

# **SWIM IMPLEMENTATION KIT: A PRACTICAL GUIDE TO SYSTEM-WIDE INFORMATION MANAGEMENT FOR ANSPs**

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# Acknowledgements

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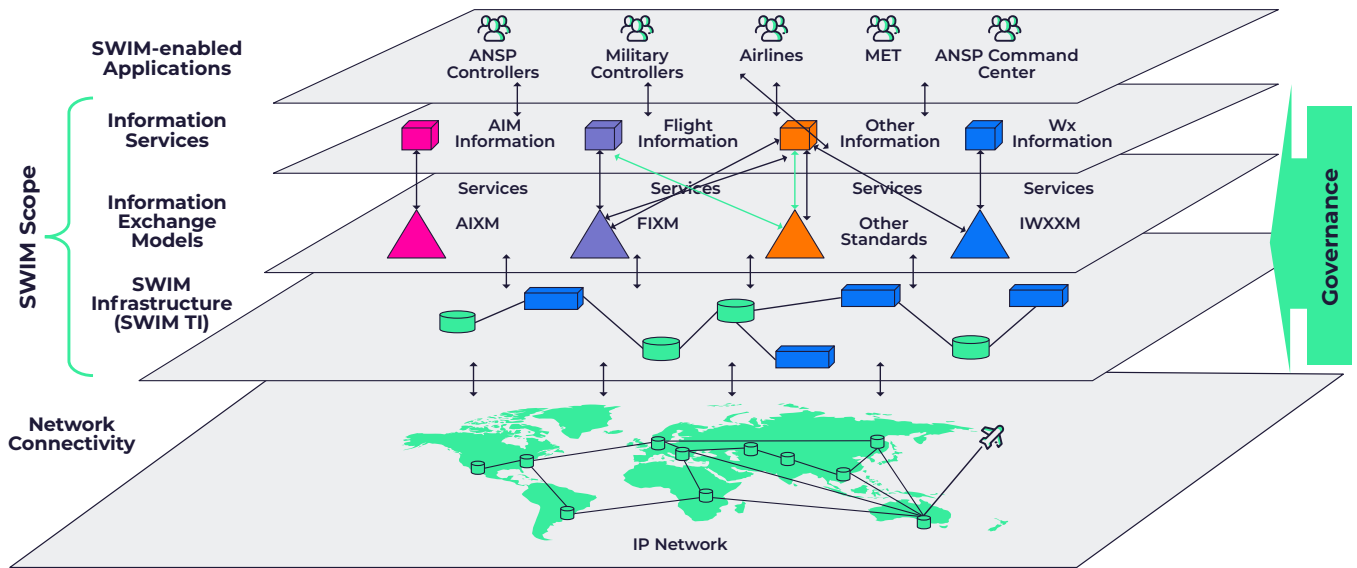
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# 1. Executive Summary

## 1.1 What is System-Wide Information Management (SWIM)?

SWIM enables air traffic management (ATM) information to be exchanged using service-oriented architecture and open standards to ensure interoperability and efficiency across systems.

SWIM enables organisations to move beyond the status quo by flowing information across silos, systems, locations and clouds. SWIM data will improve situational awareness, optimise ATM, and provide an avenue to take advantage of new applications as they evolve. (The SWIM Concept is detailed at a high level in Figure 1.)



**Figure 1** – SWIM global information sharing layers

## 1.2 What is the SWIM kit?

This document focuses on implementing SWIM and goes deeper into the technical aspects than what is in ICAO documents. This document focuses on implementing SWIM by providing more detailed technical information to complement relevant ICAO documents.

The SWIM Kit is a living document that will evolve and be updated as new concepts, provisions, guidance and standards are introduced. The objective of the SWIM Kit is to assist in the implementation of a SWIM project. The SWIM Kit is designed to show that getting started with SWIM implementation can be straightforward, using available SWIM tools. Examples for SWIM approval, progress, and procurement processes are presented in the SWIM Kit which contains the implementation provisions and guidance information.

