International Civil Aviation Organization

ICAO

The Fifth Meeting of System Wide Information Management Task Force (SWIM TF/5)

Video Tele-conference, 9 – 11 August 2021.

Agenda Item 7: Development of APAC SWIM Implementation Materials

UPDATE ON APAC SWIM IMPLEMENTATION MATERIALS

(Presented by the Secretariat)

SUMMARY

This paper presents the update on APAC SWIM Implementation Materials since SWIM TF/4 for review and consideration by the meeting.

1. INTRODUCTION

1.1 During the Third Meeting of the APAC SWIM Task Force (SWIM TF/3), one ACTION ITEM was developed as **ACTION ITEM SWIM TF/3/2-** *The Task Leads will address the Table of Contents at the next quarterly Task Force Lead Teleconference and provide input of the implementation materials by SWIM TF/4.* In SWIM TF/3, the title of the **Regional Implementation documents** was agreed as: "**APAC SWIM Implementation Materials**".

1.2 The Fourth Meeting of the APAC SWIM Task Force (SWIM TF/4) was held at the ICAO Asia-Pacific Regional Office, Bangkok, Thailand, from *03 to 06 November 2020*. During the meeting, Table of Contents (TOC) of **APAC Regional SWIM Implementation Guidance Document (IGD)** was proposed through Working Paper (WP)/03.

2. DISCUSSION

2.1 Information Management Panel (IMP) is in the process of developing a draft SWIM Manual Vol. II Implementation Guidance (Doc 10039) to provide top-level guidance. The manual is being updated to reflect the latest changes discussed for the proposed PANS-IM. A new version will be delivered at IMP end of September 2021. The latest version (the one presented during IMP-WG/10) is provided in **Appendix A.** It is to be noted that ICAO may choose to publish it as a separate document instead of Vol. II of the existing SWIM manual.

2.2 The objective of the SWIM Manual Vol. II is to provide global implementation guidance. Therefore, the SWIM TF is expected to follow the principles and guidance, and to further develop practical recommendations for implementation of SWIM in the APAC Region. Each task group has been developing recommendations and proposed solutions which would contribute to the deliverable of the APAC regional implementation document. The "APAC SWIM Implementation Materials" table of contents being under consideration by the Task Force is provided in **Appendix B**

2.3 The WP/03 of SWIM TF/4 discussed that APAC SWIM Implementation materials should be supplementary to the global implementation guidance manual for use by States at regional and national level. It should make reference to the global document and provide detailed guidance for SWIM planning and implementation in the APAC Region. It should be a living document for maintenance of useful materials developed by the SWIM TF. The regional document would also be used as reference for feedback to the global implementation manual for what detailed guidance would be required for SWIM implementation at regional and national level. The target date for completion of regional document would be after the availability of the global implementation manual as the gap for the regional need could be identified. The meeting agreed that the regional document should not conflict with the global guidance nor duplicate the core information of the global SWIM implementation manual.

2.4 The WP/03 also considered a follow-up to Action Item **SWIM TF/3/2** of SWIM TF/3 meeting. The SWIM TF/4 meeting discussed about the target audience, its purpose and its relation with **Global SWIM Implementation Guidance** (**SWIM Manual Vol. II**). The Task Leads and the associated contributors were requested to prepare their consolidated input to the APAC SWIM Implementation Materials at SWIM TF/4 meeting based on their presentations and studies, therefore a draft of APAC SWIM Implementation Materials was expected as outcome of SWIM TF/4 meeting.

2.5 The outbreak of COVID-19 pandemic projected unprecedented impact on aviation industries and also changed the original plan and available resource of this task. Considering the significant change of task force programme after SWIM TF/3, and the progress of DOC 10039 Vol II, the SWIM TF/4 agreed to **suspend** the ACTION ITEM SWIM TF/3/2 for some time and reactivate it upon further updates during the future Task Lead meetings or SWIM TF/5.

2.6 The outbreak of COVID-19 pandemic and consequently challenges continued in the year 2021. The impact on aviation industries became severe due to prolonged effect of business discontinuity for more than one year. The two task leads meetings held in the year 2021 focused on the Statement of Work (SOW) updates, timelines revision, and sub-tasks of revised Task 1-11 and to conduct ICAO APAC SWIM Workshop, which was successfully conducted on *06 July-07 July 2021*.

2.7 SWIM Repository was created in the **ICAO APAC-SWIM** Secure Portal to keep those useful materials to facilitate SWIM implementation at regional level. ICAO APAC-SWIM Secure portal is also being improved and being updated and modified with uploading of available information and documentation. The participants and concerned parties are encouraged to provide and share SWIM related video, training material and other useful information to SWIM TF and secretariat for future compilation on **ICAO APAC-SWIM** Secure Portal. The holders for Task assigned i.e. Task Leads and the associated contributors are also requested to prepare their consolidated input to the APAC SWIM Implementation Materials at SWIM TF/5 meeting based on their presentations and studies on subject/tasks assigned.

2.8 With the information aforementioned, the draft TOC of APAC SWIM Implementation Materials may be completed by SWIM TF/5 meeting, if possible or the SWIM TF/5 may **suspend the ACTION ITEM SWIM TF/3/2** for some more time and reactivate it upon further updates during the future Task Lead meetings or SWIM TF/6.

3. ACTION BY THE MEETING

3.1 The Meeting is invited to:

a) note the information contained in this paper;

b) consider a practical way to consolidate the outcomes and achievements made by this task force into the draft implementation under the proposed TOC structure; and

c) discuss any relevant mater as appropriate.

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English Only

Doc 10039

Manual on System Wide Information Management (SWIM)

Volume II — SWIM Implementation Guidance

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Chapter 1 AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

1.1 RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

TABLE OF CONTENTS

FOREWORD

Historical Background

TBD

Purpose

System-wide information management (SWIM) is a means for managing and exchanging information. It replaces the current ground-ground point-to-point message exchange paradigm with the information exchange via interoperable services based on internet technologies.

The goal is to provide the means for organisations to make ATM information available, allowing information service providers to interact effectively with information consumers. This volume provides an in-depth look at how the information provider prepares for the delivery of information and how the information service consumer discovers and consumes information services through SWIM.

This manual elaborates on the information management as articulated in the *Global Air Traffic Management Operational Concept* (*GATMOC Doc 9854).*

Volume I addresses the following:

1. Definition of SWIM-relevant terms to enable international discourse
2. Description of the SWIM concept and key principles
3. Introduction to the SWIM components (information, information services, technical infrastructure and governance)
4. Introduction to SWIM global interoperability framework (GIF) layers (information services, information exchange models (XMs), technical infrastructure) and their relationship to applications and network connectivity
5. Description of how information is exchanged, both air-ground[1] and ground-ground, using exchange standards, information services and technical infrastructure

Scope

Volume II of the Manual on SWIM contains guidance for information service providers and consumers when implementing SWIM.

It addresses SWIM implementation supporting, for example, flight and flow, aeronautical and meteorological information exchange. The SWIM technical infrastructure provides capabilities such as messaging and service monitoring.

The scope is limited to the exchange of information between information service providers and consumers. It touches on data origination in the quality management system aspects; however, the global aspects of data management and information management are out of scope of this document.

Volume II describes the Global Information Framework (GIF) and architectural frameworks that provide the backbone for interoperability.

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[1] Air-ground information exchange is out of scope of this edition of the *Manual on SWIM (Doc 10039), Volume II – SWIM Implementation Guidance*

Contents of the Document

Chapter 1 – Definitions and Acronyms – contains a list of terms with their technical meanings as well as the list of acronyms used in this document.

Chapter 2 – Service Orientation and SWIM Architecture – expands on the concept of SWIM global interoperability framework (GIF) introduced in the *Manual on System Wide Information Management (SWIM) (Doc 10039), Vol. I – SWIM Concept.* It also realises the link between the information services' principles provided by *Procedures for Air Navigation Services – Information Management – PANS-IM (Doc XXXX), Vol. I – System Wide Information Management* and the corresponding service-oriented architecture (SOA) principles.

Chapter 3 – Information Services – provides details on information services in the SWIM context. It covers the roles and the responsibilities in the framework of the information services, the service overview, the quality of service (QoS) and the validation of the information services, the SWIM service registries and the information service lifecycle.

Chapter 4 – Information – introduces the key components and practices that enable information interoperability in the context of SWIM. It also provides specific guidance on achieving information interoperability, through the syntactic and semantic alignment. It elaborates as well on the AIRM, the reference model for the definition of the data constituting the information services' payload. The alignment of the information exchange models with AIRM is paramount in achieving semantic interoperability.

Chapter 5 – Technical Infrastructure – provides details on the SWIM Technical Infrastructure (TI) for the implementation of interfaces between systems. It provides a decomposition of the SWIM TI into its functional (message, security, management) and non-functional capabilities, as well as details on the SWIM TI interface bindings and other technical infrastructure considerations.

Chapter 6 – Governance – provides details on the means of establishing a collaborative approach between SWIM Stakeholders for managing SWIM implementation and evolution. It allows building the trust among the SWIM stakeholders, with a focus on the expectations of the information service consumers, supporting in the same time the implementation of SWIM by the information service providers.

Chapter 7 – Evolution into SWIM – refers to the management of the SWIM planning and transition from the current services and infrastructure to information services and SWIM technical infrastructure (TI).

Chapter 8 – Quality – TBD

Chapter 1 Definitions and Acronyms

1.1 DEFINITIONS

Authoritative source. A State authority organisation or an organisation formally recognised by State authority that originates or publishes data which meets the Data Quality Requirements.

Availability (of a service). The degree to which a service is operational and accessible when required for use.

Business process. A defined set of business activities that represent the steps required to achieve a business objective. It includes the flow and use of information and resources.

Capability. The ability of a system to provide a service or perform a function that, either on its own or with other services or functions, can deliver a definable level of performance.

Capacity (of a service). The maximum rate at which a service can process transactions and the maximum message size of responses.

Note — Measurements can include the number of items that can be stored, the number of concurrent users, the communication bandwidth, throughput of transactions, and size of messages.

Collaborative validation. A validation of information service jointly carried out by the service provider together with service users.

Community of interest. A collaborative group of users who exchange information in pursuit of shared goals, interests, missions or business processes.

Note. – Communities of interest are established in a variety of ways and may be composed of members from one or more functions and organisations as needed for a shared mission.

Confidentiality (of a service). The degree to which a service ensures that data are accessible only to those authorized to have access.

Data. A representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing.

Data Exchange Language. Data definition language for describing data and data structures in an information exchange.

Data format. A structure of data elements, records and files arranged to meet standards, specifications or data quality requirements.

Exchange Schema. Formal description of the data involved in an information exchange, in particular including the encodings and other applicable constraints.

Note - An exchange schema assists information service consumers in understanding the syntax of the data delivered by the information service, and the technologies required for locally *processing the data received. An exchange schema is based on a data exchange language which is standardized. For example, XML Schema is a W3C data exchange language used to define XML encoded messages.*

Governance. The set of governance bodies, standards, policies and processes that ensure information required for global interoperability is provided by reliable, trusted services.

Independent validation. A validation of service carried out by an independent authority.

Information. The result of the assembly, analysis, formatting, and documenting of data, to make the data useful in an ATM context.

Information domain. The scope of the integrated data for a distinct set of business activities that produce a set of unique information products and services.

Information exchange model. A document in a formal language identifying the information that is agreed to be shared between two or more organisations or groups and includes at least one exchange schema for the associated data.

Note — an information exchange model is normally defined for a specific information domain, such as aeronautical information, meteorological information or flight information. This typically includes the definition of information entities and their relationships.

Information exchange requirement. A specification of the information that is to be exchanged.

Information quality. The degree or level of confidence that both the data quality and the process used to convert data into information meet user requirements.

Information service. A type of service in a service-oriented architecture that provides an ATM information sharing capability.

Information Service Consumer. A service consumer receiving information from information service providers using information services.

Note – The information service consumer role and the information consumer role may be allocated to different parties.

Information Service Function. A type of activity describing the functionality of an information service.

Information Service Interface. The means by which the underlying capabilities of a service are accessed.

Information service payload. The assembly of information exchanged using an information service.

Note — Information Service Payloads support specified function(s) or purpose, independent of overhead required to enable the information exchange, such as headers, and security requirements.

Information Service Provider. A service provider making information available to information service consumers using information services.

Infrastructure service. A type of service that provides SWIM infrastructure capabilities such as interface management, request-reply and publish-subscribe messaging, service security, and enterprise service management.

Integrity (of a service). An expression of the assurance that a system, product or component prevents unauthorized access to, or modification of an information service interface or information.

Interface binding. Specification of the protocols and data formats to be used in transmitting messages defined by the associated interface.

Note — Two systems that implement the same interface binding are considered technically interoperable and are able to connect to each other and exchange information. There are two types of interface bindings to be distinguished based on their position in the TCP/IP protocol: service bindings and network bindings. Service bindings specify the service interface protocols (e.g. protocols to interface with the applications, such as HTTP and AMQP). Network bindings specify the transport and network related protocols that will be used to exchange data over the network (e.g. TCP, IP v4/v6).

Interoperability. The ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable the sharing of information and knowledge.

Loose coupling. A characteristic of systems, in which dependencies among system's constituting parts are minimal.

Message. A discrete unit of communication intended by the source for consumption by a given recipient or group of recipients.

Note — the term message refers to a unit of information exchange between systems that communicate via information services. Although there are similarities, no direct comparison should be made with the term message used in other ICAO documents (e.g. CPDLC message).

Message exchange pattern. A template that describes relationships of multiple messages exchanged between interacting components to accomplish a single complete information exchange.

Messaging capability. The SWIM Technical Infrastructure capability enabling the delivery of messages.

Metadata. Information about a resource.

Note — An information service, an information service overview, a dataset are examples of resources.

Non-functional requirement. Requirement that specifies criteria or constraints on the design or implementation of a system or service.

Open standard. A standard which is made available to the general public and is developed (or approved) and maintained via a collaborative and consensus driven process.

Operational (status of a service). The status indicating that the service is employed in its operational environment.

Prospective (status of a service). The status indicating that the service is being designed, developed, or tested for operational activities and is expected to be available in the future.

Quality of service. The degree or level of confidence that the performance of a service meets users' requirements.

Recoverability (of a service). The degree to which, in the event of an interruption or a failure, the desired state of the service can be re-established.

Reference model. An abstract framework for understanding significant relationships among the entities of some environment.

Reliability (of a service). The degree to which a service performs specified functions under specified conditions for a specified period of time.

Retired (status of a service). The status indicating that active support for the service has been withdrawn, the service has been partially or totally replaced by a new service, or an upgraded service has been installed.

Security capability. The SWIM technical infrastructure capability enabling secured information exchange.

Self-validation. A validation of service carried out by the service provider.

Semantic interoperability. The ability of computer systems and organisations to exchange information with unambiguous, shared meaning.

Service. A mechanism to enable access to one or more capabilities using a prescribed interface.

Note — in the context of system wide information management, the notion of service addresses machine-to-machine interaction based on service-oriented architecture principles, and is not to be confused with the notion of service as used in ICAO provisions referring to business services such as AIS, ATS, etc.

Service consumer. An entity which seeks to satisfy a particular need through the use of capabilities offered by means of a service.

Service definition. A document, issued by a community of interest, used to harmonize service implementations.

Service description. Information needed in order to use, or consider using, a service.

Service instance. The service deployed into a running ICT system.

Service lifecycle stage. A classification of services in terms of status indicating their current, past, or future availability for provisioning.

Service operation. Specification of a transformation or query that an object may be called to execute.

Service orientation. The designing of systems in terms of services and service-based development.

Service-oriented architecture. Architectural style that supports service orientation.

Service overview. A set of information service metadata intended to promote service discovery and an initial evaluation of the information service characteristics.

Service parameter. A variable that an operation can interpret when invoked.

Service provider. An entity (person or organisation) that offers the use of capabilities by means of a service.

SWIM region. A geographical area in which a group of States and/or ATM stakeholders has agreed upon common regional governance in support of system wide information management implementation.

Note: A SWIM region can be an ICAO region or any other area in which a community of interest has agreed on common governance.

SWIM service registry. A directory containing entries with the information necessary to discover and access services.

SWIM stakeholder. A stakeholder in the SWIM community, having distinct roles pertaining to and aligned with the components of SWIM.

SWIM standard(s). (One member of) The set of technology standards and specifications selected by SWIM Governance for use in a SWIM implementation.

Syntactic interoperability. The ability of systems to correctly interpret the structure of exchanged data, and thus, of being capable to read its content.

Note 1 – syntactic interoperability is enabled by using a standard exchange language.

Note 2 – syntactic interoperability is a prerequisite for semantic interoperability.

System Wide Information Management (SWIM). SWIM consists of standards, infrastructure and governance enabling the management of ATM related information and its exchange between qualified parties via interoperable services.

Technical infrastructure. The assembly of software and hardware used to enable the provision of information services.

Technical infrastructure management capability. The SWIM technical infrastructure capability enabling the monitoring of the performance of the technical infrastructure.

Time behaviour (of a service). A measurement of the processing times of a service.

Note — this parameter may be expressed as an indication of a maximum time needed for the service provider to complete the request, measured from the time instant the service provider receives the request to the time instant the service provider sends the response or makes it available.

User validation. A validation of service carried out by service users.

Validation of information service. An activity whereby a service is checked for conformance with the service objectives and requirements.

Note — the service objectives and requirements are captured in the service overview and the technical specifications.

1.2 ACRONYMS

AFS	Aeronautical Fixed Services
AIDC	ATS Interfacility Data Communication
AIS	Aeronautical Information Services
AFTN	Aeronautical Fixed Telecommunication Network
AIRM	ATM Information Reference Model
AIXM	Aeronautical Information Exchange Model
AMDAR	Aircraft Meteorological Data Relay
AMHS	Advanced Message Handling System
AMQP	Advanced Message Queuing Protocol
ANSP	Air Navigation Service Provider
API	Application Programming Interface
ASBU	Aviation System Block Upgrades
ASP	ATM Service Provider

ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Services
AU	Airspace User
BPM	Business Process Model
BPMN	Business Process Model and Notation
CIDIN	Common ICAO Data Interchange Network
COM	Communications
FF-ICE	Flight and Flow – Information for a Collaborative Environment
FIXM	Flight Information Exchange Model
FPL	Flight Plan
GANP	Global Air Navigation Plan
G/G	Ground-to-Ground
GIF	(SWIM) Global Interoperability Framework
GML	Geography Markup Language
HTTP	Hypertext Transfer Protocol
ICC	Inter-Centre Communications
IER	Information Exchange Requirements
IP	Internet Protocol
IPS	Internet Protocol Suite
IPsec	IP Security
IWXXM	ICAO Meteorological Information Exchange Model
MEP	Message Exchange Pattern
MET	Meteorological Services
METAR	Meteorological Aerodrome Report
NFR	Non-functional Requirements
NOTAM	Notice to Airmen
OLDI	On-Line Data Interchange
OPMET	Operational Meteorological information
OSI	Open Systems Interconnection
QoS	Quality of Service
PIREP	Pilot Report

PKI	Public Key Infrastructure
RESQ	Improved Traffic Flow Through Runway Sequencing
REST	Representational State Transfer
SARPs	Standards and Recommended Practices
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SPECI	Special Weather Report
SWIM	System Wide Information Management
TCP	Transmission Control Protocol
TI	Technical Infrastructure
UML	Unified Modelling Language
URN	Uniform Resource Name
UTM	Unmanned aircraft system Traffic Management
WSDD	Web Service Deployment Descriptor
XM	Information Exchange Model
XML	eXtensible Markup Language

Chapter 2 Service Orientation and Architecture of SWIM

From an implementation point of view, SWIM builds upon the notion of service as known in information and communication technology (ICT). It is defined as: "a mechanism to enable access to one or more capabilities using a prescribed interface". Whereas the term service is generic, information service is a specialisation whereby the function performed is information exchange. In SWIM, applying service orientation, stakeholders collaboratively define information exchanges by means of information services.

In support of the global interoperability, *PANS-IM (Doc xxxx) Volume I – SWIM* articulates in Chapter 2 the essence of SWIM by stating six principles applicable to information services. This chapter explains, from an implementation point of view, how the alignment with these principles can be achieved by following Service Oriented Architecture (SOA) practices.

2.1 CONTEXT – THE SWIM GLOBAL INTEROPERABILITY FRAMEWORK (SWIM GIF)

The SWIM GIF, presented in the *Manual on System Wide Information Management (Doc 10039), Volume I – SWIM Concept*, establishes the notion of information services in relation to other elements of the overall architecture of global ATM. These relations determine the specific application of SOA in the context of SWIM.

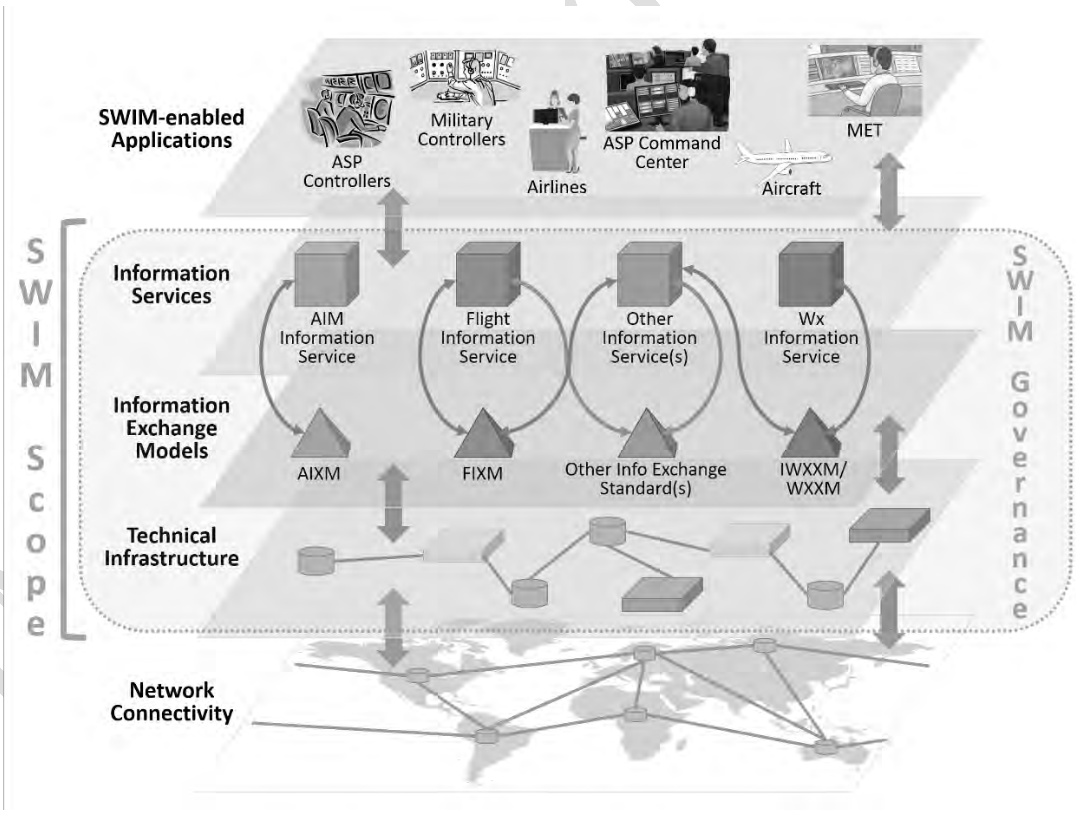

Figure 2-1: SWIM Global Interoperability Framework (GIF)
(from ICAO Doc 10039 Volume I)

Figure 2-1 provides a pictorial view of the SWIM GIF. According to the *Manual on SWIM (Doc 10039), Volume I – SWIM Concept,* the layers within the SWIM scope are information services, information exchange models and technical infrastructure. In order to support the six principles stated, SWIM Governance is considered an integral part of any SWIM implementation initiative. The GIF layers adjacent to the SWIM scope are the network connectivity and application layers. They are as such not part of the scope of SWIM.

SWIM-enabled applications consume or provide information services to enable interactions between users such as air traffic managers and airspace users. A SWIM-enabled application interacts with SWIM by providing or consuming information services. The interaction occurs through implementation of agreed-upon industry and technology standards that enable interoperability. In some cases, SWIM-enabled applications are new, but in many cases existing applications can be adapted to consume required information services, progressively migrating toward SWIM.

Information services support ATM information exchange within an information domain or across domains based on information exchange requirements. Descriptive information is needed to use or consider using an information service. Therefore, *PANS-IM (Doc XXXX), Volume I – SWIM* stipulates in Chapter 5 that information service providers describe service characteristics and share the resulting information for discovery. The present *Manual on SWIM (Doc 10039), Volume II – SWIM Implementation Guidelines* elaborates on service description information through the notion of service overview, the metadata about an information service intended to promote service discovery and initial evaluation.

Information exchange models, represented as the SWIM GIF layer directly supporting information services, determine each information domain's data and information characteristics. Information services typically use information exchange models to define information service payloads. This includes information content, structure and format. For example, a trajectory information exchange would be expressed based on the flight information exchange model (FIXM). Together the information services and the information exchange models define messages exchanged between information service providers and consumers when an information service is invoked.

The SWIM technical infrastructure provides capabilities such as interface management, messaging, service security, and enterprise service management. This SWIM GIF layer is essential for technical interoperability as it ensures secure information exchange.

Network connectivity transports messages over interconnected networks. The SWIM technical infrastructure is one client of this layer, and as such it is a source of functional and non-functional requirements that have to be delivered by the network connectivity layer.

From an implementation perspective, the *Manual on SWIM (Doc 10039), Volume I – SWIM Concept* represents the components of SWIM as depicted in Figure 2-2 below:

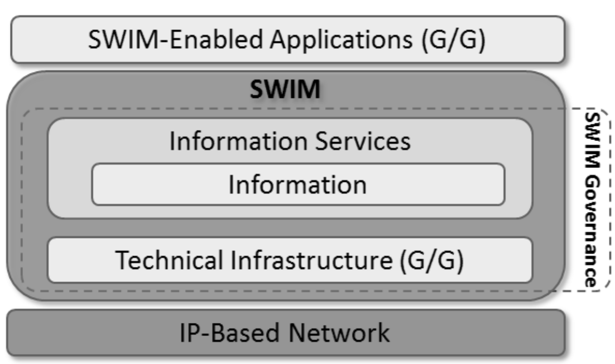

Figure 2-2: The components of SWIM

Figure 2-2 shows the SWIM components which are further discussed in this *Manual on SWIM (Doc 10039), Volume II – SWIM Implementation Guidelines*:

- Information Services (Chapter 3)
- Information (Chapter 4)
- Technical Infrastructure (Chapter 5)
- SWIM Governance (Chapter 6)

Note: Information is part of the information service component and referred to as information service payload.

2.2 REALIZING THE PRINCIPLES OF SWIM THROUGH SERVICE ORIENTED ARCHITECTURE (SOA)

2.2.1 Introducing SOA

Defining a single information service can be straightforward. However, creating interoperable services that work together, are re-usable, and respond to operational needs may become complex. It requires organizing and utilizing capabilities that may be distributed and under the control of or owned by different parties. Consequently, ATM stakeholders have to collaborate effectively in order to define and build services that can be combined. To facilitate this, a common paradigm is provided by SOA practices as an architectural style that supports service orientation and SOA principles.

While there is no formally-agreed-upon definition of SOA, partitioning functionality into de-coupled, self-contained and reusable services for discovery by potential information service consumers discriminates SOA from traditional architectural paradigms.

Note: Services can also deliver more complex capabilities, e.g. automatic execution of entire business transactions. Such applications of service orientation are not in scope of SWIM as discussed in this manual.

2.2.2 SOA Principles for SWIM Implementation

PANS-IM (Doc xxxx) Volume I – SWIM, articulates in Chapter 2 the essence of SWIM by stating six principles applicable to information services:

a) Use of interoperable information services
b) Separation of information provision and information consumption
c) Loose coupling
d) Discoverability
e) Use of open standards
f) Secure information exchange

A comprehensive set of SOA principles is captured, inter alia, in the ISO/IEC 18384-1 standard “Reference Architecture for Service Oriented Architecture”. Given that the focus of SWIM is on information services, not necessarily addressing all features of a fully-fledged SOA, the ISO/IEC 18384-1 principles stating that services should be interoperable, discoverable, self-contained and loosely coupled are further discussed in the following paragraphs.

According to ISO/IEC 18384-1, the **interoperable** principle is achieved when information service providers and consumers are able to exchange information using information services effectively at the technical, syntactical and semantic level. Chapters 3 to 5 of the present manual provide guidance on how to achieve this, for instance through the use of the AIRM, information exchange models, and open technology standards, a particularly relevant consideration in a global cross-stakeholder environment using different technologies. These aspects contribute to achieving interoperability, but further interoperability dimensions exist such as at the organisational level. Chapter 6 elaborates further on this topic.

The **discoverable** principle is achieved when it is possible to find out about the existence, location and description of an information service, usually in preparation of an interaction with it. Chapters 3 and 6 on the service overview and the SWIM service registry explain how this objective is achieved in SWIM. The SWIM service registry approach to realising the discoverable principle of information services implies that all services are duly described by metadata (note that ISO/IEC 18384-1 lists the existence of service descriptions as a separate SOA principle).

The **self-contained** principle is achieved when an information service can be consumed using only the information made available about the information service itself. According to ISO/IEC 18384-1 this means that an information service can be consumed with only the information available in the description of the information service. This implies that the information service consumer does not need to know how the information service is built and operated by the information service provider. In SWIM, achieving this is key to realizing separation of information provision and information consumption, one of the principles applicable to information services (the self-contained principle has a dependency on the “discoverable” principle). Chapter 3 addresses service description by elaborating on the scope of the service overview defined in *PANS-IM (Doc XXXX), Volume I – SWIM*.

The **loosely coupled** principle is defined as: “A characteristic of software systems, in which dependencies among system's constituting parts are minimal”. Loose coupling is achieved when service consumption is insulated from underlying implementation. In such cases system components make use of as little knowledge as possible of the definitions of other distinct components. This principle applies to the service interface bindings. Chapter 5 elaborates on the interface bindings used in SWIM.

ISO/IEC 18384-1 defines further SOA principles including reusable, compose-able and late bind-able. These SOA principles are effective in particular when an organisation uses service orientation to refactor the ICT support of its operations (i.e. its applications or internal systems) into a modular architecture to make it more flexible. These advanced uses of SOA redefine the way SWIM-enabled applications are built. These aspects, and hence the associated additional SOA principles, are however not in scope of SWIM supporting global interoperability. Nevertheless, a service architect (see section 2.4) may use these additional principles as supplementary guidance when working on local SWIM implementation.

This manual recognizes that many organisations in ATM internally pursue SOA as a strategic aim to foster agility in a connected digital environment and improve cost efficiency. It is important to realize that service orientation in the context of SWIM complements this type of strategy at an inter-organisation level. However, neither is a precondition for the other. Organisations will benefit from SWIM whether or not they internally pursue SOA, and SWIM can be deployed in absence of SOA initiatives within the stakeholder organisations.

Note: ISO/IEC 18384-1 also establishes as principle that SOA services should be "manageable". This is achieved when services and solutions can be operated and governed such that pertinent governance policies and agreements are adhered to. The principle of being "manageable" establishes the need for an effective SOA Governance. The SWIM concept considers SWIM Governance as part of SWIM itself. Therefore the "manageability" principle is not stated explicitly as a SWIM principle.

2.2.3 Information Service Principles for SWIM and their SOA Realization

In summary, the information service principles for SWIM can be realized by applying the SOA principles as follows:

Information service principles for SWIM	Realized by application of SOA principle
Use of interoperable information services	Interoperable
Separation of information provision and information consumption	Self-contained
Loose coupling	Loosely coupled
Use of open standards	Interoperable
Secure information exchange *Note: resilience of the aviation system against cyber threats is a safety prerequisite.*	Interoperable
Provision of a discovery function	Discoverable

Table 2-1: SOA principles applicable in the SWIM context

In addition, standards such as ISO/IEC 18384-1 and other ICT industry guidance on SOA can be used to further elaborate the information service principles for SWIM into concrete software and systems architectural rules applicable as required for specific deployments. Also, a suitable service orientation process needs to be put in place to ensure the application of these rules.

2.3 SERVICE ORIENTATION

2.3.1 Service Orientation Practices

The overarching objective of any service orientation process is to establish a coherent set of information services. There are different ways to achieving this, including a "top-down" approach (generic requirements and architecture driven), or "bottom-up" (productivity driven), or even a combination of top-down and bottom-up.

The "top-down" approach aims at architecting services through stepwise refinement of a comprehensive set of high-level requirements, guided by the information service principles for

SWIM. SOA methodologies for this type of approach typically contain four generalized service orientation process steps: **identify, design, implement,** and **deploy** (see Figure 2-5):

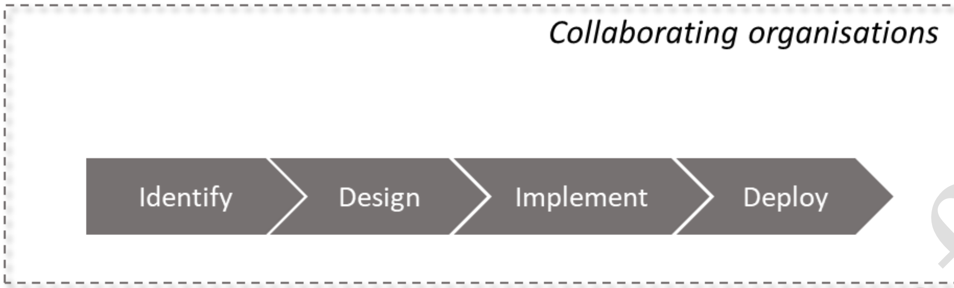

Figure 2-3: Service orientation process steps

Section 2.5 contains a detailed example of a sequence of activities that would be executed in a "top-down" approach by the roles described in section 2.4.

A "bottom-up" approach typically involves incremental change of existing interfaces to improve alignment with the information service principles for SWIM. An important difference with regards to "top-down" approaches is the absence of the "identify" process step.

"Bottom-up" service orientation activities will primarily be driven by existing collaborations. SWIM stakeholders interested in more detailed advice on "bottom-up" service orientation could for example look into adapting one of the "agile" methodologies of ICT for their purpose. They could also take into account the skill descriptions of section 2.4, noting that in "bottom-up" approaches there is usually less emphasis on formal documentation of artefacts such as models.

Yet, whatever the approach used in service orientation, the result is an implemented and running service which service consumers can use. Going back to the "top-down" approach, at the end of the deploy step, a running service (i.e. a service instance) will need to be managed. It means that when the deploy step is achieved, the work continues at this level. The following section further expands on this separation.

2.3.2 Service Orientation and Service Management

The notion of service covers two aspects that a service may entail:

- A representation of a service (e.g. a model of a service);
- A realisation of a service (i.e. a running service).

The notion of service can also be observed through two points of view:

- Collaborating organisations practicing SOA;
- Individual organisation's ICT asset management.

From the point of view of collaboration between organisations, the primary concern when practicing SOA is to "agree on services", i.e. to create a representation (document or model) defining what is to be provided and consumed. This perspective corresponds to the service notion in ISO/IEC 18138-1: a logical representation of a service. In this manual, the SOA point of view is captured by the service orientation process steps that describe the typical activities carried out when performing service orientation “top-down”. The collaboration between implementing organisations leads to the definition of a service which is subsequently realised by an individual organisation when implemented and addressable.

Note: SOA practitioners generally avoid including technology-specific details when designing services collaboratively and differentiate between platform-dependent and platform-independent specifications. When technology-related agreements can be reached upfront collaboratively, this strict separation may not be required.

From an individual organisation’s ICT asset management point of view, the actual delivery of value is based on the provision and/or consumption of running services. These running services are part of an organisation’s ICT assets and value chain. ICT management practitioners typically demonstrate the good management of the provided services in accordance with a service management system such as standardised in ISO/IEC 20000-1. This involves the service lifecycle steps: **planning**, **design**, **transition**, **delivery**, **improvement**, and **retirement** as described in Chapter 3. These steps are depicted in **Figure 2-6**:

Figure 2-4: Service management system – service lifecycle steps

Whilst service orientation ultimately leads to running services, service orientation itself is complementary to service management applied by the individual implementing organisation. Hence, service orientation itself does not lead to the ability of an organisation to demonstrate the provision of quality running services.

Based on the two points of view described above, it is apparent that there are touch points between the service orientation process steps and the service lifecycle. The two points of view are merged in the Figure 2-5 below:

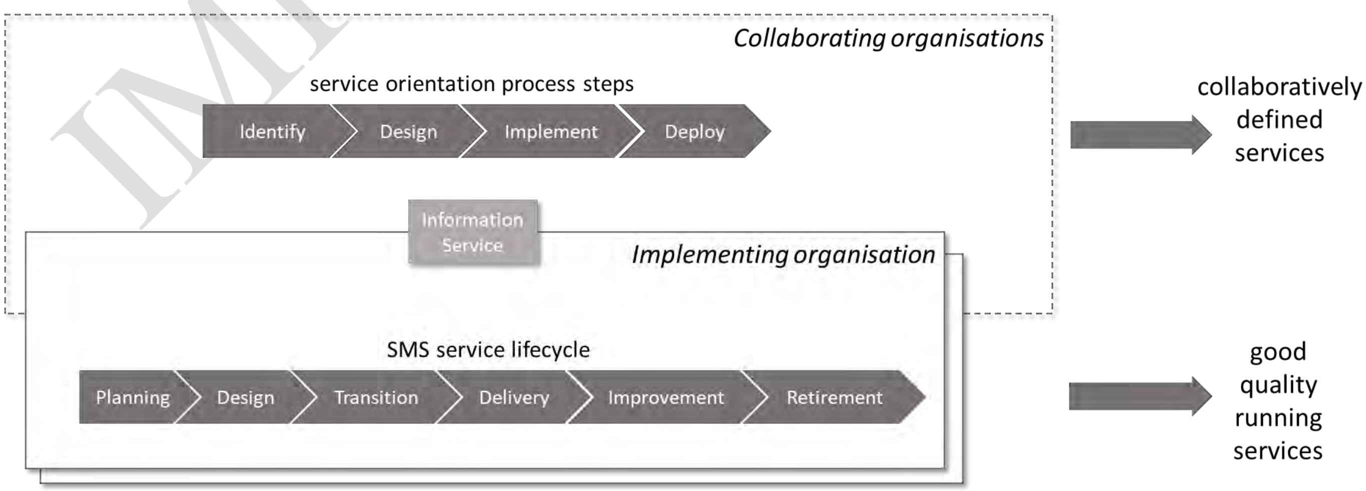

Figure 2-5: Service orientation process steps and service management system service lifecycle

Applying service management system practices leads to well-managed information services in operations and their controlled evolution, hence resulting in good quality running services. This contributes to the value proposition of an organisation. Applying service orientation process steps leads to a coherent portfolio of collaboratively defined services (i.e. service definitions). This contributes to the positioning of an organisation in collaborative business processes.

