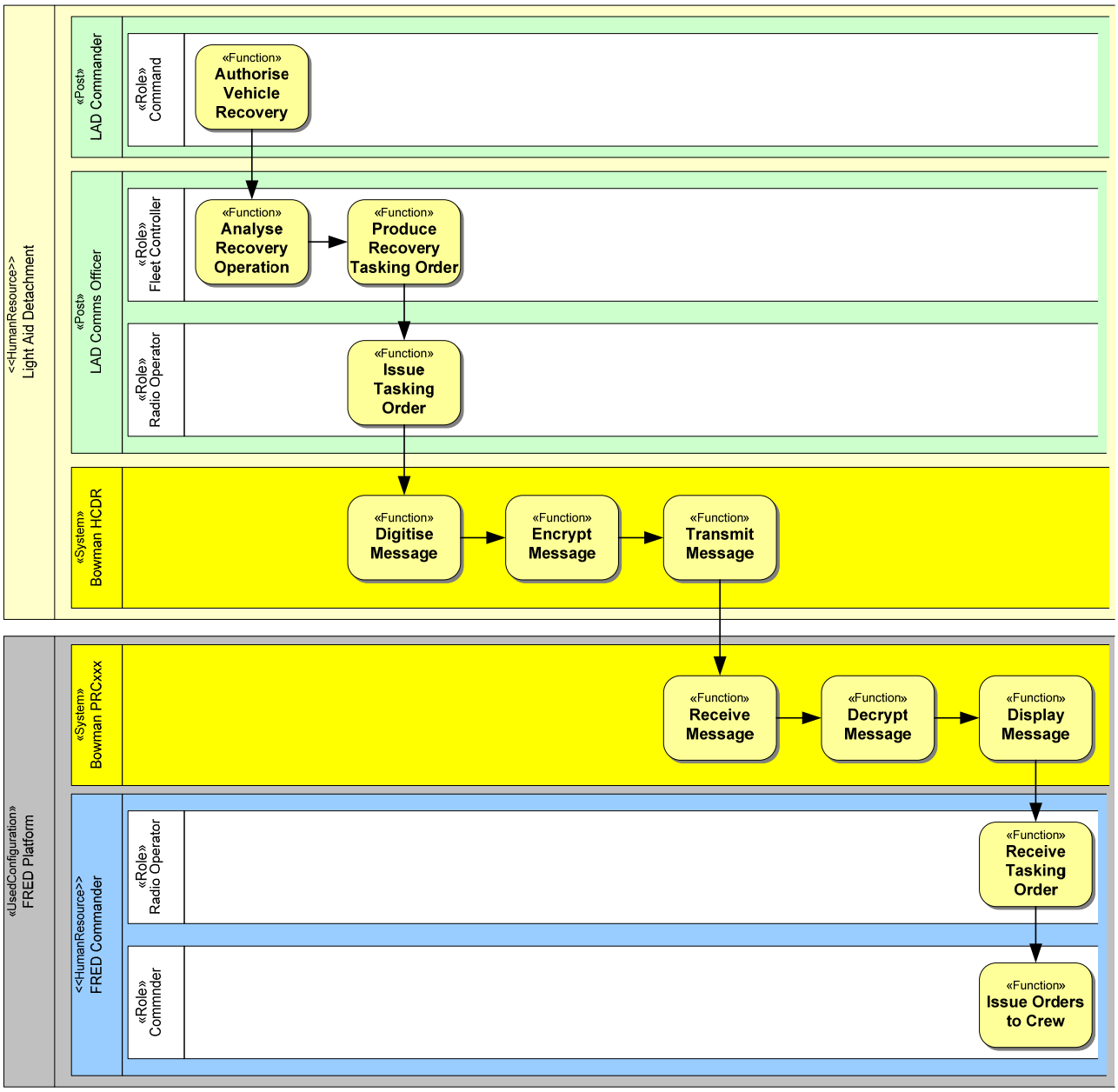


SV-4 Hierarchy Schematic with System Context

Within a system architecture, SV-4 flow diagrams document resource functions and the flows of data between those functions. Any type of resource may be used in an SV-4, and it is often used to depict the functional interactions between people and systems.



Simple Example of SV-4

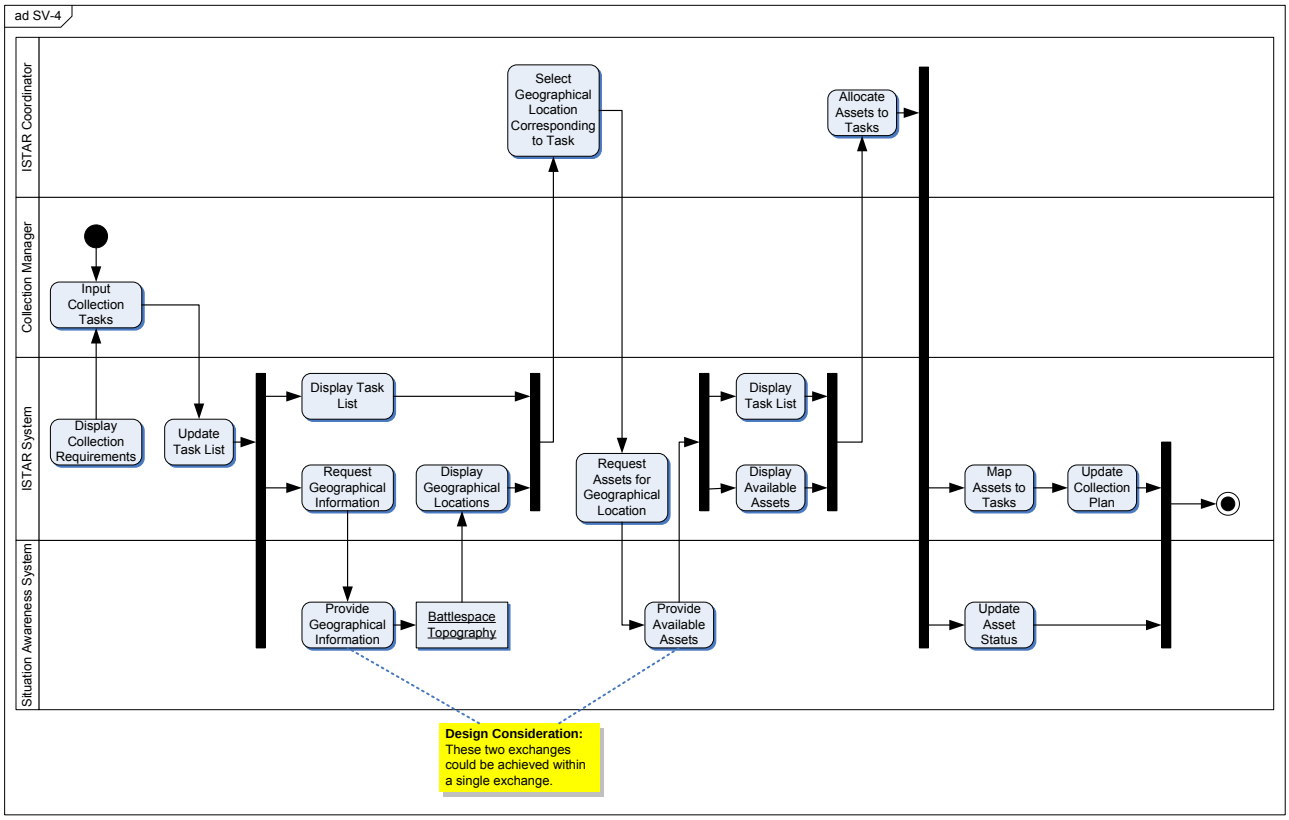


SV-4 Data Flow Schematic

The functions may realise Operational Activities captured in OV-5 and these Operational Activities may optionally be shown in SV-4, traced to the functions that realise them. The full mapping is documented in SV-5, The Function to Operational Activity/Service Function Traceability Matrix.

An SV-4 functional flow view may be used with ‘swimlanes’. A swimlane may be associated with a resource, for example a system, a capability configuration (usually based on a physical asset) or a role.

Swimlanes are presented either vertically or horizontally. A function is placed in the swimlane associated with the resource that performs it. This provides a graphical means of presenting the interactions between systems or capability configurations (shown through resource interactions on SV-1) in functional terms.



Example SV-4 Function Description (Swimlanes) (Source: IPT Deskbook)

MODAF also has the relationship ‘functions upon’ between functions and data elements, materiel, human resources, or energy. This allows architects to specify that the functions operate on a particular element.

In addition to information flows between functions, an SV-4 may show flows of materiel, energy or human resources.

SV-5 - Function to Operational Activity/Service Function Traceability Matrix

The SV-5 provides two alternate views:

- The mapping between functions described in SV-4, Functionality Description, and the operational activities in OV-5, Operational Activities Model.
- The mapping between functions in SV-4 and the service functions in SOV-5, Service Functionality.

Background

The SV-5 depicts the mapping of functions (and optionally, the resources that perform them) to operational activities or service functions. It therefore identifies the transformation of an operational need into a purposeful action performed by a resource. For service functions, SV-5 provides the link between the services used at the operational level and the specific functions provided by the resources that implement the services.