## 1.3 The State of SWIM

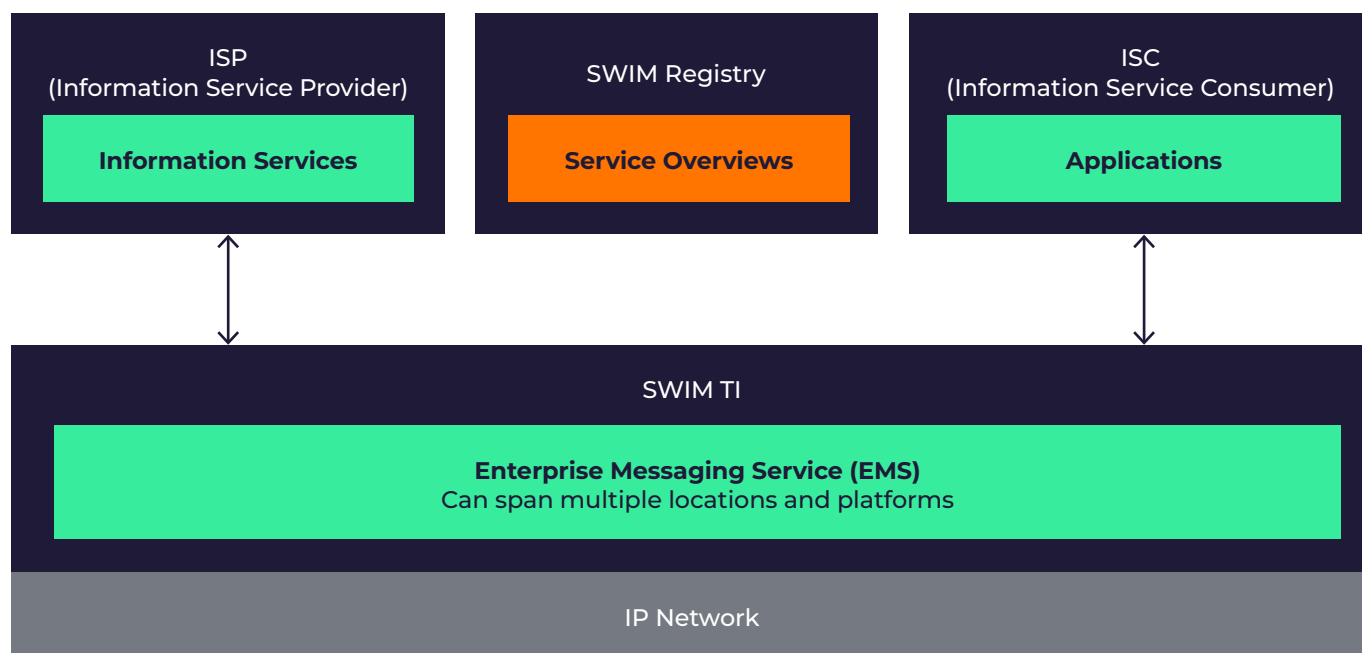
SWIM requires new ways of thinking, procuring and delivering ATM services. ICAO has developed SWIM Provisions and guidance material to assist in the implementation process. Along the way, many successful implementations have been achieved. Although multiple ANSPs have operationally proven their SWIM implementation, there are many ANSPs still trying to get their SWIM implementation started or completed. The SWIM Kit combines lessons learned with a hands-on approach to assist ANSPs with their implementation of SWIM.

## 1.4 SWIM Technical Infrastructure (SWIM TI)

The SWIM Technical Infrastructure (SWIM TI) provides the foundation for secure, digital information exchange in a SWIM environment. As illustrated in Figure 2, SWIM decouples the underlying infrastructure from information services and user applications, enabling flexibility and scalability in implementation.

An Enterprise Messaging Service (EMS), also referred to as SWIM Core Messaging, plays a central role in SWIM implementations to support the SWIM principles. It provides the messaging capabilities for SWIM information exchange and supports SWIM message exchange patterns. An EMS is made up of one or more products in one or more locations and platforms to provide this service which may include message brokers, API Management products, an iPaaS, etc. Organisations are encouraged to explore product-agnostic, cost-effective approaches, including Commercial Off-The-Shelf (COTS) technologies, that align with enterprise and security requirements.

Successful SWIM implementation will require technical expertise to evaluate and adopt appropriate messaging and service strategies, ensure security, and establish Service Level Agreements (SLAs). Organisations should start with simple, clearly defined use cases and build incrementally, while also fostering a culture of innovation and equipping staff with the necessary skills.