This manual underlines the difference between service orientation and service management when performing a digital transformation, to ensure:

(i) good practice when working towards a SOA, and
(ii) good service management practice when implementing services.

The remainder of this chapter discusses service orientation aspects. Chapter 3 introduces topics relevant to information service management throughout the service management system lifecycle.

Note: Data management practitioners commonly understand the related lifecycle steps as: create, store, update, archive, and delete. Information results from assembling, analysing, formatting and documenting data. The activities performed to manage information relate to the information management lifecycle steps, such as for example in the aeronautical information domain: collect, process, store, integrate, exchange and deliver (see Annex 15, Chapter 3, 3.1).

2.4 SKILLS FOR SERVICE ORIENTATION

Organisations working together in developing a SOA need to ensure that the required skills are available to design and implement the new architecture.

The typical skill profiles involved in service orientation are listed here:

Business expert: defines the business function, mission statements and value chain. The business expert states the specific business to be covered using information services in accordance with the directions of the stakeholder community.

Operational expert: contributes to operational concept descriptions and performs the role of operational subject matter expert knowledgeable about stakeholder needs. In order to capture collaborative processes, the operational expert contributes to process documentation, captured for example in business process models (BPMs). Operational experts also contribute to eliciting information exchange requirements (IER) and non-functional requirements (NFR) in relation to information exchanges. To accomplish their tasks in the context of service orientation, it is good practice to assist operational experts with service and information architects with the necessary skills to re-express these inputs in technical terms suitable for further elaboration into information services.

Service architect: responsible for service orientation, and primary "guardian" of the information service principles. The service architect uses operational concepts, BPMs or other process documentation, IERs and NFRs to drive the service orientation process. Typically, a service architect collaborates with an operational expert to identify information services that establish an information exchange. Service architects work closely with information architects on information service payload aspects. Service architects may also be active at the implementation level and collaborate with technical infrastructure experts and solution implementers.

Information architect: responsible for defining and representing required information in the information service payload context. Information architects use the IERs to assemble the information service payload for implementation purposes. Information architects may be specialised in one of the ATM information domains and provide the corresponding subject matter expertise. Information architects work closely with service architects and should have a good understanding of the AIRM, how to align, and how to model the information service payload(s).

Technical infrastructure expert: responsible for defining the technical infrastructure used to execute information services and perform the information exchange. The technical infrastructure expert provides the expertise needed to ensure that the information exchange is performed in a trusted, reliable and secure way. This requires an understanding not only of the applicable technology standards and their implementation, but also of the practical needs of IT operations. Technical infrastructure experts collaborate with service architects to ensure that the technical infrastructure meets information services' NFR.

Solution expert: responsible for implementing information services and SWIM-enabled applications. For example, a solutions expert integrates a consuming client into an application which consumes an information service or implements an information service (provider side). A solutions expert builds applications based on the applicable service designs and technology standards. A solution expert is consulted by the service architect and infrastructure expert, for example on the technical choices of a service design and possible optimizations in relation to implementation considerations.

2.5 WORKED EXAMPLE: "TOP-DOWN" SWIM SERVICE ORIENTATION

This section provides an indicative example of a service orientation performed top-down based on the skill profiles explained before. Indeed, as mentioned above, the top-down process is one of stepwise refinement. Furthermore, to describe the refinement process, this section introduces lower-level conceptual components of an information service, namely the service interfaces, operations and parameters. Service interfaces are the means used to access the underlying service capabilities. To do so, service interfaces consist of one or more service operations. Services typically communicate by sending/receiving messages as a result of invoking service operations. A parameter is a variable that an operation can interpret when invoked. **Figure 2-6** below depicts these components:

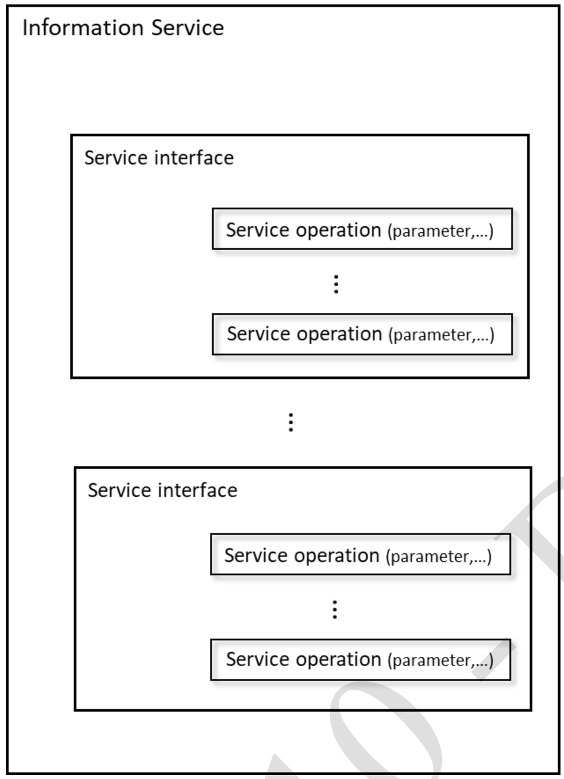

Figure 2-6: Conceptual components of an information service

Based on the above information service component breakdown, the following section describes the service orientation process in four generic steps: **identify**, **design**, **implement** and **deploy**. It is assumed throughout this description that all stakeholders concerned with the deployment of information services are involved by a suitable arrangement of "who does what" in terms of the skill profiles explained in section 2.4.

Identify: Service identification is the set of activities involved in documenting the information service's operational context in relation to the business need, information exchange requirements (IER), non-functional requirements (NFR) and operational scope. Examples of activities include:

- Description of an operational environment in which service orientation is envisaged;
- Determination of operational process (e.g. business process analysis using business process models (BPM)) leading to identification of information exchanges assigned to information service(s) (e.g. in response to a new business opportunity);
- Determination of IER and NFR related to information service(s); and
- Investigation of existing information service(s) for possible re-use, as-is or with modification;
- Characterization of the identified information service in terms of functionality.

Outcome:

- Documentation of operational processes and information flows;
- Identification of one or more information service(s) with determination of operational context (scope), requirements and functionality; and
- Service identification information (name, abstract, operational context, IERs, NFRs and functionality).

Skill profiles involved:

- Operational expert;
- Service architect; and
- Information architect.

Building blocks:

- ICAO documents (i.e. SARPs, PANS, Manuals);
- Business Process Model and Notation (BPMN); and
- List of existing services.

Design: Service design is the set of activities involved in expressing what the information service does and how it works. Service design practitioners typically use a modelling language notation to represent the blueprint of the information service.

Examples of activities:

- Selection of the message exchange pattern (MEP);

  Note: the MEP is chosen from the list of MEPs (see section 5.3.1.1.1).

- Definition of the service (interface, service operations and information service payload); and

  Note: it is a good service orientation practice to provide the blueprint of a service (i.e. the service design) as a service model, e.g. using the Unified Modelling Language – UML – as a notation mechanism (e.g. including for service interfaces, service operations, and service payload).

- Sharing of service description information through the service overview (e.g. using a SWIM service registry).

Outcome:

- Chosen MEP;
- Service model (service interface(s), service operation(s), service behaviour);
- Service payload (the logical representation of information exchanged by service interface operations);
- Service design information expressing what the service does and how it works (e.g. the blueprint of the service); and

  Note: A service design (e.g. as a service model) is typically used when multiple service providers run the same service (e.g. the service implementations are based on the same definition).

- Service overview with "prospective status" to announce future service availability.

Skill profiles involved:

- Service architect;
- Information architect; and
- Technical infrastructure expert.

Building blocks:

- List of MEPs;
- List of service designs;

- UML; and
- AIRM.

Note 1: Making a service design available (e.g. as a standard service definition) before the service instance is actually implemented is a good SWIM practice that can lead to harmonization of implementation (e.g. when multiple providers provide the same service).

Note 2: Mapping the information service payload to the AIRM will support semantic interoperability.(see also Chapter 4)

Implement: Service implementation is the set of activities by which the information service is implemented in a target environment and technology context. Service implementation involves testing and validation.

Examples of activities:

- Selection or definition of the data format;

Note 1: the data format is based on an information exchange model (XM), or a profile thereof, or a new data format is defined.

Note 2: typically the exchange schema component of an XM is used as the standard exchange language to define messages.

Note 3: the choice for an XM may already be available from the design step.

- Definition of the message(s) used to interact with the service interface;
- Selection of the service interface protocols;

Note 1: a service interface protocol is chosen from the list of technical infrastructure protocol standards. These protocols may be grouped into interface bindings (see section 5.3.3).

Note 2: technology details may already be available from the design step.

- Implementation of service(s) using technology and based on implementation choices made;
- Integration of the service(s) into the target environment;
- Verification and testing of the service(s); and
- Validation of the service(s).

Outcome:

- Chosen XM or other data format;
- Chosen service interface protocol;
- Message definition;
- Implemented service(s) (interfaces and operations);
- Machine readable service definition;
- Verification report, validation report;
- Service Overview (update);
- Verification report;
- Validation report; and
- Implementation information (e.g. service interface protocols and Quality of Service (QoS) characteristics).

Skill profiles involved:

- Solution expert;
- Technical infrastructure expert;
- Service architect;
- Information architect; and
- Operational expert.

Building blocks:

- Lists of standards (e.g. formats, technical infrastructure protocols/bindings).

Deploy: Service deployment is the set of activities by which the information service instance is made available for use in operation.

Examples of activities:

- Deployment of the information service instance with an addressable end-point used in operations;
- Completion of the description of the service for service consumers; and
- Registration of the information service instance to enable discovery of the service (e.g. using a SWIM service registry to publicize the service overview).

Outcome:

- A configured information service running and available for operational use by service consumers.
- Completed service overview publicized with "operational status", to announce operational availability of the service.

Skill profiles involved:

- Solution expert; and
- Service architect.

Building blocks:

- No examples provided since the building is assumed to be completed at this stage.

2.6 MANAGING TECHNICAL ARTEFACTS IN SWIM

The SWIM GIF, presented in the *Manual on SWIM (Doc 10039), Volume I, – SWIM Concept* and in section 2.1 above represents the minimum understanding required to start work on SWIM and is therefore the baseline for the service orientation process.

At the next level of refinement, the interoperability architecture provided in 8.3Appendix A is an example of a structured approach under the form of a grid that facilitates collaboration. It is used to organize, categorize, and collaboratively understand the building blocks used to develop and implement information services. An interoperability architecture is recommended to ensure coordination between the different activities of the service orientation process, both in terms of content and planning.

Service orientation may also require specifically defined documents reflecting for example the operational environment, the requirements and different evolution stages of the service design. As these documents/artefacts are service orientation process specific, further guidance is not given in this manual.

For the individual information services, the interoperability architecture is complemented by the service overview. This may regionally be amended with further information that is accessible through a SWIM service registry.

Chapter 3 Information Services

3.1 INTRODUCTION

Information services provide ATM information sharing capabilities, including the capability for an information service consumer to interact with a provider. Information services therefore consist of operations and messages within a defined functional scope that allow for efficient information exchange. For example, an information service in the flight domain may enable an information service consumer to receive all flight plan information within a specific Flight Information Region (FIR). Information services are thus designed to be the means through which the ATM community will disseminate and access ATM information.

The *Global Air Traffic Management Operational Concept* (Doc 9854) in paragraph 2.9.1 describes the role of information services as ensuring the "cohesion and linkage" between the ATM system components. To that end, the information services development must adhere to certain objectives derived from other ICAO documents and to the operational experience as included below:

a) ATM information must be shared on a system-wide basis (Doc 9854, 2.9.5);

b) ATM information should be available when and where it is required (Doc 9854, 2.9.6);

c) The temporal and geographical nature of ATM information should be recognized and accommodated when data is issued (Doc 9854, 2.9.7 and Doc 9882, R79);

d) ATM information that is not relevant anymore should be removed and/or archived (Doc 9882, R75);

e) Historical ATM information should be made available for strategic planning and analysis;

f) Planned changes and forecast ATM information should also be made available for strategic planning and analysis;

g) ATM information should be structured in such a manner to permit personalization, filtering and access, as needed. (Doc 9854, 2.9.8);

h) The initial quality of the ATM information should be the responsibility of the originator; subsequent handling will not compromise its quality (Doc 9854, 2.9.8);

i) ATM information services should use information exchange mechanism when proven beneficial to the ATM system, through messaging protocols and procedures that ensure appropriate performance can be achieved (Doc 9882 R12).

3.2 INFORMATION SERVICES

As the means through which organisations make information available to other organisations, information services represent a critical component of the SWIM implementation. As information services will be a form of interaction across organisations, the method by which each information service is described and communicated to other organisations is key to ensuring a common understanding of the information service, content, interfaces, and the governance policies that the information service follows.

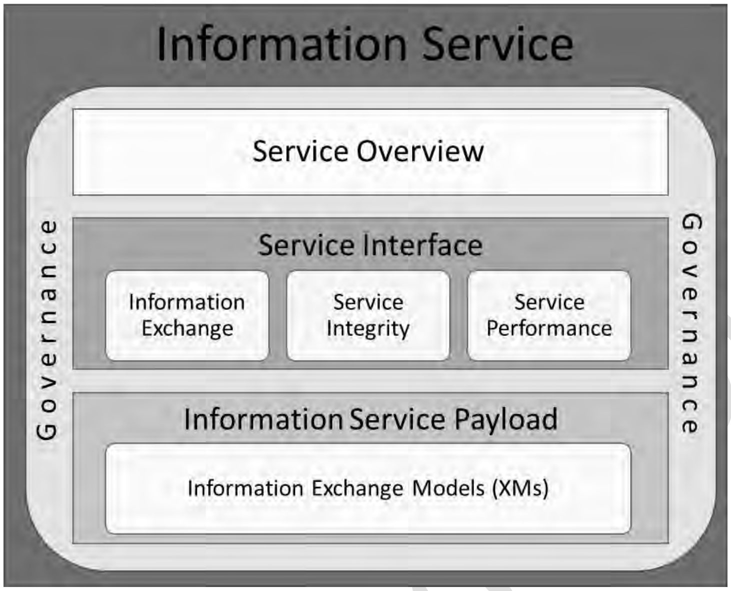

Figure 3-1: Information Service Components

Figure 3-1 illustrates components in which the information service can be described. These components are organized into a hierarchy of the Service Overview, Information Service Interfaces, and Information Service Payload, with Governance overarching all aspects of the information service.

3.2.1 Service Overview

A common set of information for the Service Overview provides SWIM service registries, discussed in section 3.7, with a consistent approach to the description of the information service function and data provided to support service discovery and initial evaluation. This enables information service consumers to discover which information services suits their individual needs. The Service Overview is further expanded upon in section 3.4 Information Service Overview.

3.2.2 Information Service Interfaces

3.2.2.1 Information Exchange

Information services enable the exchange of information between information service providers and consumers by exchanging discrete information packets, known as messages. Depending on the information service function, these information exchanges may be accomplished using various types of messaging methods (e.g. publish/subscribe, request/reply, etc.). Messaging is further discussed in section 5.3.1.1 Messaging Capabilities.

3.2.2.2 Service Integrity

Service integrity assures providers and consumers that the information exchanged originates from trusted sources and is not modified by unauthorized systems. Various information services require different levels of service integrity including, but not limited to identity management, authentication and authorization, cryptography, key management, etc. Technical information service integrity is handled by SWIM Technical Infrastructure, as discussed in section 5.3.1.2.

3.2.2.3 Service Performance

Information services require a certain level of performance and QoS to ensure that messages are exchanged within given tolerances to meet the needs of both the information service provider and consumer. Information service performance and QoS include parameters such as availability, latency, capacity, etc. Information service performance and QoS are further addressed in section 3.5.

3.2.3 Information Service Payload

3.2.3.1 Information Exchange Models

There are many different means and principles employed in the exchange of aeronautical, flight, and weather messages. Documenting the information exchange model used by each information service and providing that information within a Service Overview supports the ability for the information service consumer to make informed decisions in choosing which information service to consume and which standards they wish to support.

The aviation industry has made progress towards information exchange model harmonization (e.g. Aeronautical Information Exchange Model (AIXM), ICAO Meteorological Exchange Model (IWXXM), Flight Information Exchange Model (FIXM), etc.). The development and maintenance of these specifications will enable a wider global effort to participate and share consensus and outcomes. These exchange specifications are further addressed in section 4.4.3.

3.3 INFORMATION SERVICES PROVIDER AND CONSUMER ROLES AND RESPONSIBILITIES

Information services provide capabilities to share information pertinent to ATM business operations by exchanging information between information service providers and consumers. An information service provider is an entity (person or organisation) that offers the use of capabilities by means of a service. A service consumer is an entity seeking to satisfy a particular need through the use of capabilities offered by means of a service. Each of these roles has different needs and requirements, as addressed in the following sections.

3.3.1 Information Service Providers

Information service providers are responsible for providing an information service payload and all associated documentation. Therefore, they must offer confidence they can meet the expectation they are setting with the provided service.

Information service providers operate within constrained environments that drive the parameters of the services they offer. Typical constraints include sensor data generation rates, bandwidth, etc.

The service proposed by the information service provider includes a Service Overview that describes measurable QoS characteristics that the service is predicated upon. The information service provider declares their quality parameters to establish the necessary agreement and trust to ensure the operational requirements are met. If the information service consumer does not accept the offered QoS, the information service provider and consumer may initiate service level negotiations, which may include both parties performing design trade-offs and business-specific analysis, to determine whether their desired performance requirements are met. A service level agreement would then be established against those negotiated parameters.

An organisation that provides an information service may also act as both provider and consumer of information based on the type of information the service employed. For example, an ANSP-operated Air Traffic Flow Management (ATFM) information service may provide airspace flow constraint information to the service consumers, which also allows information service consumers to submit preferred routes to the service, serving as inputs to ATFM calculations.

3.3.2 Information Service Consumers

An information service consumer is a user, application, or system that consumes an information service made available by an information service provider. Before ingesting an information service, the potential consumer identifies a need for ATM information, e.g. a flight plan (FPL) information. To find applicable information services, the potential information service consumer accesses a SWIM service registry and searches, based on their information need – FPL information in this case. A SWIM service registry serves as central repository of the information service metadata included in the Service Overview, as described in section 3.4. Depending on the information service provider, different services may have different conditions for access, as specified in the Service Overview; this will be resolved in any agreements entered into with the information service provider. 8.3Appendix C provides a specific example of how a potential information service consumer would interact with an information service provider to begin using a service.

Note: Further considerations about roles and responsibilities of SWIM stakeholders are provided in section 6.5

Additionally, the information service consumer will determine whether the quality of the service provided meets their respective performance requirements. Hence, it is incumbent upon the information service consumer to determine whether the QoS satisfies the requirements for their intended use.

3.4 INFORMATION SERVICE OVERVIEW

In a SWIM environment, it is important to use a common means by which information service providers and information service consumers can understand what these services actually provide.

A Service Overview is a set of information service metadata intended to promote service discovery and an initial evaluation of the information service characteristics (8.3Appendix B provides examples of service overview). This information allows information service consumers to discover information services that may meet their need.

Service Overviews should be available in a SWIM service registry, which serves as a repository to enable potential information service consumers to discover information services. The Service Overviews will be populated by the information service providers and aggregated in a registry. Details on SWIM service registries are further provided in section 3.7. Examples of Service Overviews are shown in 8.3Appendix B.

According to *PANS - IM (Doc xxxxx), Volume I,* Chapter 4, 4.2.6, the following fields essential to the discovery and initial evaluation of information services are included in the service overview with a mandatory value:

- **Information service name:** Title of the service for reference by stakeholders;
- **Information service version:** Release information for the service in the overview;
- **Information service lifecycle status:** Indication of which service development lifecycle stage the service is in;
- **Information service lifecycle date**
- **Information category**
- **Brief description of the service:** Summary of the service offering;
- **Quality of the service:** Qualitative and quantitative information pertaining to service performance characteristics;
- **Information service validation type:** Validation method of used to assess a service.
- **Information service validation description**
- **Access restrictions:** Description of access constraints the service;
- **Message exchange pattern:** Message Exchange Pattern used by the service;
- **Geographical extent of information:** Geographic coverage details of the information provided by the service;
- **Provider organisation:** Name of the organisation responsible for information service provisioning;
- **Provider point of contact:** Point of contact for the information service provider organisation;
-
- **Information Exchange Models:** Information exchange models adhered to by the service; and

The following fields may be included in the Service Overview with a value or "NIL":

- **Additional** information on the information **service**: Location at which more information, potentially including more detailed technical information on a service may be found.
- **Service Functions**: A business-level description of the service functions.
- **Filtering available**: An overview of which filters the information service provider offers to the information service consumer for the information service.
- **Sources of information**: A description of the origins of information provided by the service along with an indication whether there were any subsequent modifications.
- **Support availability**: An overview of service support may be offered to information service consumers (e.g. help desk hours of operations).

3.4.1 Information Service Overview General Guidance

General guidance for completion of template and aggregation of templates in the registry:

- The Service Overview should be provided, completed, and aggregated in a registry in English (may additionally be completed in other languages).
- The completed Service Overview should define all acronyms as they are used (applies to first use only). For example: The North American Flight Track Data Service (NAFTDS) is provided for use by airlines with flights transiting the North American continent.
- When a service overview is used in a registry, it should follow the order of fields as presented in *PANS - IM (Doc xxxxx), Volume I,* Chapter 5, 5.2.4.

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Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Information service name	The name of the information service providing consumers the ability to reference or identify an information service.	Free text	• *DONLON TargetOffBlockTimeSetting Service* • *North Atlantic Flight Track Data Service*	Rationale: Well named services will give an indication of the purpose of the information service. Guidance: Include only the name of the service.
Information service version	Structured description of the information service version; enabling consumers to distinguish the information service.	n.n.[n]	*1.0.0*	Rationale: Allows distinction between versions of an information service. Guidance: An indicator of version is always provided regardless of whether or not there are multiple versions of a service. Each version of a service shall have its own completed overview

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Information service lifecycle status	Information on the service lifecycle stage indicating the current status.	PROSPECTIVE (PLANNED OPERATIONAL BY) ddmmyyyy *or* OPERATIONAL SINCE ddmmyyyy or RETIRED	*OPERATIONAL* *or*This service is currently undergoing pre-operational validation and will be available operationally December 2019	Rationale: Information on lifecycle will be a factor in choosing to implement a service. Guidance: Specify the service lifecycle stage that the service version is currently in. List as one of three phases: Prospective, Operational, Retired. Information may be represented through unformatted text or a table.

<table>
<tr><th>Field Name</th><th>Detailed Content</th><th>Field Schema</th><th>Example</th><th>Rationale and Guidance</th></tr>
<tr><td>Information service lifecycle date</td><td>Information on the service lifecycle stage indicating the timeline of the current status of the information service.</td><td>YYYY-MM-DD

or NIL</td><td>2018-07-01
Or
<table>
<tr><td>Lifecycle Stage</td><td>Date</td></tr>
<tr><td>Prospective</td><td>Current</td></tr>
<tr><td>Operational</td><td>Planned Go-Live for July 2020</td></tr>
<tr><td>Retired</td><td>Planned for February 2022</td></tr>
</table></td><td>Rationale: Information on lifecycle date facilitates the planning of the implementation and the use of an information service.

Guidance:

Provider may provide dates for current and future lifecycle stages.

Note: It is possible for both the operational and the retired phase to not have dates listed, though it is highly recommended that the planned date of retirement be listed whenever it is known to exist</td></tr>
<tr><td>Information service functions</td><td>Description of the business-level characteristics of the information service functions; assisting business and operational experts with a business view of the interactions with the information service, without having to look at the interface details.</td><td>Free text
or NIL</td><td>NIL</td><td>Rationale: The functions provide business and operational experts with a business view of the interactions with the service, without having to look at the interface details.

Guidance: Describe the functionality of the service as a list of the functions and real-world effects.</td></tr>
<tr><td>Information category</td><td></td><td></td><td></td><td></td></tr>
</table>

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Brief Description of the Service	Description of the information service providing a brief summary of the service including the intended use of the information service and the information domain(s) covered by the information service; assisting the consumer on whether the described service is suitable for use in a particular situation.	Free text (intended use) *and* FLIGHT INFORMATION; *and/or* AERONAUTICAL INFORMATION *and/or* METEOROLOGICAL INFORMATION *and/or* ENVIRONMENT INFORMATION *and/or* CAPACITY DEMAND & FLOW INFORMATION *and/or* SURVEILLANCE INFORMATION *and/or* OTHER INFORMATION	*The TargetOffBlockTimeSetting service supports the Airport CDM concept and its implementation by allowing A-CDM Partners, typically aircraft operators and ground handlers, with the capability to set the Target Off-Block Time (TOBT) that indicates the target time for the aircraft to be ready for Off-Block.* *FLIGHT INFORMATION*	Rationale: It supports the service consumer in deciding whether the described service is suitable for use in a particular situation Guidance: The brief description of the service covers the following pieces of information o The operational need being addressed by the service o The intended use of the information service o The intended consumer audience for the service

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Additional information on the information service	Description of the location at which more information, potentially including more detailed technical information, on an information service may be found.	Free text *or* NIL	*NIL*	Rationale: The service overview has information limited to discovery of a service and as such a provider may want to direct a consumer to available documentation. Guidance: Provide link to a site where a user can find more information, potentially including more detailed technical information, on the service offering (e.g. Interface Control Document, Service Description Documents (e.g. FAA WSDD))

Quality of the service	Description on the qualitative and quantitative information pertaining to the performance characteristics of an information service.	CAPACITY: Free text (description of capacity) *and/or* TIME BEHAVIOUR: Free text (description of time behaviour) *and/or* AVAILABILITY: Free text (description of availability) *and/or* RECOVERABILITY: Free text (description of recoverability) *and/or* INTEGRITY: Free text (description of integrity) *and/or* CONFIDENTIALITY: Free text (description of confidentiality)	*AVAILABILITY: 99.95 % outside the planned outages* *CAPACITY: 2000 service requests per hour* *TIME BEHAVIOUR: 2s delay for 95% of messages*	Rationale: Allow consumer to understand the performance of the service offering. Guidance: QoS may be expressed using the following parameters (or other applicable parameters) when relevant: • Performance parameters (quantitative) o Capacity of a service o Time behaviour of a service • Reliability parameters (quantitative) o Availability of a service o Recoverability of a service • Security parameters (qualitative) o Integrity of a service o Confidentiality of a service

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
				Information of QoS parameters may be provided in a qualitative or quantitative manner.
Information service validation type				

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Information service validation description	Description on the applied method of validation to assess a service; assisting consumers in their confidence level for the information service.	INDEPENDENT VALIDATION: Free text (validation result) *and/or* COLLABORATIVE VALIDATION: Free text (validation result) *and/or* USER VALIDATION: Free text (validation result) *and/or* SELF VALIDATION: Free text (validation result)	*SELF VALIDATION:* *DONLON Airport tested the service in accordance with its QMS based requirements* • *INDEPENDENT VALIDATION:* *This information service has undergone extensive testing prior to deployment by the information service provider "LMN", infrastructure service provider "ABC", and regulator "XYZ" to ensure that specific QoS standards are met. Operational monitoring by the information service provider is in place and the information service continues to meet all QoS requirements. For more information on this organisation's validation policies please see <URL>. Specific information regarding the validation by the regulator is available in a validation report upon request.*	Rationale: User needs to know how the information service was validated in order to have confidence in the service. Guidance: State the validation method used, (User Validated, Self-Validation, Collaborative, and Independent), a brief statement on the validation results, and if/how the potential consumers may obtain the validation evidence If a service has not been validated yet, there is no validation information available.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Filtering Available	A description of the filters the provider offers to the consumer for the information service.	Free text *or* NIL	*NIL*	Rationale: Filters allow users to narrow the content of data/information that they ingest. Guidance: List the filters that are available to a consumer of the service.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Access restrictions	Free text description of any constraints on access to the information service; assisting the consumer to understand whether they may be eligible to access the information service as well as any relevant security constrains on access.	Free text	*The service is targeting aircraft operators and ground handlers for their flights at Donlon Airport. The access to the service is subject to the signature of a Service Level Agreement with the Donlon Airport Operator. The access to the service is based on user id and password.* *The service may, as well, be used by the Donlon Tower Controllers in specific circumstances, such as under adverse conditions or other special circumstances.*	Rationale: Information for the consumer to understand whether they may be eligible to access the service as well as any relevant security constrains on access. Guidance: Specify the requirements and/or restrictions for each user type for accessing the data exchanged by the service which are considered to be sensitive for security or competition reasons. Specify under which conditions the restricted and non-restricted the payload generated by the information service can be distributed to a consumer(s). Note: This information can be used to develop a governance policy for distribution of the data through a third party Any security mechanisms which affect information service access may be described.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Message exchange pattern	Description of the Message Exchange Pattern used by the information service; assisting the consumer to understand how information interaction with the information service works.	REQUEST/REPLY *or* ONE WAY or PUBLISH/SUBSCRIBE	*REQUEST/REPLY*	Rationale: The Message Exchange Pattern helps the consumer understand how information interaction with service works. Guidance: Specify the message exchange pattern used by the service (request/reply, one way (“fire-and-forget”), publish/subscribe).
Information exchange model	Free text description on the information exchange model adhered to by the information service including information on AIRM alignment.	Free text	*The service is using an information exchange model aligned with the AIRM version 1.0.0.*	Specify the information exchange model (including extensions), and alignment with ATM Information Reference Model (AIRM) of the data provided by this service Guidance: identify global exchange models supported (e.g. Aeronautical Information Exchange Model (AIXM), AIRM, etc.). Further guidance in Chapter 4.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Geographical extent of information	Description on the details of the geographic coverage of the information provided by the information service; could be expressed in terms of ICAO region, FIR, Aerodrome, polygon, etc. .	Free text	*DONLON Airport*	Rationale: Allow consumer to understand the geographical coverage of the information being provided. Guidance: Geographical coverage may be expressed in terms of ICAO region, FIR, Aerodrome, polygon/geobox, etc. *Note: that listing more granular information (e.g. coverage at Airport X, FIR Y) may facilitate search responses when provided textual (vs. graphically).*
Sources of information	A description of the origins of information provided by the information service along with an indication whether there were any subsequent modifications.	Free text *or* NIL	*NIL*	Rationale: Provide the user with background on information source and modifications. Guidance: Specify origin of the information, and if any modifications were applied by the information service provider.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Provider organisation	Information on the name of the organisation responsible for the provision of the information service; assisting a service consumer in identifying and gaining context on the information service.	Free text	• *DONLON Airport Operator* • Federal Aviation Administration (FAA) • Aeronautical Radio of Thailand (AEROTHAI • Airport Support Services Corporation (ASSC)	Rationale: Providing a Provider Organisation assists an information service consumer in identifying and gaining context on the information service. Guidance: Provide the name of the organisation responsible for the information service followed by any abbreviated name by which the organisation is known (if applicable) o
Support availability	A description of the support a provider is offering to consumers on all relevant aspects related to the information service.	Free text or NIL	*For Incidents on services in operation, contact the Service desk [24/7]: +693 555 01 service-desk@donlon-airport.com*	Rationale: Consumer needs will vary and may require different levels of provider support. Guidance: Specify days and hours the information service provider can be contacted by users requiring support for the provided service.

Field Name	Detailed Content	Field Schema	Example	Rationale and Guidance
Provider Point of Contact	Information on the point of contact for the provider organisation for the specific information service; assisting a consumer in obtaining information on an information service beyond the service overview.	Free text	*To request access to the service: www.donlon-airport.com/swim/service-request*	Rationale: The service overview has information limited to discovery of an information service and as such it is important that an information service consumer has a point of contact in order to receive additional information. Guidance: Provide a point of contact (e.g. service@ICAO.org) to direct additional questions for the potential consumer.

Table 3-1: Service Overview

3.5 QUALITY OF SERVICE (QOS) CHARACTERISTICS

Information services are discovered, accessed, constructed and processed through infrastructure, procedures, and systems by both providers and consumers. These processes affect decisions, and invariably, the performance of the ATM system as a whole. It is expected that providers offer confidence they can meet the expectation they are setting with the service they are offering.

Quality of Service (QoS) is the degree or level of confidence that the performance of a service meets the user’s requirements. QoS is independent of SWIM technical infrastructure performance characteristics. However, the information service consumer’s experience is contingent upon the end-to-end performance of the information service, including all technical infrastructure components, which may be out of the control of the information service provider.

From a service consumer perspective, an information service is required to satisfy a specific operational need. This need is agnostic of the technologies utilized to meet the objective. The operational need will also drive the performance requirements that the service must meet. These performance characteristics constitute a minimum bundle of values for measurable QoS parameters (e.g. latency, capacity, etc.) and are described in more detail in this section. These performance requirements are not a feature of the service, rather of the transformation of the service consumer’s operational need in technical terms.

From the information service provider perspective, every information service is designed and implemented based on a set of QoS parameters. This is the technical representation of information service provider’s QoS requirements. QoS conveys the provider’s performance metrics on these characteristics. An information service’s advertised QoS metrics are necessary for consumers to assess the information service’s fitness for purpose for a given operational need. Based on an understanding of a particular operational need from the information service consumer, an information service provider may claim in the service overview that the QoS exhibited by an information service is fit for purpose for that consumer.

SWIM requires matchmaking at each of the ATM operations, information service abstraction, and service implementation levels to ensure that the user’s requirements are expressed, and the information service provider declares their quality parameters to establish the necessary agreement and trust to ensure the operational requirements are met.

Well defined and well communicated QoS parameters for an information service are an essential input to services consumers in the process to verify that a service can meet an operational need. However, due to the wide variance in operational needs and technical implementations, it is fully expected that QoS requirements will vary. Information service providers and information service consumers may be interested in measuring and communicating a quality characteristic in different manners. Additionally, each of the quality characteristics may be expressed using different units of measure. As a result, the information service overview must document QoS and should include a minimum set of specific parameters (and how they are measured).

The development of QoS requirements will vary based on the operational need the information service is intended to meet. The information service providers and consumers may be interested in measuring and communicating a quality characteristic in various ways.

ISO 25010 provides a globally accepted quality model for systems and software engineering comprised of eight quality characteristics further broken down into sub-characteristics. ISO 25010 states that although the scope of the product quality model is intended to be software and computer systems, many of the characteristics are also relevant to wider systems and services such as the information services.

Categorized into performance, reliability and security parameters, examples of QoS characteristics applicable to the implementation of information services are:

- Performance parameters (quantitative)
  - Capacity of a service
  - Time behaviour of a service
- Reliability parameters (quantitative)
  - Availability of a service
  - Recoverability of a service
- Security parameters (qualitative)
  - Integrity of a service
  - Confidentiality of a service

Note: Security parameters are in relation to the probability of an occurrence with harmful effect. The parameters should be derived from the engineering or design approach assessing the elements of the service. The parameters are thereafter verified through the systematic actions necessary to provide adequate confidence that the service and its elements achieve acceptable or tolerable security.

It is important to note that the QoS parameters provided in this manual are not intended to be all inclusive; therefore, information service providers and consumers may choose to use other parameters to characterize their QoS. The sections below provide guidance on measuring these QoS values.

3.5.1 Measurement of Performance Parameters

Capacity of a service – The maximum rate at which a service can process transactions and the maximum message size it supports.

Note: Measurements can include the number of items that can be stored, the number of concurrent users, the communication bandwidth, throughput of transactions, and size of messages.

Time behaviour of a service – A measurement of the processing times of a service.

Note: Measurements can include response time, latency, or other measurements appropriate to describing processing times of the service. The response time constraints could be defined as 'how long does it take to process a request and provide the necessary response', independent of the infrastructure limitations. In case where information service providers are required to provide a response to the consumer within an agreed upon time, infrastructure plays a greater role in the response time calculation. Latency is the time between the triggering event and the information service output which is applicable for publish/subscribe information services.

3.5.2 Measurement of Reliability Parameters

Availability of a service –The degree to which a service is operational and accessible when required for use. Availability represents the probability that a service is ready and available immediately when invoked. Some common ways of stating availability is a service is available X hours out of 24 hours (e.g. 16 hours out of 24 hours) or a service has X nines availability (e.g. one nine or 90%, three nines or 99.9%).

The availability of a service can be measured under load conditions and introduce failures to the system that cause some downtime to allow for monitoring tools to calculate any downtime and how long it takes for the service to recover from a failure. The downtime metric can be captured by using enterprise management tool suites.

Recoverability of a service –The degree to which, in the event of an interruption or a failure, the desired state of the information service can be re-established. The recoverability measure could take into account the time to get back data, time for support staff interaction, time to bring up information service provider infrastructure, time to restore data, time to bring up service, and other potential interaction in a manner that meets the agreed upon level of service between the service provider and service consumer.

The factors that could affect information service failures and recovery times include functional failure and operational failure. Functional failure is failure of components of the system due to bugs and hardware faults. This type of failure typically results in long recovery time that is dependent on the provider’s change management process and metric collections. Operational failure occurs when a system of some participant service is unavailable due to communication or unpredictable load.

Service performance parameters need to be monitored and recorded (e.g. Service Logs). Service logs can be used to alert and identify in case of anomalies or failures and assess functional and operational failures. This also allows to determine whether the reliability parameter values asserted to the service consumer have been met. Most of the mature Service Bus products provide monitoring capability to view service start and service operation invocations.