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

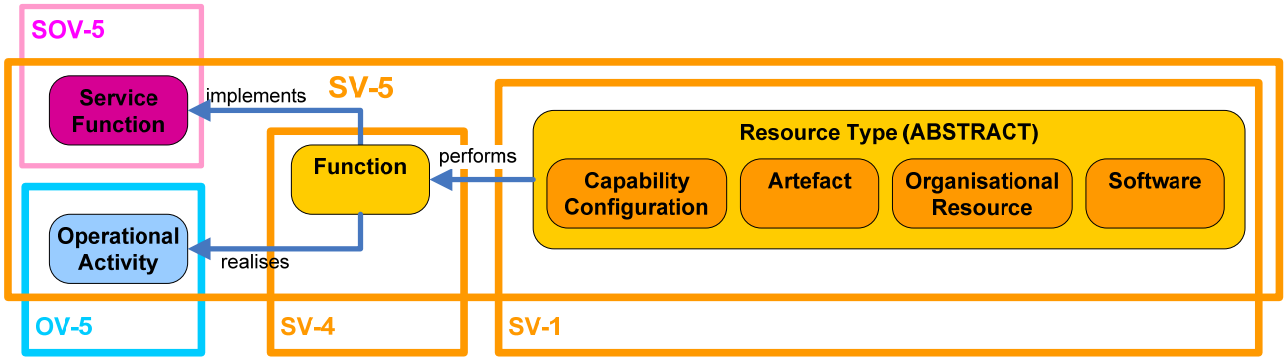
Usage

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

Data objects

The data in an SV-5 can include:

- Function.
- Resource.
- Operational activity.
- Service function.



Relationships between Key Data Objects (Simplified from M3)

Representation

- Tabulation.

Detailed Product Description

The SV-5 is a specification of the mapping between the set of operational activities or service functions to the functions that realise them.

MODAF uses the term 'operational activity' in the OVs and the term 'function' in the SVs to refer to essentially the same kind of thing, that is, both activities and functions are tasks that are performed, accept inputs, and develop outputs. The distinction between an operational activity and a function is a question of "what" and "how"; an operational activity is a specification of what is to be done, regardless of the mechanism used whereas a function specifies how a resource carries it out. For this reason, the SV-5 is a significant view, as it ties together the logical specification in the OV-5 with the physical specification of the SV-4. This logic can also be applied to services where the service functions are a specification of what functionality is to be delivered, specified independently of implementation.

The relationship between functions and operational activities or service may be many-to-many (i.e. one activity / service function may be supported by multiple functions and one function may support multiple activities / service functions).

The SV-5 is normally a matrix showing the relationship between functions, and operational activities / service functions.

SPECS 2 Functions (↓) / Operational Activity (↓)	Recce	Collate Intelligence	Conduct Estimate	Co-ordinate Plan	Attack	Recuperate
Provision of Real-Time Video Imagery	X	X			X	X
Provision of Real-Time IR Imagery	X	X			X	X
Monitoring of Airspace	X	X				X
Timelapse Recording of Designated Areas	X				X	
Communications Relay	X	X	X	X	X	X
Command and Control				X	X	

Example SV-5

SV-5 may be further augmented with the resources (e.g. systems, roles and capability configurations) that conduct the functions. The architect may also wish to hide the functions in an SV-5 so that the table simply shows the mapping from resources to operational activities / service Functions.

SPECS 2 Sub-systems / Operational Activity	Recce	Collate Intelligence	Conduct Estimate	Co-ordinate Plan	Attack	Recuperate
Real-Time Imagery Sub-System	X	X			X	X
Imagery Reference Library		X	X			X
Analyst Exploitation Station		X	X	X		
Communications Sub-System	X	X	X	X	X	X
Mission Support System				X	X	

Variant SV-5 (systems mapped to operational activities)

SV-6 - Systems Data Exchange Matrix

The SV-6 specifies the characteristics of the data exchanged between systems.

Background

SV-6 focuses on the specific aspects of the system data flow and the system data content in a tabular format.

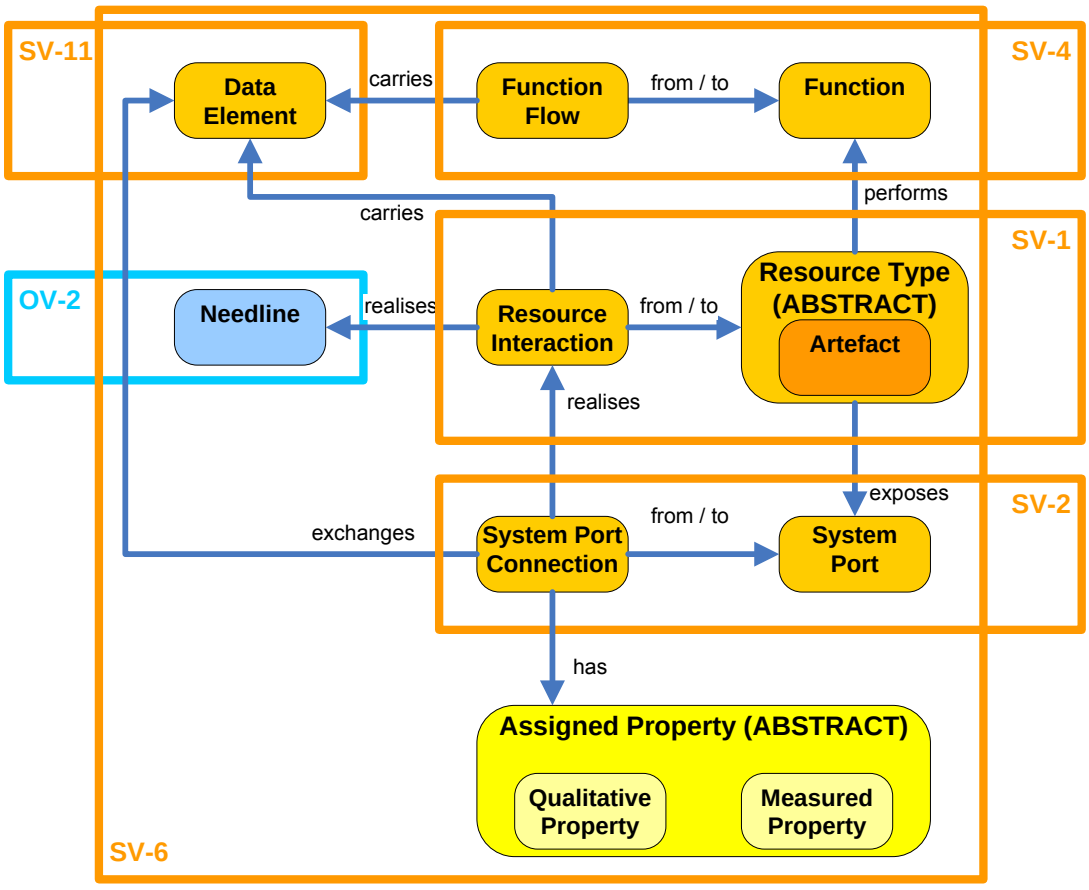
Usage

- Detailed definition of data flows.

Data objects

The data in an SV-6 can include:

- System.
- Resource interaction.
- System port connector.
- Data element.
- Information exchange (from OV-2, Operational Node Relationship Description).



Relationships between Key Data Objects (Simplified from M3)

Note: *The term 'System Data Exchange' does not refer to one M3 element. A data exchange as described in SV-6 is a combination of a system port connector and the data elements that flow through it. Any properties shown in an SV-6 table will be properties of the system port connector.*

Representation

- Tabulation.

Detailed Product Description

The SV-6 specifies the characteristics of data exchanges between systems. SV-6 is the physical equivalent of the logical OV-3, Operational Information Exchange Matrix, and provides detailed information on the system connections that implement the information exchanges specified in an OV-3. Human communications, such as verbal orders, are captured in the SV-1, Resource Interaction Specification, and SV-3, Resource Interaction Matrix, products only.

SV-6 describes, in a tabular format, data exchanged between systems, and the functions that produce and consume that data. SV-6 also specifies properties of these system data exchanges. MODAF does not mandate a set of standard properties, but it is typical to see periodicity, timeliness, throughput, size, information assurance and security characteristics of the exchange. In addition, the data elements, their format and media type, accuracy, units of measurement, and system data standard may also be described in the matrix.