**Figure 2** – SWIM TI context

## 1.5 Call to Action

The SWIM Kit is a reference to assist ANSPs in getting started with their SWIM journey. In addition, CANSO is here to help you with guidance and workshops.

## 2. Overview

The SWIM Kit answers the question “How do I get started with SWIM Today?” It does this by bridging the gap between regulations and implementation through guidance and publicly available tools that foster collaboration across stakeholders, operational and technical staff. It uses best practices and valuable lessons learned from mature information exchanges in the ATM, finance and critical systems in other industries and successful SWIM implementations.

ANSPs can learn how to implement SWIM by experimenting with an implementation that embodies the provisions in the ICAO PANS-IM with the best practices and lessons learned in this tool kit. The SWIM Kit can help an ANSP learn what is important to consider when buying or building SWIM solutions, products, and services. It also helps to understand the possibilities of SWIM, while identifying what is needed and what questions to ask. This will help in the development of SWIM-related Request for Proposals (RFPs), or tenders, when seeking third-party solutions. This will also assist in identifying what is needed to support and align with global, regional, and State SWIM regulations and implementations.

A SWIM implementation can start simply, and then grow as a safe, resilient, and agile ATM information sharing backbone. The Kit can be used to test, validate and collaborate on SWIM use cases and compatibility. It can also be used to collaborate with SWIM participants, stakeholders and other ANSPs through information services.

It is important to highlight that SWIM implementation benefits extend beyond ATM. The benefits can be multiplied within and across an organisation, across multiple organisations and across industries. This makes SWIM a much larger “win”. It can, and has, become a digital foundation for ANSPs.





### 3. How do I get started?

The approach in this document is to start by doing. This section is intended to clearly illustrate the essentials of accelerating SWIM implementation. The reader is guided through the SWIM Tool (that is not meant for operational use). No programming knowledge is required, though it is a benefit. This tool represents what is needed in a Minimal SWIM Implementation (MSI) using PANS-IM terminology and provisions. We describe the samples to interact with SWIM below.

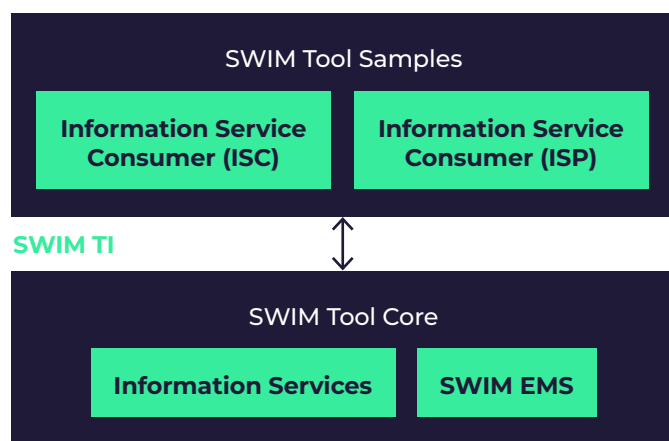
### 3.1 Step 1 - What is the SWIM Tool?

The SWIM Tool is a self-contained MSI and is used within this document to make SWIM implementation more real. It includes sample **Information Service Consumers (ISC), Information Service Providers (ISP)** and **information services** that are accessed from web pages or a command line. The sample information services require Internet access. Some of the supplied information services provide streaming SWIM information that sample ISCs consume and display.

To help you visualise the SWIM Tool, a simple diagram is provided below. The SWIM Tool has three parts:

1. **SWIM Tool Samples** – Sample ISCs and ISPs to consume and provide Information Services.
2. **SWIM Tool API (Application Programming Interface)** – The SWIM Tool interface used by ISCs and ISPs to exchange information with a SWIM EMS.
3. **SWIM Tool Core** – SWIM EMS, information services and a simple registry.

## SWIM Tool – a minimal SWIM implementation



### Figure 3 – The SWIM tool

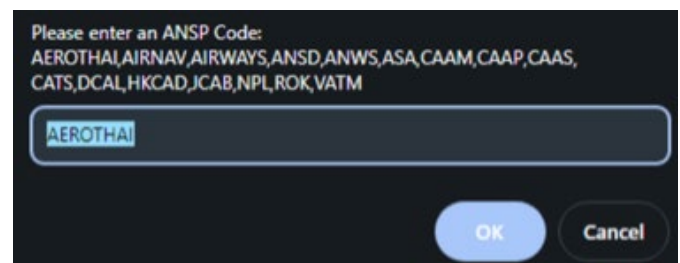
### 3.2 Step 2 - Run ISC NOTAM Samples

The following example is taken from only one of many ATM information products and information domains under SWIM.