3.5.3 Measurement of Security Parameters

Integrity and confidentiality are examples of QoS security parameters that are not quantifiable, for example performance parameters. However, an information service provider can communicate their strategy to meet the user’s security requirements by expressing methodology and tools utilized to ensure the information service maintains the required service integrity and confidentiality.

Integrity of a service – An expression of the assurance that a system, product or component prevents unauthorized access to, or modification of, an information service interface or information.

Message level security can prevent unauthorized data manipulation while in transit. Standards such as WS-Security define facilities for protecting the integrity of messages by applying XML digital signatures to SOAP messages. For Web Services, it is recommended to separate the signatures from the payload. However, achieving message level integrity in some environments, such as REST, may not be as straightforward. Another quality aspect of service Integrity is how the Web Service maintains the correctness of the interaction with respect to the source of information. Proper execution of Web Service transactions will provide the correctness of interaction. A transaction refers to a sequence of activities to be treated as a single unit of work. All the activities must be completed to make the transaction successful. When a transaction does not complete, all the changes made are rolled back.

Confidentiality of a service – Confidentiality is the degree to which a service ensures that data are accessible only to those authorized to have access. In addition to signatures, the "WS-Security" standard allows the application of XML Encryption to encrypt certain parts of the messages. This makes sure that the information included in these parts can only be read by the intended recipient of the message and remains secret to attackers and other possible parties. For Web Services it is recommended to first encrypt and then sign to prevent against certain types of targeted attacks.

Access to operations can be bound to user's access / role privileges. Access should be routinely logged (taking personal data protection considerations into account), so that unauthorized access and undesired use of the service can be identified by online and offline log analysis.

3.6 VALIDATION OF INFORMATION SERVICES

Through the continued global evolution toward SWIM and information services, it is anticipated (and intended) that Service Overviews and Service Registries will result in increased exposure of information services. As a result, in order to maintain trust between information service providers and consumers where trust may not have existed before, there is a need to validate the QoS parameters promised by information service providers. The interplay between measurement and validation of QoS parameters as the foundational mechanism of trust building is illustrated in (Figure 3-2)

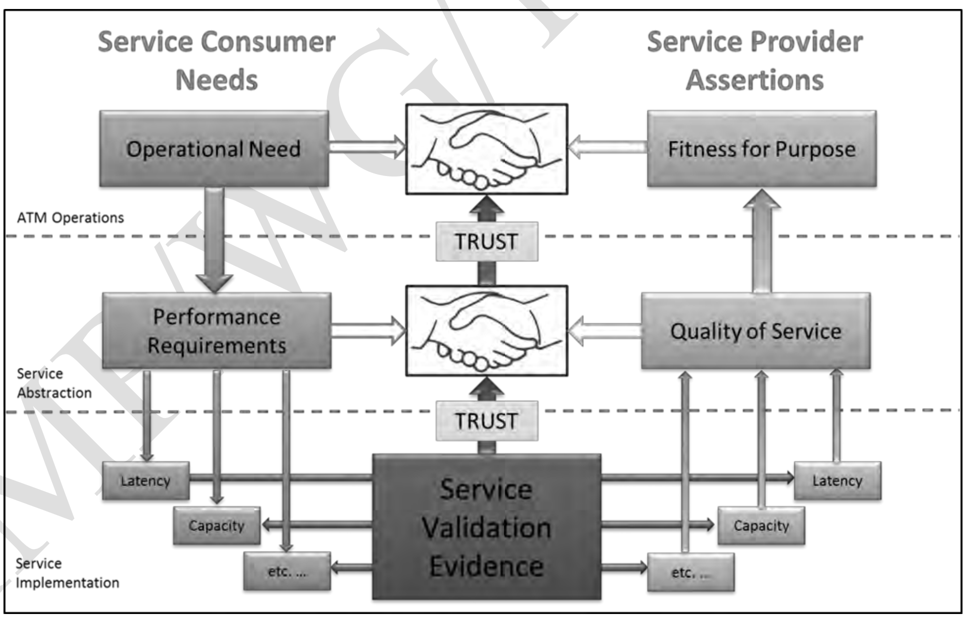

Figure 3-2: Role of service validation in building trust between consumers and providers.

Validation of services is the activity whereby a service is checked for conformance with the service objectives and requirements and provides assurance of conformance to the information service consumer.

Validation is a complex and iterative process and the approach to validation will naturally vary for each individual information service based on a number of variables including the aspects of an information service being validated, the foreseen use cases for the information service, the robustness of the information service requirements, the providing entity, the information service lifecycle stage, etc. Additionally, validation of services occurs across information service lifecycle stages, though it is expected that the initial validation of service is completed before the operational phase.

It is anticipated that in order to maintain its relevance, the validation of a service is expected to be carried out for each new version (where a new version of a service is marked by a modification of the scope or contents of the service offering.) The scope of the validation for a new version of a service should be commensurate with the changes made with reference to its previous version.

In this framework, validation includes the check of various QoS parameter values, as declared in the service overview. However, the QoS experienced by the service consumer depends on the ability of the end-to-end components (including the information service provider, service consumer and technical infrastructure systems) to support the QoS.

Validation of information services may be performed using one of the following methods wherein various actors carry out the validation process:

- Independent validation – a validation of service carried out by an independent authority
- Collaborative validation – a validation of service jointly carried out by the information service provider together with service consumers
- User validation – a validation of service carried out by service consumers
- Self-validation – a validation of service carried out by the information service provider

The utilization of a particular method of validation is not in itself an indicator of trustworthiness of an information service, but rather a starting point for the exchange of more detailed information (when required) between the provider and consumer to ensure that user expectations and information service performance are consistent. The ultimate responsibility for ensuring the information service meets the user needs rests with the end-user.

3.6.1 Independent Validation

Independent validation is carried out by an entity which is separated from the process of information service development and which does not have conflicting interests with validating an information service and offers the advantage of validation performed by an un-biased third party (e.g. a regulator). In some instances, it is possible that an independent authority and an information service provider are part of the same organisation. Example: An information service is developed to provide terrain and obstacle data, based on collecting and processing data across ANSP data sources. The aviation authority is asked by the provider whether this service can be “stamped” as certified for operational use. The aviation authority carries out the validation of the information service, as requested by the provider. The service can then be put into operations (operational lifecycle).

3.6.2 Collaborative Validation

Collaborative validation is a joint effort by both the information service provider and information service consumers and is generally used when consumer inputs are necessary to assess the fitness for purpose of the service. Example: A provider makes an information service about flight plan filing available. The service is used by various airspace users and continuously evolves. The provider and the consumers have a common interest in the new versions to be validated: the consumers commit in validation of new versions that are developed to meet their operational requirements; the provider gets better exposure by having the commitment of the service consumers. The provider and the consumers set joint teams to carry out the validation of new versions. The validation evidence is made available to the stakeholders (provider and consumers).

3.6.3 User-Validation

User-validation occurs when an information service consumer performs analysis that affirms that the provided information service meets the specified service requirements. The information service consumer shares the results of the validation with the information service provider. The information service provider uses this information as feedback for the performance of the information service. This result may be shared with other information service consumers through the registry.

3.6.4 Self-Validation

Self-validation occurs when an information service provider independently affirms that the provided information service meets the specified service requirements. In some cases, a provider will be the actor with the most in-depth knowledge on the information service and anticipated information service performance, and thus the most capable of assuring a specified level of service. Self-validation by itself may be sufficient to ensure user confidence when the service provider is recognized and trustworthy. Example: an ANSP which plans to exchange data across its own internal systems using its SWIM infrastructure to meet internal requirements makes the determination that this information may also be of interest to airlines, without a detailed understanding of how the data will be used in practice. As a result, the ANSP will provide the information service to external stakeholders but will only perform the validation required to validate its internal quality requirements, e.g. availability or response time.

3.6.5 Validation Evidence

To support the alignment of service providers and service consumers based on operational need, validation evidence is recorded and generally provided in the form of a validation report which, when enacting best practices, is made available to potential service consumers upon request.

A validation report typically includes the version that has been tested, the context of the validation (e.g. Prospective, Operational), the date of the validation and the conclusions of the report. Additionally, it is expected that the validation report mentions those functionalities that have not been subject to validation.

3.6.1 Information Service Consumer Responsibility

In addition to service validation information provided by the information service provider, it is the responsibility of the information service consumer to ensure that the consumer's systems and technical infrastructure also meet the QoS required for the operational needs of the service. It may be required that the end-to-end service is validated to confirm the service provided stated QoS with the addition of the consumer systems. It is incumbent on the service consumer to ensure that the components in their remits meet the applicable QoS.

3.7 SWIM SERVICE REGISTRY

3.7.1 General

SWIM service registries, providing a means to publicize and discover information services, may be implemented by various stakeholders at the national or regional levels. Making the SWIM service registry publicly available improves user awareness of the available information services. Although the term “SWIM service registry” is used in the singular, there will likely be multiple SWIM service registries in different regions. To ensure efficiency, a limited number of registries are preferred to a proliferation of registries. Regional registries may be interconnected so that users have a single access point for global service discovery. Formal arrangements between different registry providers can be made so that service overviews are discoverable in multiple registries.

The web location where information service overviews are publicized shall be included in the aeronautical information publication (AIP). To mitigate the risk of inconsistencies, a limited number of locations where service overviews are made available is preferred.

3.7.2 Objective and Functions

The objective of a SWIM service registry is to publicize available information services and discover their corresponding service overviews.

Figure 3-3 illustrates how a SWIM service registry is used by service providers and consumers.

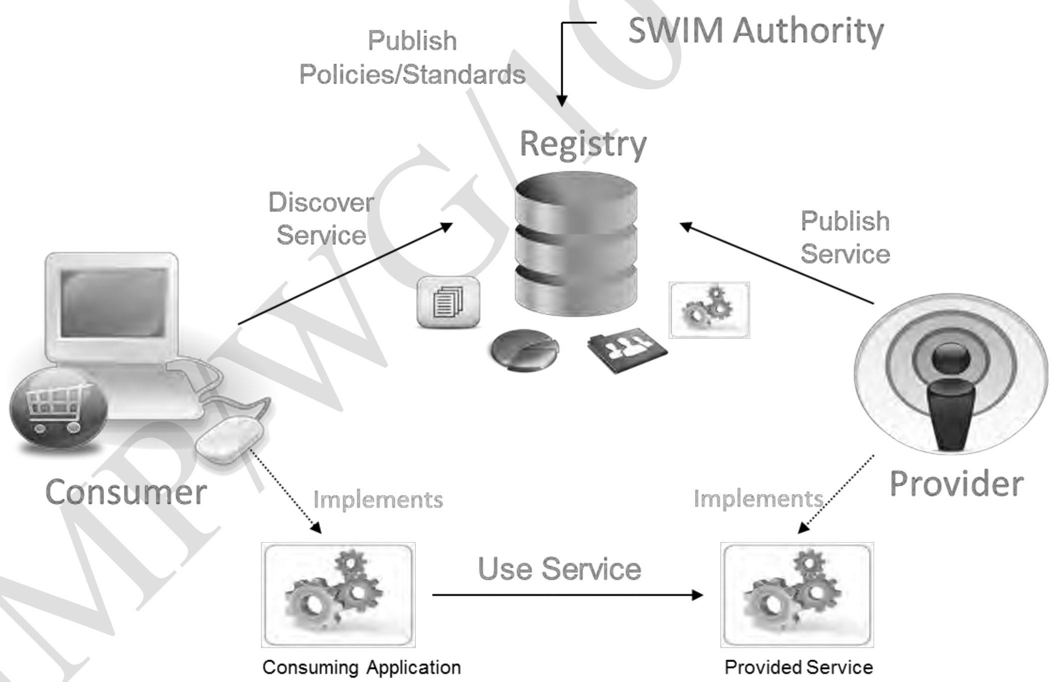

Figure 3-3: SWIM Service Registry

The functions of a registry are:

- Service registration: means by which a service overview is added and updated in the registry, including the rules for registering the service;
- Search: means by which users can look for available services;
- Filtering: ability to optimize the search through selecting criteria;

- Notification: providing information on updates to registry information based on user subscription;

3.7.3 Registry Contents

The content of a registry is:

- Service overview content;
- (Optional) SWIM supporting material, (e.g. SWIM standards, policies, etc.);

3.7.4 SWIM Service Registry Management

When implementing a registry, the following needs to be taken into account:

- A registry is set up by an organisation which wants to publicize a number of available information services.
    - Examples of organisations setting up a registry: a State, an ANSP, a MET provider, an airport, a private ATM-related company, an international organisation
- Practically, it consists in a repository of service overviews, made available through Internet (e.g. a website)
- The rules applicable for registration of services need to be defined.
- The necessary mechanisms for IT performance and security need to be established.
- The security mechanisms used for access control need to be defined and implemented.
- Roles and responsibilities:
    - The organisation setting up a registry also known as the registry provider:
        - is responsible for registry policies (e.g. scope, registration, access control)
        - can operate it or delegate its operations to a third-party (the party operating the registry is called registry operator)
    - The registry operator is responsible for the day-to-day operations of the registry:
        - Application of registration rules (including check of information consumer credentials) and technical registry policies (e.g. access control).
        - Functionality updates
        - Performance and security monitoring
        - Maintenance
    - The service providers are responsible for:
        - The service overview and its lifecycle management included in the registry.
        - Providing access control parameters regarding visibility of the service.
    - The service consumers are responsible for:
        - Providing information as required in registration rules.
- Rules for registering a service
    - Access control: definition on how the provider credentials are checked.
    - Service registration: checks carried out on the service overview before actual service registration.
- Structure and technical aspects
    - The registry provides a structured way for capturing the service overview (to facilitate future interconnection of registries).
    - There is no recommended standard for the practical implementation of a registry, however best practices and examples exist: European SWIM Registry (https://eur-

registry.swim.aero), United States of America NAS Service Registry and Repository (NSRR - https://nsrr.faa.gov), etc.

3.8 INFORMATION SERVICE LIFECYCLE

The information service lifecycle builds upon the Service Orientation Process, as discussed in section 2.2. Within the Service Overview, an information service lifecycle is listed as Prospective, Operational, or Retired. It is also expected that the information service consumer also has similar a lifecycle for the consumption of information services. Activities within the Prospective phase for both the information service provider and consumer include Planning, Design, and Transition. Activities within the Operational phase for both the information service provider and consumer include Delivery, and Improvement. The Improvement Activity also encompasses the Retirement Phase as necessary to deprecate and decommission information services. The lifecycle activities are introduced in Section 3.8.1 and 3.8.2 and further elaborated upon in Appendix C.

3.8.1 Information Service Provider Lifecycle Activities

The SOA principles for the lifecycle of the entire SWIM "ecosystem" of information services were outlined in Chapter 2. Similarly, the information services themselves have a lifecycle. Together SOA and information service lifecycle complement each other on the evolutionary transformation journey into services (see Figure 2-5). Unlike the SOA process, the information services lifecycle includes five (5) phases: Planning, Design, Transition, Delivery, and Improvement (based on ISO/IEC 20000-1). A major differentiation is the addition of the Improvement phase, which accounts for updates to an existing information service or resolve issues. The ISO/IEC 20000 Standard on "IT Service Management" provides further guidance for the management of information service lifecycles and this is further elaborated upon in 8.3Appendix C.

Planning. In the planning phase, the information service provider defines the environmental and domain conditions that will guide the rest of the information service process. In this phase the information service provider will define the scope of the information service based on business or operational needs. This may include defining the information payload and QoS. The information service provider may wish to list and describe the information service using the service overview on a SWIM service registry in the "Prospective" lifecycle stage.

Design. In the design phase, the information service provider defines the requirements and capabilities of the information service and how it will function. The information service provider specifies and develops information service characteristics (e.g. information shared, message exchange patterns, latency, update rate, error handling, validation, etc.). The information service provider develops required technical documentation and provides to the SWIM service registry as required.

Transition. In the transition phase, the information service provider shifts from designing the information service to completing the activities required to ensure the information service functions properly once it is operational. In this phase the information service provider validates the service using SWIM architecture to ensure service functionality once operational. The transition phase may be returned to after the improvement phase if an information service provider wishes to update a service to a new version or retire/deprecate an old version.

Delivery. In the delivery phase, the information service provider activities include Operation, Monitoring, Measurement, Review, and Maintenance. Additionally, in this phase, the information service is fully operational and actively providing information to information service consumers. The information service is now listed as “Operational” in the SWIM service registry.

Improvement. The improvement phase can occur concurrently with the operations phase, as the information service provider works to improve an existing information service or resolve issues. The improvement phase may also be seamlessly linked to the transition phase if an information service provider wishes to update as service to a new version or deprecate an old version.

Retirement. In the retirement phase, the information service provider ceases publication of information service. As an information service provider best practice activity, retirement should only happen after due notification, and the service description should assert a lead time before a service is retired. The information service is now listed as “Retired” in the SWIM service registry.

3.8.2 Information Service Consumer Lifecycle Activities

Planning. In the planning phase a potential information service consumer identifies a need for a specific type of information that may be obtained through an information service. The information service consumer identifies initial performance requirements to meet the operational need. The information service consumer accesses a SWIM service registry to obtain information about available information services (e.g. service overview).

Design. In the design phase, the information service consumer selects an information service to consume. The information service consumer ensures service performance requirements are met by the QoS offered by the information service provider. The information service consumer signs any agreements with the information service provider necessary to consume this information.

Transition. In the transition phase, the information service consumer develops and implements a user interface in order to consume the information service. Based on the Service Validation method needed, the information service consumer can validate sample data in this interface to ensure functionality. The transition phase may be returned to after the improvement phase if an information service consumer wishes to modify service subscriptions, consume to a new version of a service, cease consumption of a service, etc.

Delivery. In the delivery phase, the information service consumer is connected to the information service and consuming information. The information service consumer is actively using the information service to make ATM decisions. To resolve any service issues, the information service consumer may continue to contact the information service provider in this phase.

Improvement. In the improvement phase, the information service consumer may consider consuming a different information service or updated version of an information service, as well as make improvements to the user interface. This phase may be seamlessly linked back to the transition phase if the information service consumer decides to make any of these changes.

Retirement. In the retirement phase, the information service consumer ceases to receive the information service. As a best practice activity, the information service consumer should monitor the status of an information service that has been noted as soon to be “Retired” by the information service provider.

3.8.3 Information Services Lifecycle within a SWIM Service Registry

The scenario outlines the steps that an information service provider would complete to register an information service with a SWIM service registry, as shown in Figure 3-4. Depiction of the SWIM service registry operational scenario is broken down into the three lifecycle stages as specified in the Service Overview: Prospective, Operational, and Retired. The three (3) information service lifecycle stages are further delineated into the five (5) step SWIM service registration process presented below:

3.8.3.1 Lifecycle Stage: Prospective

1. SWIM Service Registry Identification
    a. Information service provider wishes to list information services in a SWIM service registry;
    b. Information service provider researches SWIM service registry rules and regulations as required by SWIM service registry provider;
    c. Information service provider registers as an information service provider with the SWIM service registry provider;
2. Service Overview Development;
    a. Information service provider populates the Service Overview with information service metadata;
    b. SWIM service registry provider validates if the populated Service Overview complies with the guidance and the formatting;
    c. SWIM service registry provider lists the information service as “prospective” and lists the Service Overview in the SWIM service registry;
3. Additional Information Service Documentation:
    a. Information service provider publishes in the SWIM service registry any additional documentation required or suggested by the SWIM service registry provider (e.g. technical documentation, WSDD, WSDL, JMSDD, etc.);
    b. SWIM service registry provider validates that the technical documentation complies with the SWIM service registry provider requirements;
    c. SWIM service registry provider lists additional information service documentation in the SWIM service registry

3.8.3.2 Lifecycle Stage: Operational

4. Fully Operational;
    a. Information service provider begins providing information service using the information service technical infrastructure;
    b. SWIM service registry provider lists the information service as “Operational” in the SWIM service registry;

3.8.3.3 Lifecycle Stage: Retired

5. Retire Information Service;
   a. Information service provider ceases the publication of the information service;
   b. SWIM service registry provider lists the information service as "Retired" in the SWIM service registry;

The full information service lifecycle may include additional steps beyond 1-5 presented above. These follow-on steps may include:

a. registering a new or updated version of the information service; or
b. registering the information service with a different or additional SWIM service registry provider.

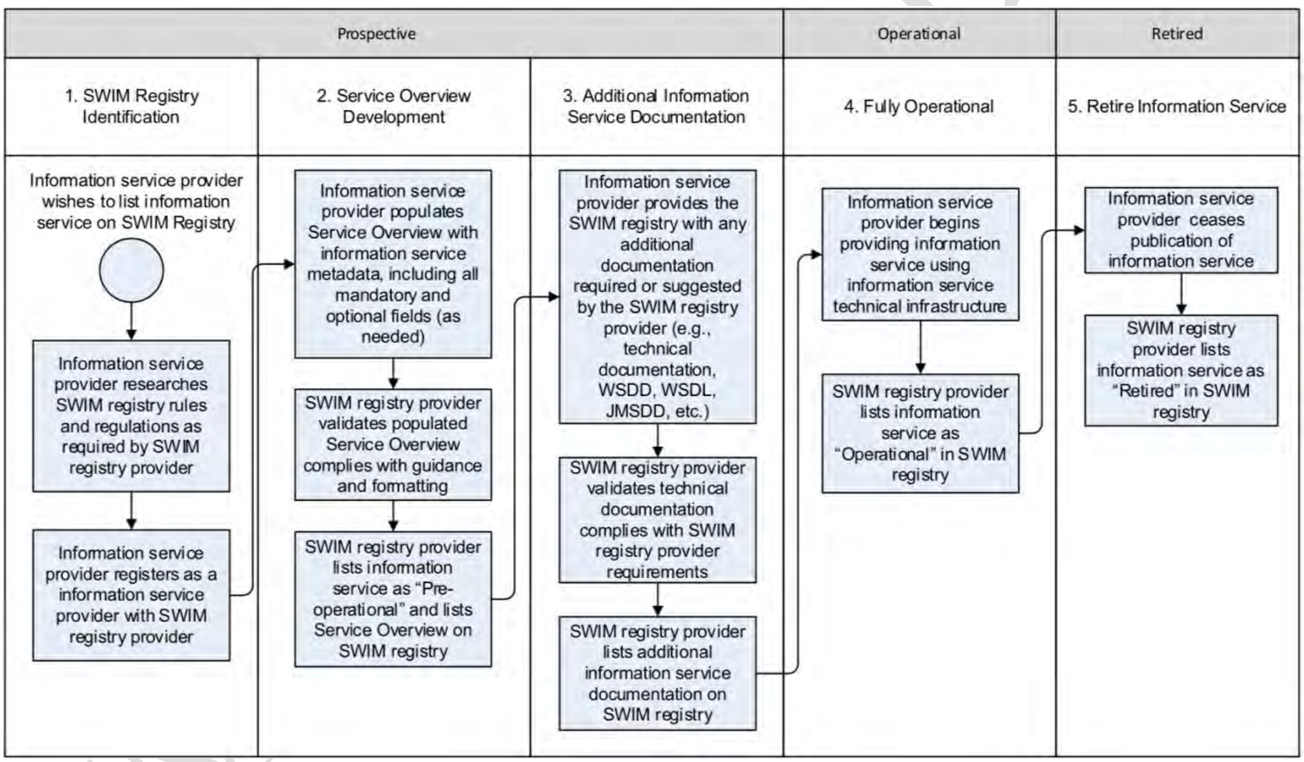

Figure 3-4: SWIM Service Registry Lifecycle

Chapter 4 Information Interoperability

This chapter introduces through sections 4.1 up to 4.4 the key components and practices that enable information interoperability in the context of SWIM. Based on this material, section 4.5 provides specific guidance on achieving information interoperability.

4.1 INTRODUCING INFORMATION INTEROPERABILITY

In the context of SWIM, information is exchanged through information services. A key concern of SWIM stakeholders is that the information service payloads are interoperable. Therefore, information service payloads must be defined, mutually understood by information service providers and consumers, and correctly used.

Following *PANS-IM (Doc xxxxx), Volume I – SWIM*, information service providers/consumers should have a common understanding of:

- the meaning of the information in an information service payload; and
- the encoding of the data in an information service payload.

In addition, the encoding of the data exchanged in an information service payload should be based on a standard exchange language.

These requirements respectively address semantic and syntactic interoperability of the information service payload. In other terms, information exchanged via information services needs to be (a) “well defined” and (b) “well formatted”. The present chapter 4 elaborates on semantic and syntactic interoperability in relation to information services and how to achieve information interoperability.

4.1.1 Well Defined Information – Semantic Interoperability

Semantic interoperability concerns the meaning of the information. In SWIM, the mutual understanding between SWIM stakeholders of the definitions of ATM information terms is important. More particularly, semantic interoperability:

- ensures that the precise meaning of the information is shared by all parties and preserved as the information is exchanged using information services;
- supports the consistency of collaborative decision making; and
- enables service consumers to combine and process information from multiple sources. For example, a service consumer receiving information about a runway from a provider, depending on the application context, can combine it with information concerning runways from other information services.

Note: The term semantic interoperability is used in a general sense that is agnostic of any "semantic technologies". This does not exclude the use of these technologies in any particular context.

As stated in *PANS-IM (Doc xxxxx), Volume I – SWIM*: “Semantic interoperability of the information service payload is achieved by aligning the meaning of the information exchanged with a common reference, the Air Traffic Management Information Reference Model (AIRM)”. Guidance on how to achieve the requirement is provided through section 4.5 below. An understanding of the AIRM is inter alia provided by section 4.3. The semantic interoperability requirement in *PANS-IM* and the alignment of the information service payload semantics with the AIRM vocabulary fosters semantic interoperability throughout ATM.

4.1.2 Well Formatted Data – Syntactic Interoperability

Syntactic interoperability ensures that a service consumer reads the data exchanged as intended by the service provider. The encoding of data in an information service payload by information service providers and the decoding by information service consumers may not lead to unintentional loss that could occur (e.g. due to data type conversions or misinterpretation of data).

As stated in *PANS-IM (Doc xxxxx), Volume I – SWIM*: "Syntactic interoperability of the information service payload is achieved by establishing agreements in relation to the data encoding".

The data format used to encode information service payloads is based on a standard exchange language (e.g. XML Schema is used to define the structure of an XML encoded data; JSON Schema for JSON encoded data). This enables the specification of the data encoding of information service payloads by:

- canonical representations of data types (e.g. basic data types for float, character string, integer, etc.) provided by the standard exchange language; and
- additional specifications, driven by a particular specification context (e.g. information domain) using the conventions of the selected standard exchange language, of value spaces (e.g. length, characters sets), properties (e.g. cardinality, ability to encode nil values, restrictions on value space, ordering relations) and characterizing operations (e.g. time arithmetic) as well as composition rules and constructs.

Following the description of the components of an information service (see Chapter 2 section 2.5) the data encoding of an information service payload applies to the message payloads of the messages that are exchanged as a result of invoking service operations provided by service interfaces.

Note: specific implementation technicalities may need to be considered when encoding in a particular technology context (e.g. serialization).

The ISO/IEC 11404 (2007) standard provides further information on the requirements for syntactic interoperability. The requirement in *PANS-IM (Doc xxxxx), Volume I* to use a standard exchange language fosters syntactic interoperability.

4.2 INFORMATION SERVICE PROVIDER AND CONSUMER RESPONSIBILITIES

4.2.1 Information Service Provider Responsibilities

4.2.1.1 Semantic Interoperability

The requirement that an information service payload should be aligned with the vocabulary of the ATM Information Reference Model (AIRM) puts a responsibility on the information service provider. The information service provider needs to provide or make reference to documentation of this alignment for use by service consumers, who rely on semantic interoperability of the information service payload in question with the information service payloads of other services.

The alignment of the information service payloads with the AIRM is part of the information service provider's offering in the context of SWIM for the benefit of service consumers who use information services. However, information service providers can also benefit from using the AIRM during information service design activities.

Guidance on how information service providers can achieve AIRM alignment of their information service payloads is provided in section 4.5 below.

4.2.1.2 Syntactic Interoperability

Implemented information services are in the remit of the information service provider. The information service provider is therefore responsible for specifying the encoding of the information service payloads. In doing so, the information service provider ensures that the encoding chosen is (a) fully documented using a standard exchange language and (b) whenever possible, consistent with established encoding practices for specific data items in accordance with the standard exchange language used. This in particular includes formalized encoding conventions in the context of an information domain (e.g. coding guidelines) (see section 4.4). The objective is to facilitate the decoding by the service consumers of the data exchanged and its correct interpretation.

Similar to semantic interoperability, the preferred approach to ensuring syntactic interoperability is to base the encoding of the information service payloads on an information exchange model. Yet, this may trigger the need for an extension of the information exchange model, due to regional operational variations.

4.2.1.3 Provision of Metadata

To foster information interoperability and to the benefit of information service consumers, information service providers are also charged to provide additional context information that documents information service payloads. This information is known as metadata (section 4.6 provides additional details).

Note: metadata about information services is shared through the service overview as further explained in Chapter 3. This includes fields covering the information service payload aspects.

4.2.2 Information Service Consumer Responsibilities

4.2.2.1 Semantic Interoperability

Information service consumers have no responsibility with regards to the documentation of the alignment of the information service payload with the AIRM. This documentation is provided by the information service provider. However, service consumers have a responsibility in terms of preserving the meaning of the information when they pass it on.

Information service consumers are the beneficiaries of semantic interoperability of information service payloads. The documentation of the alignment with the AIRM provided by the various information service providers will enable them to compare the meanings of the different payloads. This is essential for achieving the key benefit of being able to create a coherent information environment using information services provided by different stakeholders.

4.2.2.2 Syntactic Interoperability

Information service consumers have no responsibility with regards to the documentation of the encoding of information service payloads. This documentation is provided by the information service provider. However, service consumers have a responsibility to preserve the syntax constraints to the data when they pass it on. This is because consistency of syntax is a prerequisite of consistency of semantics, and so system-wide information interoperability. It is important for an efficient implementation of information services that data is encoded consistently. For example, all data recipients should have the same information on the eligible value space of an enumerated data type. This is because such values (or their absence) are often indicative of the process that drove the creation of the original information, and hence the information quality. Again, use of a standard information exchange model is the preferred approach to ensuring this consistency.

4.3 INFORMATION INTEROPERABILITY ACROSS INFORMATION DOMAINS

The ATM information reference model (AIRM) addresses semantic interoperability at the cross-domain level.

4.3.1 AIRM Definition

The AIRM contains the ATM system-wide reference vocabulary for ATM information exchanged through SWIM. The AIRM constitutes knowledge about ATM related information and data.

4.3.2 AIRM Key Features

AIRM provides a structured, traceable, unified, harmonised, common and digital representation of ATM-specific terms, definitions and essential associations based on standard modelling notation. The AIRM serves to:

- cover ICAO-relevant information domains through ATM-specific terms;
- support information interoperability by facilitating semantic alignment;
- facilitate information exchange model consistency with ICAO provisions;
- provide a common and harmonised ICAO reference of the operational language;
- provide an integrated and formalized reference across ICAO documents (annexes, manuals, etc.); and
- complement and support information exchange models in a consistent manner.

4.3.3 AIRM Content and Structure

The AIRM captures ICAO ATM business terms as defined in an agreed upon set of ICAO Annexes and documents and global information exchange models such as AIXM, FIXM and IWXXM. It is divided into several subjects to make the classification of the concepts clear. The subjects are listed below and are further shown in Figure 4-1.

Base Infrastructure: Airspace Infrastructure and Aircraft subjects describe concepts about the infrastructure and assets of ATM. Infrastructure and assets exist even if no operations are actually conducted. For example, this subject is where the “aerodrome” concept is found.

Flight: Describes concepts about a specific flight and its trajectory.

Air Traffic Operations, Surveillance, and Meteorology: These subjects describe concepts about the operations that are necessary for safe, efficient and environmentally friendly flights.

Stakeholder: Describes organisations that either operate in ATM or have relationships with ATM. For example, this subject contains definitions for stakeholder contact details and activities they perform.

Common: Contains concepts such as geospatial and temporal concepts, which are used throughout the AIRM.

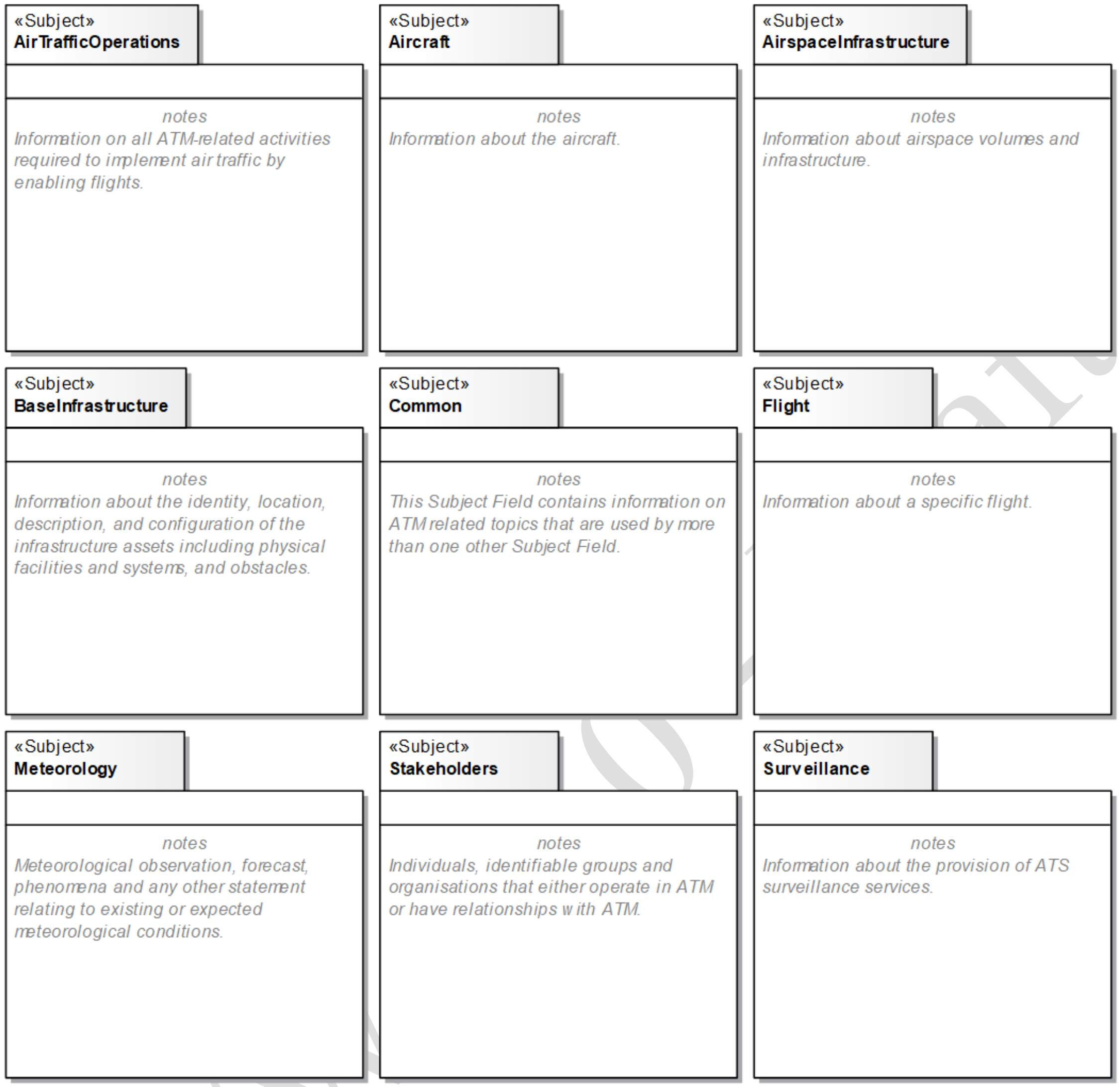

Figure 4-1: Content and structure of AIRM

4.3.4 AIRM Usage Scenarios in Relation to Service Orientation Process

The AIRM is also an important asset in ensuring coherency of the service orientation process discussed in Chapter 2, specifically:

- operational experts may use the AIRM's ATM business terms and information constructs to support operational concept development. This is important for defining SWIM-enabled collaborative workflows;
- operational experts may use the AIRM when defining information exchange requirements (IERs). This can be the case when performing service identification activities;
- enterprise architects may use the AIRM by importing its content into a regional or local architecture repository;
- data/information architects may use the AIRM by importing its content into a regional or local reference model;

- data/information architects may use the AIRM as a reference for cross-domain coordination activities, for example, in the context of collaborative exchange model developments (see Appendix D);
- an oversight authority may use the AIRM to express requirements;
- a standard developing organisation may use the AIRM as a reference to align a data catalogue, a data dictionary or a standard information service payload to the AIRM; and
- solution implementers may use the AIRM as a semantic reference when reading information inputs from various sources and writing outputs.

4.4 INFORMATION INTEROPERABILITY WITHIN INFORMATION DOMAINS

ATM information domains address information interoperability at the domain level. This typically leads to development of related information exchange models that in principle address semantic and syntactic interoperability.

These information exchange models are used to support defining and specifying information service payloads in the context of SWIM. An information exchange model is tied to a specific domain scope and is used to support technological solution implementation. Additionally, ATM information domains produce artefacts such as data catalogues, business rules, coding guidelines and information exchange requirements.

Each information domain addresses its own needs by standardising the related information exchange model. However, in order to satisfy the consumers' information needs, information exchange models may have to include concepts usually seen as outside the domain (e.g. a flight information exchange model may need to include aerodrome related concepts) while retaining the domain's own specificities in terms of syntax agreements and/or technological choices.

4.4.1 Defining the Information Domain Semantics

Information domains agree upon an information exchange model to ensure the domain vocabulary used is correctly understood, hence ensuring common semantics. Thereto, an information exchange model typically provides a formal expression of the domain concepts (e.g. using UML as a common language) and packages it into a separate model component.