Data Exchange ID	Sending System	Sending Port	Receiving System	Receiving Port	Description	Data Elements / Formats	Data Rate	Contention Ratio	Readio Frequency (MHz)	Operational Info Exchange
1	Web Application Server	HTTP1	Web Provider's LAN	TCP-IP-WPL1	Local Area Connection for Web Server	HTML, Javascript, PNG, JPEG	100 Mb/s	1:1	N/A	1
2	LAN-WAN gateway	TCP-IP-LWG1	Web Provider's LAN	TCP-IP-WPL2	Local Area Connection for LAN-WAN Gateway	Any	100 Mb/s	1:1	N/A	1
3	LAN-WAN gateway	TCP-IP-LWG2	Public WAN	TCP-IP-PW1	LAN-WAN Gateway Connection to Public Wide Area Network	Any	20 Mb/s	20:1	N/A	1
4	WAN _GPRS gateway	TCP-IP-WG1	Public WAN	TCP-IP-PW2	GPRS-WAN Gateway Connection to Public Wide Area Network	HTML, Javascript, PNG, JPEG, POP3, SMTP, IMAP, FTP	T4	5:1	N/A	1
5	WAN _GPRS gateway	TCP-IP-WG1	GPRS Support Node	BSSGP-GSN-1	WAN-GPRS Gateway Connection to GPRS Support Node	HTML, Javascript, PNG, JPEG, POP3, SMTP, IMAP, FTP	1 Gb/s	1:1	N/A	1
6	GPRS Support Node	GPRS-GSN-1	GSM Network	GPRS-GSM-1	GPRS Support Node to GSM Network	HTML, Javascript, PNG, JPEG, POP3, SMTP, IMAP, FTP	128 Kb/s	1:1	900-1800	1
7	Mobile Phone	GPRS-MB-1	GSM Network	GPRS-GSM-2	Mobile Phone to GSM Network connection	HTML, Javascript, PNG, JPEG, POP3, SMTP, IMAP, FTP	128 Kb/s	9:1	900-1800	1

Example SV-6 Based on GPRS SV-2b Example

Where a suite of SVs provides a physical specification for a logical requirement specified in a suite of OVs, the SV-6 properties should cover all the information exchange properties specified in OV-3. Similarly, it is recommended that all data elements carried by the data exchanges are shown.

It should be noted that each data element exchanged may be related to the function (from SV-4) that produces or consumes it. However, there need not be a one-to-one correlation between data elements listed in the SV-6 matrix and the data flows (inputs and outputs) that are produced or consumed in a related SV-4.

Because an SV-6 is about showing flows across system boundaries, data flows between system functions performed by the same systems may not be shown in the SV-6 matrix; there will be no corresponding system port connection.

Note: although flows of materiel, human resources and energy are permitted in SV-1 and SV-4, they are *not* permitted in SV-6.

SV-7 Resource Performance Parameters Matrix

The SV-7 depicts the performance characteristics of a Resource.

Background

The SV-7 expands on the information presented in an SV-1, Resource Interaction Specification, by depicting the characteristics of the resources shown in the SV-1.

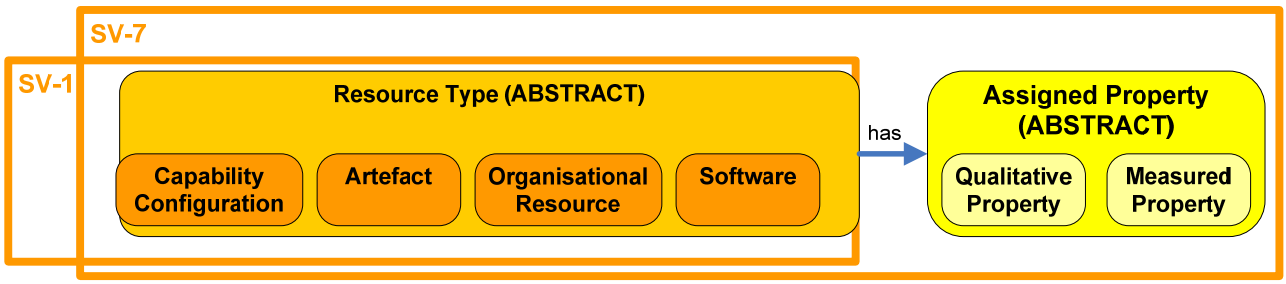
Usage

- Definition of performance characteristics.
- Identification of non-functional requirements (input to System Requirements Document).

Data objects

The data in an SV-7 can include:

- Resource.
- Measurable property.
- Qualitative property.



Relationships between Key Data Objects (Simplified from M3)

Representation

- Tabulation.

Detailed Product Description

The SV-7 specifies qualitative and quantitative characteristics of resources; i.e. the performance parameters of each resource. The SV-7 is typically a tabular view.

One of the primary purposes of the SV-7 is to communicate which characteristics are considered most crucial for the successful achievement of the mission goals assigned to the resource. These parameters can often be the deciding factor in acquisition and deployment decisions, and will figure strongly in systems analyses and simulations done to support the acquisition decision processes and system design refinement.

The Figure below is a template of SV-7, listing notional user defined performance. It should be noted that these are example metrics – MODAF does not mandate a specific set of resource characteristics.

Parameter ID	System / Element	Performance Requirement	Metric	Measure
Hardware				
H 1.1	SPECS 2 Transmitter	Transmission Rate	2	GB
H 2.1	SPECS 2 Receiver	Gain	60	dB
H 2.2		Signal to Noise ratio	20	dB
H 3.1	SPECS 2 Signal Processor	Comms Channel Bandwidth Support	2	GB
H 4.1	SPECS 2 Video Recorder	Top-end Resolution	1024x768	Pixels
H 4.2		Storage Capacity	20	Hours @ top-end resolution
Software				
S 1.1	Video Analysis	Minimum target location co-ordinate accuracy	10	metres
		Minimum target speed accuracy	5	metres / second
S 1.2	Target Status Alerting	Minimum status Change alert accuracy	500	metres
		Minimum Alert Response time	30	seconds

Example SV-7

It is sometimes useful to analyse resource evolution by comparing performance characteristics for current and future resources. For this reason, repository tools may produce hybrid SV-7 products that span architectures for multiple enterprise phases.

SV-8 - Capability Configuration Management

The SV-8 depicts the whole lifecycle view of a resource, describing how its configuration changes over time.

Background

The SV-8 provides an overview of how a capability configuration changes over time. It shows the structure of several capability configurations mapped against a timeline.

Usage

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

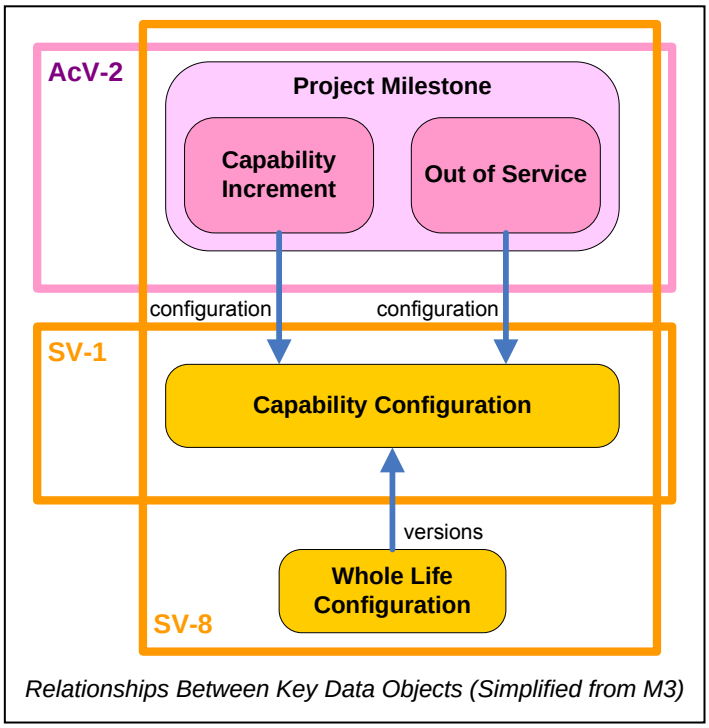
Data objects

The data in an SV-8 can include:

- Capability configurations.
- Resources that are parts of capability configurations.
- Project milestone (that reflect equipment delivery).

Representation

- Timeline view.
- 'Herringbone' diagram.