### 3.2.1 Consume from a NOTAM information service and display as a list

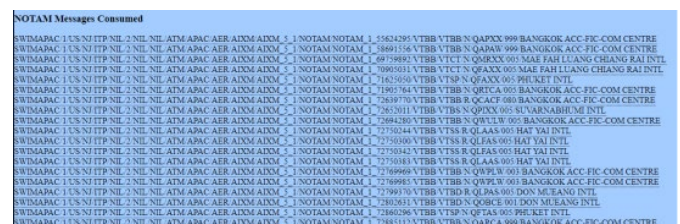
The example described here requires an Internet browser with access to the Internet. The sample is a web page that subscribes to and consumes information from information services running in the SWIM Tool in the cloud.

1. Go to the [NOTAM List web page](#)



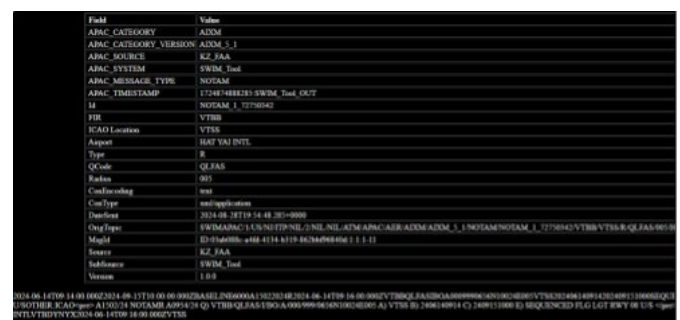
#### Figure 4 – Prompt for ANSP

2. Enter an ANSP code from the list and hit the 'OK' button.
3. You will see something like the next page.



### Figure 5 – NOTAM list

4. Move your mouse pointer over an item and the NOTAM's details will display as below.



### Figure 6 – NOTAM detail



This ISC web page does the following internally in JavaScript:

1. Prompts for the ANSP code (which you enter and click 'OK')
2. Looks up FIRs for this ANSP
3. Subscribes to the topics representing these FIRs
4. Sends a request for NOTAMs matching these FIRs from the information service
5. Waits for messages... (the information service starts publishing these NOTAM messages)
6. On receiving these NOTAM messages, it interprets the message and places a line of text representing the topic it was sent upon that has a tooltip for the details. If the line is moused over, it displays the NOTAM's details.

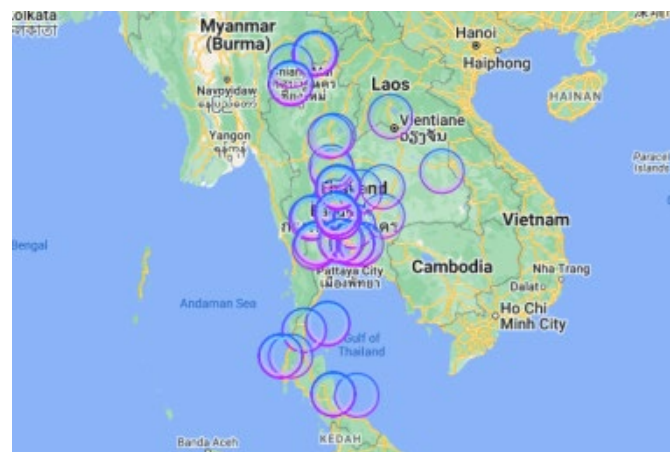
### 3.2.2 Consume from a NOTAM information service and display on a map

This example is for illustration only and to show the same sample using a map.