The alignment of an information exchange model semantics to the cross-domain semantics captured in the AIRM (**Figure 4-2**) fosters consistency ATM system-wide and, in particular, when an information exchange model includes concepts from more than one information domain. 8.3Appendix D provides more details on this aspect.

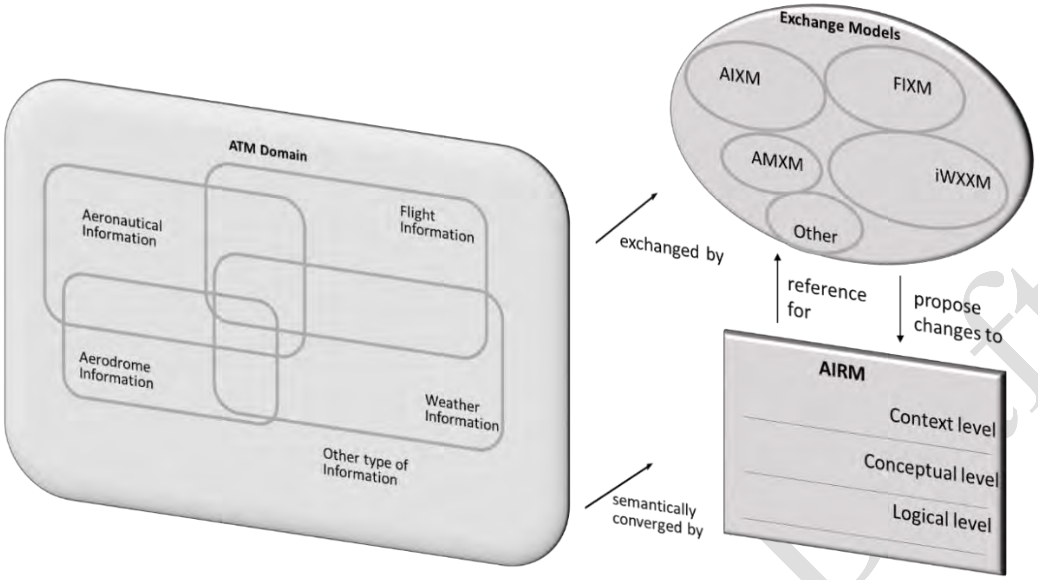

Figure 4-2: AIRM in respect to ATM Domain and Exchange Models

4.4.2 Specifying the Domain Information Exchange Syntax

In addition to the semantics, the information domain agrees upon the domain syntax for data encoding purposes. This is based on the use of a standardized exchange language and is typically provided as part of an information exchange model through the exchange schema component it includes.

For example:

- AIXM XML Schema is an exchange schema used as standard exchange language for the aeronautical information domain. AIXM XML Schema is part of the AIXM information exchange model;
- FIXM Core XML Schema is an exchange schema used as standard exchange language for the flight information domain. FIXM Core XML Schema is part of the FIXM information exchange model.
- IWXXM SIGMET Schema is an exchange schema used as standard exchange language for the meteorological information domain. IWXXM SIGMET Schema is one of the parts of the IWXXM information exchange model.

4.4.3 Information Exchange Models

4.4.3.1 Information Exchange Models in Relation to SWIM

An information exchange model (XM) is a building block of the SWIM information concept component typically containing an exchange model (i.e. a representation of the domain concepts) and an exchange schema (i.e. a standard exchange language for the encoding of domain data). XMs define the information of an information domain. In the context of *Manual on SWIM (Doc 10039), Volume 1 – SWIM Concept*, the bespoke information exchange models are (not excluding others):

- AIXM for the aeronautical information domain;
- FIXM for the flight and flow information domain; and

- IWXXM for the meteorological information domain.

An XM drives how the data is exchanged. It commonly relies on mainstream technology standards providing, for example, metadata, geometry and time definitions (e.g. Geography Markup Language (GML), GeoJSON, etc.). When doing so, software components/libraries can be leveraged from sectors other than air transport for similar purposes.

When providing information service payloads formatted according to the cited XMs, or profiles thereof, it is important to realize that implementations may still be subject to local variations and interpretations. In the context of SWIM, in which information exchange is driven by information services, the information and data interoperability scope are also driven by the information service function scope and implementation choices (e.g. using technical infrastructure interface protocols may lead to data transformations such as encryption, compression).

4.4.3.2 Awareness about Implementation Variations

While the correct and common use of an information exchange model is outside the scope of this manual, it should be clear that this impacts interoperability. Consequently, it is important that data/information architects understand the materials surrounding each information exchange model since it takes more to achieve interoperability and build quality information services. The following sections are provided to ensure the awareness of available material for each of the cited information exchange models.

A few typical variations are provided as examples to illustrate where additional alignment is needed to ensure common understanding by information service providers and consumers. These take the form of business rules, constraints and coding guidelines as in the following examples:

- **understanding spatial domain aspects:** In a digital exchange it is important to consistently understand the coordinate reference system (CRS). The CRS indication is critical for correct geographical data encoding and processing. The CRS indicates the geodetic datum, and ellipsoid used to express coordinates. This determines the order of the coordinate axes in which coordinate values are encoded (e.g. latitude before longitude, a convention used in the aviation domain). When encoding aeronautical data that complies with WGS-84 it is therefore important to adopt common practices as indicated by the AIXM guidance;
- **understanding temporal domain aspects:** In a digital exchange it is important to understand time intervals in the same way requiring conventions (is the end-time of a time period captured as an interval open-ended or not?); and
- **understanding which information is to be provided:** Depending on the scope of the information service function, it may be possible that optional information exchange model elements may become mandatory. For completeness reasons, it may be required that this is made explicit. Therefore, business rules may be provided as part of XM profiles (e.g. prescriptive subsets of the XM reflecting the payload content requirements of the information service).

4.4.3.3 AIXM Guidance

Reference information about the Aeronautical Information Exchange Model (AIXM) can be found on www.aixm.aero, including:

- the UML model, XML Schema and other documentation for the AIXM versions in use.

- information about coding guidelines for specific applications/products, support for implementation, model evolution and governance and links to other relevant resources; and
- guidance for the provision of digital aeronautical data as specified in Annex 15 – *Aeronautical Information Services* and *PANS-AIM (DOC 10066)*. Topics include temporality, feature identification and reference, GML profile use, metadata, specific coding and data verification rules for each data set category, such as AIP data sets, obstacle data sets, instrument flight procedure data sets, etc.

4.4.3.4 FIXM Guidance

Reference information about the Flight Information Exchange Model (FIXM) can be found on www.fixm.aero, including:

- the UML model, XML Schemas and other documentation;
- general guidance for FIXM implementation (high-level considerations about the use of FIXM, general encoding rules, etc.);
- specific FIXM guidance and examples in support of FF-ICE/1 applications including SWIM aspects such as harmonised representation of the messages exchanged using information services.

4.4.3.5 IWXXM Guidance

Reference information about the ICAO Meteorological Information Exchange Model (IWXXM version 3) can be found on https://wiswiki.wmo.int, including:

- guidance for the provision of digital meteorological data according to ICAO Annex 3.

4.4.3.6 AMXM Guidance

Reference information about the Aerodrome Mapping Information Exchange Model can be found on www.amxm.aero, including:

- the AMXM UML Model, and AMXM XML Schema;
- AMDB related guidance.

4.5 ACHIEVING INFORMATION INTEROPERABILITY

4.5.1 Role of Information Exchange Models

In SWIM, information interoperability is primarily achieved through the information exchange models at the level of the information domains. The use of information exchange models, such as AIXM for aeronautical information, FIXM for flight information, and IWXXM for weather information, are ready made domain standards which cover both semantic and syntactic interoperability. The use of the information exchange models as ready-made "domain packages" enables information interoperability when used in the context of an information service payload and when aligned with the AIRM. However, it may occur that an information exchange model may not satisfy the needs of a particular information exchange.

These models, and their relations with the AIRM covering ATM information as a whole, are discussed in section 4.4 above.

4.5.2 Information Service Payload Alignment with the AIRM

An information service's payload design and implementation specification reflects the need for information exchange in a certain business context, i.e. it implements one or more information exchange requirements (see section 2.3 on the service orientation process for more information).

In order to achieve alignment with the AIRM, the information service provider, has two options:

- Choose to base the information service payload on an existing information exchange model that is aligned with the AIRM; in this case, the overhead associated with the semantic alignment requirement is minimal.

  Note: Practical steps for this option are described in subsection 4.5.2.1 below.

- Provide dedicated evidence of the alignment of the information service payload with the AIRM; this can happen if there is no suitable information exchange model available, or no model can be used due to other constraints such as encoding limitations.

  Note: Practical steps to be taken in this case are described in subsection 4.5.2.2 below.

Mixed forms of these options are possible. A typical case is the creation of an extension to an existing information exchange model to fully cover a given information service payload based on the contents already available in the existing information exchange model. **Figure 4-3** depicts the steps discussed in section 4.5.2.1 and 4.5.2.2 below:

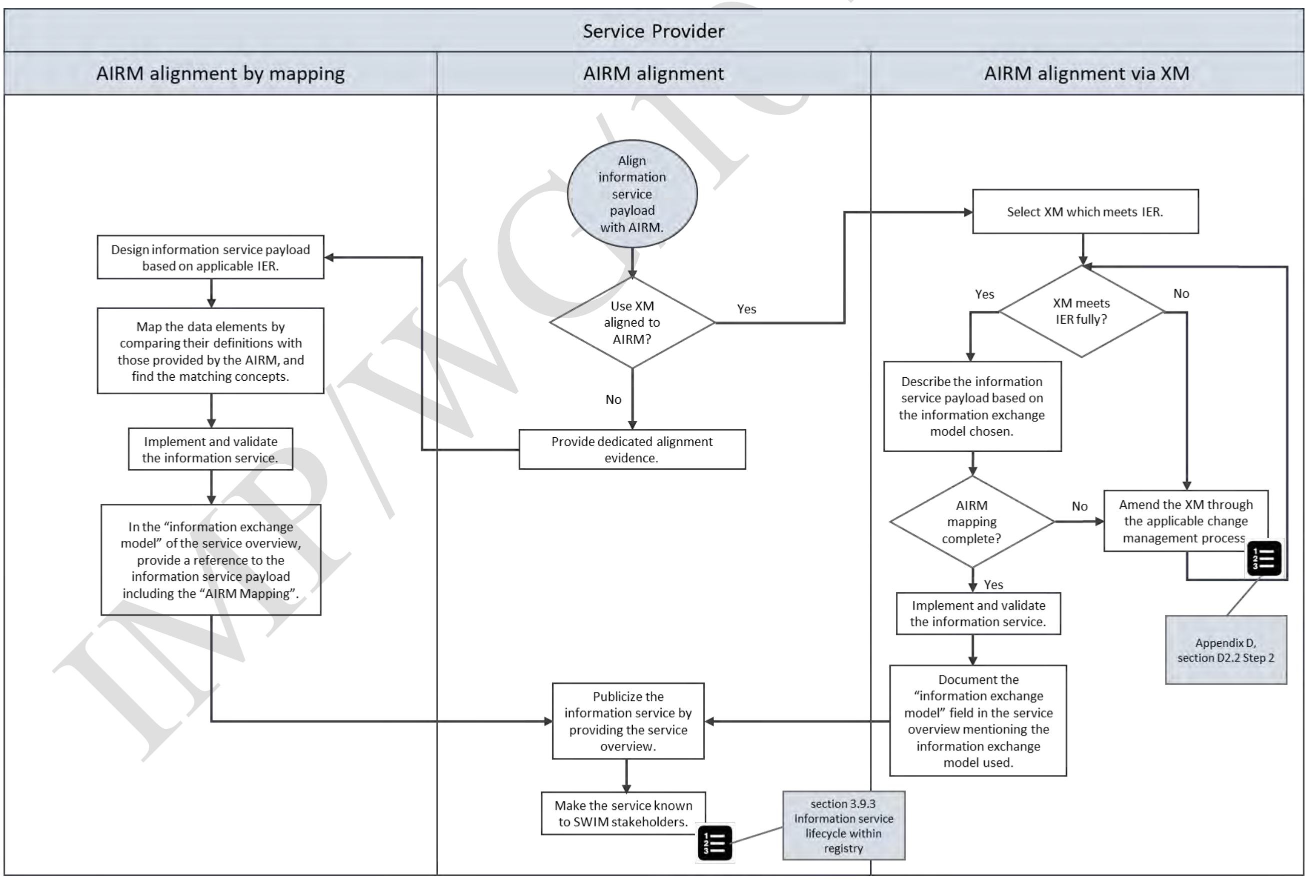

Figure 4-3: information service payload to AIRM alignment

4.5.2.1 AIRM Alignment via an Information Exchange Model

The guidance hereafter describes steps which could be followed:

1. Select an existing information exchange model that meets the information exchange requirements (IER);
    a. Describe the information service payload based on the information exchange model chosen (e.g. AIXM, FIXM, IWXXM, AMXM);
        i. Ensure that the data intended to be exchanged is correctly described by the definitions provided by the information exchange model chosen.
        ii. If this is not the case, i.e. the IERs and hence the information service payload cannot be fully covered, go to step 2.
    b. Implement and validate the information service;
    c. Document the "information exchange model" field in the service overview mentioning the information exchange model used;

Note: The semantic alignment of the information service payload with the AIRM is achieved when the information exchange model itself is aligned with the AIRM (see also Appendix D regarding information exchange model alignment).

    d. Publicize the information service by providing a service overview.

Note: the preferred way to make the Service Overview available is through a SWIM Service Registry.

2. When the selected information exchange model is not fully meeting the IER:
    a. Amend/modify the information exchange model through the applicable change management process, go to Step 1 or if not the preferred solution proceed to 2b)
    b. Create an extension to the information exchange model following the conventions of the information exchange model and applying the steps described in section 4.5.2.2 below.

4.5.2.2 AIRM Alignment by Mapping

The guidance hereafter describes steps which could be followed:

1. Design the information service payload based on the applicable IERs. In this process, create a definition to capture the ATM business meaning for every data element of the information service payload.

Note 1: ISO 11179 (Part 4) provides guidelines for creating payload data element definitions.

Note 2: The design of the information service payload can also be based on the content of the AIRM itself (i.e. the payload structure can be derived from the AIRM) if the data element definitions required are in the AIRM.

2. Map the data elements by comparing their definitions with those provided by the AIRM, and find the matching concepts. Annotate the data definitions with the identifiers of the AIRM concepts.

Note 1: The annotations to the definitions of the data elements constituting the information service payload demonstrate the alignment of the respective payload with AIRM, i.e. the "AIRM mapping".

Note 2: detailed guidance for this activity can be found in the www.airm.aero domain.

Note 3: When the data elements of the information service payload are based on the AIRM the mapping activity can be skipped, and the annotations emerge as a by-product of Step 1. Using the AIRM does not prevent further technical optimization that may be required in any specific implementation and technology context.

Note 4: when no match with an AIRM concept can be found although your definition is in scope of the AIRM, an AIRM change request should be considered. Information about the AIRM Change Management process can also be found at www.airm.aero.

3. Implement and validate the information service; and

4. In the "information exchange model" of the service overview, provide a reference to the information service payload including the "AIRM Mapping".

5. Publicize the information service by providing a service overview.

Note: the preferred way to make the service overview available is through a SWIM service registry.

4.6 DOCUMENTING INFORMATION: METADATA

Metadata provisioning is essential in SWIM. Metadata enables building trust, comparability and transparency. Metadata is also used when discovering information services (see Service Overview in Ch3). In the context of this section, metadata is used to document information (i.e. the information service payload).

Metadata about information typically describes aspects such as:

- Identification: information needed to identify the information;
- Context: information about the context of the information. For example, the scope and content of the information service payload;
- Quality: information (e.g. accuracy, timeliness) needed to give an assessment on quality of the information;
- Lineage: information needed to understand the history (including source, processing, and transformations) of the information; and
- Access and usage limitations: information that outlines how to access the information and on what conditions (e.g. there may be legal conditions to be met before the information received through an information service can be used).

The above metadata categorization provides a high-level indication of information metadata scope. When further exploring the details of metadata, more fine-grained categorizations exist that go beyond these aspects. Also, metadata about the provided information may be layered and may apply to an entire data set (e.g. an ICAO AIP data set made available as a service), to a particular data element (e.g. an aerodrome) or to a particular property (characteristics) of a data element (e.g. the status of a runway).

Metadata itself needs to be interoperable. Hence, it is important to use a common metadata vocabulary. In terms of open metadata standards, current ICAO SARPs refer to the metadata standard for geographic information, ISO 19115.

When providing metadata, it is possible to derive from a standard such as ISO 19115 a common profile to support interoperability. It is also important that the obligation to provide metadata does not overburden the information service provider while still providing potential consumers with all necessary descriptive information.

4.6.1 Information Domains and Metadata

Information domains may have specific metadata requirements based on applicable guidance, law and policy. For example:

- Annex 15 imposes on Aeronautical Information Services the collection, storage and transmission of metadata. AIXM uses the ISO 19115:2003 – Geographic information – Metadata standard.
- Annex 3 requires metadata to accompany messages such as volcanic ash advisory information (3.1.4), tropical cyclone advisory information (5.1.5), METAR and SPECI (2.1.5). It references the metadata profile in the Manual on the Digital Exchange of Aeronautical Meteorological Information (Doc 10003).

Chapter 5 Technical Infrastructure (TI)

5.1 SWIM TI INTRODUCTION

The SWIM Technical Infrastructure (TI) enables the implementation of interfaces between systems, providing technical capabilities for secure, high performing and reliable information exchange. The SWIM TI is a collection of software and hardware enabling information services provisioning. Applications consume information services via a SWIM TI, which enables information exchange over an IP network (Figure 5-1). Both the information service provider (responsible for the information service) and the information service consumer (responsible for the consuming application) are responsible for implementing their own infrastructure.

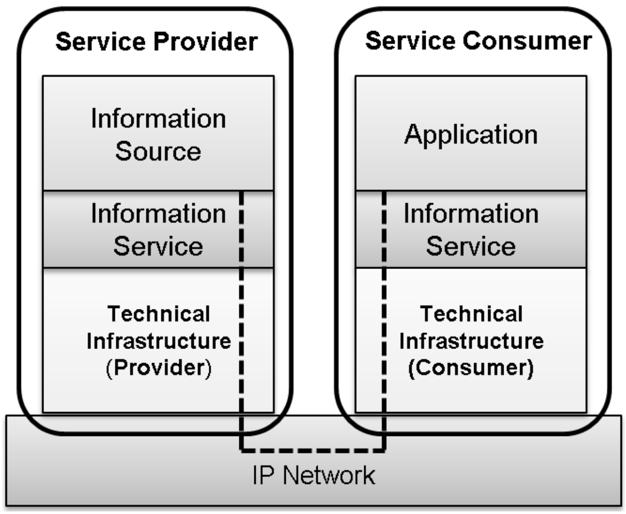

Figure 5-1: SWIM TI Overview

SWIM TI enables technical interoperability by specifying interfaces based on industry standards. The SWIM TI interface bindings specify the protocols for message exchanges between systems. The SWIM TI provides technical capabilities that are adapted to support various information exchange needs, including:

1. Communication needs such as Ground/Ground or Air/Ground;
2. Exchange patterns such as Publish/Subscribe or Request/Reply; and
3. Service levels with different Quality of Service attributes (see section 3.5).

5.2 SWIM TI PRINCIPLES

The SWIM TI contributes to achieving the SWIM benefits described in the *Manual on SWIM (Doc 10039), Volume I*, Chapter 2, 2.3 by respecting the following principles:

- **Managed technical diversity:** Technological diversity is managed to minimize the significant costs to maintain expertise while allowing flexibility to accommodate new technologies and select technologies that best meet ATM needs. In the absence of a commonly agreed upon set of standards that allow organisations to efficiently exchange data over SWIM, a service consumer could be confronted with a complex and heterogeneous environment where every information service provider chooses its own communication protocols;

  Note: This is the primary focus of the SWIM TI Bindings as explained in section 5.3.3.

- **Standards Based Technical Interoperability:** SWIM TI implementation is based on open standards that promote technical interoperability;

  Note: Concrete examples of such standards are provided in section 5.3.3

- **Established technology standards:** SWIM TI implementation is based on widely deployed and supported technology standards that enable economical and efficient information services implementation and operation;
- **Modularity:** SWIM TI implementation is modular, enabling progressive deployment of SWIM TI functional capabilities and bindings, which will allow a fit for purpose, flexible and agile implementation and evolution; and

Note: An example of modularity would be deploying initial TI capabilities, for example messaging; subsequent capabilities for mediation can be added later. The benefits of modularity include aligning features and deferring implementation until those features are needed.

- **Platform Independent interfaces:** Interfaces between systems do not create dependencies imposed by implementation platforms, such as operating system or programming language. This principle relates to the loose coupling concept introduced in *Manual on SWIM (Doc 10039), Volume 1 – SWIM Concept*.

5.3 SWIM TI DECOMPOSITION

The *Manual on SWIM (Doc 10039), Volume 1 – SWIM* describes the conceptual role of the SWIM TI in terms of infrastructure services. Yet it follows from the definition of "service" introduced in chapter 2 of this document ("a mechanism to enable access to one or more capabilities using a prescribed interface") that to characterize the "infrastructure services" of the SWIM TI in more detail, it is necessary to explore the set of their capabilities:

SWIM TI capabilities: These are divided into functional and non-functional capabilities. While the TI functional capabilities can be conceptualized as functions that can be invoked or executed by a system and have inputs and outputs (e.g. encryption, authentication), the non-functional capabilities are derived characteristics of a system as a result of implementing functional capabilities (e.g. confidentiality) or other contributing elements, such as the deployment architecture (e.g. a redundant deployment contributes to availability);

  - SWIM TI functional capabilities are infrastructure functions (e.g. protocol transformation, encryption), not specific to a business area or information domain, that enable information exchange between systems;
  - SWIM TI non-functional capabilities are SWIM TI characteristics that contribute to the quality of services (e.g. the availability of the SWIM TI has direct impact on the availability of the service it supports); and

Although some of the capabilities and terminology expressed in this chapter exist at network level (e.g. message routing), this section refers only to the SWIM TI-specific capabilities that work with higher-level protocols above those used by the network.

The means to technically access the SWIM TI capabilities is to implement an interface. To this end, technology needs to be specified. This is the role of SWIM TI interface bindings, defined as follows:

- **SWIM TI interface bindings:** a set of protocols and their configurations that define how to interoperate with a system; there are two types of interface bindings in the TI, service binding (e.g. HTTP, AMQP, etc.) and network binding (all values/data needed to connect to the given IP network, e.g. IPv4 Secure Unicast). Interface bindings play a critical role in enabling technical interoperability in SWIM and are highlighted as specific TI components. Interface bindings assume the existence of an IP network.

Note: an information service may be based one or more service binding as well as on one or more network bindings.

5.3.1 SWIM TI Functional Capabilities

The SWIM TI functional capabilities can be grouped into three categories:

- **Messaging Capabilities:** Employ technologies that enable information exchange using various access methods (e.g. publish/subscribe, request/reply);
- **Security Capabilities:** Provide infrastructure security technologies that enable secured information exchange, including, but not limited to, identity access management, digital certificates, encryption, etc.; and
- **TI Management Capabilities:** Monitor technical infrastructure for fault and performance, ensuring reliable and compliant information exchange (e.g. monitoring).

The functional capabilities described in this section are common features widely supported by mainstream commercial off the shelf (COTS) systems and services. Implementing a SWIM TI that supports all these capabilities is recommended. However, it is up to the implementer to identify the capabilities required to support the implementation of its services.

A suitable combination of functional capabilities can realize a desired non-functional capability, for example:

- a combination of functional capabilities, such as authentication, authorization or cryptography can implement non-functional requirements, such as confidentiality or integrity; and
- a combination of design patterns (e.g. clustering) combined with functional capabilities such as load balancing and replication can implement non-functional requirements such as availability.

5.3.1.1 Messaging Capabilities

In SWIM, ATM-related information exchange between organisations is done via information services. Information services enable the consumer to access information and functionality offered by a provider based on a prescribed interface. A service interface defines operations and related input and output messages for those operations that consumers and providers exchange to implement the functionality offered by a service. Messaging is therefore a key capability in SWIM and the most important function of the SWIM TI. The messaging capability of the SWIM TI includes:

- **Connectivity:** Enabling message exchange according to well-defined protocols. The transport function will instantiate interface binding specifications (set of protocols) into adaptors or connectors to exchange information with other systems;
- **Message Distribution:** Enabling synchronous or asynchronous message processing. This function uses information exchange resources (e.g. queues, topics) to decouple TI functions involved in message processing (connectivity, validation, etc.) based on configurable

distribution rules (e.g. content/context-based routing). The components that provide this kind of functionality are message brokers;
- **Message Validation:** Enabling message validation to ensure they are syntactically well formed;
- **Policy Enforcement:** Enforcing messaging policy (e.g. routing and filtering policies, reliability policy) application; and
- **Orchestration:** Enabling coordination between TI capabilities.

5.3.1.1.1 Message Exchange Patterns (MEP)

Several types of MEP are expected to be supported within a SWIM environment, including synchronous request/reply, asynchronous request/reply, one-way (“fire-and-forget”) and publish/subscribe. The MEP used in any given exchange is directed by the information service provider to meet information service objectives. These MEP include:

- **Synchronous Request/Reply:** Consumer sends a request to an information service; the service then executes the request and provides a reply to the consumer. This pattern requires that the consumer wait for the information service to provide a response and is unable to send/receive any other requests/responses until the initial response is received. This pattern is specifically applicable to information services that execute and provide quick responses to consumers;
- **Asynchronous Request/Reply:** Consumer sends a request to an information service; the service then executes the request and provides a reply to the consumer. However, the consumer is not restricted from completing other operations while waiting for the information service to respond. This MEP requires that the consumer be able to receive messages at any time and correlate those messages with prior requests;
- **One-way (“Fire-and-Forget”):** Consumer sends a message to an information service without any requisite response from the information service. This MEP may have more use at the lower (application layer) level of SWIM where message responses are not required;
- **Publish/Subscribe (P/S):** Consumer sends a subscription request to an information service. The subscription may be capable of providing details (e.g. through a filtering parameter) on the information being subscribed to;
    - In the case of a P/S with a push mechanism, the information service sends necessary updates (publish) to the consumer, in accordance with the subscription. This MEP requires that the consumer can receive messages at any time. However, the consumer is not restricted from completing other operations while waiting for the information service to respond; and
    - In the case of a P/S with a pull mechanism, the information service would keep necessary updates available to the consumer, in accordance with the subscription. This MEP requires the consumer sending requests to the service to receive the updates.

5.3.1.2 Security Capabilities

As supporting functions to messaging, the SWIM TI security capabilities are of high importance as they enable a trusted information exchange. These capabilities are:

- **Identity Management:** Enabling identity management (e.g. identity creation, identity validation, federated identity retrieval);

- **Authentication:** Enabling credential verification and validity and their correspondence with an identity;
- **Authorization:** Enabling permission management associated to identities and, based on these, enforcing access control to TI services and resources;
- **Cryptography:** Providing secure functions for encryption, decryption and hashing;
- **Key Management:** Enabling cryptographic keys' secure management;
- **Audit:** Recording contextual information related to security events;
- **Security Monitoring:** Enabling security related event monitoring, event handling and reporting;
- **Policy Enforcement:** Enforcing security policy application; and
- **Boundary Protection:** Providing capabilities to ensure infrastructure protection against external threats (e.g. firewall, rate limit management).

5.3.1.3 TI Management Capabilities

As supporting functions to messaging, the TI management capabilities ensure reliable and performant information exchange. These capabilities are:

- **Resource Monitoring:** Enabling TI resources (e.g. processors, memory) monitoring;
- **Service Monitoring:** Enabling the TI service (e.g. status, uptime, and response times) monitoring;
- **Alerting:** Enabling management alerts regarding infrastructure-related events (e.g. threshold management) monitoring;
- **Logging:** Enabling the system event recording with the relevant contextual information;
- **Replication:** Enabling system and data replication management, enabling different degrees of fault tolerance and failover;
- **Persistence:** Enabling data persistence management in the TI; and
- **Load Balancing/Clustering:** Enabling load distribution management across TI resources, enabling horizontal scaling and high availability.

5.3.2 SWIM TI Non-Functional Capabilities

Non-functional capabilities directly contribute to the quality of SWIM services that use the SWIM TI (see section 3.5). While the TI functional capabilities are executable (e.g. encryption), the SWIM TI non-functional capabilities addressed in this section are a consequence of using functional capabilities (e.g. confidentiality is the result of using encryption). The non-functional capabilities of the SWIM TI are based on ISO 25010 and are described in the following sections.

5.3.2.1 Performance Efficiency Qualities

The SWIM TI performance characteristics include:

- Time behaviour, including response time and latency, can be directly correlated to the functional capability execution time of the TI. The deployment architecture can also influence time behaviour as well as the SWIM TI replication and load balancing functionalities; and
- Capacity (e.g. messages per second) is directly correlated to the functional capability execution time of the TI. The deployment architecture can also influence capacity as well as the SWIM TI replication and load balancing functionalities.

5.3.2.2 Reliability Qualities

The SWIM TI reliability characteristics include:

- Availability enables the SWIM TI to remain operational and accessible when required for use. The deployment architecture is of high importance to ensure availability as well as the SWIM TI replication and load balancing functionalities;
- Recoverability enables the SWIM TI to recover the data directly affected by an interruption or a failure and re-establish the desired system state. The deployment architecture is of high importance to ensure availability as well as the SWIM TI persistence and replication functionalities; and
- Fault tolerance enables the SWIM TI to operate as intended despite the presence of hardware or software faults. The deployment architecture is of high importance to ensure fault tolerance as well as the SWIM TI persistence, load balancing and replication functionalities.

5.3.2.3 Security Non-Functional Qualities

The SWIM TI security characteristics include:

- Confidentiality ensures that data is accessible only to those authorized to have access, and it can be achieved as a combination of functional capabilities such as authentication, authorization or cryptography;
- Integrity prevents unauthorized access to, or modification of data, and it can be achieved as a combination of functional capabilities such as authentication, authorization or cryptography;
- Non-repudiation ensures actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later; this can be achieved as a combination of functional and non-functional capabilities such as logging, cryptography, etc.;
- Accountability ensures actions of an entity can be traced uniquely to the entity and it can be achieved as a combination of functional capabilities such as logging, authentication, and cryptography; and
- Authenticity ensures the identity of a subject or resource can be verified, and it can be achieved as a combination of functional capabilities such as authentication, cryptography.

5.3.3 SWIM TI Interface Bindings

As explained in Functional Capabilities (Section 5.3.1), the SWIM-TI enables message exchange between systems, providing a “Messaging Capability” composed of several functions responsible, among other things, to manage systems’ connectivity. Related to the connectivity function, SWIM TI interface bindings are a critical aspect for interoperability. An interface binding is a consistent, self-contained grouping of interface requirements that specify the protocols and configuration options to be used for information exchange between systems. Two systems that implement the same interface binding are considered technically interoperable and can connect to each other and exchange information.

There are two types of interface bindings to be distinguished based on their position in the TCP/IP protocol suite[2]:

- **Service Bindings:** Specify the service interface technical interoperability, including protocols to interface with the applications, such as HTTP and AMQP; and
- **Network Bindings:** Specify what is expected by the SWIM TI to communicate over the IP network, including protocols from the network and transport OSI layers. Although the network layer is not considered part of the SWIM scope, SWIM systems require an IP network. The network bindings specify the transport and network related protocols that will be used to exchange data over the network, such as TCP, IP v4/v6 and IPsec.

The number of potential technologies used for interface bindings and the number of information flows to be realized create a risk of unnecessary diversity, which may negatively impact the cost. Furthermore, consuming from SWIM based on interface bindings selected by information service providers may also trigger costs related to consuming clients' implementation. For these reasons, it is good practice to consolidate the interface bindings around mainstream technology standards (Figure 5-2). This will then enable cost benefits and other synergies among the SWIM stakeholders.

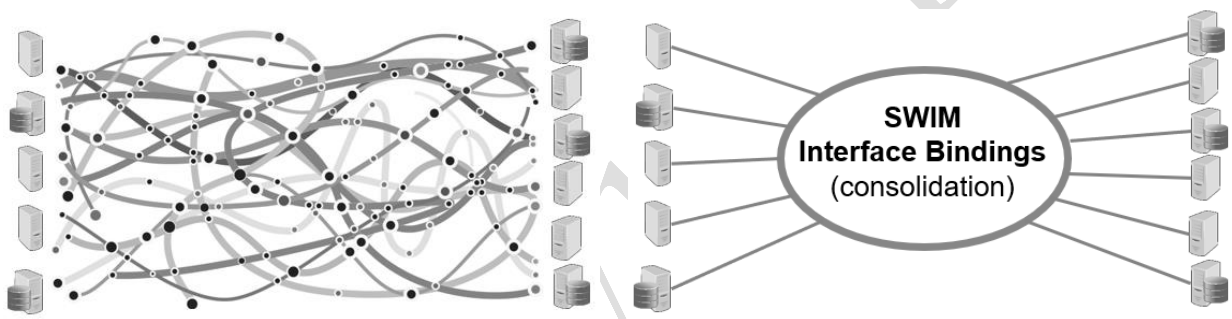

Figure 5-2: SWIM TI Interface Bindings Consolidation

Examples of consolidated, and commonly defined and agreed upon, SWIM TI interface bindings include:

- The EUROCONTROL Yellow Profile[3] Technical Infrastructure Specification, chapter "Interface binding specification", provides a list of service interface bindings based on mainstream technology standards (e.g. HTTP, WS SOAP, AMQP, etc.) and network interface bindings (e.g. IPv4 Unicast, IPv6 Secure Unicast, etc.) that enable addressing a wide range of information exchange needs; and
- The FAA uses a Description Document for every user that publishes SWIM information to the FAA's NAS Enterprise Messaging Service. The documents provide interface management definitions addressable to consumers by access type: 1) JMSDD for publish/subscribe methodology (Java Messaging Service Description Document); and 2) WSDD for request/reply methodology (WSDD).

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[2] The TCP/IP protocol suite is the conceptual model and set of communications protocols used on the Internet and similar computer networks.

[3] SWIM TI profiles are used in Europe to group technical infrastructure requirements. The so-called Yellow Profile is the generic profile for SWIM ground-ground communication. Other more specialized profiles could be introduced in the future (e.g. Purple for air-ground communications)

The following technology standards and specifications list illustrates some of the possible content included in the interface bindings:

- AMQP
- TLS
- HTTP, HTTPS
- SOAP
- OGC Web Coverage Service
- ISO/OGC Web Feature Service (ISO 19142:2010)
- ISO/OGC Web Map Server Interface (ISO 19128:2005)

Note: in order to ensure technical interoperability, the implementations should specify the version of the technology standards, where relevant

While the above list focuses on the technical standards that ensure technical interoperability between systems, complementary technologies will be used to implement a SWIM TI, including:

- Messaging libraries: JMS
- Interface description languages: WSDL, WADL, OpenAPI,
- Architectural styles: REST

The interface binding will also encompass selection of an appropriate standard exchange language, as required for syntactic interoperability (see section 4.2), e.g.

- Data description languages: JSON Schema, XML Schema, Protocol Buffers, Apache Avro Schema
- Data serialization format: JSON, XML, Protocol Buffers, Apache Avro.

The above list of technologies can be referred to as platform technologies, and by the principle of platform independence, their use by a stakeholder should not constrain any other stakeholder to use these technologies when implementing a common interface.

5.4 OTHER SWIM TI CONSIDERATIONS

5.4.1 SWIM TI Context

The SWIM TI is not an implementation objective in itself and can only be justified and understood within the context it operates and shall support. This section provides a description of the SWIM TI from the following points of view:

- **Protocol:** Looking relation to existing technology protocols;
- **Deployment:** Clarifying the different potential TI deployment approaches; and
- **Functional:** Providing a view to how SWIM TI capabilities support information exchanges.

5.4.2 Protocol View

The SWIM TI uses interface bindings to enable technical interoperability between systems and specifies protocols for information exchange. **Figure** 5-3 illustrates how the protocols specified in the interface bindings relate to the most common protocol layering frameworks.

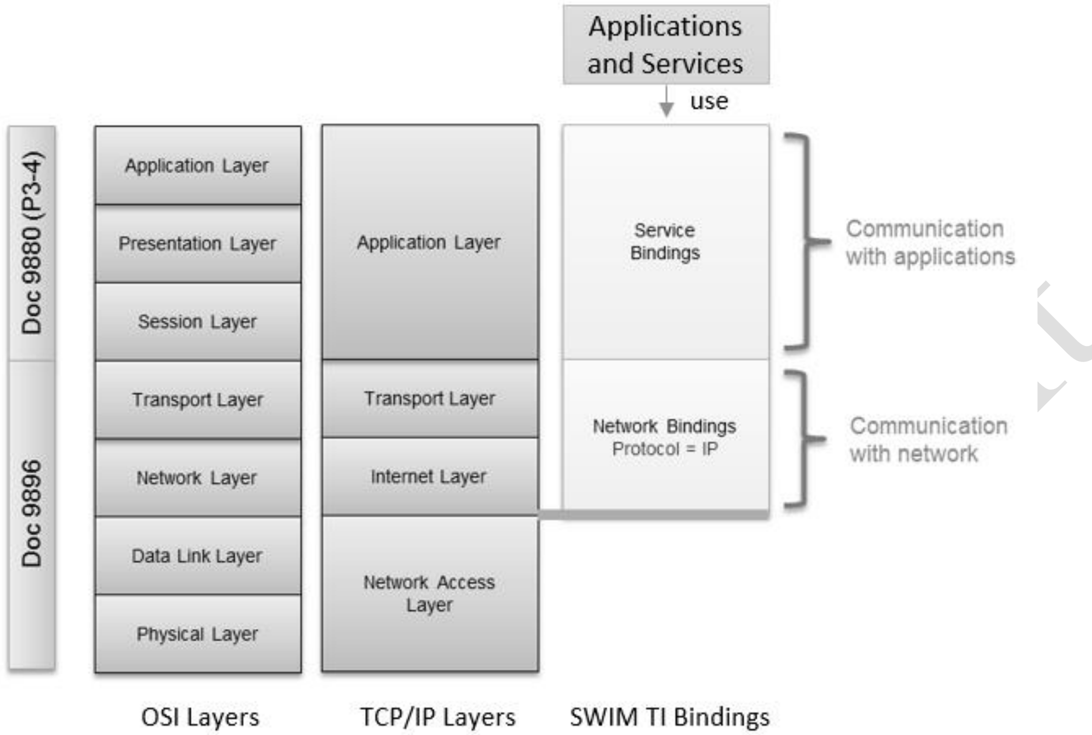

Figure 5-3: SWIM TI Interface Bindings and Protocol Layers

Note: 'Services' could be SWIM information services and 'Application' could be SWIM enabled application. In GIF context, they would be on separate layer. In OSI context, both are "application".