Relationships Between Key Data Objects (Simplified from M3)

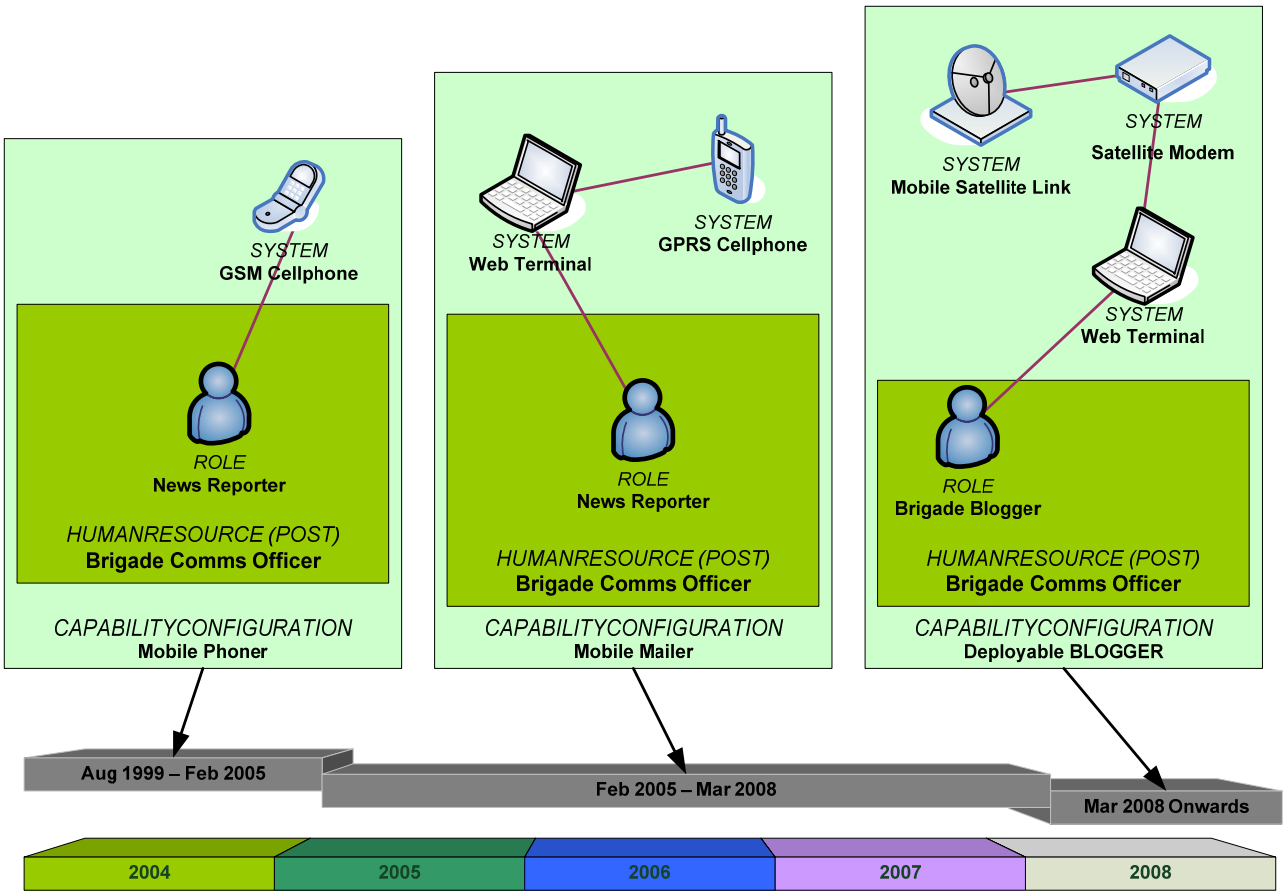
Detailed Product Description

An SV-8 provides a rich definition of how the enterprise and its capabilities are expected to evolve over time, especially when linked together with other evolution views such as AcV-2, Programme Timelines, StV-3, Capability Phasing, and TV-2, Standards Forecast.

In this manner, the view can be used as an architecture evolution project plan or transition plan. In meta-model terms, an SV-8 product is constructed from data specified in AcV-2 and SV-1, Resource Interaction Specification, though there may be several SV-1 products – one for each version of the configuration. It may therefore be possible for MODAF tools to automatically generate SV-8 products from existing data.

An SV-8 can describe legacy, current and future capability configurations against a timeline. Using similar modelling elements as those used in SV-1, (resource composition, resources, etc), the view shows the structure of each capability configuration. Resource interactions which take place *within* the capability configuration boundaries may also be shown.

The changes depicted in the SV-8 View are derived from the project milestones that are also shown in AcV-2.



Example SV-8 Showing Evolution of Front Line News Reporting

SV-9 - Technology & Skills Forecast

The SV-9 identifies the technologies and skills required by the Entererprise over time. These are technologies and skills that can be reasonably forecast against the current state and expected improvements / trends. New technologies and skills will be tied to specific time periods, which can correlate against Enterprise Phases.

Background

SV-9 provides a summary of the current and emerging technologies and skills that impact on the Resources that constitute the Architecture. The SV-9 provides descriptions of relevant:

- Emerging and current technologies.
- Industry trends.
- Predictions (with associated confidence factors) of the availability and readiness of specific hardware and software products.
- Current and possible future skills (modelled using M3 Competence elements).

In addition to providing an inventory of trends, capabilities and products, the SV-9 also includes an assessment of the potential impact of these items on the enterprise (provided as text in the M3 Forecast element). Given the future-oriented nature of this product, forecasts are typically made in short, mid and long-term timeframes, such as six, 12 and 18-month intervals.

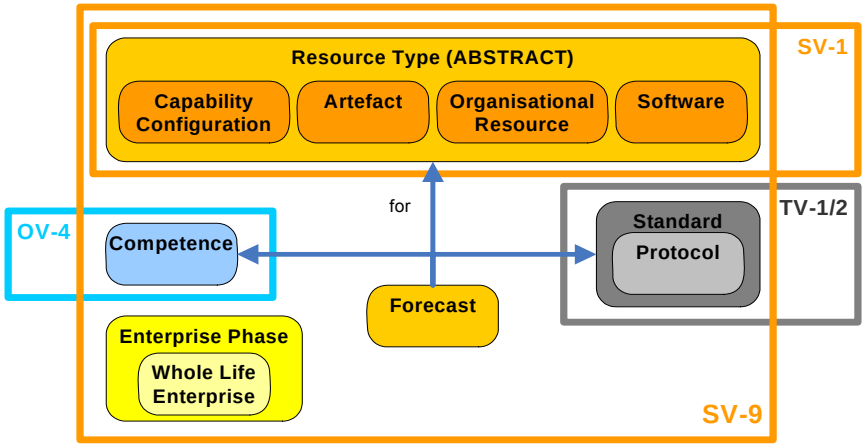
Usage

- Forecasting technology readiness against time.
- HR trends analysis.
- Recruitment planning.
- Planning technology insertion.
- Input to options analysis.

Data objects

The data in an SV-9 can include:

- Resources.
- Competences.
- Standards.
- Forecasts (for the any of the above).



Relationships Between Key Data Objects (Simplified from M3)

Representation

- Timeline view.
- 'Herringbone' diagram.

Detailed Product Description

An SV-9 summarises predictions about trends in technology and personnel skills, and is usually presented as a table, with forecasts categorised by periods of time (e.g. 6-month, 12-month, 18-month intervals). Architects will generally produce separate SV-9 products for technology and skills.

The specific time periods selected (and the trends being tracked) will usually correspond to Enterprise Phases. However where technology is fast-moving (e.g. CPU and Storage technology) then shorter periods may be required. The forecast includes a text summary of potential impacts on current architectures and thus influences the development of transition and target architectures.

If standards are an integral part of the technologies important to the evolution of a given architecture, then it may be convenient to combine SV-9 with the TV-2, Technical Standards Forecast.

Where applicable, the SV-9 may relate forecasts to those resources that are impacted by the technology changes – this is stored as plain text in the M3 “Forecast” element.

TECHNOLOGY AREA	TECHNOLOGY FORECASTS		
	SHORT TERM	MEDIUM TERM	LONG TERM
APPLICATION SOFTWARE			
OFFICE APPLICATIONS	MICROSOFT OFFICE 2000	MICROSOFT OFFICE 2005 (DISTRIBUTED)	MICROSOFT DISTRIBUTED OFFICE APPS
BUSINESS APPLICATIONS	INDIVIDUAL APPS – BATES QP24	BISAs	INTEGRATED BISA SUITE
APPLICATION PLATFORM			
DATA MANAGEMENT	ORACLE 9	ORACLE 10	
OPERATING SYSTEM	WINDOWS 2000	NEXT WINDOWS OS	OPEN SOURCE OS
EXTERNAL ENVIRONMENT			
USER INTERFACE		THIN TOUCH SCREEN	BIOMETRIC INTERFACE
STORAGE	HDD	SOLID STATE MEMORY CHIPS	ORGANIC STORAGE
COMMS	BOWMAN	BOWMAN + VOIP	ALL IP COMMS

Example Systems Technology Forecast (SV-9)

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

Behavioural modelling and documentation are key to a successful architecture description. OV-5, Operational Activity Model, and the OV-6 series provide a logical specification of behaviour, which are mirrored in the SV-4, Functionality Description, and SV-10 specifications of resource behaviour.

SV-4 provides a functional specification of the behaviour of resources, however, it is useful to augment this with specifications of the constraints the resources are subject to, the states they can have and the sequence in which interactions between them take place. SV-10 provides this additional specification. SV-10 is in three parts:

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

SV-10a - Resource Constraints Specification

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

Background

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

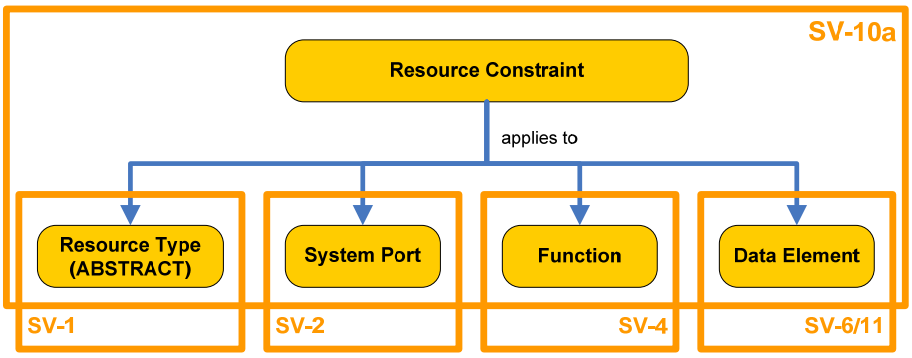
Usage

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

Data objects

The data in an SV-10a can include:

- Resource constraint.