1. Go to the [NOTAM List web page](#)

**Figure 7** – Prompting for the ANSP

2. Enter an ANSP code from the list and hit the 'OK' button.
3. You will see something like the next page



**Figure 8** – ANSP NOTAMs

4. Click on one of the circles to display the NOTAM's details as below.

Field	Value
APAC_CATEGORY	AIXM
APAC_CATEGORY_VERSION	AIXM_S_1
APAC_SOURCE	KZ_FAA
APAC_SYSTEM	SWIM_Tool
APAC_MESSAGE_TYPE	NOTAM
APAC_TIMESTAMP	1724873724993 SWIM_Tool_OUT
ID	NOTAM_1_73470644
FIR	VTBB
ICAO Location	VTBB
Airport	BANGKOK ACC-FIC-COM CENTRE
Type	N
QCode	QAMCA
Radius	999
ConEncoding	text
ConType	xml/application
DateSent	2024-08-28T19:35:24.993+0000
OrigTopic	SWIMAPAC/1/US/NL/ITP/NL/2/NL/NL/ATM/APAC/AER/AXM/AXM_S_1/N ACC-FIC-COM CENTRE
Msgid	ID 08f0a605-7090-4651-a054-1646ca3e9662 1:1:1-124
Source	KZ_FAA
SubSource	SWIM_Tool
Version	1.0.0

CDR Y5 (RNLV 2) AVBL FOR FLIGHT PLANNING AS FLWY PERIOD : MEA LOWER/UPPER LIMITS 0000-2359  
FL130/FL460

**Figure 9** – ANSP NOTAM details

This ISC web page does the following internally in JavaScript:

1. Prompts for the ANSP code (which you enter and click 'OK')
2. Looks up FIRs for this ANSP
3. Subscribes to the topics representing these FIRs
4. Sends a request for NOTAMs matching these FIRs from the information service
5. Waits for messages... (the information service starts publishing these NOTAM messages)
6. On receiving these NOTAM messages, it interprets the message and places a line of text representing the topic it was sent upon that has a tooltip for the details. If the line is moused over, it displays the NOTAM's details.

### 3.3 Sample Service Overview: Local\_NotamPub

This is the service overview for the Local\_NotamPub information service.

### 3.3.1 Service Overview

Field Name	Detailed Content
Information Service Name	Local_NotamPub
Information Service Version	1.0.0
Provider Organisation	Org x
Provider Point of Contact	support@swimtool.org
Brief Description	Publishes NOTAMs given a list of FIRs
Lifecycle Information	PROSPECTIVE 10102024
Geographical Extent of Information	Global
Quality of the Service	AVAILABILITY: 99.95% outside planned outages
Access Restrictions	For ANSP testing purposes only
Message Exchange Pattern	PUBLISH/SUBSCRIBE
Information Exchange Model	AIXM 5.1
Information Service Validation Type	SELF VALIDATION. Org x tested non-production use
Additional Service Information	See <a href="http://swimtool.org/home.html">swimtool.org/home.html</a>
Information Service Functions	Get NOTAMs
Filtering Available	Topic Model filtering
Source of Information	North American SWIM Implementation
Support Availability	For service incidents, contact Org x

### 3.3.2 Service Interface

The Service Interface provides the information necessary to evaluate integrating and invoking an information service. This is the information needed for an ISP to provide the service at runtime and the ISC to consume the service at runtime in the TI.

This is an abbreviated example of a service interface specific to the SWIM Tool. The SWIM Tool includes this demonstration service interface for each information service overview available. This includes the service binding for an information service, depending on the information exchange pattern (publish-subscribe or request-reply).

Service interfaces details are provided in Service Descriptions when available.

Field Name	Detailed Content
Topic Model	SWIMAPAC
Topic Model Version	1-0-0
SWIM TI	SWIM Tool
Subscribe Location	<a href="amqps://swimtool.org:61617">amqps://swimtool.org:61617</a>

This information service uses TLS to encrypt the information exchange.

### 3.4 What SWIM Provisions are implemented in the SWIM Tool?

See Section 5.2 for the mapping of PANS-IM Provisions in the SWIM Tool.

What else is needed to build out SWIM?  
Organisational processes, such as the first two items below, are most important.

**Note: \*Indicates implemented by the SWIM Tool in this and following sections:**

1. Quality Management System (QMS) for data, information and information services - An existing QMS should be reviewed and adjusted as needed
2. Information Collection as per information domains require
3. \*Use EMS encrypted protocols to communicate
4. \*Use open standard information models
5. \*Provide a way to discover services

### 3.5 How do I collaborate with SWIM Stakeholders using Information Services?

For users interested in collaborating with other SWIM stakeholders using Information Services, options are available. These include:

- SWIM Tool – This self-contained tool includes a Minimal SWIM Implementation. Service overviews point to compatible SWIM TI's using existing or modified sample ISCs and ISPs to test.
- SWIM Sandboxes of various types which contain the heart of the SWIM TI, the EMS.
- The FAA's [SWIFT Portal](#) (Also known as the SWIM Cloud Distribution Service (SCDS) [Jumpstart Kit](#)





## 4. SWIM Benefits and Use Cases

### 4.1 Benefits

SWIM concerns itself with the exchange of information across ATM information domains, organisations and organisational silos to accelerate improvements in safety, efficiencies and operational benefits using information services. SWIM is the key to quickly liberating valuable information to enable broad and real-time business value and agility.