The SWIM TI is primarily concerned with the TCP/IP stack's application layer protocols, including HTTP, SOAP and AMQP. These are specified as part of the SWIM TI Service Bindings to implement secured service interfaces that enable communication with the applications.

Although the network layer is not considered part of the SWIM scope, SWIM systems require an IP network (irrespective of the protocol, i.e., IPv4 or IPv6). The SWIM TI network bindings specify what is expected by the SWIM TI to communicate over the IP network, including protocols from the network and transport OSI layers[4].

The protocol split between Service and Network bindings corresponds with the split in scope followed by the ICAO Manual on Detailed Technical Specification for the Aeronautical ATN using ISO/OSI standards and protocols Part III and IV (Doc 9880) and the Manual on the ATN using Internet Protocol Suite (IPS) Standards and Protocol (Doc 9896) concerning the ICAO ATN/IPS protocol architecture.

5.4.3 Deployment View

[4] The Open Systems Interconnection model (OSI model) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard protocols

5.4.3.1 Progressive Deployment Based on SWIM TI Modularity

As explained in the capabilities sections, the SWIM TI considers a wide range of capabilities. However, not all these capabilities need to be deployed from the start, as some of the capabilities might not be relevant to the implementer’s context. The SWIM TI capabilities are defined as modules that the implementer can deploy progressively in accordance to the evolution of its needs.

5.4.3.2 Different Deployment Options within an Organisation

From a logical point of view, the SWIM TI is used within an organisation to support:

- implementation of an information service (by a provider), that enables access to an internal function and exposes it via a prescribed interface; and
- implementation (by the consumer) of an interface that allows an application to consume from an information service.

From a deployment point of view, there are different alternatives related to how the different logical units became part of software components and how these interact.

Note: Depending on the SWIM implementation, the Information Service and the Infrastructure Service may be provided by the same entity.

5.4.4 Functional View

This section complements the description of the SWIM TI capabilities by providing an example illustrating how the functionality of the SWIM TI enables the implementation of an information service, and how this helps decoupling the back-end application that provides the information from the various communication mechanism supported by external systems.

Note: this content is for clarification purposes only and shall not be understood as deployment guidance.

The following example (Figure 5-4) considers different entities exchanging information:

- an information service provider that implements a service that enables consumers to query via a request/response exchange pattern; and
- a service consumer that initiates the communication when requires and information update.

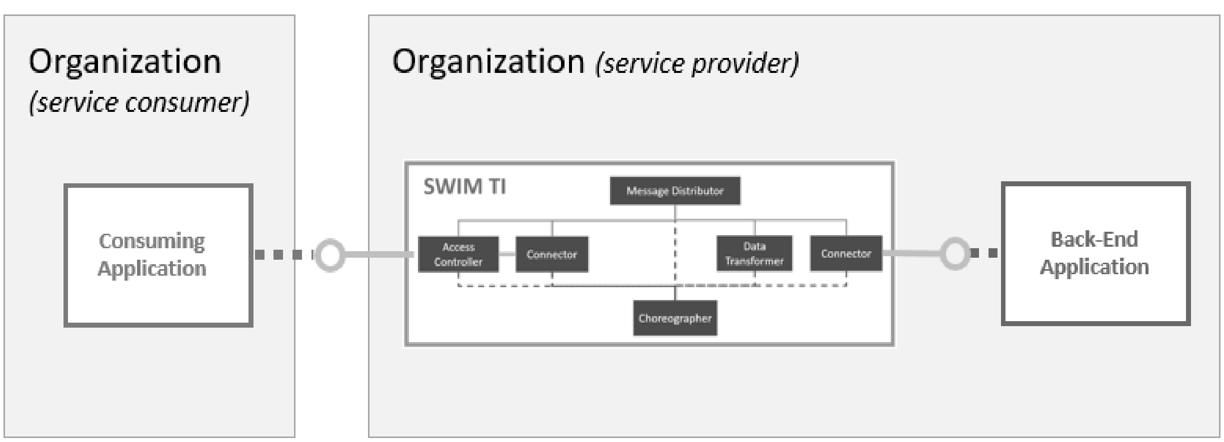

Figure 5-4: SWIM TI Functional Overview

The following components are used to implement the SWIM TI functionality for this example:

- An access controller component that implements security functionality to:
  - authenticate and authorize requests
  - provide boundary protection including overload protection
- Connectors that provide connectivity functionality
  - With one connector implementing a standardized binding specification that enables standardized access to information to the consumers
  - With another connector implementing a proprietary set of protocols that enables connectivity with the back-end application
- A data transformer that enables to translate
  - standardized data formats supported by the service for exchanging data with the consumers
  - proprietary application formats
- An orchestrator component that implements the orchestration flow and enables to compose the R/R message exchange pattern
- A message distributor (Figure 5-5) component that decouples all other components asynchronously and enables every component to be independent from the others (working at its own pace)

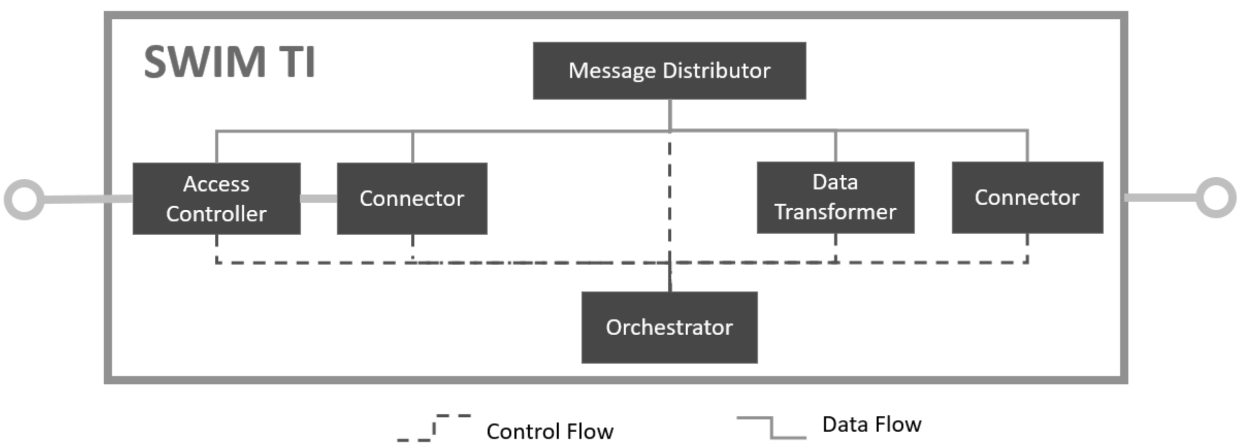

Figure 5-5: Message Distributor

The following information flows are established (Figure 5-6):

- A **service discovery** step, not represented in the figure, which is required by the consumer to identify how to connect to the service (e.g. interface binding and location). This is typically done with the support of a SWIM Service Registry[5] (see section 3.7).

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[5] A design time registry will enable service discovery during the design phase allowing systems to be developed and configured to bind to a particular information service. A runtime registry will enable dynamic discovery of services in the runtime phase where the system is already operational, and it uses registry information to bind to a particular information service.

- As step 1, the external connector receives a request from the Consuming application and sends this to the message distributor.
- In step 2 the choreographer determines the process to deal with this request, sends it for transformation (to the back-end application format), and then sends it to the message distributor as a request to the back-end application.
- In step 3 the internal connector obtains the back-end application request and sends it.
- In step 4 the internal connector receives a reply from the back-end application and sends this to the message distributor
- In step 5 the choreographer correlates it to the original request, sends it for transformation (to the consumer format), and then sends it to the message distributor as a reply to the consuming application
- In step 6 the external connector obtains the reply and sends it to the consuming application.

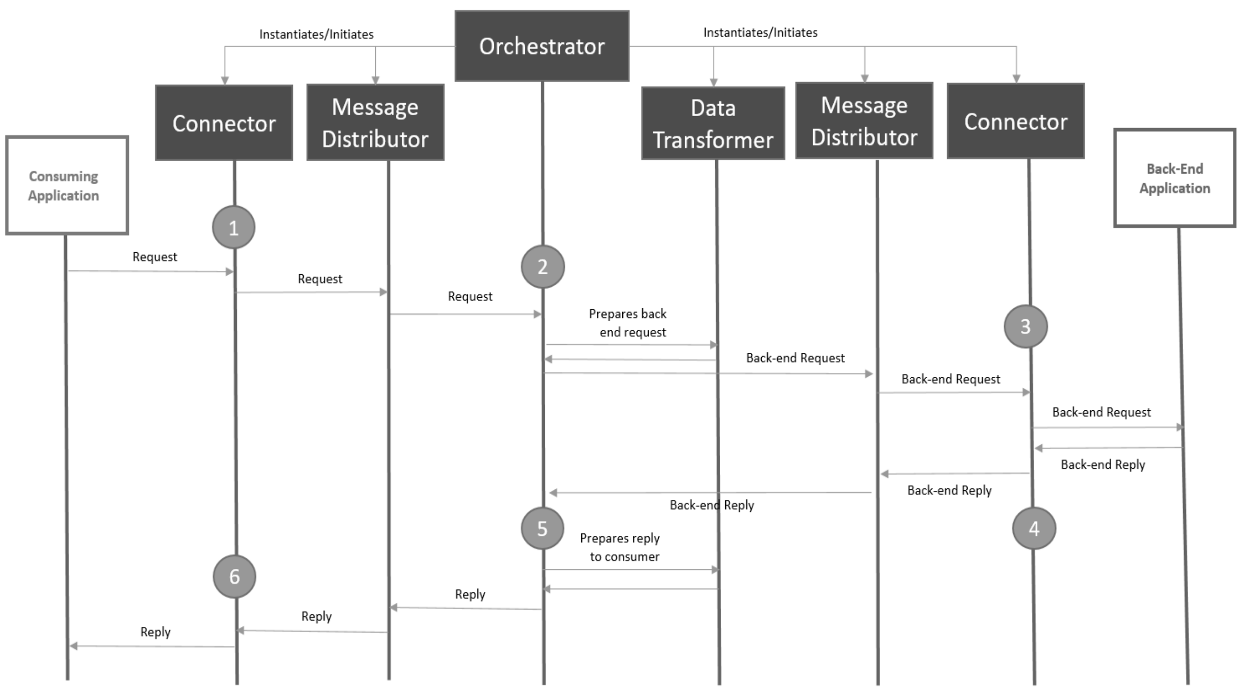

Figure 5-6: Information Flows

When decoupling of back-end applications is not an architectural concern, the integration of applications via SWIM represents essentially an integration and reuse of internet resources. But more complex scenarios will also be encountered. Figure 5-7 provides a simple example where a consumer does not require TI. A SWIM Service Registry is not included since it is not relevant for data flow.

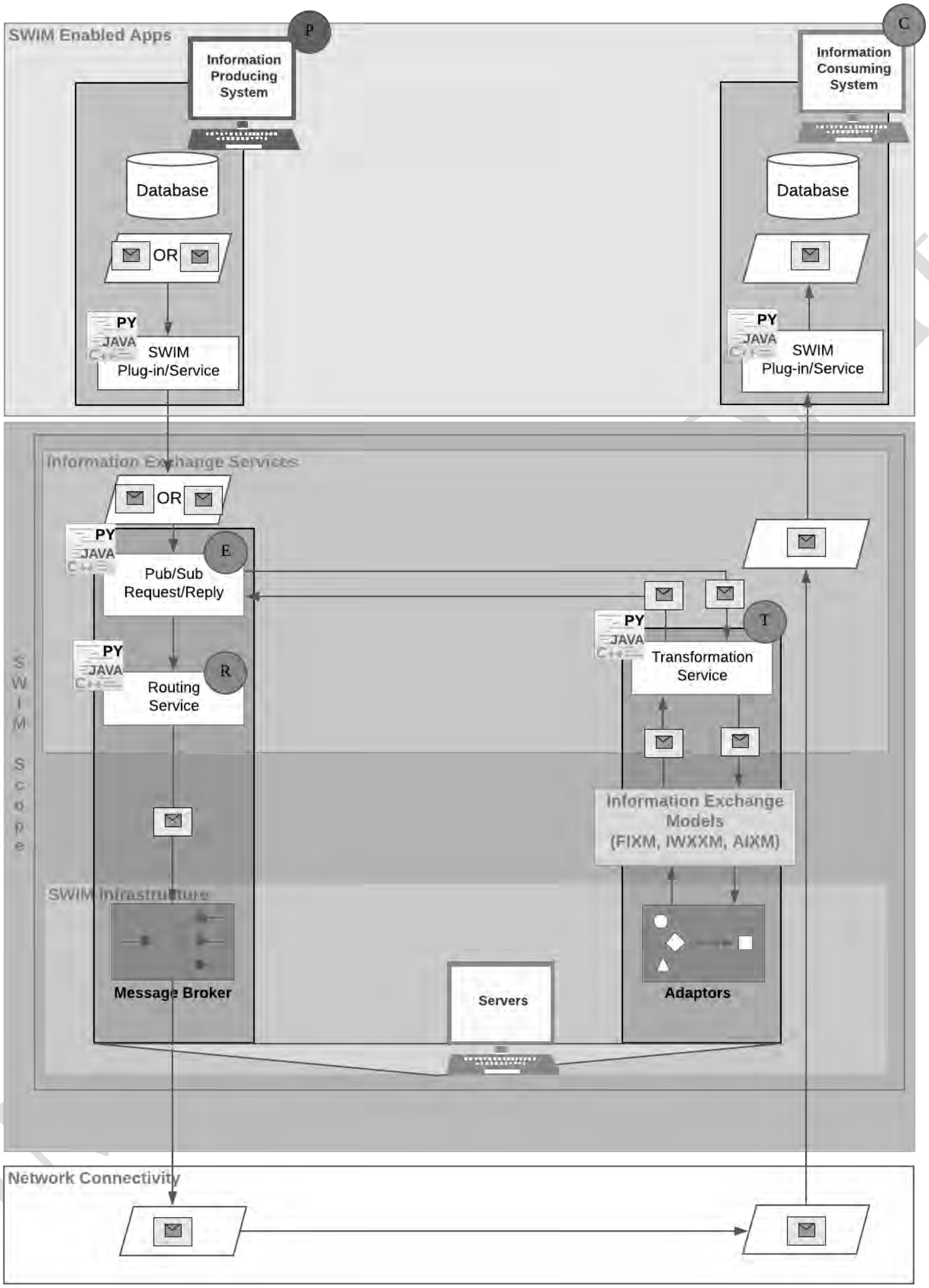

Figure 5-7: Example of SWIM TI Functional Overview

Chapter 6 Governance

6.1 INTRODUCTION

In the context of SWIM, governance encompasses information, information services and technical infrastructure. SWIM governance aims at facilitating the implementation of information services and at ensuring interoperability, whilst not hampering flexibility and agility. Therefore, SWIM governance needs to find the right balance between "too stringent" and "too loose".

SWIM governance generally is driven by mutually agreed objectives and priorities to achieve a successful SWIM implementation in a given State or region. SWIM governance considers SWIM Stakeholders requirements and contributes to transition planning.

6.2 OBJECTIVES

SWIM governance objectives include, but may not be limited to, the following:

- establishing a collaborative approach between SWIM Stakeholders for a managed implementation and evolution of SWIM;
- ensuring interoperability through services enabling management and exchange of ATM information;
- building and maintaining the trust among the SWIM stakeholders, with a focus on the expectations of the consumers of services; and,
- supporting SWIM implementation, with a focus on providers of services.

6.3 SWIM GOVERNANCE ACTIVITIES

SWIM Governance activities may include the following:

- Establishing and implementing SWIM governance bodies
- Developing and maintaining SWIM policies
- Developing and maintaining guidance material
- Identifying and documenting the applicable standards for SWIM and additional standardization needs
- Planning SWIM transition
- Supporting and communicating with SWIM Stakeholders

6.3.1 SWIM Governance Bodies

The implementation of SWIM requires high-level decision making (for example, about the general directions of SWIM evolution), a managed approach to operating SWIM and implementing changes, and coordination between the subject matter experts to work out the practical details of SWIM information exchanges. Therefore, SWIM governance bodies may represent SWIM Stakeholders at various levels (e.g. decision-making, technical management, subject matter expertise).

An example of an organisational structure of SWIM Governance bodies is illustrated below in Figure 6-1.

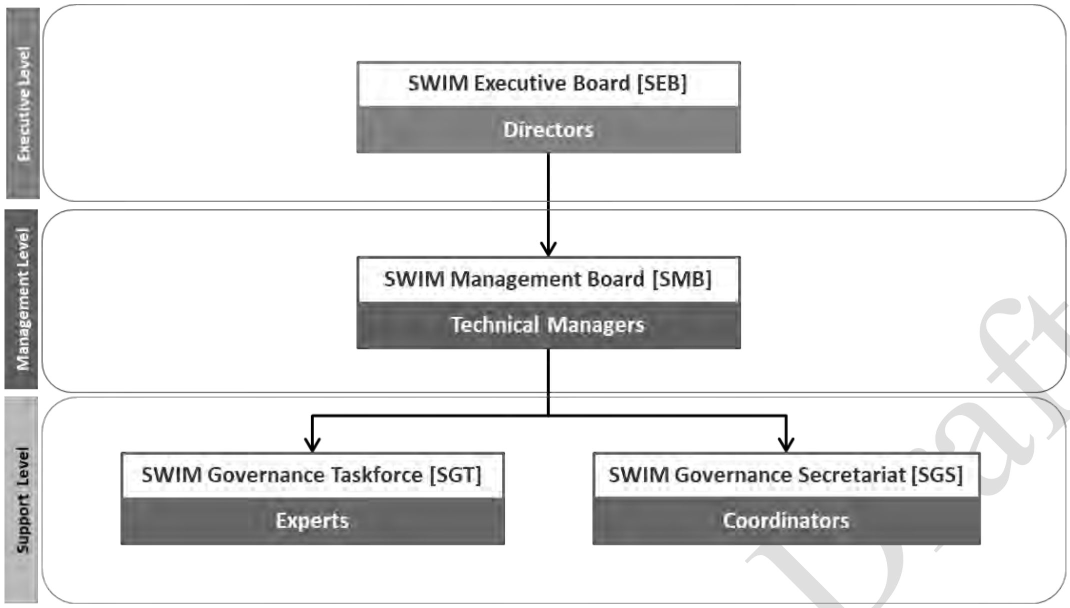

Figure 6-1: Example of SWIM governance bodies

In this example, the organisational structure of the SWIM Governance is designed in three different levels: SWIM Governance Executive Level, SWIM Governance Management Level and SWIM Governance Support Level. The SWIM Governance Executive level is the highest level of the SWIM Governance structure, as well as the highest decision-making level. It is targeted to steer the overall SWIM Governance. The SWIM Governance Steering Level is composed of one board: the SWIM Executive Board (SEB)

The SWIM Governance Management Level is the second level on decision-making within the SWIM Governance Structure. It is the level where the technical discussions are conducted. The SWIM Governance Management Level is composed of one board: the SWIM Management Board (SMB)

The SWIM Governance Support Level is the lowest level of the structure. It provides appropriate support to the decision-making levels of the SWIM Governance in aspects within the remit of the SWIM Governance Tasks. The SWIM Governance Support Level is composed of the SWIM Governance Secretariat (SGS), which is a body executing transversal functions, and SWIM Governance Taskforces (SGTs), which are created in an ad-hoc basis by the SMB for specific mandates.

At the work level, the participating organisations may carry the day-to-day intra-organisational aspects of practical SWIM implementation effort forward through a “SWIM SOA community of interest”, as described in section 2.4 above. Then, SWIM Governance would support this community of interest by agreeing suitable working arrangements etc. SGTs could be created to support in critical issues, e.g. to prepare SMB decision making when required by the community of interest consensus.

6.3.2 SWIM Governance Processes

In order to earn the trust of stakeholders, SWIM governance follows commonly accepted practices. For example, the development and approval of a new governance policy includes a rational sequence of actions and steps taken by the appropriate governance body, such as coordination with the SWIM stakeholders, development of draft policy, consultation and an approval mechanism.

6.3.3 SWIM Regions

A SWIM region may but does not necessarily need to be an ICAO region. A SWIM region may be based on the operational requirements of individual States, and limited to a subset of States within an ICAO region, not necessarily contiguous.

SWIM Governance can be considered for a SWIM region, which can be formed (either/or):

- through grouping of various existing national / local SWIM initiatives
- as an initiative from various Stakeholders to « team-up » / share efforts and resources

ICAO Regions are an important large-scale structure in which States, and hence the operational stakeholders seated therein, are already organized by regional and operational proximity. Also, they are responsible for organizing and managing the ICAO Regional Air Navigation Plans, including the SWIM related ones. Therefore, it is anticipated that the boundaries of an ICAO Region will in many cases also be the boundaries of a corresponding SWIM Region.

Not all SWIM stakeholders have the same requirements for SWIM. Rather, each stakeholder has its specific portfolio of requirements for information services that stem from the ATM operational needs. Within a SWIM region, the participating stakeholders take benefit of the "natural alignment" of operational requirements. This is deemed easier and more practical to agree at a regional level than at a global level.

An additional benefit of a SWIM region is that it offers the opportunity to share resources and efforts. Enabling a "SWIM SOA community of interest" is a convenient means to pool expertise. Also, there can be a unique technical infrastructure or a single common registry for the whole SWIM Region.

Moreover, within a SWIM region, various technology standards or policies may be agreed between the stakeholders so that it complements the global ICAO provisions and contributes to an optimum regional interoperability.

Examples of existing SWIM Regions show that stakeholders in the same operational context prefer to join forces than work in isolation.

A SWIM region implies an amount of coordination between the various parties. It also assumes that compromises are made for the benefit of all Region participants.

At the global level, the main challenge is to ensure interoperability of the various SWIM Regions.

6.4 STANDARDS, POLICIES AND GUIDANCE

6.4.1 Standards and Standardisation Requirements

A standard is "a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose" [ISO]. SWIM components are based on common standards and conform to a shared set of rules to guarantee interoperability and alignment with business goals.

The identification and documentation of applicable existing standards is a key activity of SWIM governance. Establishing a common understanding of the formally applicable standards (such as

PANS), and agreeing on the application of technology standards and specifications (e.g. in the form of interface bindings to be used), is an important aspect of SWIM governance in order to support interoperability.

SWIM governance may identify the need for new standards or update to existing standards. In such cases, coordination with Standards Development Organisations (SDOs) is necessary so that the corresponding standardization activities are carried out.

Applicable standards may be referenced in SWIM governance policies and further complemented by guidance.

6.4.2 Policies

Within the SWIM governance context, the SWIM Policies are a set of requirements aiming at achieving a managed implementation of SWIM. These requirements are applicable to SWIM stakeholders and address, e.g. identification, design, implementation, deployment and management of services enabled by SWIM. For example, a policy could state that all information exchanges over information services shall be encrypted. This assertion is then applied to every information service that is subject to the policy.

The policies can address various topics such as service provisioning policy, service lifecycle policy, registry policy, security policy, versioning policy, etc. For example, a versioning policy supports the creation and management of multiple releases of services and associated documentation, and provides a way to communicate changes to service consumers.

Policies can be presented in a natural language text for human readers, or they can be codified to be implemented by software. Policy statements may be implemented within a registry process (e.g. registration of a new service). For example, a registry could be designed so that a service cannot be registered if it does not apply the agreed versioning policy.

Policies may be complemented by guidance.

6.4.3 Guidance

Guidance material, together with standards and policies, aims at facilitating information services implementation in a SWIM context and ensuring interoperability. Guidance describes how standards and policies should be applied and also provides explanatory material. For example, there can be guidance material on protocols, on service lifecycle, etc.

6.5 Roles, Responsibilities and Accountabilities

6.5.1 Roles and Responsibilities

Traditional roles within the aviation community can be slightly modified with the advent of SWIM and its adoption. For example, a State ANSP, instead of just being an information service provider, may also be an information service consumer and in some instances an originator of ATM related information.

The four key roles relevant to SWIM are “Originator”, “Information Service Provider”, “Information Service Consumer” and “Regulator”:

a) **Originator.** The originator creates and produces the data and information which is exchanged as part of an information service. Some examples of originators include survey organisations, airlines, ANSP, ATM, airports

b) **Information Service Provider.** Defines, integrates, transforms, analyses, provides, disseminates and archives information service. Some examples of providers include airlines, ANSP, ATM, airports

c) **Information Service Consumer**. Identifies services that meet their needs. Uses the information service provided. Some examples of consumers include airlines, ANSP, ATM, airports, flight planning systems

d) **Regulator**. Regulate, provide oversight, authorise, develop and enforce national and / or regional standards and policies.

The following examples illustrate these roles and responsibilities in the SWIM context.

- An airline, as a consumer, wants to avoid/reduce exposure to turbulence. The airline searches Registries for turbulence services and contacts three information service providers. These providers could be State ANSPs, State Weather Services, commercial weather service providers, etc. The providers offer distinctly different services that the airline requires: turbulence prediction services, turbulence reporting services and historical turbulence services. The providers build their various services around data provided by many originators. These originators could also be State ANSPs, State Weather Services, commercial weather information service providers, etc.
- The airline consumer contracts with the three information service providers for their distinct services. The Airline also contracts for a cockpit and dispatch-ready application. The application is created from the three services found in registries, as well as airline-provided inputs from PIREPS (Pilot Reports), AMDAR (Airline Meteorological Data Relay), airline tolerance levels, flight plans, etc. The application works only with the airline's internally derived sources and the airline's procured and contracted services. The application does not interface with the airline's information service providers.
- Depending on the airline's requirements, alternative services could be selected that include predictive data, trajectory amendments, altitude recommendations, models of current and future turbulence, etc.
- The services and application using the information derived from the service may be subject to regulatory oversight and subsequently regulatory approval depending on the operational usage of the information. In the context of this example, regulators may determine that the application requires prior approval for use.

6.5.2 Accountability

The accountability of the SWIM roles typically includes, but is not limited to:

- For the originator – ensuring that the data and information provided meet the applicable standards
- For the information service provider – ensuring that the service meets the stated quality of service
- For the service consumer - ensuring that the service is consumed within the context and limitations defined by the information service provider

SWIM governance facilitates the establishment and allocation of the accountability among SWIM stakeholders. Indeed, the accountability may be distributed over the parties that contribute to the overall provision of a particular service.

The accountability may be captured in:

- Applicable standards;
- SWIM governance policy(ies); and/or
- Agreement(s) between the parties.

For example, the quality of a service can be subject to obligations in a standard (e.g. ICAO PANS-IM, service overview), a SWIM governance policy or can be documented in the contract between the information service provider and information service consumers.

Chapter 7 Evolution into SWIM

In a connected digital environment, organisations interact using interfaces. These interfaces enable the organisation's information flows and business processes. The evolution into SWIM is the journey towards service orientation by establishing standardized interfaces through information services, forming the foundation of an internetworked global air transportation system. This chapter explains what the evolution into SWIM means for an organisation.

The long term vision is for all ATM information exchanges to be realised through information services provided in the context of SWIM, in accordance with *PANS-IM (ICAO Doc XXXX)* and thus for all organizations involved to reach an end state, named "native SWIM". An organisation is "native SWIM" when it interoperates digitally with other organisations exclusively, using SWIM enabled applications consuming or providing information services. Legacy interfaces are no longer required and have been withdrawn. "Native SWIM" organisations participate in standardised information flows and collaborate digitally following collaborative business processes. Service orientation practices ensure that future collaborative business processes drive the implementation of information services.

Figure **7-1** below depicts the "native SWIM" end state from an organisation point of view:

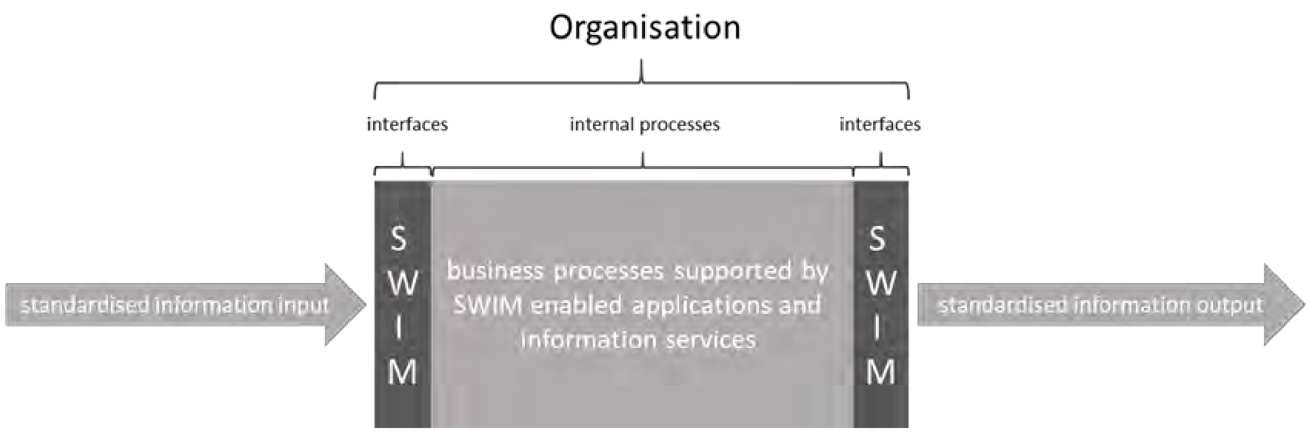

Figure 7-1: To-be end state: native SWIM

Service providers make available information services into the networked global air navigation system and service consumers use the services made available. Information services are discoverable using SWIM service registries, which provide a design-time capability to publicize and find information about information services. SWIM thus appears as a pool of information services shared between collaborating organisations (see **Figure 7-2**). In this pool, the addressable end-points of the information services do not necessarily correspond to the physical locations of the involved organisations. The distinction exists between identification of the organisations and the addressing of the information service interfaces, the latter being handled at the SWIM TI level.

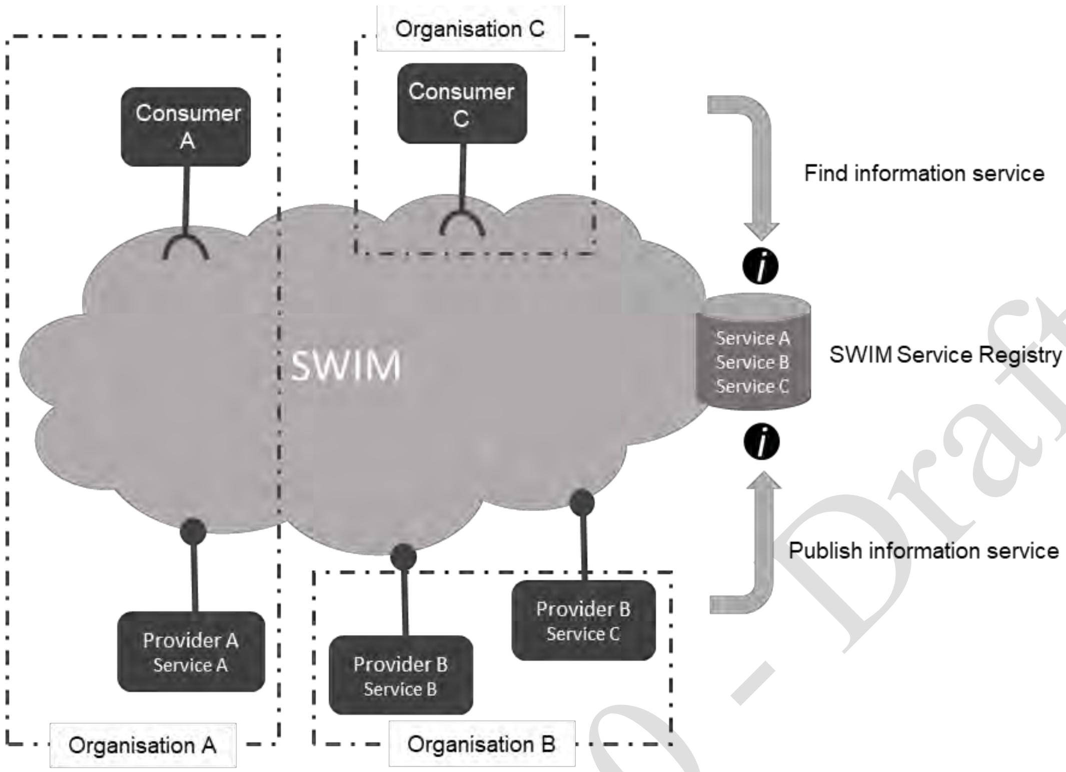

Figure 7-2: Collaborating organisations

7.1 UNDERSTANDING THE NATURE OF THE INFORMATION EXCHANGES

7.1.1 Information Services and Messages

At a more fine-grained level, all information exchanges are realized by messages that are transmitted because a corresponding operation of the interfaces has been triggered by an event.

Messages are discrete units of communication that convey required information, regardless of the nature of the information conveyed (infrastructure data, flight data, meteorological data, aircraft data, etc…) and regardless of message intent (e.g. distribute a dataset, request flight data, subscribe to information service, notify on an event). This pattern is shown on Figure **7-3** below:

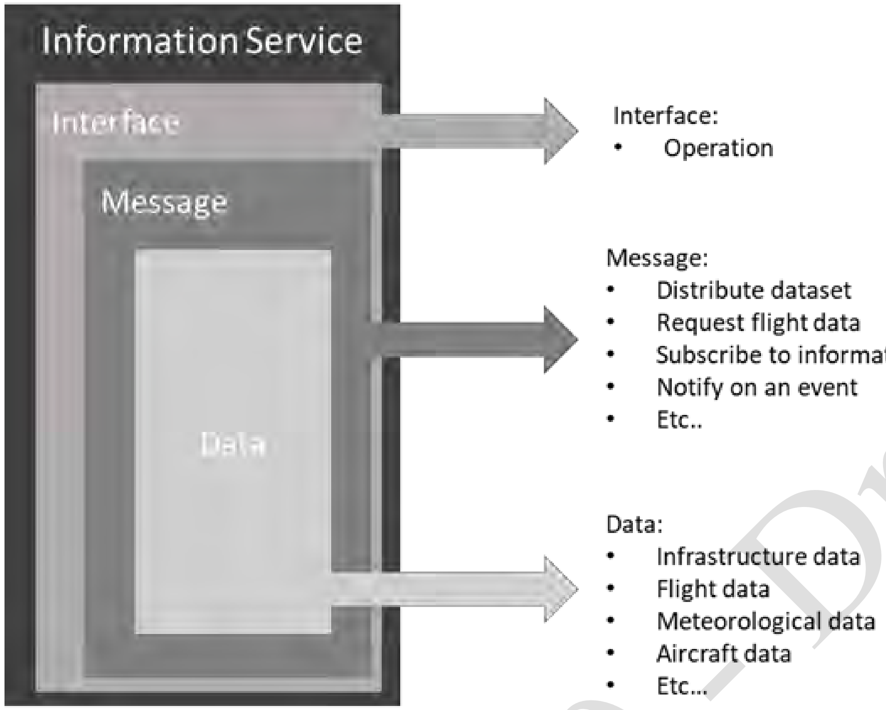

Figure 7-3: Information services use messages

Information services and their underlying messages are designed to support particular ATM business contexts (e.g. FF-ICE messages). The exchange of these messages is determined by the nature of IP-based network connectivity.