Relationships Between Key Data Objects (Simplified from M3)

Representation

- Text (preferably specified in a computer-interpretable constraint language such as Object Constraint Language (OCL).
- Tabular.

Detailed Product Description

The SV10-a describes the rules that control, constrain or otherwise guide the implementation aspects of the architecture. Resource constraints are statements that define or constrain some aspect of the technology or business, and may be applied to:

- Resources.
- Functions.
- System ports.
- Data elements.

Constrained Element	Constraint	Description
«PostType» FRED Crane Operator	Age > 18 Yrs Old	All FRED Crane Operators must be older than 18 for insurance purposes.
«System» Bowman PRCxxx	Range > **km	A Bowman PRCxxx shall have a useable transmission range of **km.
«Function» Analyse Recovery Operation	Duration < 1hr	A fleet controller must be able to conduct the op analysis in less than one hour.

An SV-10a Presented in Tabular Form

OV-6a, Operational Rules Model, provides a specification of logical constraints (i.e. rules that will apply in general, regardless of what resources are used). The SV-10a provides a set of resource-specific constraints that are applied in order to satisfy the general constraints from OV-6a.

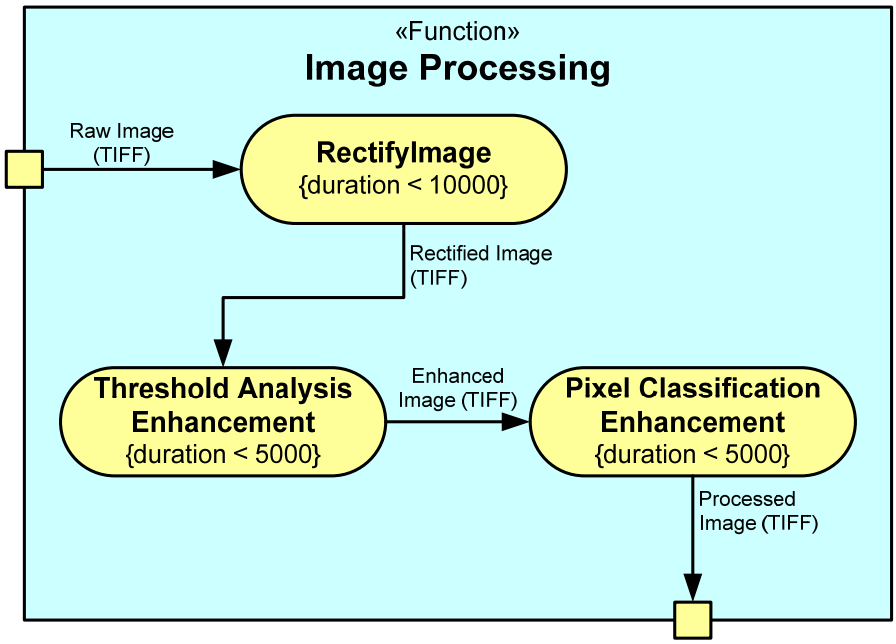
MODAF categorises resource constraints as follows:

- Structural assertions – non-functional constraints governing some physical aspect of the architecture.
- Action assertions – functional constraints governing the behaviour of resources (constraints on functions).
- Derivations – these involve algorithms used to compute facts.

Where a resource constraint is based on some standard, then that standard should be listed in the Standards Profile (TV-1).

Some resource constraints can be added as annotations to other views, in which case SV-10a should provide a listing of the complete set of those rules and any others that are not shown in other views.

With potentially complex resource constraints it may be more useful to express these rules in Object Constraint Language (OCL), as below.



Example SV-4 with SV-10a OCL Constraints Embedded in Functions

SV-10b - Resource State Transition Description

The SV-10b is a graphical method of describing a resource's response to various events in terms of its changes of state. The view specifies the possible states a resource can be in, the possible transitions between those states, and the triggers for those changes.

Background

The functional specification of a resources behaviour presented in SV-4, Functionality Description, can show the flows of control and data between resources, but it cannot reflect the changes of state that occur when control or data is passed from one resource to another. SV-10b provides this additional information.

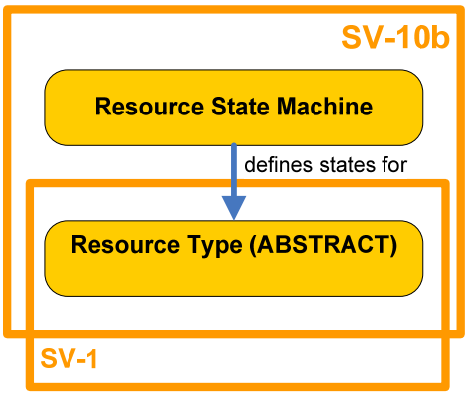
Usage

- Definition of states, events and state transitions (behavioural modelling).
- Identification of constraints on possible states (input to System Requirements Document).

Data objects

The data in an SV-10b can include:

- Resources.
- States (associated with a resource or function).
- State transitions (each associated with an event).



Relationships Between Key Data Objects (Simplified from M3)

NB. The M3 does not provide much detail on SV-10b, the assumption being that the UML meta-model (that underpins M3) is sufficient to cover all the requirements for state transition diagrams.

Representation

- UML state diagram (preferred).

Detailed Product Description

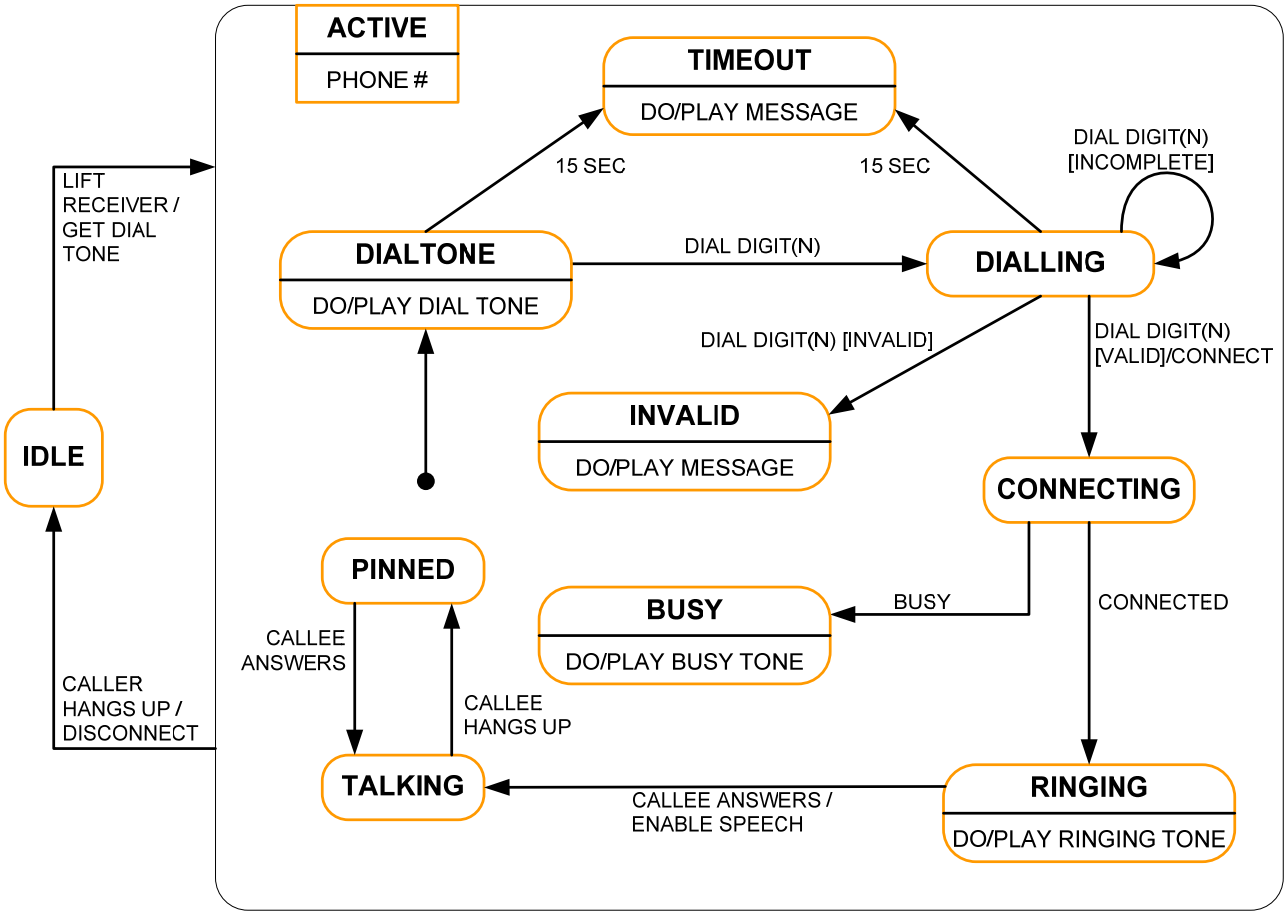
The SV-10b relates events to resource states and describes the transition from one state to another. SV-10b describes state transitions from a resource perspective, with a focus on how the resource responds to stimuli (e.g. triggers and events). As with the OV-6b, Operational State Transition Description, these responses may differ depending upon the rule set or conditions that apply as well as the resource's state at the time the stimuli is received.

The Figure below provides a template for a simple SV-10b. The black dot and incoming arrow point to initial states (usually one per diagram), while terminal states are identified by an outgoing arrow

pointing to a black dot with a circle around it. States are indicated by rounded corner box icons and labelled by name or number and, optionally, any actions associated with that state. Transitions between states are indicated by one-way arrows labelled with event or action notation, which indicates an event-action pair and shows, when an event occurs, the corresponding action which is executed. This notation indicates the event that causes the transition and the ensuing action (if any) associated with the transition.

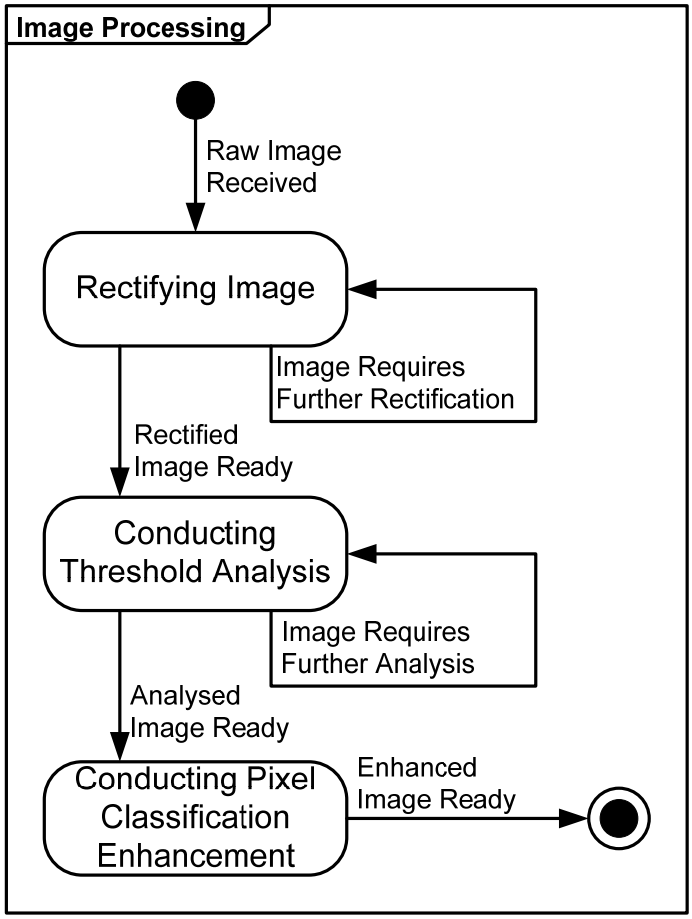
Generic State Transitions Diagram

Composing state transitions provides a model of states known as a state chart.



Example of a State Chart

The SV-10b relates states, events, and actions. A state and its associated action(s) specify the response of a resource or function to events. When an event occurs, the next state may vary depending on the current state (and its associated action), the event and the rule set or guard conditions. A change of state is called a transition. Each transition specifies the response based on a specific event and the current state. Actions may be associated with a given state or with the transition between states.



Example SV-10b

States in SV-10b products may be nested. This enables quite complex models to be created to represent resource behaviour.

SV-10c - Resource Event-Trace Description

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

Background

The SV-10c provides a valuable mechanism for improving the level of detail from the initial solution design, in order to help define a sequence of interactions, and to ensure that each participating resource or resource port has the necessary information it needs, at the right time, in order to perform its assigned functionality.

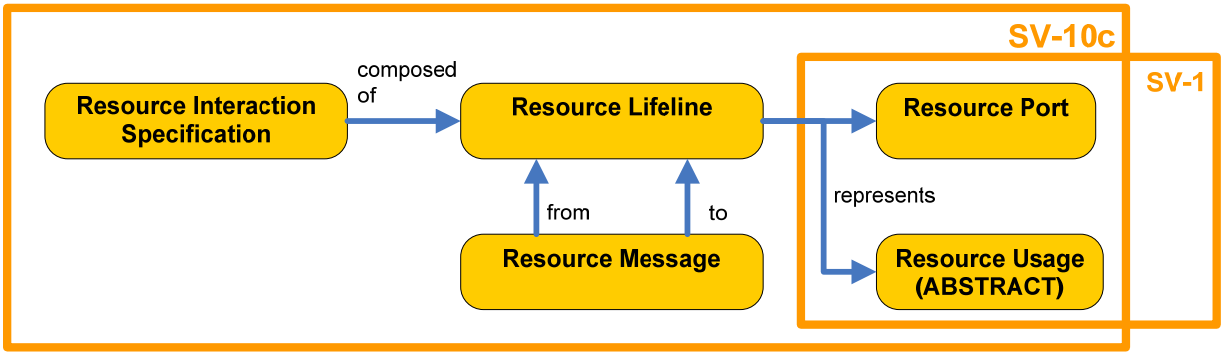
Usage

- Analysis of resource events impacting operation.
- Behavioural analysis.
- Identification of system requirements (input to System Requirement Document).

Data objects

The data in an SV-10c can include:

- Resource Interaction Specification
- Lifelines (each associated with a functional resource or a system port).
- Resource Message



Relationships between Key Data Objects (Simplified from M3)

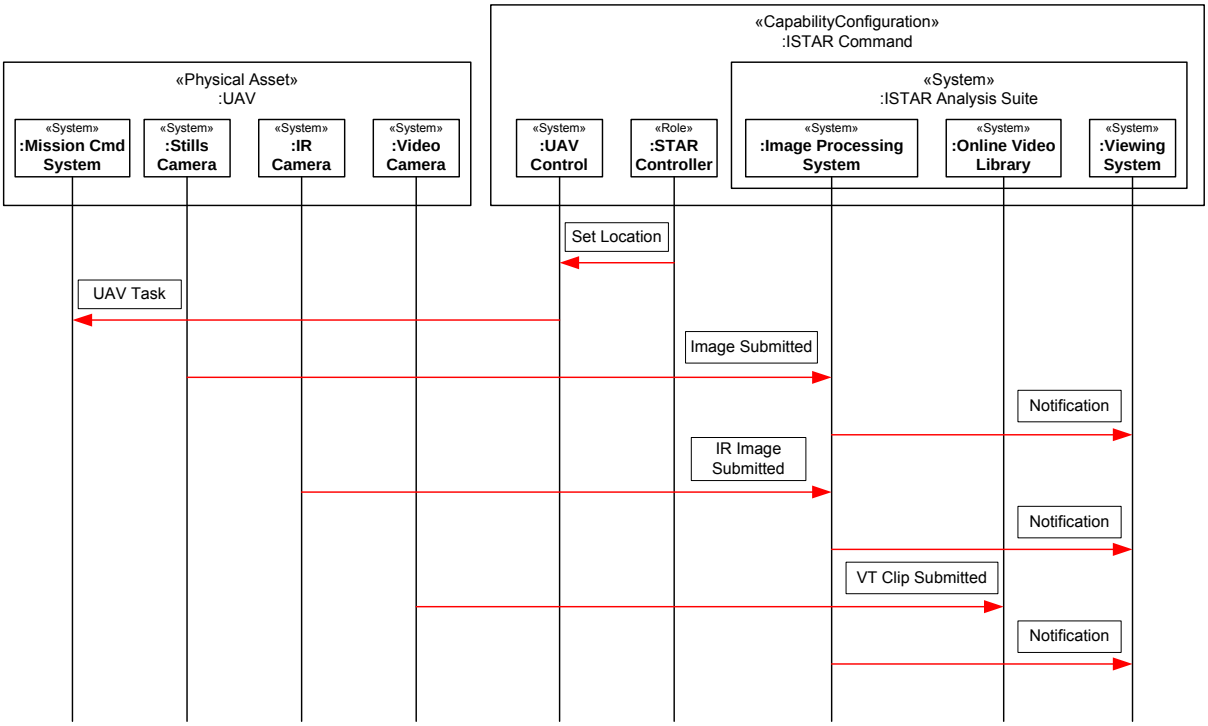
Representation

- Topological (connected shapes).
- UML Sequence Diagram (preferred).

Detailed Product Description

The SV10-c specifies the sequence in which data elements are exchanged in context of a Resource or Resource Port. Resource event / trace descriptions are sometimes called ‘sequence diagrams’, ‘event scenarios’ or ‘timing diagrams’.

The diagram below shows the components of an SV-10c. The items across the top of the diagram are usages of resources or resource ports. The lifelines are depicted as vertical lines descending from the resources and ports.