When looking at SWIM from a service perspective, the view of SWIM appears as a pool of information services, however when zooming into this view down to level of the message view showing connectivity, information exchanges occur between IP-network addresses. These two viewpoints are shown in

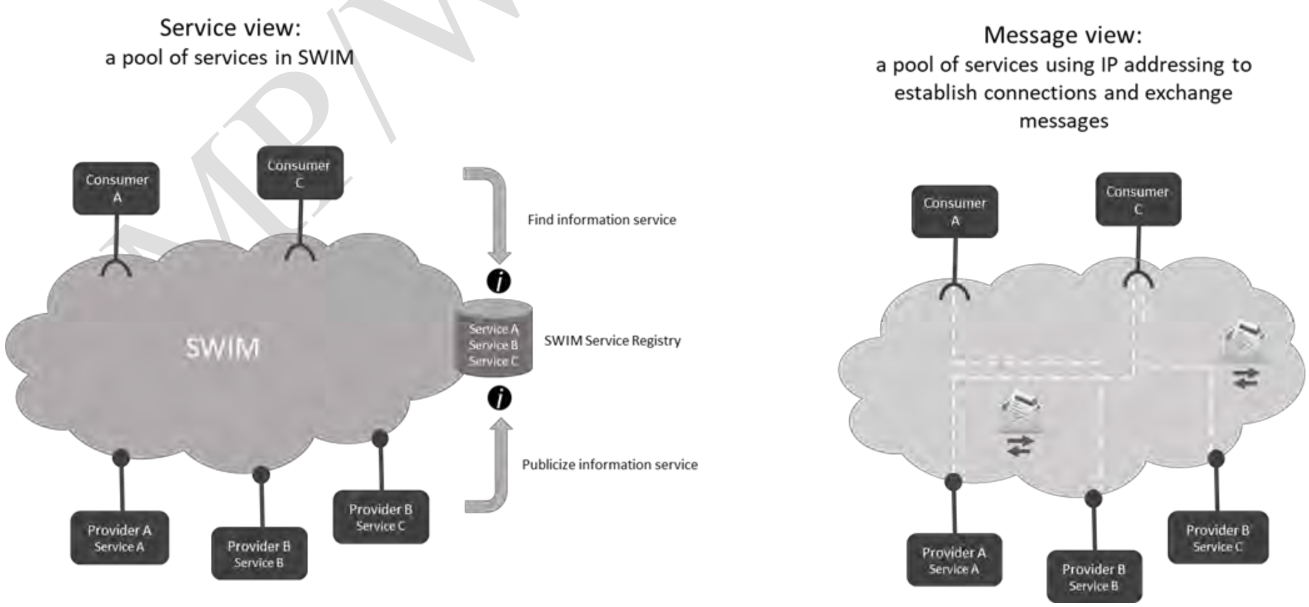

Figure 7-4 below:

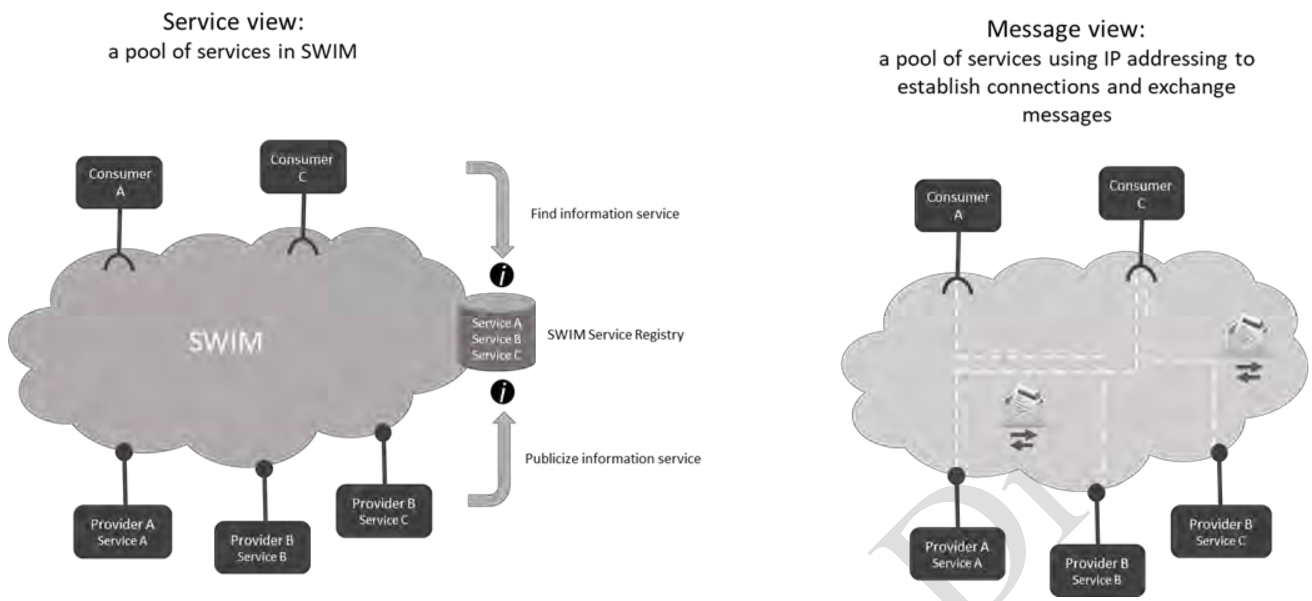

Figure 7-4: Service and message views

The SWIM principles of loose coupling and separation between service provider from service consumer foster the re-use of information services. This reduces the custom communication protocol dependencies and the individually managed and maintained interfaces.

7.1.2 Changes in the Nature of the Information Distribution

SWIM introduces message exchange patterns that may imply changes such as:

- Changes in roles and responsibilities: in an environment whereby service consumers manage subscriptions to available information services, it becomes the responsibility of service consumers to ensure they are subscribed to the right information service.

Note: SWIM service registries facilitate the discovery of the information services to which service consumers may wish to subscribe to.

- Change in the management of the information distribution. The consumption of an information service, which establishes a connection between a service provider and a service consumer, implies the management of the (service consumer / subscriber) IP addresses is decoupled from the information exchanges. Whereas traditionally, the data provider identified the technical recipients of the information in an offline process, SWIM allows information service consumers to self-manage their data flows by registering for access by online subscription.

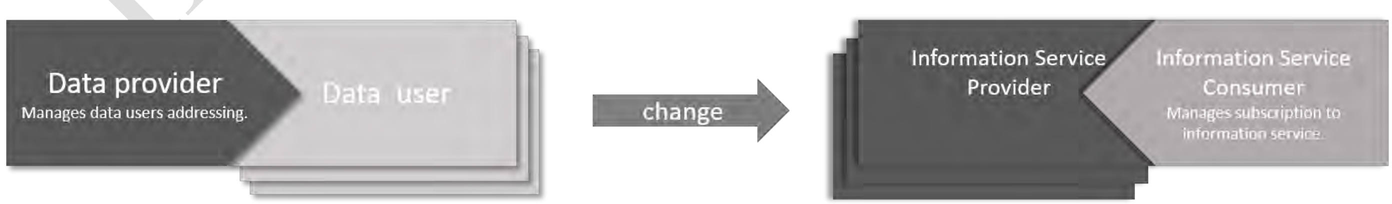

Figure 7-5: Changes when consuming information services

7.2 UNDERSTANDING THE NATURE OF THE EVOLUTION

The evolution into SWIM is driven by the evolution of business needs. Technology is a key enabler for the evolution to happen but it is not the driving force.

The evolution towards implementation of services follows gradual refinement. When engaging evolutionary activities towards SWIM there is no singular pathway. Preparatory work is essential in terms of identifying the community of interest (see section 7.4.3.3), the planning (see section 7.2.2) and the set of enablers (see section 7.2.4) required to start. Each evolutionary journey into SWIM needs careful management to avoid disruptions. It means a stepwise implementation and a gradual gain of maturity. Consequently, the evolution into SWIM is an iterative process, as depicted in Figure 7-6.

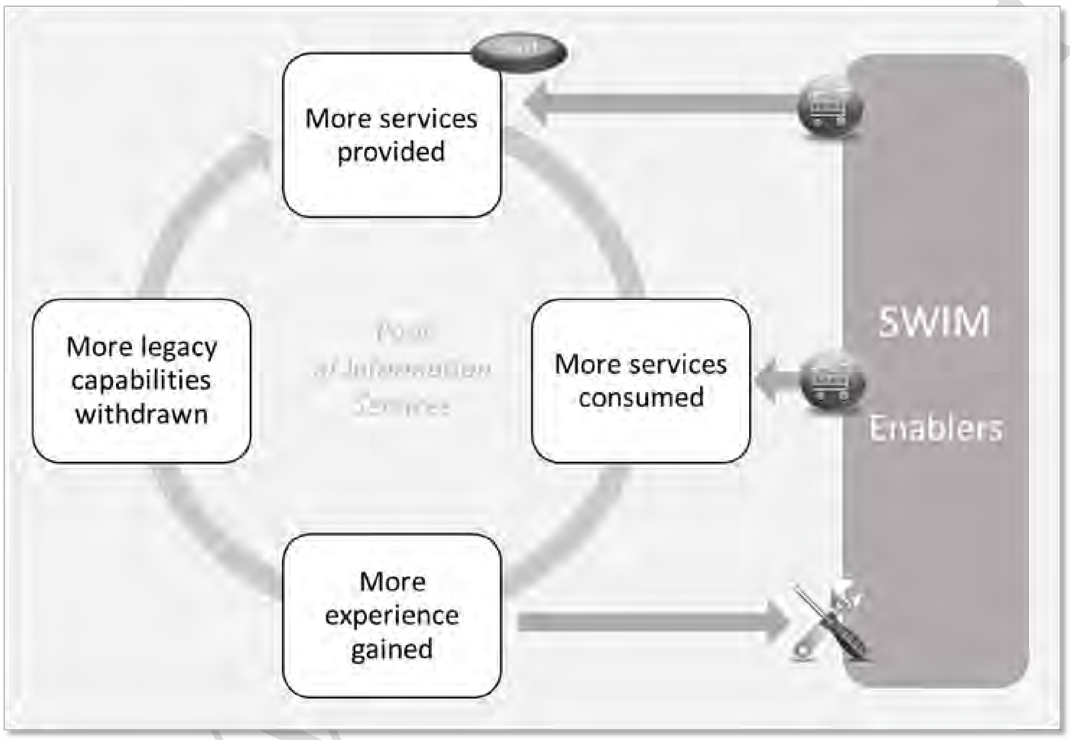

Figure 7-6: Evolution into SWIM as an iterative process

7.2.1 The Evolution Explained

The evolution towards SWIM aims at implementing, providing and consuming services. It follows an iterative process.

7.2.1.1 Preliminary Activities

When preparing to provision services the first activity is to assemble the set of SWIM enablers to be used starting from those enablers which are common to all. The selection and specification of the SWIM enablers to be used is driven by the interoperability requirements (see section 7.3). Due to the complexity of the SWIM enablers, i.e. the SWIM standards landscape, this management is supported by the use of the Interoperability Architecture provided by SWIM (see 8.3Appendix A).

7.2.1.2 More Services Provided

Stakeholders make information services ready for consumption and publicize them, following the identification of business needs (e.g. AIM digital dataset services addressing the provision of ICAO Annex 15). Two scenarios are envisaged:

- Scenario 1: an existing information service that could be re-used (further guidance steps are provided as part of **scenario 1** of the basic steps to SWIM implementation, see section 7.5.2);
- Scenario 2: a new information service (further guidance steps are provided as part of **scenario 2** of the basic steps to SWIM implementation, see section 7.5.3).

Chapter 2 describes the service orientation process and the service management system when providing more information services.

7.2.1.3 More Services Consumed

Due to Step 1, stakeholders are now able to consume information services available for use which satisfy a business need. For further guidance, see **scenario 3** of the basic steps to SWIM. Ensure service management as a service consumer. When consuming a service, participating in the collaborative service orientation process is a practice that will foster interoperability.

7.2.1.4 More Experience Gained

Leveraging implementation experience and building up community knowledge during the evolution is important to ensure maturity gains and harvest value. This contributes to promoting experience gained from each iteration for the next iterations to come.

The SWIM enablers are expected to gradually mature and grow when iterating the evolution steps towards SWIM. Collaboration when working the SWIM enablers is key to ensure that the required interoperability is gradually achieved.

The Service Orientation Architecture is also expected to gradually evolve. For instance, the evolution of the information services granularity is important to promote re-use. An example of reusable information service could be an “event service”.

7.2.1.5 More Legacy Capabilities Withdrawn

During the evolution into SWIM, as information services get provided and consumed, the need to maintain legacy interfaces, possibly superseded by information services, has to be evaluated. This evaluation needs to be carefully conducted to prevent disruptions. This evaluation also needs to take into account various viewpoints that lead to agreeing on a sunset date for a particular legacy interface. See section 7.4.3 below.

7.2.2 Planning

SWIM implementation planning can follow different schedules when applied to a specific organisation. These schedules may be influenced by local factors, such as the specific business needs and implementation scenarios, as well as by regional factors. ICAO regional plans and sub-regional plans, such as the implementation planning of the Aviation System Block Upgrades (ASBU) Elements of the Global Air Navigation Plan (GANP – Doc 9750) need to be considered, when available.

The transition planning should consider the operational benefits, the maturity of the concepts and the impact on legacy systems when planning the introduction of information services.

7.2.3 SWIM Uptake Cases

This section introduces evolution to native SWIM and transition from legacy interfaces. The introduction of information services is either based on a legacy information exchange requirement or a new information exchange requirement. Therefore, essentially the following SWIM uptake cases can exist:

- Direct introduction of SWIM (“greenfield” approach)
- Transition to SWIM (“brownfield” approach)
- No uptake of SWIM

A direct introduction of SWIM occurs when an information exchange requirement that did not exist before is allocated to an information service (e.g. for unmanned aircraft system traffic management (UTM)). In this case there is no corresponding legacy interface to be replaced by an information service.

A transition to SWIM occurs when some form of mix of legacy interfaces and information services exists. Specific transition management aspects need to be taken into account. When in transition and an information exchange between a legacy interface and an information service is bridged, the risk of information loss due to bridge processing needs to be managed. The transition to SWIM is temporary in nature and legacy messages may coexist with information services only until all information consumers have transited to information services.

Finally, there could be no uptake of SWIM when a legacy interface is simply not covered by any future information service. This can be the case if the information shared through the legacy interfaces is not required by future operations. Then, systems supporting only legacy operations may not be affected by the transition, as it is assumed that the legacy interfaces can eventually be phased out when legacy operations stop.

Table 7-1 shows the SWIM uptake cases when moving to SWIM at a more fine grained level:

Case	Uptake	Provider	Consumer	Comment
1	Direct	Information service	Information service	Direct introduction of SWIM
2	Transition	Legacy interface & Information service	Legacy interface	Consumer dependency on legacy interfaces
3	Transition	Legacy interface & Information service	Information service	Provider can withdraw legacy interfaces
4	Transition	Information service	Legacy interface	Consumer dependency on bridge
5	No uptake	Legacy interface	Legacy interface	No information service allocation

Table 7-1: SWIM uptake cases

Additional notes on the SWIM uptakes shown in Table 7-1:

- Case 1: In this uptake case the end-state of the evolution into SWIM is reached. Potentially a bridge capability may be needed due to an expansion of the consumer operations into an area which is not yet migrated to SWIM.
- Case 2: The consumer dependency on the legacy interface typically takes the form of coordination between provider and consumer. The consumer indicates that plans are made to move to SWIM and the provider agrees to maintain the legacy interface meanwhile.
- Case 3: Typically a next step after scenario 2, whereby the provider can now decide to withdraw the legacy interface.
- Case 4: The consumer needs a bridge capability. This bridge may be offered by a third party.
- Case 5: The legacy interface is no longer required in future operations and as a consequence there is no allocation to an information service.

Table 7-1 above shows the uptake cases from a single provider consumer perspective. Hence, from the perspective of a provider organisation having more than one consumer, multiple uptake types could occur. When an organisation maintains both information service and legacy interfaces the evolution towards SWIM is a mixed-mode state. This implies information management aspects in terms of information distribution over legacy interfaces as well as through information services.

Figure 7-7 below depicts SWIM uptake when in transition from legacy systems to SWIM-enabled applications. It shows that:

- legacy interfaces are out phased during transition; and
- information services take over information exchanges.

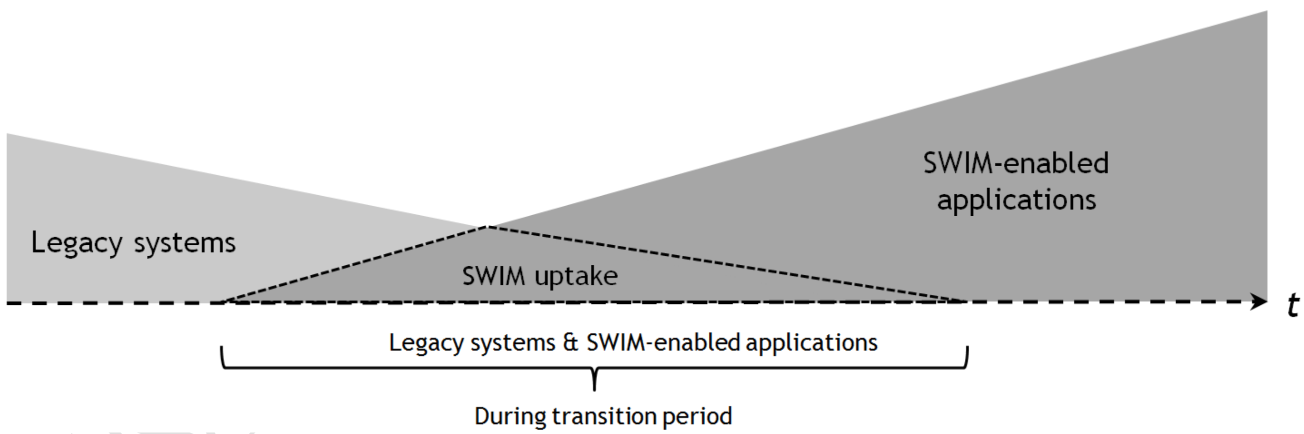

Figure 7-7: Transition to SWIM

When there is a need to support both legacy interfaces as well as information services, the sunset date for the provision of the legacy interfaces is an important aspect to be managed.

7.2.4 SWIM Enablers

The evolution into SWIM does not start from an empty sheet. SWIM provides a set of common enablers supporting this evolution. It addresses various aspects of interoperability in accordance with the SWIM concept components and is scalable. Some enablers are common to all evolutions into

SWIM. In addition, they can be complemented with enablers addressing the business-specific requirements for a certain use of information

7.2.4.1 Common Enablers Relevant for all SWIM Evolution Efforts

The current list of common enablers is the following:

- Specifications of SWIM TI interface and network bindings, as listed in *PANS-IM (Doc XXXX), Volume I – SWIM*
  - Provider side: used to build information services (see Chapter 5 for guidance)
  - Consumer side: used to know how integrate an information service (see Chapter 5 for guidance)
- Information exchange models (-XMs)
  - Provider and consumer side: used to shape the content of the messages exchanged by information services and understand the syntax (see Chapter 4 for guidance)
- The ATM Information Reference Model (AIRM), as referred by *PANS-IM (Doc XXXX), Volume I – SWIM*
  - Provider and consumer side: used as the common reference vocabulary for information exchanged by information services (see Chapter 4 for guidance)
- The Service Overview template
  - Provider side: used for describing implemented information services (see Chapter 3 for guidance)
- Service Overview
  - Consumer side: used for initial discovery of the information service
- SWIM Service Registries, as referred by *PANS-IM (Doc XXXX), Volume I – SWIM*
  - Provider side: used for publicizing information services, using service overviews (see Chapter 3 for guidance)
  - Consumer side: used for discovering the available information services ready for consumption (see Chapter 3 for guidance)
- PKI as an implementation of the security service for identity access management, used in a given authorization context;
  - Provider and consumer side: used to establish a common chain of trust for authentication.

During the evolution, the set of SWIM enablers is gradually improved and enriched in a collaborative manner (see Section 7.2.1).

7.2.4.2 Complementary Enablers to Support Specific Business Needs

The set of common SWIM enablers may be complemented with additional enablers addressing the business-specific requirements of a given community of interest. These complementary enablers may be specified before the actual start of a service implementation or may be gradually defined and enriched based on concrete implementation experience, as appropriate.

Examples of complementary enablers are:

- Description of business rules.
  - *Example: the business rules provided by the AIXM community and expressed according to the OMG 'Semantics of Business Vocabulary and Rules' standard.*
- Harmonised business-specific message data structures:
  - *Example: the harmonised FF-ICE message data structures provided by the FIXM community as part of the 'FF-ICE Message Application library'.*
- Harmonised description of the messages exchanged by information services.
  - *Example: the individual FF-ICE Message templates provided by the FIXM community as part of the 'FF-ICE Message Application library'.*
- Community examples of information service realisation that service implementers may take inspiration from:
  - *Example: examples of FF-ICE Service realisations provided by the FIXM community as part of the FIXM Implementation Guidance, including, but not limited to, selection of interface bindings, naming of service interfaces & operations.*
- Standards for specific services :
  - *Example: the ICAO definition of the Aeronautical Dataset Service - add REF*
  - *Example: The EUROCAE ED-254 'Arrival Sequence Service Performance Standard' providing a standardised SWIM service design for an AMAN Sequence Service.*
- Community complements to the ICAO provisions for SWIM:
  - *Example: EUROCONTROL Specification for SWIM Service Description that complements the ICAO service overview information.*
  - *Example: EUROCONTROL Specification for SWIM Information Definition containing semantic interoperability requirements in support of reaching AIRM alignment through semantic correspondence.*

(www.eurocontrol.int/publication/eurocontrol-specifications-system-wide-information-management-swim)

Complementary enablers being potentially applicable to the wider ATM community, at least partly, may be abstracted and promoted to the common set of SWIM enablers, or may be leveraged in order to derive common SWIM practices, as appropriate.

7.3 INTEROPERABILITY REQUIREMENTS

SWIM enablers are based on standards and are used to build information services. When assembling the set of SWIM enablers needed to achieve implementation of a given set of information services (e.g. FF-ICE step1), it is important to understand the interoperability requirements in terms of completeness of the set of SWIM enablers and in terms of concreteness of the specification level of each SWIM enabler. Both aspects contribute to a wider consideration of getting the stringency balance of these requirements such that innovation is fostered. To achieve this balance, the common enablers form a baseline that can be complemented with business requirements and implementation context specific SWIM enablers. Specification stringency can vary in terms of role of each SWIM enabler and in terms of maturity of the service orientation along the evolution to SWIM.

The interoperability architecture supports the understanding of the interoperability requirements. The columns of the interoperability architecture grid cover completeness through the organisational view, the information view, and the technical view. The rows of the interoperability architecture grid cover concreteness through the contextual level, the conceptual level, the logical level, and the physical level (see 8.3Appendix A). As an example, an indicative and non-exhaustive use of the interoperability architecture could read as follows:

- Organisational interoperability:
  - Information exchange: alignment between collaborating organisations through service orientation. Addressed through information services. Specification at community level.
  - Service description: alignment of the common understanding of what an information service does. Addressed through the service overview. Set of information fields specified at global level. Possibly further specified at community level.
  - Common components: alignment around common means to support information service discovery and publication. Addressed through SWIM service registry. Implementation specification at community level.
- Information interoperability:
  - Semantics: alignment around common meaning of the information exchanged. Addressed through the AIRM. Specification at global level.
- Technical interoperability:
  - Syntax: alignment around common syntax for information encoding of the information exchanged. Addressed through the XMs and components thereof. Specifications and version management at community level.
  - Technical infrastructure: The ability to incorporate the information service into an organisation's IT infrastructure. Addressed through the listing of protocols grouped into interface bindings. Specification at global level.
  - Metadata: alignment around the use of metadata. (e.g. used to exchange the content of service overviews). Addressed through metadata standards and profiles and SWIM service registry. Profile specification at community level.

7.4 AFS TRANSITION

7.4.1 Description of Prior-to-SWIM Environment

AFS, as described in ICAO Annex 10 Vol II, Chapter 4 includes OPMET, AFTN, CIDIN, AMHS and ICC.

In the AFS context, message originators need to know exactly to which addressee(s) a message needs to be addressed and which message types, based on message text, are those. The AFS build by meteorological operational circuits, AFTN and AMHS are mainly used for this.

AFS transports most of the messages which in the future are handled by information services.

7.4.2 Considerations about the Transition to Information Services

7.4.2.1 Messages before and after Transition

When in transition, it is important to note that the notion of "message" appears both before and after the transition. Figure 7-8 shows the messages "notion" in relation to the legacy and to SWIM. The figure represents how the parts that compose a message are appearing in the legacy and how they are appearing in information services following the loose coupling principle. Applying the information service principle of loose coupling implies a structuring of the information exchanged in terms of messages which is independent of messaging technology used.

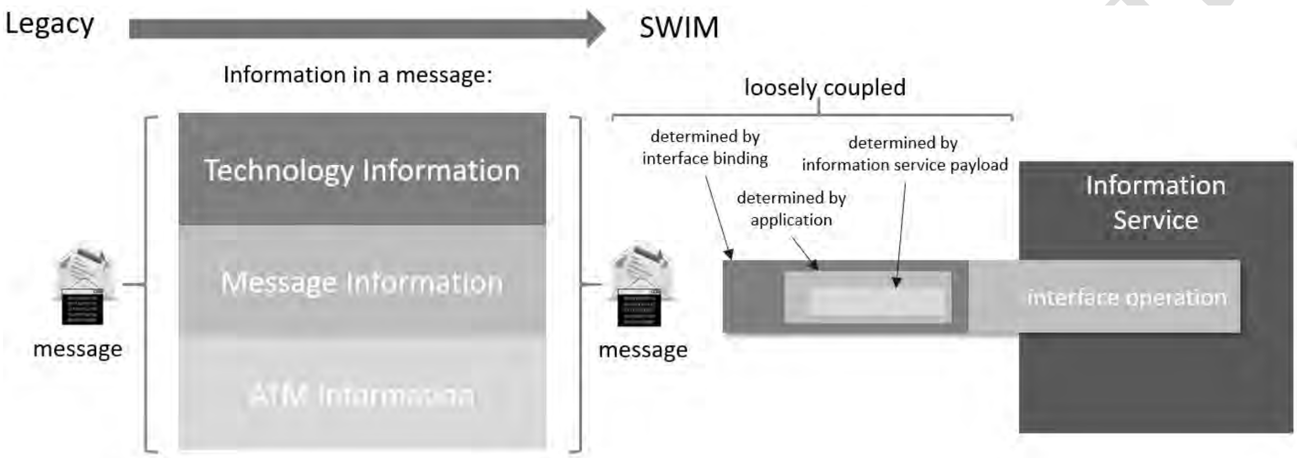

Figure 7-8: Transition to information services

In principle, when applying service orientation, the identification of information services and related message exchanges does not necessarily result in a granularity of the information services that reflects the actual operational view on information exchange requirements.

Note: a mapping of the messages used before and after transition supports the transition planning.

7.4.2.2 Information Distribution in Mixed-mode

An organisation in a mixed-mode state maintains both information service and legacy interfaces. This may imply additional information distribution management since legacy interfaces essentially implement the "store-and-forward" MEP and information services are primarily based on the "Pub/Sub" or "Request/Response" MEPs.

Figure 7-9 below shows a transition from AFS to "native SWIM".

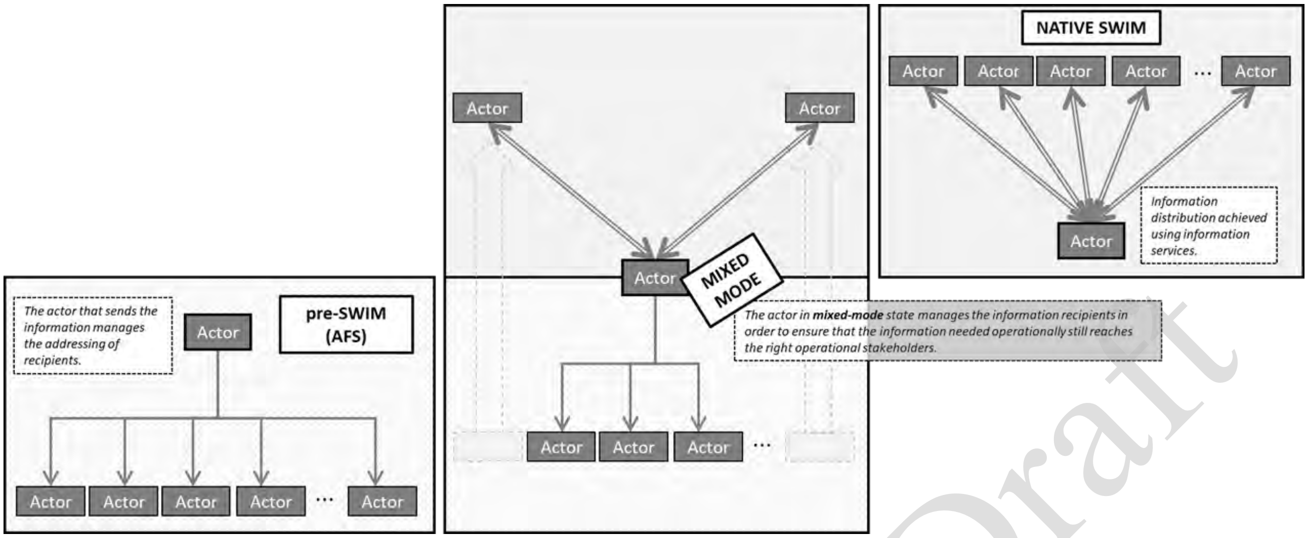

Figure 7-9: Information distribution when transitioning from AFS to “native SWIM”

Note: AFS may be based on IP addressing

In mixed-mode environments, information exchanges may be realized using bridges. These bridges, depending on the operational needs, address data conversions which translate the information service message into a legacy message, knowing that this may involve potential loss of information service capabilities (without affecting the intended use of information). As an example: the FF-ICE “Translate and forward” capability addresses the conversion of an FF-ICE flight plan into legacy FPL, and the distribution of that FPL to legacy AFS users. In order to ensure interoperability, agreements on standards to be used, as well as on applicable rules and processes are included in the SWIM transition planning prior to implementation.

Figure 7-10 illustrates how systems may interact within a SWIM environment while taking into account interactions with legacy applications via a bridge. This interaction depicts a possible SWIM implementation between an ANSP with a legacy system and SWIM-enabled ASPs. It illustrates the interactions between information services and legacy interfaces.

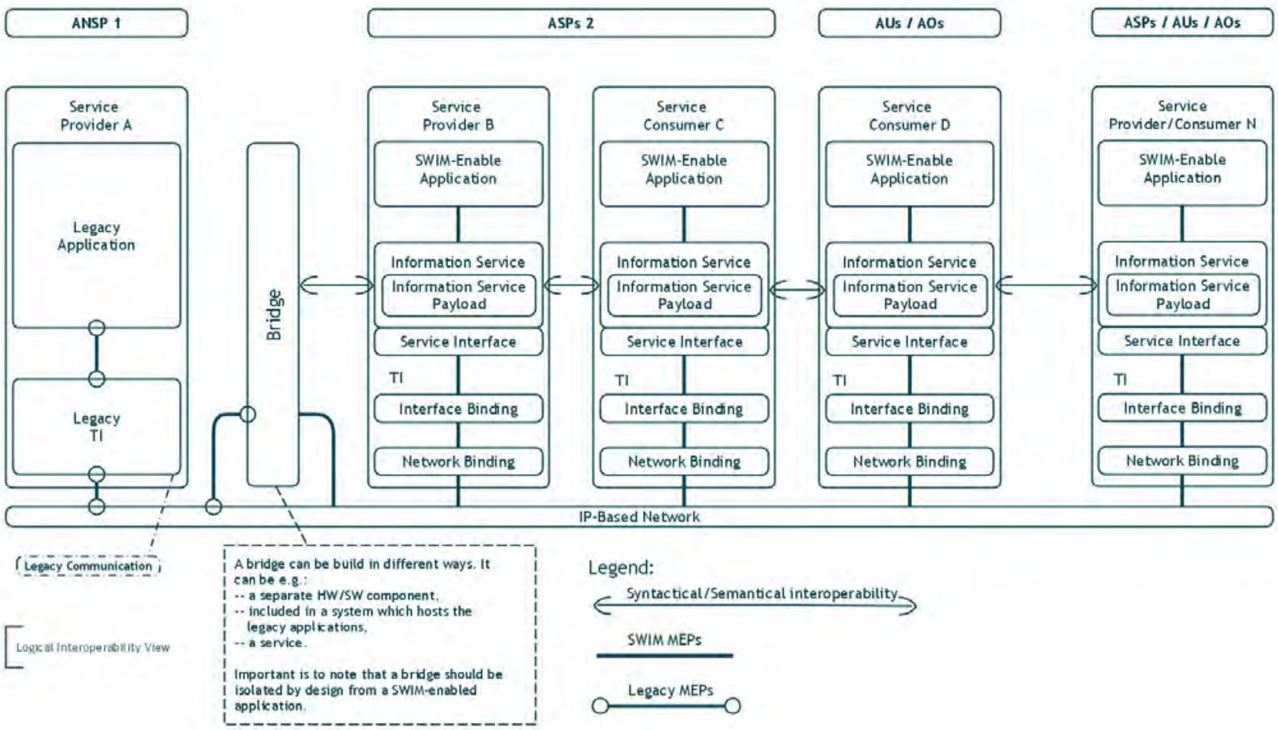

Figure 7-10: Example of a mixed-mode environment with bridge

Note: It is important to map legacy messages and information service messages on interface level-only to be implement within a bridge. This will keep the legacy systems and SWIM-enabled applications loosely coupled.

7.4.3 AFS Sunset Considerations

As organisations evolve to SWIM, legacy AFS-based data or message exchange capabilities will be gradually superseded by SWIM information services. A sunset date corresponds to the date at which a legacy AFS-based data or message exchange capability is withdrawn. A sunset date can be defined at Service Consumer level, at Service Provider level and at SWIM region level.

7.4.3.1 Consumer Perspective

An organisation consuming SWIM information services may decide to withdraw a legacy AFS-based data or message exchange capability when this legacy capability is no longer used within that organisation. In this situation, the sunset date for a legacy AFS-based data or message exchange capability will correspond to the date at which the legacy capability is no longer required in support of the Service Consumer's operations.

7.4.3.2 Provider Perspective

An organisation providing SWIM information services may decide to withdraw a legacy AFS-based data or message exchange capability when this capability has no user anymore, both within and outside that organisation. In this situation, the sunset date for a legacy AFS-based data or message exchange capability will correspond to the date at which all former users have abandoned the use of the legacy capability and consume the provided SWIM information services instead.

A service provider may want to anticipate the withdrawal of a legacy AFS-based data or message exchange capability. Anticipating this withdrawal should be planned collaboratively with the remaining users so that they can complete their evolutionary activities towards SWIM in a managed fashion.

7.4.3.3 SWIM Region Perspective

Organisations that participate in a given SWIM region will complete their evolutionary activities into SWIM at a different pace. This implies different sunset dates between organisations for a given legacy AFS-based data or message exchange capability. Therefore, from the perspective of a SWIM Region, the sunset date will correspond in theory to the sunset date of the service provider being the last one to withdraw the legacy capability. A SWIM Region may want to specify a sunset date by which all members should have completed their evolutionary activities to SWIM Information Services. This sunset date should be set collaboratively, in particular so that the remaining users of the legacy capability have enough time to migrate.

7.5 BASIC STEPS TO SWIM IMPLEMENTATION

7.5.1 Introduction

This section provides at a high level some indicative scenarios describing "basic steps to implement SWIM", to which implementers can refer to build solutions that meet the requirements and expectations set forth at the global level. The scenarios are simplified to avoid overload, however, when digging into the details, they may lead to more steps further documented in other sections of this document. More details can be added when used in a particular context.

At the same time, the scenarios are predicated on the assumption that the (IP-based) network infrastructure required to support the information services, both from the service provider and the service consumer perspectives is ensured.

The steps described in this section do not include details that may exist in each individual service provider or service consumer context such as for service lifecycle aspects. 8.3Appendix C provides examples of specific service provider/consumer scenarios that show how various service lifecycle stages are traversed in a particular context.

The following scenarios are described:

1. Scenario 1 (service provider perspective): using an existing digital on-line service.
2. Scenario 2 (service provider perspective): providing a new digital on-line information service.
3. Scenario 3 (service consumer perspective): becoming an information service consumer.

Generic requirements are available from *PANS-IM (Doc XXXX), Vol. I – SWIM*. The ICAO domain specific SWIM requirements may be available from information domain related SARPs, PANS, and guidance material. Community SWIM requirements may complement ICAO requirements.

Business and safety cases, including consequential impact assessments, are considered out of scope of this section.

Each scenario described below begins with a "starting point", followed by a "questions to be answered" section, and closing with a "description of the indicative steps to follow". Each scenario is depicted showing the steps in relation to the SWIM concept components: information, information service and technical infrastructure.

7.5.2 Scenario 1: Using an Existing Digital On-line Service

Starting point: The use of Internet technologies and World Wide Web standards is current practice and digital on-line services are already provided. The "top-down" identification using service orientation practices is not deemed necessary in this scenario since the services already exist. For these existing services the provider may already perform service lifecycle activities (see Chapter 3, Section 3.8.1).

The question to be answered in this case is: can an existing service qualify as an information service, and if not, what is required in order to achieve this goal?

The scenario summary shows the indicative steps and possible relations with service provider lifecycle phases described in Chapter 3, Section 3.8.1:

1. Collect information about the service. [Planning]
2. Collect the applicable SWIM requirements. [Planning]
3. Check the interface protocols used to perform the service. [Planning]
4. Check the information provided by the service. [Design]
5. Complete the service overview for the service. [Transition]
6. Make the service known to SWIM stakeholders. [Transition]

Figure 7-11 depicts the scenario which is further documented below and includes indications of other scenarios at a more fine-grained level:

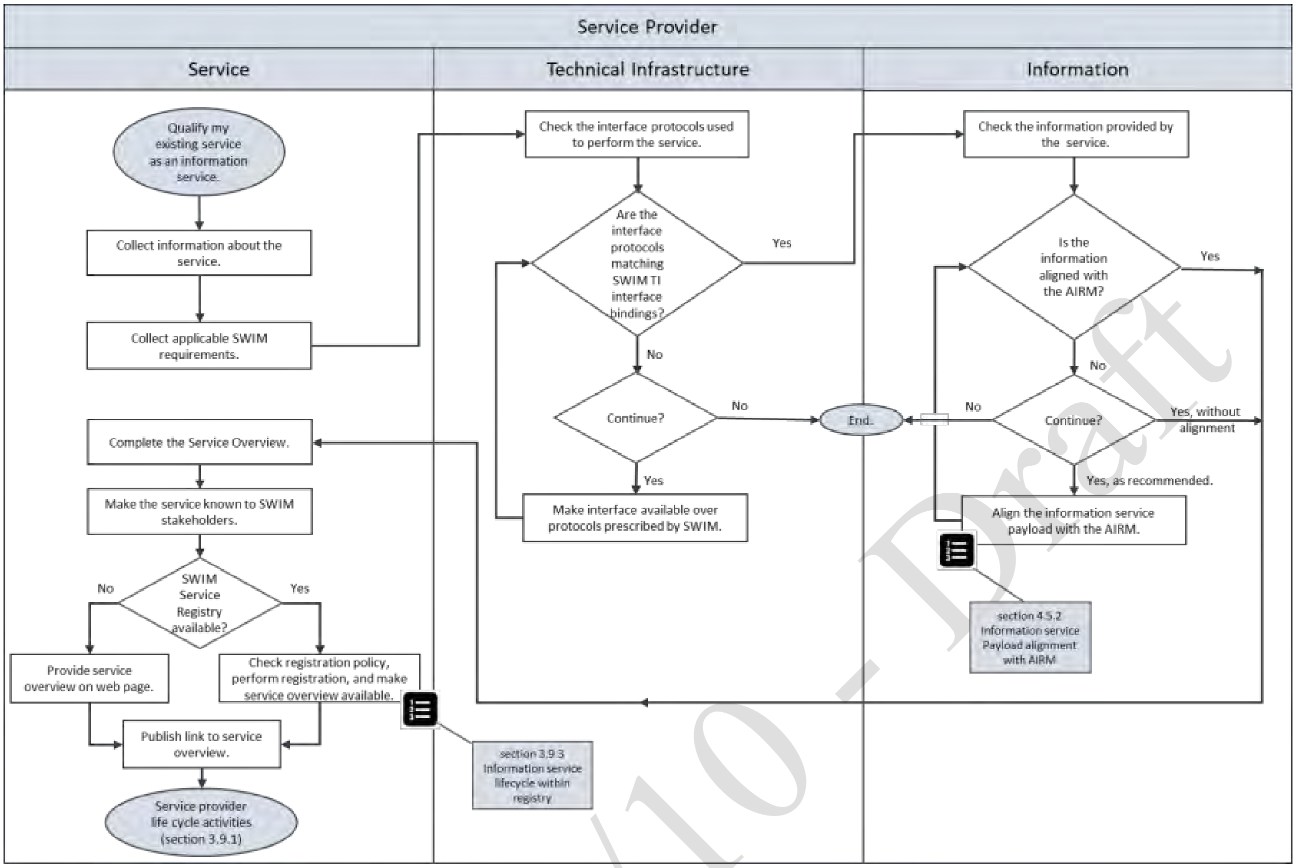

Figure 7-11: Using an existing online digital service

Description of the indicative steps to follow:

1. Collect information about the service. The purpose is to collect the information that will be needed for completing the service overview in step 5. The information may be available from existing technical documentation, e.g. interface control document (ICD), or documentation accompanying an API). This may facilitate the accomplishment of this step.
2. Collect the applicable SWIM requirements. ICAO requirements and SWIM enablers may need to be complemented by regional and local SWIM requirements. Consider any policies that may apply (e.g. when a SWIM service registry is used).
3. Check the interface protocols used to perform the service. To perform this check, answer the following question:
   a. Are the service interface protocols matching the applicable technical infrastructure requirements for the implementation of SWIM (i.e. the technology standards of the technical infrastructure interface bindings)? To accomplish the analysis:
      i. Compare available interface specification documentation (e.g. ICDs) to the applicable technical infrastructure requirements.
      ii. Consider documenting the result of the inspection for convenient re-use at any later stage.
   b. If the answer to question 3 a) is yes, continue to step 4.

c. If the answer to question 3 a) is no, decide to make the information available over interface protocols prescribed by SWIM. At this step it could be decided to end the scenario (e.g. due to feasibility considerations). It could also be decided to wait until step 4 below is performed before proceeding. When working this step consider the following:

i. If no interface protocols are specified and applicable to you, consider adapting to those specified in another SWIM region. This implies testing.

ii. Make implementation choices together with the service stakeholders in order to reach common design decisions.

iii. Implement interface protocols applicable at global, regional and local levels.

Note: following step 3, the service should satisfy the SWIM requirements from a technical infrastructure point of view.

4. Check the information provided by the service. To perform this check, answer the following question:

a. Is the information aligned with the AIRM? Using an information exchange model which is already aligned with the AIRM will satisfy this requirement and result in a positive answer.

b. If the answer to question 4 a) is yes, continue to step 5 assuming that step 3 is achieved.

c. If the answer to question 4 a) is no, align the information with the AIRM. Guidance on AIRM alignment is provided in Chapter 4, section 4.5.2. At this step it could be decided to end the scenario or continue since the alignment with the AIRM is a recommendation and alignment could be on-going in parallel for later achievement.

Note: following step 4, the service should satisfy SWIM requirements from an information point of view.

5. Complete the service overview for the service. The service overview content to be provided is service description information. The service overview fields are documented in Chapter 3, section 3.2.1. Whereas service overview information is required at the global level, additional regional/local service description requirements may apply.

6. Make the service known to SWIM stakeholders. The use of a SWIM service registry is preferred. When providing information about an information service as structured metadata, consider harmonizing with metadata types already used in other contexts. To perform this step, answer the following question:

a. Is a SWIM service registry available? To answer the question, consult the AIP:

b. If the answer to question 6 a) is yes,

i. Check the applicable policies for service registration.

ii. Follow the applicable service registration steps (see Chapter 3, section 3.7).

iii. Make the service overview and any additional service description information available.

c. If the answer to question 6 a) is no,

i. Provide the service overview as a document or a web page (e.g. on the service provider organisation website).

ii. Publish the link (i.e. web location) where the service overview is available. This information is published in the AIP.

Note: following step 6, the service should satisfy the SWIM requirements from an information service point of view.

7.5.3 Scenario 2: Providing a New Digital On-line Information Service

Starting point: The potential for providing information services exist. Various technologies are used which create data that is exploited; however, data exchange is not yet based on information services. Engaging into SWIM involves considering collaborative service orientation practices which have not been started up yet. The service provider may already provide services and may already perform service lifecycle activities (Chapter 3, section 3.8.1).

The question raised in this scenario: which steps should be taken to provide an information service that is re-usable, fulfils an information exchange requirement and is a member of the services ecosystem?
The scenario summary shows the indicative steps and possible relations with service provider lifecycle phases described in Chapter 3, section 3.8.1:

1. Build a SWIM team with service orientation skills.
2. Collect the applicable SWIM requirements. [Planning]
3. Document the overall service orientation process steps deemed viable to you.
4. Perform service orientation. [Planning, Design, Transition]
5. Complete the service overview for the service. [Transition]
6. Make the service known to SWIM Stakeholders. [Transition]

Figure 7-12 depicts the scenario further documented below:

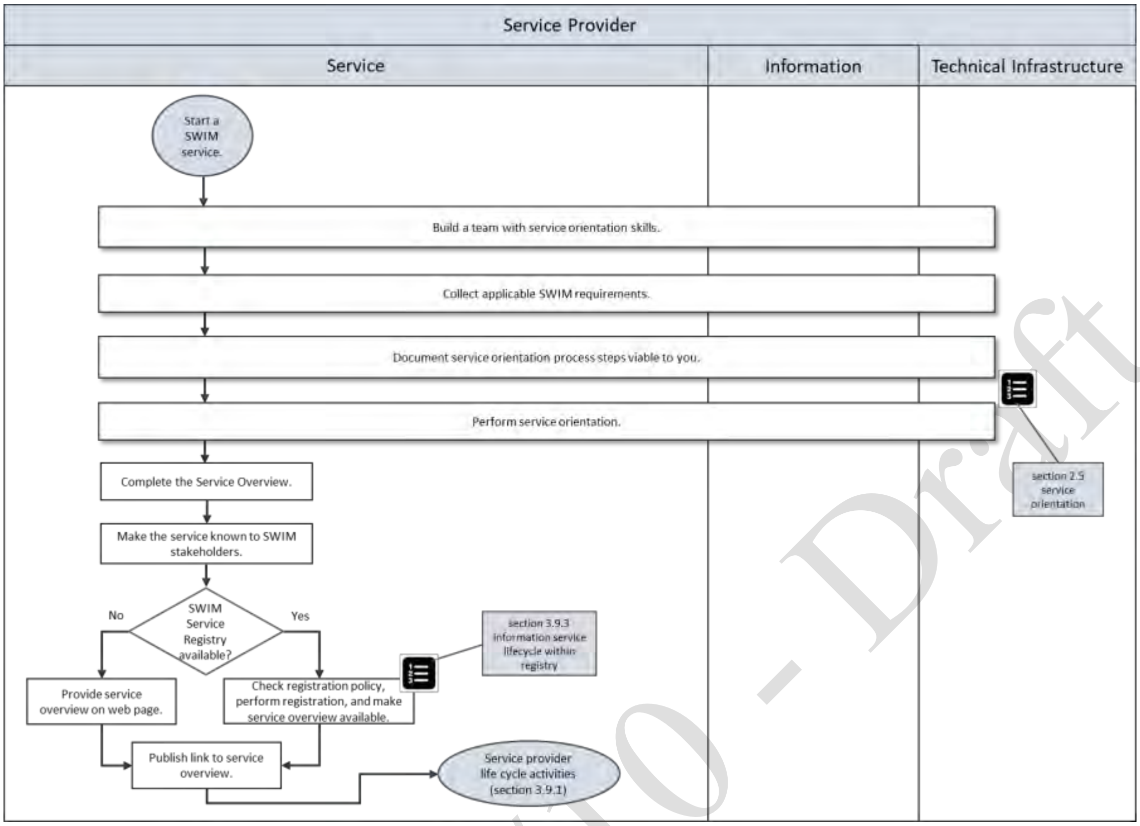

Figure 7-12: Providing a new digital on-line information service

Description of the indicative steps to follow:

1. Build an internal implementation team, including operational expert, service architect, information architect, technical infrastructure expert and solution expert roles to people of the team (see Chapter 2, section 2.4 for details on the skills required..

2. Collect applicable SWIM requirements. ICAO requirements and SWIM enablers may need to be complemented by regional and local requirements. Consider any policies that may apply (e.g. when a SWIM service registry is used).

3. Document the overall service orientation process steps deemed viable to you. Service orientation process steps can be more or less complex depending on your regional/local needs and reality. When defining service orientation process steps involve the experts that will have to execute it. Chapter 2, section 2.5 provides more information about possible steps. Not all steps are necessarily required depending on the approach followed.

4. Perform service orientation. Service orientation is a collaborative process involving stakeholders. Therefore, as applicable, ensure that the implementation team interfaces with the relevant community of interest. One essential information service identification activity is business process analysis to determine information exchange requirements of the "to-be" situation. This analysis may lead to early identification and attribution of QoS characteristics that need to be met by the service. The choice of using particular standards is important for both the service provider and the service consumer (e.g. choice of interface bindings), and has an impact on interoperability. Therefore collaboration through SWIM Governance is paramount. For the

purpose of this scenario it is assumed that this step results in information services that satisfy SWIM requirements collected in step 2 of this scenario.

5. Complete the service overview for the service. The service overview content to be provided is service description information. The service overview fields are documented in Chapter 3 section 3.2.1. Whereas service overview information is required at the global level, additional regional/local service description requirements may apply.

6. Make the service known to SWIM stakeholders. The use of a SWIM service registry is preferred. When providing information about an information service as structured metadata, consider harmonizing with metadata types already used in other contexts. To perform this step, answer the following question:

    a. Is a SWIM service registry available? To answer the question, consult the AIP:

    b. If the answer to question 6 a) is yes,

        i. Check the applicable policies for service registration.

        ii. Follow the applicable service registration steps (see Chapter 3, section 3.7).

        iii. Make the service overview and any additional service description information available.

    c. If the answer to question 6 a) is no,

        i. Provide the service overview as a document or a web page (e.g. on the service provider organisation website).

        ii. Publish the link (i.e. web location) where the service overview is available. This information is published in the AIP.

Note: following step 6, the service should satisfy the SWIM requirements from an information service point of view.

7.5.4 Scenario 3: Becoming an Information Service Consumer

Starting point: Information services exist, and service overviews are available. A service consumer has an information need and is interested to use an information service that will satisfy this need. Information services made available in principle resulted from service orientation activities, hence this aspect is considered out of scope of the scenario. The service consumer may already consume services and may already perform service lifecycle activities (Chapter 3, section 3.8.2).

The question raised in this scenario: are information services available that I can consume and that meet my information requirements and information needs?

The scenario summary shows the indicative steps:

1. Define the application requirements and information needs. [Planning]
2. Find information services. [Planning]
3. Assess the feasibility to consume a candidate information service. [Design]
4. Make implementation choices. [Transition]
5. Adapt business processes. [Delivery]
6. Participate in the SWIM stakeholder community. [Improvement, Retirement]

Figure 7-13 depicts the scenario further documented below:

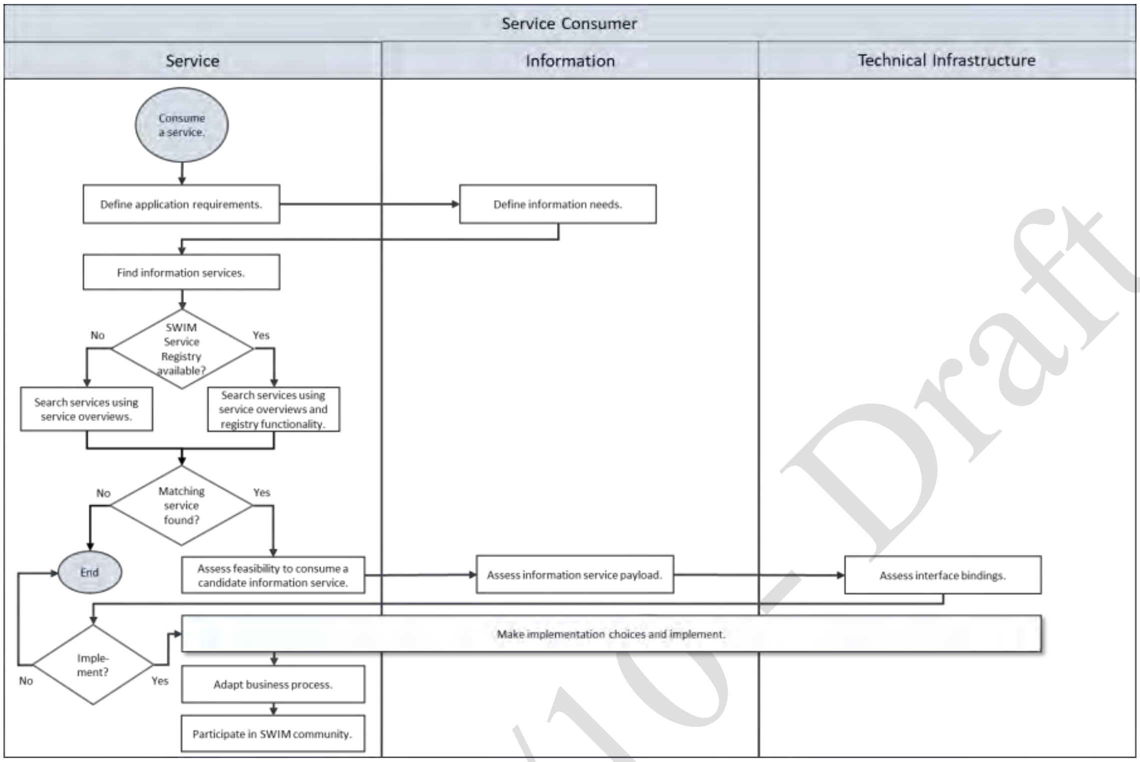

Figure 7-13: Becoming an information service consumer

Description of the indicative steps to follow:

1. Define the application requirements and information needs. Before analysing available information services, it is important to have a clear view on what is needed. Finding the right information service depends on matching available information services to the SWIM enabled application information needs (i.e. IER), intended function (i.e. service function), and performance requirements (i.e. QoS parameters). These requirements may stem from an existing or newly envisaged application and the operational environment, including its processes, in which it will be used.

2. Find information services. Use service overviews as a first indication, to identify information services that could match the defined application requirements and information needs. When available, use SWIM service registry functionality (e.g. search) to find information services and possibly additional service description information. Otherwise determine from the service overview where more detailed service description information can be obtained by using the service provider point of contact information. Obtaining more detailed service description information may include signing an agreement with the service provider.

3. Assess the feasibility to consume a candidate information service. Depending on more detailed service description information, investigate the feasibility to setup a service consumer application. Conclude whether the information service matches the need in terms of information, functionality, performance, and implementation feasibility. When the outcome is positive, this step may include signing an agreement with the service provider to access the service.

4. Make implementation choices. To implement the service consumer interface, a decision is taken whether to adapt an existing application or create a new application. At this stage further technical decisions in relation to the interface bindings used by the information service are also made. Establish the connection to the information service interface and integrate the service into the consumer application. Perform validation of the application.

5. Adapt business processes. At this stage of the scenario, configuring an information service into the service consumer environment creates a dependency that needs to be managed (e.g. to cater for eventualities such as a service outage or malfunctioning). As a consequence, the business processes are adapted in order to manage dependencies that result from the integration of the information service.

6. Participate in the SWIM stakeholder community. Service consumers should keep themselves informed about service evolutions. Potentially disruptive evolutions that may occur need to be known well in advance. Typically, this is where SWIM governance plays a key role. Service consumers may consider contributing to the evolution of the consumed services. When using a SWIM service registry, notifications about information services could be a function provided by the registry.

Chapter 8 Quality – to be changed into the structure

8.1 CONSIDERATIONS ABOUT QUALITY

Data quality is a degree or level of confidence that the data provided meets the requirements of the user. While quality requirements are addressed per domain, the quality of the processes used to create information, apply to all ATM domains and SWIM information providers. For example, AIS data quality includes aeronautical data accuracy and resolution whereas MET data quality includes accuracy measurement observations and forecasts and period of validity. However, the process to derive Aeronautical Information and MET information from AIS/MET data is documented and supported by internal procedures.

According to EUROCAE ED-76A/RTCA DO-200B an authoritative source is:

- A State authority organisation, or
- An organisation formally recognized by State authority that originates or published data which meets specified data quality requirements (DQRs)

Any and/or all participants in an aeronautical data chain may originate aeronautical data. Historically, most aeronautical data is originated by an authoritative source (e.g. individual States, organisations on behalf of the State). Other originators may supplement data originated by an authoritative source or originate data themselves. Examples of other chain participants that may originate aeronautical data include, but are not limited to, data providers, airlines, aircraft manufacturers, airport authorities, defence mapping agencies, communication service providers and geospatial information providers.

In SWIM, information is data processed, organized, structured and/or presented in a context that makes it useful. Transforming data into information involves several activities, such as assembly, selection, and formatting. The value of SWIM is reliant on both data/information quality (the contents and payload) and on the service quality (the way the contents is exchanged in a SOA). Both are equally important to ensure consumer requirements are met.

In the SWIM context, the quality of data, information, and services are related. For example:

- Data quality requirements for AIS data are defined in terms of accuracy, resolution, integrity, format, traceability, timeliness, and completeness
- Information quality requirements may be defined in terms of aggregation, credibility, relevance, and consistency
- Service quality requirements may be defined in terms of availability, performance, continuity, reliability, security, and accessibility

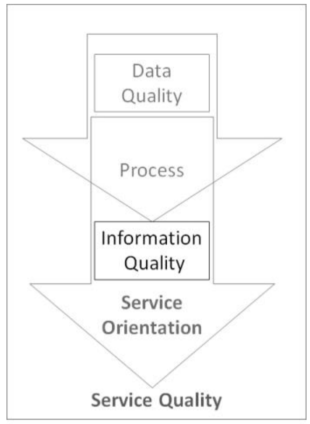

Figure 8-1: Quality of Data and Quality of Service

Users and providers of information and services determine the quality requirements based on the allowable contribution to failure of the information or individual components that make up the SWIM infrastructure. Since SWIM enabled applications depend on the quality of the data, information, or service received, it is necessary to ensure these elements are validated to the required level. Greater levels of rigor may be used if the error would reduce safety margins of the application. Lower levels of rigor may be used if the error has little or no negative effect of the application.

8.2 QUALITY MANAGEMENT SYSTEM

The Quality Management System (QMS) involves the process that creates the information and the service orientation that delivers the information, as well as the environments (technical, regulatory, business, etc.) in which these processes reside. The value of SWIM is reliant on both the quality of data/information (i.e. the quality of the information service payload) and the quality of the information service including the supporting technical infrastructure (the quality of the means to exchange the information in a SOA). Both are equally important to ensure consumer requirements are met. To ensure compliance to QMS principles, demonstration to such compliance may be through periodic audits or reviews. However, other methods may be acceptable as determined by the affected participants.

A Quality Management System (QMS) provides the framework upon which the procedures for doing the job are developed, managed, controlled, assessed and changed. Organisations have been implementing Quality Management Systems for years based on applicable standards. Some specific references in ICAO Annexes and other international standards that may be helpful in the development of a QMS are:

- *Annex 3* – Governs the quality management of MET source information for aviation
- *Annex 15,* Section 3.2 – Quality management states, “Quality management systems (QMS) shall be implemented and maintained encompassing all functions of an aeronautical service”
- Flight and Flow Information
    - Manual on Collaborative Air Traffic Flow Management, Doc 9971, addresses information quality

    - *FF-ICE, Doc 9965*, addresses quality of service

- The ISO 19100 series of standards address quality of geographic information

- ISO/IEC 25012 defines a general data quality model for data retained in a structured format within a computer system. It can be used to establish data quality requirements, define data quality measures, or plan and perform data quality evaluations. It categorizes quality attributes into fifteen characteristics considered by two points of view: inherent and system dependent

- ISO 8000 describes fundamental concepts of information and data quality and how these concepts apply to data quality management processes and quality management systems.

8.3 GOVERNANCE AND SECURITY

The current text is in italics below, but proposed to be rewritten by the draft text below this italics.

Security requires a combination of technical controls and organisational procedures and policies, usually captured in a Security Management Plan.

Governance needs to include processes to ensure:

- *risk assessment and mitigation, security monitoring and improvements*
- *availability of means to detect breaches and means to alert stakeholders*
- *that the effect of a given breach can be contained and that recovery actions are planned*

Governance applied to security addresses:

- *risks of exchanging information*
- *levels of confidentiality required*
- *access control or identity checks*
- *provider authentication and information integrity.*

<u>Proposed new text</u>

SWIM information needs to be actively protected to safeguard its quality. This requires mitigating any threats to its confidentiality, integrity and authenticity. Establishing an Information Security Management System (ISMS) aligned with these objectives therefore strongly recommended for all information service providers

Note: ISO 27001 contains further information on ISMS.

In view of the intra-organisational nature of SWIM, it is important that all stakeholders agree on the consistent application of the technical controls and organisational procedures stipulated by the respective ISMS for the information exchanges.

SWIM Governance is positioned to enable stakeholders to collaboratively ensure for information services the following:

- trusted identity management
- risk assessment and mitigation, security monitoring and improvements
- availability of means to detect breaches and means to alert stakeholders
- that the effect of a given breach can be contained and that recovery actions are planned

The practical objective of these activities is to ensure that the SWIM requirements for IT Security are considered and consistently handled in the ISMS of participating organisations, and that adequate communication mechanisms between organisations are established.

APPENDIX A INTEROPERABILITY ARCHITECTURE

A.1 INTRODUCTION

Manual on SWIM (Doc 10039), Volume I – SWIM Concept outlines that standardisation and architecture are cornerstones of the interoperability alignment process. While the SWIM GIF provides a common view on the layers that together achieve interoperability, it does not describe how to combine the standards of each layer. This is the purpose of the interoperability architecture. It facilitates the collaboration between SWIM stakeholders. It is an architectural view in support of the experts working on SWIM who need to work with the detailed content to achieve interoperability.

Since the landscape of SWIM standards (e.g. information exchange models, data catalogues, the ATM Information Reference Model, technology standards, etc.) is complex, an overarching interoperability architecture becomes a valuable tool. It provides the means to communicate about and link standards using common terminology and structure. It also provides a guiding means used by experts working on service orientation.

The interoperability architecture is not something that a State must provide. The interoperability architecture is provided as an informative example on how to manage and understand from a holistic point of view the standards used in SWIM.

It is acknowledged that States may already have architecture practices in place. The interoperability architecture is provided as a utility that may be used, when nothing else exists. It can also be used, as a common reference, to coordinate between States which have their own architectures and views defined.

Note 1: Some building blocks may be declared as standards, but this is not necessarily always the case. In this appendix, reference will be made to building blocks that are considered part of the interoperability architecture.

Note 2: Multiple standards exist that support enterprise architecture. The "grid" is not a published and documented standard on its own but is a practical realisation in the context of what is needed in SWIM. It is broadly aligned with current practice in enterprise architecture and can be bridged to other frameworks should that need exist in any particular context.

A.2 TERMS AND DEFINITIONS

The interoperability architecture uses the following terms:

View. A representation of one or more parts of an architecture that illustrates how the architecture addresses a set of related stakeholder concerns.

Perspective. A perspective that guides the content of the views. A perspective materializes, for example, as approaches and guidelines used to ensure that a system exhibits a particular set of related characteristics that require consideration across a number of the views.

Concern. A requirement, an objective, an intention, or an aspiration a stakeholder has for the architecture.

A.3 SERVICES PERSPECTIVE

The main perspective that shapes the interoperability architecture is the services perspective. It addresses the interoperability concerns of the ATM stakeholders.

The interoperability architecture captures the building blocks needed when adopting a service-oriented architecture (SOA) within ATM. Indeed, a successful SOA relies on the building blocks from the different views.

The interoperability architecture is beneficial as it is used to restrict the possibilities of SOA in such a way that it leads to a working, interoperable and maintainable system. The interoperability architecture constrains the SOA concepts, tools, technologies and standards to be used in SWIM SOA developments.

A.4 VIEWS

A.4.1 Organisational View

The Organisational View captures the organisational interoperability related building blocks necessary to drive the development of the needed information services.

The building blocks within the Organisational View enable the identification of services as a sequence of steps aligned with business goals.

The Organisational View supports the following SOA needs:

- Ability to visualise information exchange flows between participants.
- Ability to visualise processes where the exchanged information is suitable for service development.
- Ability to agree the needs for services based on business rules, policies, information exchange requirements and other business requirements.

A.4.2 Information View

The Information View captures the information interoperability related building blocks necessary to perform meaningful information exchange using information services. The building blocks within the Information View enable the development of a unified representation of the information assets of ATM.

The Information View supports the following SOA needs:

- Ability to support information services with a shared, common and consistent expression of information/data.
- Ability to integrate information across diverse actors and organisations to communicate effectively across the different organisational domains.
- Ability to define the metadata used across the ATM network.
- Ability to support business process modelling.

A.4.3 Technical View

The Technical View captures the technical interoperability related building blocks necessary to drive the implementation of compatible solutions. The building blocks within the Technical View enable the development of the infrastructure needed to support the SOA solution throughout the SOA lifecycle.

The Technical View supports the following SOA needs:

- Ability to restrict the technologies used in a solution in order to facilitate a greater degree of interoperability.
- Ability to agree a set of common components of the infrastructure to run the SOA e.g. PKI

A.5 LEVELS

The Views are divided into levels. This is done to highlight the fact that the building blocks can be at different levels of abstraction.

A.5.1 Contextual Level

The Contextual Level contains general elements such as terms and lists of standards which provide the scope for the view.

A.5.2 Conceptual Level

The Conceptual Level contains descriptions on a level that are generally understandable to a business expert e.g. it adds the relationships between the elements within the context.

A.5.3 Logical Level

The Logical Level contains detailed and highly structured elements needed to develop technical building blocks. For example, this level adds more details such as adding typing information.

A.5.4 Physical Level

The Physical Level usually contains the same level of detail as the logical layer but adds information to facilitate the actual use of the elements in the view.

A.6 GRID

The following table presents the views and levels in the form of a grid. The purpose served by each cell is given. No method to navigate the different cells is proposed. It should be clear that one group may have an activity that produces a building block to be used by another group.

	Organisational	Information	Technical
Contextual	Capture the business activities to be considered from an organisational interoperability point of view.	Capture the scope of the ATM business terms for which a common and consistent representation is required.	Capture the standards and technology choices that constrain the service implementation.
Conceptual	Capture the business processes in support of the business activities. These can be used to identify services.	Capture the operational language. Capture semantics of metadata in the service eco-system (e.g. based on ISO 19115).	Capture the service eco-system
Logical	Capture uses cases and use case scenarios to help understand the service's functionality (a grouping of business processes). Capture the information exchange requirements. Capture the non-functional requirements.	Capture the exchanged information.	Capture the behaviour of the service, its operations and interfaces. Capture the service payload.
Physical	-	Capture an implementable representation of the exchanged information.	Capture an implementable representation of the service including a schema of the information service payload.

Table A-1: Interoperability architecture grid

A.7 USING THE INTEROPERABILITY ARCHITECTURE GRID

The interoperability architecture grid can be used at different levels. This is examined below.

A.7.1 Reference Building Blocks

A number of building blocks can be made available as a reference to communities of interest. These can be seen as a set of building blocks to control the variance that may otherwise arise if the different communities decide to e.g. use a different set of technology standards. Over time, community developed artefacts may be promoted to the reference level e.g. standardised service designs.

	Organisational	Information	Technical
Contextual	GANP SWIM Controlled Vocabulary Standards for business process modelling (e.g. BPMN)	AIRM Contextual Model AIRM standards catalogue	List of technical standards and specifications, e.g. message exchange patterns, technical infrastructure standards, specifications, exchange formats
Conceptual	-	AIRM Conceptual Model	-
Logical	-	AIRM Logical Model	-
Physical	-	-	-

Table A-2: Interoperability architecture grid with AIRM

A.7.2 Community Building Blocks

The architecture can be used within a specific community. The community can use the building blocks from the reference architecture. As an indication of the sorts of building blocks to be created within a community, two examples are given.

A.7.2.1 FF-ICE Community

The grid includes building blocks driving the move to information services - the FF-ICE/1 services are used as the example here.

	Organisational	Information	Technical
Contextual	B1-FF-ICE	-	-
Conceptual	TBO Concept FF-ICE Concept	-	-
Logical	FF-ICE/1 scenarios, use-cases, information exchange requirements Business rules	FIXM v4.2.0 Core Logical Model	Example FF-ICE/1 service design FIXM v4.2.0 Application Library
Physical	-	FIXM v4.2.0 Core XML Schema	FIXM v4.2.0 Application Library XSD

Table A-3: Interoperability architecture grid with FIXM

A.7.2.2 AIM Community

The grid includes building blocks driving the move to information services - the dataset service is used as the example here.

	Organisational	Information	Technical
Contextual	B1-DATM	-	-
Conceptual	Annex 15 PANS AIM	-	-
Logical	*PANS-AIM (DOC 10066)* Data Catalogue AIM Business Rules	AIXM v5.2.0 Logical Model	Aeronautical dataset service design Coding guidelines for ICAO datasets
Physical	-	AIXM v5.2.0 XML Schema	-

Table A-4: Interoperability architecture grid with AIXM

A.8 INTEROPERABILITY ARCHITECTURE SCOPE AND WIDER ARCHITECTURAL APPROACH

Within an architecture driven modernisation approach, it should be considered to interrelate the interoperability architecture with the business architecture and with any solution architecture.

The business architecture is used, for instance, to identify new needs, create deployment plans (e.g. the GANP) and service roadmaps. Therefore, the business architecture can provide inputs to be captured in the organisational view of the information interoperability architecture. Likewise, the work undertaken within the information interoperability architecture can feed-back to the business architecture.

A solution architecture focuses on implementation. For example, information service designs can be handed over to the solution architects for implementation. The solution architecture uses lower levels of abstraction which are more closely related to a given solution context, i.e. specific language and technology used to implement. Figure A-1 below is provided in summary of the discussion about a wider architectural approach. It is fully realised that an architectural approach is a complex activity which requires appropriate means and skills to be performed effectively.

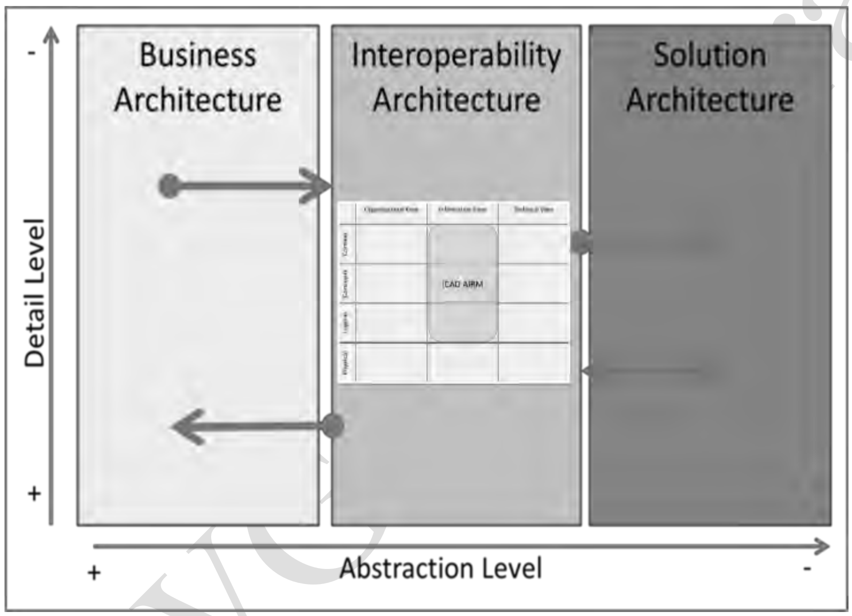

Figure A-1: Scope of interoperability architecture within a wider architectural approach

A.9 SWIM GIF LAYERS IN RELATION TO INTEROPERABILITY ARCHITECTURE

This section provides a high-level mapping between the SWIM GIF layers and the interoperability architecture views when applicable:

SWIM Enabled Applications: applications are considered outside the scope of SWIM but they produce/consume information services and become interoperable by doing so. As a consequence, they closely relate to the interoperability architecture, however their requirements should reside in the business architecture whereas their design should fit in the solution architecture.

Information Services: an information service is designed to enable the sharing of information in digital format whereby interface and exchange pattern are well understood by the service consumer. When service orientation is applied and business requirements are met, this layer therefore maps to the interoperability architecture layer of the related domain and therefore potentially covers building blocks within all the three views of the interoperability architecture. Since an information service includes the information for the payload of the information service, it may use an information exchange model for the purpose of defining the exchanged information.

Information Exchange Models layer: an information exchange model is designed to enable the sharing of information in digital format within a specific domain. Typically, an information exchange model contains a logical representation of the exchanged information and also technical artefacts such as a schema. It therefore maps to the interoperability architecture of the related domain and covers information view and technical view building blocks. Following the requirements and design decisions of each information exchange community, their specificities become visible.

SWIM Infrastructure layer: the SWIM technical infrastructure is constituted of infrastructure services (e.g. messaging, security services, etc.). Information exchange services use the SWIM technical infrastructure to perform information exchanges using the agreed technology standards. Typically, the list of standards used (e.g. as defined in a SWIM technical infrastructure interface binding) is a building block within the technical view of the interoperability architecture. The technical infrastructure implementation aspects are however part of the solution architecture.

Network Connectivity layer: the interoperability architecture does not cover the network connectivity layer. This layer is considered outside the scope of SWIM therefore the mapping to the interoperability architecture is not applicable.

SWIM Governance: typically building blocks may be subject to SWIM governance.

APPENDIX B EXAMPLES OF SERVICE OVERVIEW

This appendix provides several examples completed Service Overviews based on current and fictional information services. These examples are intended to provide guidance on the development of Service Overviews. The information provided in these examples are notional and are not intended to support decision making on the development and implementation of information services.

B.1 EMIRATES FIR SWIM GATEWAY SERVICE OVERVIEW

In line with the provisions of *PANS-IM (Doc XXXX), Vol. I – SWIM*, the following table represents the service overview of the SWIM Gateway information service made available by the service provider:

Field Name	**Detailed Content**
Service Name	SWIM Gateway
Service Version	Version 1.3.0
Provider Organisation	General Civil Aviation Authority of the United Arab Emirates Sheikh Zayed Air Navigation Centre
Provider Point of Contact	Director ATM *(Name)* *(Address)* *(Contact details)*
Brief Description of the Service	FLIGHT INFORMATION The SWIM Gateway provides access to up-to-date flight-related information as perceived by the Air Traffic Control Centre. Data from various systems is consolidated to form single "system flight objects" encoded in FIXM. Flight related information such as flight plan, flight plan fields, current trajectory, ATC clearance information, estimated and constrained times for current flights in the national airspace. This data is used by stakeholder such airports and airlines to gain information for A-CDM and DMAN implementations (CTA, CTOT, ATOT, ALDT, etc.).
Lifecycle Information	OPERATIONAL Since 25.09.2018
Geographical Extent of Information	The system covers expected and current flights in the Emirates FIR and as perceived by the federal ANSP

Field Name	Detailed Content
Quality of Service	CAPACITY: 20 concurrent subscribers, 10 SFO updates per second sustained load AVAILABILITY: 99.9% excluding the service availability of the Internet Service Provider INTEGRITY: While SZC applies operational care to achieve operationally valid data, all data is provided "as-is" CONFIDENTIALITY Service accessible only to stakeholders (ATSUs, airlines, airports) operating in the UAE or under a corresponding data sharing agreement
Access Restrictions	Access is granted to stakeholders (ATSUs, airlines, airports) operating in the UAE or under a corresponding data sharing agreement.
Message Exchange Pattern	REQUEST/REPLY PUBLISH/SUBSCRIBE
Information Exchange Model	FIXM 3.0.1 – for service consumers that subscribe to the service and in the same time publish data through SWIM GW FIXM 4.0 – for service consumers that only subscribe to the service
Service Validation	COLLABORATIVE VALIDATION: The service was validated based on agreed system validation procedures jointly developed and reviewed by the system manufacturer and GCAA technical team.
Additional Service Information	The service provision is designed in accordance with EUROCONTROL Specification for SWIM Technical Infrastructure (TI) Yellow Profile, supporting secured Request/Reply and Publish/Subscribe patterns.
Service Functions	NIL
Filtering Available	Output filters can be defined to allow a certain client to get flight information only for a certain ATSU, a certain airline, etc.
Source of Information	Data is obtained from GCAA SZC ATM system landscape include AFTN/AMHS, FDPS, AMAN, FLOW updates.
Support Availability	24 hours technical system monitoring and support is available. Contact details are shared with authorised clients.