Systems Event-Trace Description (SV-10c)

Arrows between the lifelines represent exchanges of messages (data), materiel, energy or human resources. The direction of the event lines represents the flow of information from one resource / port to another. The SV-10c provides a time-ordered examination of the data elements exchanged between participating resources or system ports, and the required time interval between exchanges may be shown as a measure between the arrows. Each event-trace diagram will have an accompanying description that defines the particular scenario or situation.

The content of exchanges that connect lifelines in an SV-10c may be related, in modelling terms, with resource interactions (from, SV-1, Resource Interaction Specification, SV-3, Resource Interaction Matrix), data flows (from SV-4, Functionality Description, and SV-6, Systems Data Exchange Matrix) and data schema entities (from SV-11, Physical Schema) modelled in other views.

The interactions in SV-10c are not just limited to representing information flows. As in SV-1 and SV-4, they may also represent flows of materiel, human resources or energy.

SV-11 - Physical Schema

The SV-11 defines the structure of the various kinds of system data that are utilised by the systems in the architecture.

Background

The SV-11 provides an implementation specific data model that realises the logical data model presented in an OV-7, Information Model.

Implementation constraints may mean that one logical entity in OV-7 is in fact realised by more than one entity in SV-11 and vice versa.

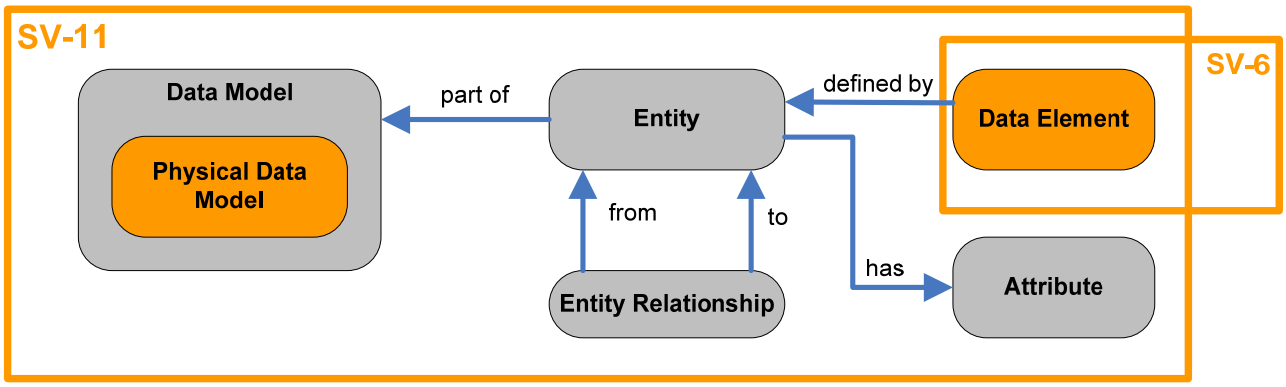
Usage

- Specifying the system data elements exchanged between systems (thus reducing the risk of interoperability errors).
- Definition of physical data structure (input to system design).

Data objects

The data in an SV-11 can include:

- System data entity.



Relationships Between Key Data Objects (Simplified from M3)

Representation

- Formal text data modelling language (e.g. SQL, ISO10303-11, etc.).
- Topological (connected shapes).
- UML class diagram.

Detailed Product Description

SV-11 allows implementation-level detail of data structures to be modelled. The view serves several purposes, including:

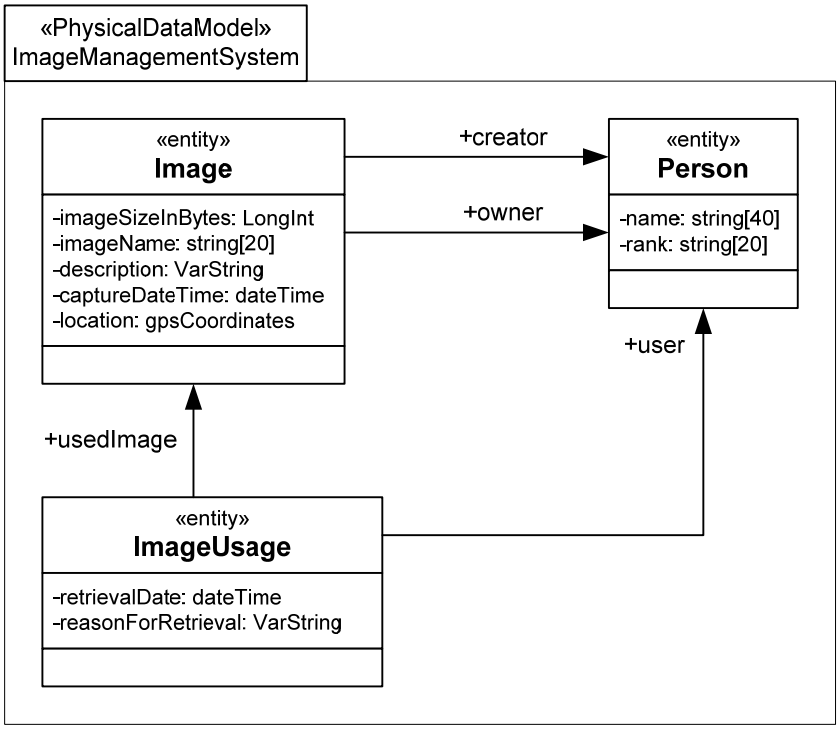
- Providing the detailed information on the system data elements exchanged between systems, thus reducing the risk of interfacing errors.
- Providing system data structures for use in the system design process, if necessary.

SV-11 is an implementation-oriented data model that is used to describe how the information requirements represented in OV-7 are actually implemented for a given solution. The entities specified in SV-11 represent data elements (from the SV-6, Systems Data Exchange Matrix).

There should be a mapping from a given logical data model (OV-7) to the physical data model (SV-11) if both models are used. This mapping is often not trivial (e.g. there may be conditional mappings), in which case a formal mapping language such as ISO10303-14 should be used (as M3 comments) against the data model or individual entities.

Standards associated with entities are also often identified in the development of the SV-11 view product; these should be recorded in the TV-1 Standards Profile.

UML provides a suitable language for developing physical schema (via class diagrams).



Example SV-11 (UML)

Note that an SV-11 also simply be a text schema (e.g. in the case of SQL or ISO10303-11).

Introduction to SV-12a and SV-12b

The SV-12 series of views specify standard configurations that deliver services. These may be configurations of resources (SV-12a) or configurations which utilise other services (SV-12b). In both cases, these views specify how services are implemented. They do not specify the services themselves (this is covered by the Service Oriented Viewpoint), nor do they describe deployed services.

SV-12a - Service Provision

The SV-12a specifies configurations of resources that can deliver a service, and the levels of service that those resources can deliver in different environments.

NAF V3 Equivalency

Note that the MODAF SV-12a differs to the strict NAF definition in NSV-12, Service Provision, which only shows where systems contribute to services. In addition, certain parts of the NAF documentation refer to this view as NSV-13, System Service Provision.

Background

The Service Oriented Views (SOVs) in MODAF provide a specification of what a service is to do and how it presents its functionality to service consumers. The SOVs deliberately avoid specifying how a service is to be implemented, so that maximum creative flexibility is available to service providers. However, when a service is implemented (and its implementation specified in the architecture), it is useful to know what resources are used to implement it. SV-12a provides the mapping from services to the resources that provide those services. An SV-12a may also show the inverse relationship of when a resource uses a service.

Note that SV-12a does not describe actual deployed resources that deliver a service, it specifies typical configurations (i.e. templates) of resources that together can deliver the services.

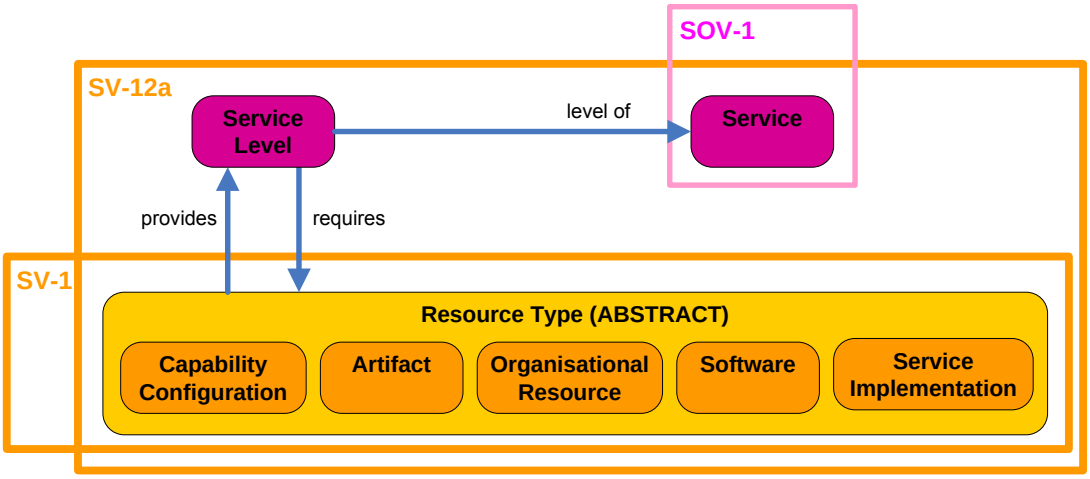
Usage

- Service implementation.
- Resource audit.
- Tracing business processes to the resources that support them.

Data objects

The data in an SV-12a can include:

- Service.
- Service Level
- Resource type.



Relationships Between Key Data Objects (Simplified from M3)

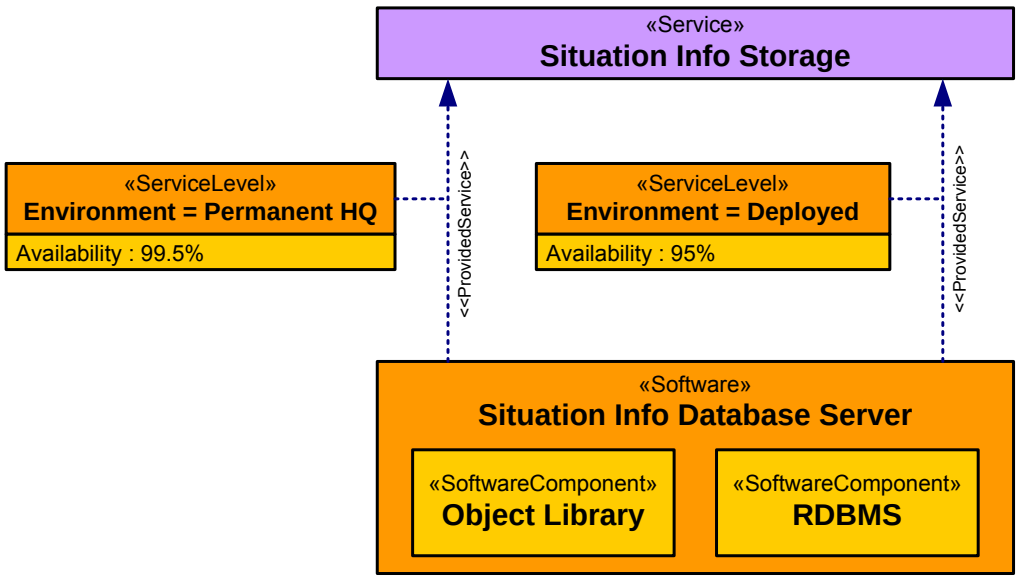
Representation

- Mapping (matrix).
- Topological – connected shapes.
- UML Composite Structure Diagram.
- SysML Blocks Diagram

Detailed Product Description

An SV-12a maps a resource (which may itself be constructed from other resources) to the services it can provide. SV-12a products are usually presented as a structural model (e.g. a UML composite structure), with tracing relationships to services. It is also be possible to present an SV-12a as a table, with services on one axis and resources on the other. Care should be taken with this approach, however, as it tends to hide any underlying structure the resources might have.

A given implementation may provide a different level of service depending on the environment in which is it used. The service attributes defined in SOV-1, Service Taxonomy, can be given values in an SV-12a and related to the environment under which those values are true.



UML Representation of SV-12a

SV-12b - Service Composition

The SV-12b specifies service implementations that use other services.

NAF V3 Equivalency

Note that the MODAF SV-12b differs to the NAF definition in NSV-12, Service Provision. The closest NAF view to SV-12b is NSOV-6, Service Composition (in NAF Chapter 5 version 3.1).

Background

The Service Oriented Views (SOVs) in MODAF provide a specification of what a service is to do and how it presents its functionality to service consumers. The SOVs deliberately avoid specifying how a service is to be implemented – even if that implementation is only based on other services – so as to maintain the principle of service opacity.

SV-12b specifies how a service implementation uses other services to provide its own service(s).

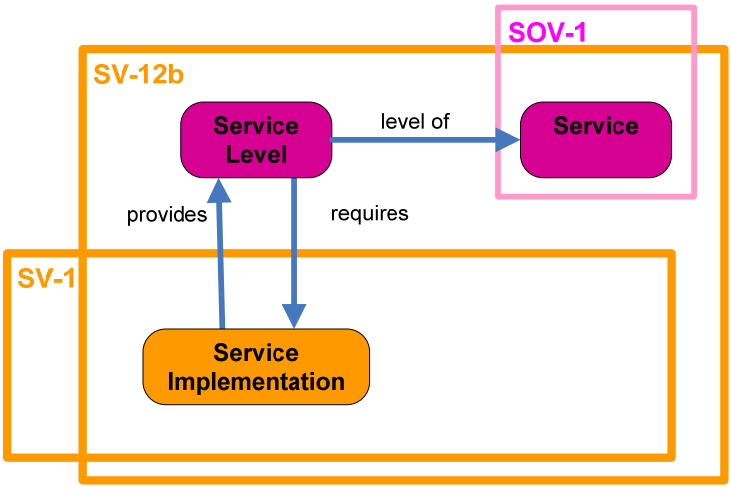
Usage

- Service implementation.
- Tracing business processes to the resources that support them.

Data objects

The data in an SV-12b can include:

- Service.
- Service Implementation.
- Service Level.



Relationships Between Key Data Objects (Simplified from M3)

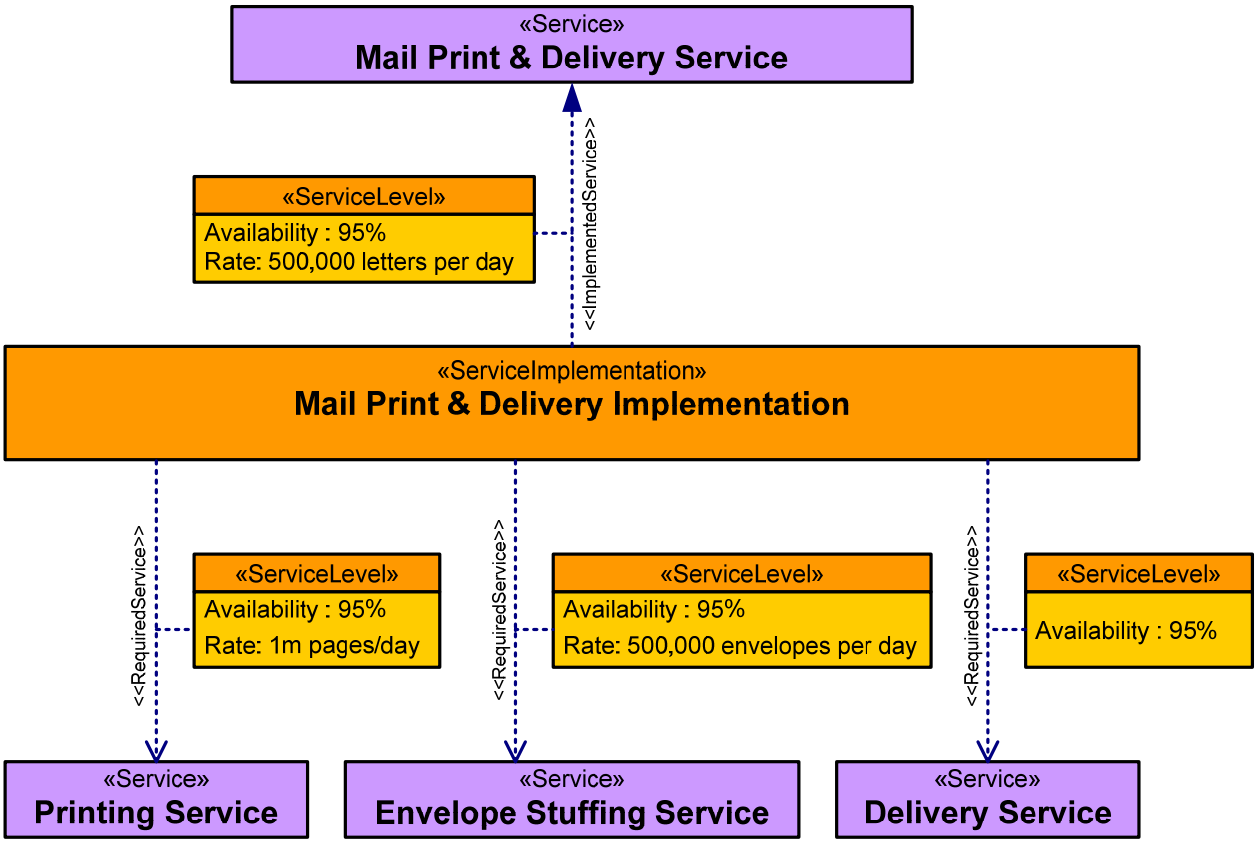
Representation

- Diagram.
- UML.

Detailed Product Description

An SV-12b shows what services are required by a Service Implementation in order to deliver one or more other services. This is effectively a composition of services.

In specifying the services the implementation requires, SV-12b will also specify the level of service required. Similarly, the level of service provided by the implementation will also be specified.



UML Representation of SV-12b