Table B-1: Emirates FIR - SWIM Gateway - Service Overview Example

B.2 TERMINAL RADAR INFORMATION SERVICE (FAA)

Field Name	Detailed Content
Service Name (M)	Terminal Radar Information Service (TRIS)
Service Version (M)	Version 4.0
Provider Organisation (M)	United States Federal Aviation Administration (FAA)
Provider Point of Contact (M)	**Programmatic** Full Name: John Doe Title: SWIM Capabilities Lead Telephone: xxx-xxx-xxxx Email Address: john.doe@faa.gov **Engineering** Full Name: Jane Doe Title: TRIS Engineer Telephone: xxx-xxx-xxxx Email Address: jane.doe@faa.gov
Brief Description of the Service (M)	FLIGHT INFORMATION The TRIS sends operational live flight plan and track data to consumers. This data set includes radar information at select Terminal Radar Approach Control (TRACON) facilities equipped with the Standard Terminal Automation Replacement System (STARS). The operational need addressed by the service is increasing information awareness to users who previously could not receive the STARS data feed. The intended use of the TRIS is to use flight track data as a decision support tool, not aircraft separation. The intended consumers of the TRIS are users of flight track information, such as Air Traffic Flow Management (ATFM), Airport, Airlines, etc.
Lifecycle Information (M)	OPERATIONAL

Geographical Extent of Information (M)	TRIS data is available for the following United States Airports:

Airport Name	**Airport Code**
Baltimore Washington International Thurgood Marshall Airport	BWI
Boston Logan International Airport	BOS
Bradley International Airport	BDL
Charlotte Douglas International Airport	CLT
Chicago Midway Airport	MDW
Chicago O'Hare International Airport	ORD
Cleveland Hopkins International Airport	CLE
Dallas Fort Worth International Airport	DFW
Denver International Airport	DEN
Detroit Metro Wayne County Airport	DTW
Fort Lauderdale / Hollywood Airport	FLL
General Mitchell International Airport	MKE
George Bush Intercontinental Airport	IAH
Hartsfield Jackson Atlanta International Airport	ATL
Honolulu International Airport	HNL
John F. Kennedy International Airport	JFK
John Wayne — Orange County Airport	SNA
LaGuardia Airport	LGA
Lambert St. Louis International Airport	STL
Las Vegas McCarran International Airport	LAS
Los Angeles International Airport	LAX
Louisville International Airport-Standiford Field	SDF
Memphis International Airport	MEM
Miami International Airport	MIA
Minneapolis St. Paul International Airport	MSP
Newark International Airport	EWK
Orlando International Airport	MCO

<table>
<tr><th>Field Name</th><th>Detailed Content</th></tr>
<tr><td></td><td>
<table>
<tr><td>Philadelphia International Airport</td><td>PHL</td></tr>
<tr><td>Phoenix Sky Harbor International Airport</td><td>PHX</td></tr>
<tr><td>Ronald Reagan Washington National Airport</td><td>DCA</td></tr>
<tr><td>Salt Lake City International Airport</td><td>SLC</td></tr>
<tr><td>San Diego International Airport</td><td>SAN</td></tr>
<tr><td>San Francisco International Airport</td><td>SFO</td></tr>
<tr><td>Seattle Tacoma International Airport v</td><td>SEA</td></tr>
<tr><td>Theodore Francis Green State Airport</td><td>PVD</td></tr>
<tr><td>Washington Dulles International Airport</td><td>IAD</td></tr>
<tr><td>William P. Hobby Airport</td><td>HOU</td></tr>
</table>
</td></tr>
<tr><td>Quality of Service (M)</td><td>Availability: 0.999
Latency: 1 second (mean) and 5 seconds (95th percentile)
Recoverability: Reconnection time is 3 minutes</td></tr>
<tr><td>Access Restrictions (M)</td><td>SWIM manages all security features for Publish/Subscribe services for authorized National Airspace System (NAS) and non-NAS consumers and NAS producers.

Access controls are supported through the use of username and password credentials supplied when establishing connections to FAA SWIM interfaces. Username and password credentials are unique to each SWIM client and established during on-ramping.

TRIS obtains updated Sensitive Flight Data Identification files on a periodic basis or as directed by System Operations Services for time critical requirements. Following the FAA-approved Security Program for Sensitive Flight Data Identification, the TRIS uses the information in those files to mark, or tag, service messages as containing sensitive or non-sensitive flight data. During the process for registering and connecting new SWIM users, each client is authorized to receive either sensitive or non-sensitive flight data, and is configured accordingly when on-ramped to SWIM. SWIM uses the client configuration and each message's "sendTo" tag to ensure messages with sensitive flight data are only sent to clients authorized to receive sensitive flight data. Flight data marked as sensitive under this FAA Security Program is Sensitive Security Information in accordance with 49 CFR 15.5(a)(16) and 49 USC 40119(a) and must be protected in accordance with FAA Order 1600.75, Protecting Sensitive Unclassified Information (SUI).</td></tr>
<tr><td>Message Exchange Pattern (M)</td><td>TRIS provides data using a Publish/Subscribe protocol using the Java Message Service (JMS) messaging protocol.</td></tr>
<tr><td>Information Exchange Model (M)</td><td>TRIS uses FIXM 3.0. A copy of the schema can be found at: https://nsrr.faa.gov/.</td></tr>
</table>

Field Name	Detailed Content
Service Validation (M)	SELF-VALIDATION FAA SWIM Services are "Self-Validated" per the FAA SWIM Governance Policies. These policies require the development and execution of Operation Test Plans, and complete documentation of the service. More information on the FAA SWIM Governance Policies can be found at: https://www.faa.gov/nextgen/programs/swim/governance/standards/.
Additional Service Information (M)	Additional information on the TRIS can be found at the FAA's NAS Service Registry and Repository (NSRR): https://nsrr.faa.gov/.
Service Functions (M)	The TRIS publishes the "TATrackAndFlightPlan" message. TATrackAndFlightPlan messages contain flight plan information and terminal radar data from the Standard Terminal Automation Replacement System (STARS). TRIS extracts aircraft position locations from the STARS surveillance data and sends this data to authorized SWIM service consumers via this message.
Filtering Available (M)	Filtering options for the "TATrackAndFlightPlan" generated by TRIS include "Message Type" and "Source Airport".
Source of Information (M)	TRIS publishes a package of track and flight plan data received from STARS at specified airports associated with TRACON facilities operated by the FAA. Only track data with altitude below an adaptable threshold (nominally 18000ft) is published. These messages may be enhanced with SWIM Flight Data Service (SFDS) flight plan data.
Support Availability (M)	Support for FAA SWIM Products can be found online. Users wishing to obtain more information regarding the process of connecting to FAA SWIM are encourages to read the SWIM External Consumer Brief found here: https://www.faa.gov/nextgen/programs/swim/documentation/. Users wishing to obtain more information on specific FAA SWIM Service can find this at: https://nsrr.faa.gov/. Additionally, users can reach out directly to the FAA SWIM program for support by emailing Data-To-Industry@faa.gov. Users can expect to receive a response during normal business hours.

Table B-2: FAA Terminal Radar Information Service - Service Overview Example

B.3 TargetOffBlockTimeSetting Service (DONLON)

Field Name	Detailed Content
Service Name (M)	TargetOffBlockTimeSetting Service
Service Version (M)	Version 1.0.0
Provider Organisation (M)	Donlon Airport Operator

Field Name	Detailed Content
Provider Point of Contact (M)	To request access to the service: http://www.donlon-airport.com/swim/service-request For Incidents on services in operation, contact the Service desk [24/7]: +693 555 01 service-desk@donlon-airport.com
Brief Description of the Service (M)	FLIGHT INFORMATION The TargetOffBlockTimeSetting service supports the Airport CDM concept and its implementation by allowing A-CDM Partners, typically aircraft operators and ground handlers, with the capability to set the Target Off-Block Time (TOBT) that indicates the target time for the aircraft to be ready for Off-Block. This service conforms to the TargetOffBlockTimeSetting service as defined by SESAR in the ISRM 2.0. It is part of a set of services supporting the Airport CDM concept and its implementation by providing the A-CDM partners with Common Situation Awareness about flights at a CDM airport.
Lifecycle Information (M)	OPERATIONAL – July 2017
Geographical Extent of Information (M)	For flights departing from Donlon airport (EADD).
Quality of Service (M)	Availability – 99.5% outside the planned outages Capacity – 2000 service requests per hour Response time – 2 seconds for 95% of messages
Access Restrictions (M)	The service is targeting aircraft operators and ground handlers for their flights at Donlon Airport. The access to the service is subject to the signature of a Service Level Agreement with the Donlon Airport Operator. The access to the service is based on user id and password. The service may, as well, be used by the Donlon Tower Controllers in specific circumstances, such as under adverse conditions or other special circumstances.
Message Exchange Pattern (M)	The service follows the Synchronous Request/Response Message Exchange Pattern
Information Exchange Model (M)	The service is using its own schema.
Service Validation (M)	The service has not been validated yet.

Field Name	Detailed Content
Additional Service Information (M)	Additional information on the service can be found at the European SWIM registry https://eur-registry.swim.aero/services/DonlonAirport/TargetOffBlockTimeSetting.
Service Functions (M)	*function* — *real world effect* Allow the service consumer to **set** (i.e. define or update) the TOBT value for a specific flight. — The Target Off-Block Time (TOBT) value is defined Allow the service consumer to **delete** the TOBT value for a specific flight. — The Target Off-Block Time (TOBT) value is undefined The A-CDM Implementation Manual defines the impact of the TOBT value at various stages of the A-CDM process. See Airport CDM Implementation Manual v4.
Filtering Available (M)	No Filtering is available
Source of Information (M)	The information (TOBT value) is provided by the service consumer.
Support Availability (M)	For Incidents on services in operation, contact the Service desk [24/7]: +693 555 01 service-desk@donlon-airport.com

Table B-3: DONLON - Target Off Block Time Service Overview Example

B.4 AERONAUTICAL METEOROLOGICAL INFORMATION SERVICE (SHANGHAI FIR)

Field Name	Detailed Content
Service Name (M)	Aeronautical Meteorological Information Service within Shanghai Flight Information Region
Service Version (M)	Version 1.0.0
Provider Organisation (M)	East China Regional Air Traffic Management Bureau of Civil Aviation Administration of China（EATMB of CAAC）

Field Name	Detailed Content
Provider Point of Contact (M)	Area Forecast Office: 021-22327522/22327520 (Tel), 021-62683667 (Fax) Hongqiao Meteorological Observatory: 021-22367500/22367506 (Tel), 021-22367508 (Fax) Pudong Meteorological Observatory: 021-22324866/22324868 (Tel), 021-22324867 (Fax)
Brief Description of the Service (M)	WEATHER INFORMATION Forward local aerodrome reports (such as SA, SP, and WS) and forecast reports (FC, FT) to operators and flight crew members; supply meteorological reports and forecasts, upper wind and upper-air temperature forecasts chart, SIGWX forecasts chart, meteorological satellite images, and real-time data from automatic weather observing systems; provide decoded Grid point data in digital form; disseminate aerodrome warnings (when the values or change values of meteorological elements related to flight reach the warning levels).
Lifecycle Information (M)	OPERATIONAL
Geographical Extent of Information (M)	Within Shanghai Flight Information Region (ZSHA)
Quality of Service (M)	The information service meets the provisions of ICAO Annex 3 (Meteorological Service for International Air Navigation) and complies with the regulations of CAAC. The information is accurate, timely and complete, which can meet the requirements of aeronautical meteorological users.
Access Restrictions (M)	Only the users who have signed service contracts or service agreements can log in and use the information. They shall not send the information to any other individuals or agencies. The meteorological information shall not be posted on the public network, such as the Internet.

Field Name	**Detailed Content**
Message Exchange Pattern (M)	• Proactively disseminates meteorological information of Shanghai Hongqiao and Pudong International Airport and Shanghai FIR via AFTN, collects the world meteorological information and forwards such information to small and medium-sized airports in East China (publish); • Provides meteorological reports and forecasts, upper wind and upper-air temperature forecasts chart，SIGWX forecasts chart, meteorological satellite images, and real-time data from automatic weather observing systems on “East China Meteorological Information Network”(publish); • Provides decoded GRIB data and aerodrome warnings by FTP (publish); • Disseminate meteorological information such as aerodrome warnings and windshear alarms on the "Weather Warnings and Notification Publishing System" via the network (publish).
Information Exchange Model (M)	The information service meets the provisions of ICAO Annex 3 (Meteorological Service for International Air Navigation) and complies with the regulations of CAAC.
Service Validation (M)	• The Meteorological Center of EATMB of CAAC evaluates the accuracy of the meteorological information provided by the forecasters afterwards (self-validation). The statistical information of the forecast quality of the area will be published in the monthly “East China Aeronautical Meteorological Forecasts Quality Analysis Report” and “East China Aeronautical Meteorological Operational Information Bulletin”; • In addition, the Air Traffic Control Center and the Area Forecast Office will jointly evaluate the accuracy of the area meteorological warnings, which have a significant impact on flow control (collaborative validation).
Additional Service Information (M)	Provide customized aeronautical meteorological service or data source based on aviation users’ requirements.
Service Functions (M)	• Provide operators and flight crew members with aeronautical meteorological information for pre-flight planning and in-flight replanning, for takeoff and landing and for aircraft in flight; • Supply AWOS data and upper wind and upper-air temperature data to the ATM automated system.
Filtering Available (M)	forecast; meteorological; observatory; SIGMET; meteorological warnings; aerodrome warnings
Source of Information (M)	The information (TOBT value) is provided by the service consumer.

Field Name	Detailed Content
Support Availability (M)	Meteorological Center of EATMB of CAAC

Table B-4: Shanghai FIR - Aeronautical Meteorological Information Service - Service Overview Example

B.5 FLIGHT PREPARATION SERVICE (EUROCONTROL)

Field Name	Detailed Content
Service Name (M)	Flight Preparation Service
Service Version (M)	Version 21.5
Provider Organisation (M)	EUROCONTROL Network Manager (NM)
Provider Point of Contact (M)	To request access to the service follow this procedure http://www.eurocontrol.int/network-operations/service-request
Brief Description of the Service (M)	FLIGHT INFORMATION FlightPreparation service provides requests aimed at easing the preparation phase of the flight plan. The service supports airspace users in building flight plans satisfying the NM/IFPS validation rules. It allows querying the validity of a flight plan (including the list of validation errors) and generating compliant flight routes. The service is intended to be used before flight plan filing to NM.
Lifecycle Information (M)	OPERATIONAL – May 2009
Geographical Extent of Information (M)	The service may be used for flight plans concerning the part of the ICAO EUR Region known as the IFPS Zone.
Quality of Service (M)	***parameter*** ***value*** Availability 99.95 % outside the planned outages Capacity 2000 service requests per hour Response time 2s delay for 95% of messages

Field Name	Detailed Content
Access Restrictions (M)	The NM B2B web services are restricted to entities which are actively engaged in ATFCM operations, aircraft operations – and related support services. **Access is subject to eligibility conditions, to specific use conditions and to the signing of an agreement.** Consult the NM Agreements and Policies page and fully acquaint yourself with the NM Operations Security Rules, the NM Data Rules, and the Acceptable Behaviour Rules for Flight Planning and ATFCM Operations. Secure access to NM B2B Web Services is ensured through a security device (certificate). The device will be delivered to you by EUROCONTROL NM Service Requests once your official request has been validated. [read more on Network Manager Business-to-business (B2B) web services web page]
Message Exchange Pattern (M)	The service follows the Synchronous Request/Response Message Exchange Pattern.
Information Exchange Model (M)	The service supports two different exchange models: a proprietary one and FIXM.
Service Validation (M)	The service is operated under EASA oversight.
Additional Service Information (M)	Additional information on the service can be found in the document "NM 21.5.0 - NOP/B2B Reference Manuals - FlightServices", specifically in section 3.1 "FlightPreparation Service". The NM B2B Reference Manuals can be accessed in EUROCONTROL OneSky Teams on NM B2B Services (https://ost.eurocontrol.int/sites/B2BWS/default.aspx), for which registration is necessary (https://ext.eurocontrol.int/elsh/registerNewUserForApplication.do?resourceId=circa)

Field Name	Detailed Content
Service Functions (M)	*function* — *real world effect* Allow the service consumer to **validate a flight plan** according to the NM/IFPS validation rules. — No real world effect, except that the service returns status and list of errors. Allow the service consumer to **request routing assistance** for a flight plan satisfying the NM/IFPS validation rules — No real world effect, except that the service returns generated NM/IFPS-compliant routes for a given flight plan The input flight plan information may be provided either in string format or via a Flight Plan structure (in a proprietary model or in FIXM).
Filtering Available (M)	Not applicable.
Source of Information (M)	The flight plan information is provided by the service consumer. The status, error list and generated routes are computed by NM.
Support Availability (M)	For Incidents on services in operation, contact CSO (Customer technical Service desk & Operations) [24/7]: +32 2 745 1997 nm.cso.help-desk@eurocontrol.int

Table B-5: EUROCONTROL Flight Preparation Service - Service Overview Example

APPENDIX C SERVICE PROVIDER/CONSUMER LIFECYCLE SCENARIOS

The following scenarios are based on …………

C.1 INFORMATION SERVICE PROVIDER LIFECYCLE

This scenario depicts the stages of how an information service provider would initiate the process of providing an information service using SWIM as shown in Figure C-1. The five (5) stages of the provider lifecycle process are presented below:

1. SWIM Infrastructure Provider and Information Service Identification;
    a. An information service provider wishes to supply airport surface movement information using SWIM technical infrastructure;
    b. Information service provider researches rules and regulations as required by the SWIM regional governance and technical infrastructure provider(s);
    c. Information service provider develops the scope of information service to be offered;
2. Select SWIM Infrastructure Provider/Sign Agreement(s);
    a. Information service provider develops service overview and other information required by SWIM infrastructure and regional SWIM service registry provider rules and regulations;
    b. Information service provider signs agreement(s) with a SWIM technical infrastructure service provider to provide information service;
    c. Regional SWIM Service Registry provider lists airport surface movement information service as “Prospective”” in SWIM service registry;
3. Information Service Development;
    a. Information Service provider specifies and develops information service characteristics (e.g. information shared, message exchange patterns, latency, update rate, error handling, validation, etc.);
    b. Information service provider develops and promulgates technical documentation (e.g. WSDD, WSDL, etc.);
4. Prepare and Test Information Exchanges and Connection;
    a. Information service provider develops test environment to evaluate sample exchanges between provider and consumers;
    b. Information service provider tests sample data to ensure service functionality;

c. Information service provider establishes connection using SWIM test technical infrastructure and ensure operational readiness (e.g. information service validation, information service meets advertised latency and update rates, can publish to or reply surface movement information as needed etc.);

5. Fully Operational;

a. Information service provider establishes connection using operational SWIM infrastructure;

b. SWIM infrastructure provider lists airport surface movement information service as "Operational" in SWIM Service Registry; and

c. Information service provider provides airport surface movement information service.

The full information service provider lifecycle could include additional stages beyond 1-5 presented above. These follow-on steps could include:

a. establishing a new or updated version of the surface movement information service;

b. deprecating older versions of the surface movement information service;

c. considering use of a different SWIM infrastructure provider; or

d. ceasing publication of the surface movement information service

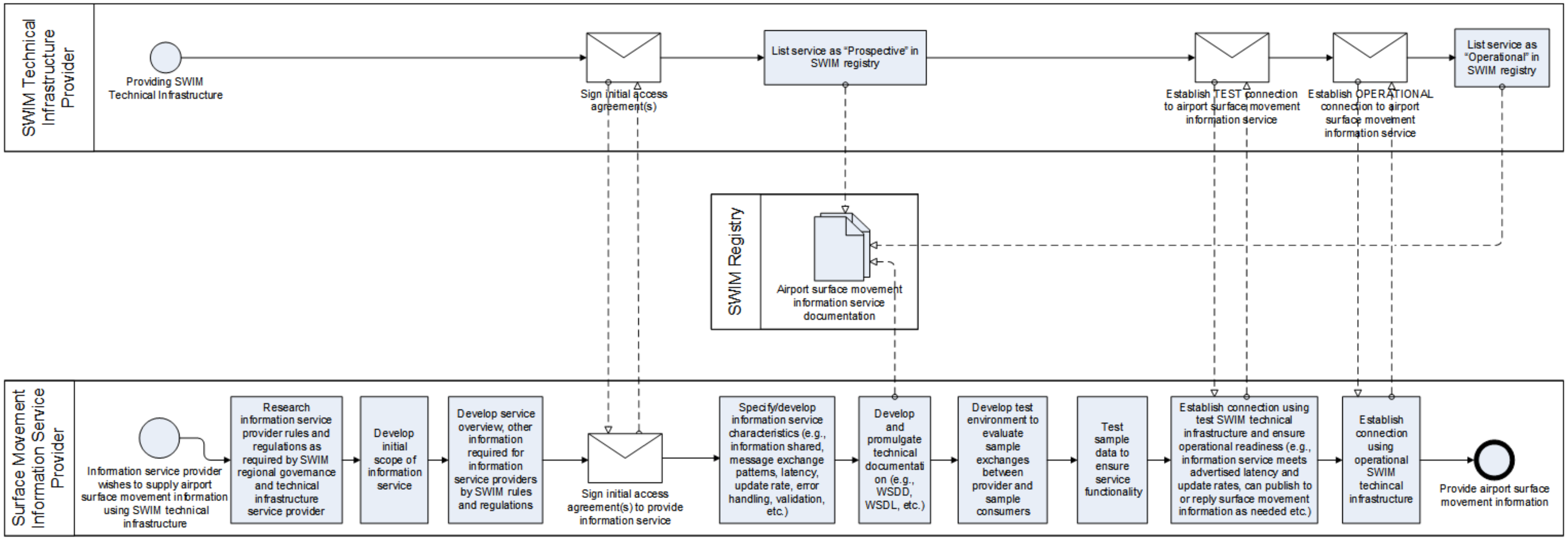

Figure C-1: Information Service Provider Lifecycle

C.2 INFORMATION SERVICE CONSUMER LIFECYCLE

Once the information service is operational, the information service consumer is able to discover the necessary services. This operational scenario depicts the stages of how an information service consumer would initiate the process of consuming an information service including the interaction with the information service provider as shown in Figure C-2. The nine (9) stages of the information service consumer lifecycle process are presented below:

1. The information service consumer identifies an operational need for airport surface movement information at Dulles International Airport (KIAD);

2. The information service consumer identifies initial performance requirements to meet the operational need (e.g. quality of service parameters, reliability, information exchange models, etc.);

3. The information service consumer accesses the SWIM Service registry to obtain information about surface movement information services (e.g. service overview, web service description document (WSDD), web service definition language (WSDL), etc.);

4. The information service consumer contacts the point of contact from surface movement information service provider and receives information about the service beyond what is included in the SWIM service registry;

5. The information service consumer signs initial surface movement information service access agreement with the information service provider;

6. The information service consumer obtains additional information about service characteristics and implementation from the information service provider

7. The information service consumer signs final surface movement information service access agreement with the information service provider;

8. Using SWIM-enabled application, the information service consumer establishes connection to the surface movement information service; and

9. Using SWIM-enabled application, the information service consumer interacts with the information service to exchange surface movement information with provider.

The full information service consumer lifecycle could include additional stages beyond 1-9 presented above. These follow-on steps could include:

1. establishing connection to a new or updated version of the surface movement information service;

2. considering use of a competing information service; or

3. stopping use of the surface movement information service

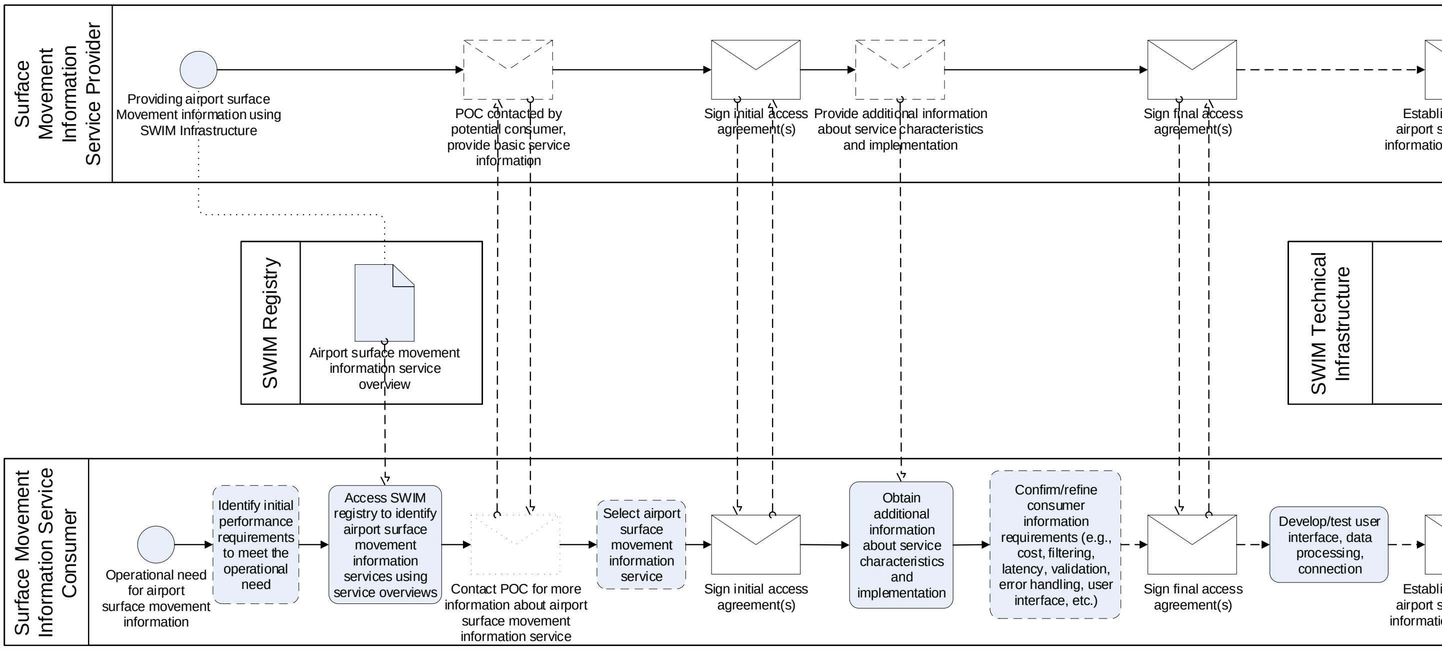

Figure C-2: Information Service Consumer/Provider Interaction

APPENDIX D AIRM ALIGNMENT EXAMPLES

D.1 AIRM AND INFORMATION DOMAINS

The vocabulary for ATM related information contained in the AIRM is used as the semantic reference for the information exchanged via SWIM information services. This enables unambiguous understanding of information in different contexts.

The AIRM supports alignment across the various information domains and related information exchange models used to specify information services for implementation purposes. When depicted on the interoperability architecture, the AIRM appears as an architectural building block at the cross-domain level performing the role of reference. Figure D-1below shows this relation of the AIRM to the information exchange models:

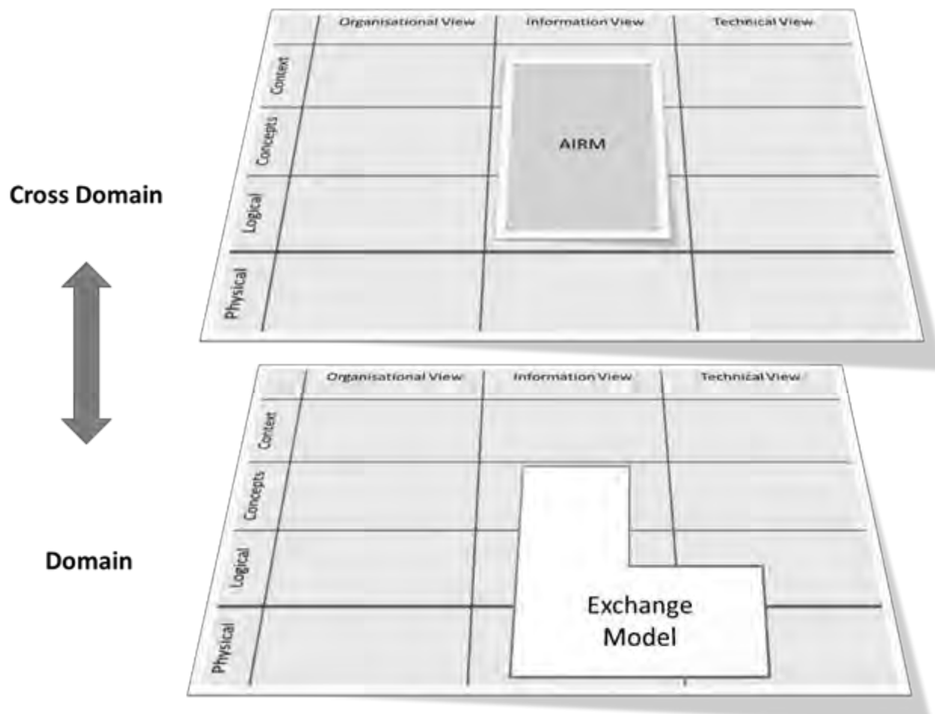

Figure D-1: AIRM as reference

Why use the AIRM as a common reference? Exploring how information exchange models relate:

- FIXM enables the sharing of flight information in a digital format. It captures the concepts for describing trajectory information associated with a flight. However, describing the movement of a flight commonly means indicating which parts of the infrastructure (aerodromes, runways, ATS routes, waypoints, radio navigation aids etc.) are used, or intended to be used, by the flight. Therefore, FIXM includes concepts concerning the ATM infrastructure published by the aeronautical information domain (i.e. modelled in the AIXM).
- AIXM enables, amongst other things, the exchange of an aerodrome description. This information pertains to the aeronautical information domain. An aerodrome description can include information about aerodrome usage, but this information may depend on the

type of flight. Consequently, AIXM, to be fit for purpose, includes the necessary flight domain concepts, such as flight statuses and flight types.

- These two examples show the intentional expression of the same concepts in different information domain contexts, i.e. different information exchange models (XMs).
- Continuing, models such as AIXM, FIXM, AMXM, and others use their specific representations of concepts for their purpose and context of use. Moreover, different operations and applications may call for specific requirements in terms of syntax and technology choices.

The sections below describe two semantic alignment related scenarios that make usage of the AIRM.

D.2 Semantic Alignment across Information Domains

This scenario elaborates on the usage of the AIRM in support of the semantic alignment across XMs.

A key principle is to ensure that coordination and harmonisation efforts remain manageable and each XM community's change management decisions and procedures remain within the remit of the managing community itself.

The scenario description covers the SWIM community and information domain viewpoints (i.e. community of interest) in relation to the AIRM:

D.2.1 SWIM Community Viewpoint

The SWIM community viewpoint describes the overall collaboration scenario. It illustrates how the AIRM enables bridging information domains and helps communities converge gradually towards consolidated and harmonised domain vocabularies.

An XM community can:

- add XM vocabulary (i.e. terms and definitions), or a subset thereof, to the AIRM;
- incorporate relevant AIRM vocabulary in support of the cross-domain consolidation of their XM;

When added to the AIRM, the vocabulary becomes available to other information domains and respective XMs.

The repetition of the activities above creates a cycle for achieving convergence of vocabularies using the AIRM and, as a result, for achieving cross-domain harmonisation.

By comparison, achieving cross-domain harmonisation without the AIRM would require every XM community to establish point-to-point coordination threads with other communities. Such an approach would:

- imply that each community manages multiple coordination threads instead of a single one;
- become hardly manageable, certainly considering the potential growth of the number of communities getting involved in SWIM;

- imply a risk possibly leading to semantic interoperability issues when a community did not identify all the communities with whom to coordinate;

D.2.2 Community of Interest Viewpoint

The community of interest viewpoint describes a "zoom in" scenario on a particular XM when the decision to engage has been taken. As the XMs and the AIRM continue to evolve, a repetition of the steps it involves is expected:

- Step 1: comparing the XM and the AIRM; and
- Step 2: managing the alignment of semantic correspondences between the XM and the AIRM.

Step 1 - comparing the XM and the AIRM:

- As an initial step, compare the semantic description of the different XM elements with the reference AIRM vocabulary.
- Record the outcome of this initial comparison:
    - Document the gaps and divergences with the AIRM vocabulary (e.g. due to the absence of the corresponding term in the AIRM, the use of a different definition in the XM, use of a synonym, absence of a definition, etc.);
    - Document semantic correspondences with the AIRM vocabulary.
- As a subsequent step, update the documented comparison:
    - An update may be necessary when changes to the XM semantics occurred due to a new version of the XM.
    - An update may be necessary when the reference AIRM vocabulary is updated although the frequency of this is deemed to be low.
- Raise awareness about the documented comparison:
    - Making the divergences with AIRM known to the ATM community is a simple but significant step towards reaching semantic interoperability. It is simple because it does not affect the content or design of the XM and has therefore no immediate impact on the services, systems or applications relying on the XM. It is significant, because it provides the necessary signals that particular information exchanges could lead to variations in the understanding. It is a good practice to make users aware.

Step 2 - managing the semantic correspondences between the XM and the AIRM:

- If there is a need for evolution of the reference AIRM vocabulary, propose changes to the AIRM in accordance with the AIRM change management process.
    - A subset of the XM vocabulary becomes reference for the SWIM community.
- If there is a need for evolution of the XM, propose changes to the XM in accordance with the applicable XM change management process.
    - Some terms from the reference AIRM vocabulary become part of the XM. A proposed change may lead to an impact on an XM implementation.
    - Following the alignment principle, it is up to the XM community to decide when it is best to integrate the change (e.g. in accordance with the applicable release strategy, versioning policy and other applicable rules governing the XM evolution).

Step 3 - go to step "comparing the XM and AIRM" again:

- When a new XM version is released, or when a new AIRM version is published the cycle can be repeated as appropriate.

D.3 ICAO DOC 10066 (PANS AIM) DATA CATALOGUE (DC) TRACING TO AIRM

The Aeronautical Data Catalogue (PANS-AIM DC) consolidates the AIM domain and covers the aeronautical data mentioned in ICAO documents:

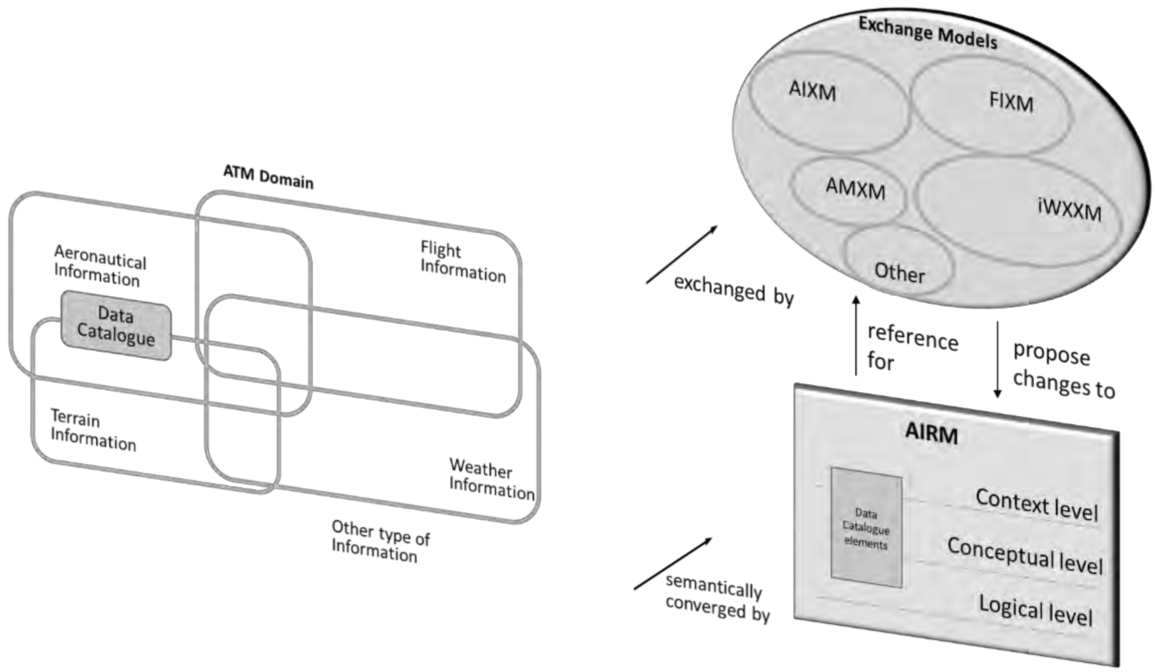

Figure D-2: PANS-AIM DC within ATM context

The PANS-AIM DC (*DOC 10066*) represents the data elements of the aeronautical information domain. A subset of the data elements is provided by States in the form of digital data sets as set out by ICAO Annex 15.

Mapping the PANS-AIM DC to the AIRM brings a considerable added value and strongly supports implementation of data sets by bringing to the PANS-AIM DC the required context descriptions and associations, which are needed in order to model the data when working towards a SWIM solution.

The process: performing the mapping between AIRM and PANS-AIM DC implies an inspection of the data elements of the PANS-AIM DC. The corresponding element in the AIRM model is looked-up. This inspection involves a number of steps:

Step 1 - compare the structure of the PANS-AIM DC and AIRM:

The structuring of the data elements is different in the AIRM and the PANS-AIM DC. These differences need to be taken into account in the mapping:

Example: Surface type of the de-icing area

PANS-AIM DC	AIRM Logical Model
Subject: De-icing area Property: Surface type	Data Entities/Data Objects: DeicingArea -> ApronElement ->SurfaceCharacteristics Attribute: composition

Step 2 - compare the semantics of the PANS-AIM DC and AIRM:

The AIRM uses a systematic and logical IT-type naming convention for all classes, attributes and associations. The PANS-AIM DC naming of subjects, properties and sub-properties follows as much as possible the language used in ICAO Annexes. Although different, they address the same concepts and can be identified and related.

Example: Height of an Obstacle	
PANS-AIM DC	AIRM Logical Model
Subject: Obstacle Properties: Height	Data Entity: VerticalStructurePart Attribute: verticalExtent

Step 3 - search for AIRM correspondent for each element of the PANS-AIM DC:

The activity requires some basic domain knowledge level and needs to be performed element by element (automation could be considered).

Step 4 - document the mapping:

The mapping can be documented by adding the URN of the AIRM element to the PANS-AIM DC entry.

APAC SWIM IMPLEMENTATION GUIDANCE DOCUMENT

(v0.1)

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