The benefits have been described in detail in the ICAO documents (E.g., the Global Air Navigation Plan (GANP) and the Manual on System Wide Information Management (ICAO Doc 10039)) and proven in capital markets for decades. Below are some fundamental use cases that reflect the infrastructural and transverse nature of SWIM.

### 4.2 Use Cases

#### 4.2.1 ATM

##### Collaborative

- **ATM Modernisation:** Air Traffic Flow Management (ATFM), Airport Collaborative Decision Making (A-CDM), CDM, Digital NOTAMs, Aeronautical Information Publications (AIPs), Flight and Flow – Information for a Collaborative Environment (FF-ICE).
- **TBO (Trajectory Based Operations):** SWIM is an enabler for TBO as the information exchange backbone for FF-ICE, ATFM and A-CDM.
- **Multi-Nodal:** ANSPs communicating with each other in a federated configuration.
- **Centralised:** A single SWIM provider for a set of ANSPs.

##### Revenue Generating

- There are numerous benefits to making ANSP information accessible to external stakeholders, including industry partners. Doing so can drive innovation and enable the development of solutions that ultimately support and enhance the operations of the ANSPs. Information may be shared freely or through paid models, depending on strategic objectives. Value can be added through enhanced data quality, enrichment, or by offering premium distribution services, such as guaranteed delivery with SLAs.

#### 4.2.2 xTM

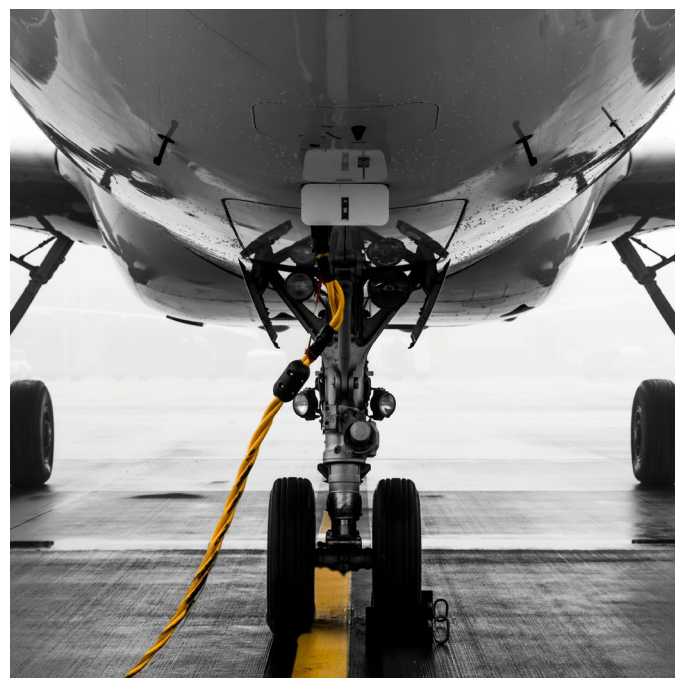
##### ATM Unmanned Aircraft Systems (UAS) Traffic Management (UTM) integration

- **Flight Information Management System (FIMS):** A FIMS bridges the ATM and UTM worlds through information services.

#### 4.2.3 Technical

##### Information Distribution

- An ISP or set of ISPs distribute information for the benefit of the State or global community. Most of the event-based information is distributed using the publish-subscribe message exchange pattern. This information can be voluminous and includes updates, such as flight positions, flight plans, NOTAMs, weather, and many other types of information. Compression is commonly used to improve performance and reduce bandwidth costs for all participants.
- Onboarding Information Services, ISPs and ISCs can be very simple. This is one place where SWIM has proven to provide significant cost savings over traditional integrations.
- Open data initiatives benefit the entire community and State and/or regional economies while reducing the overhead of provisioning.

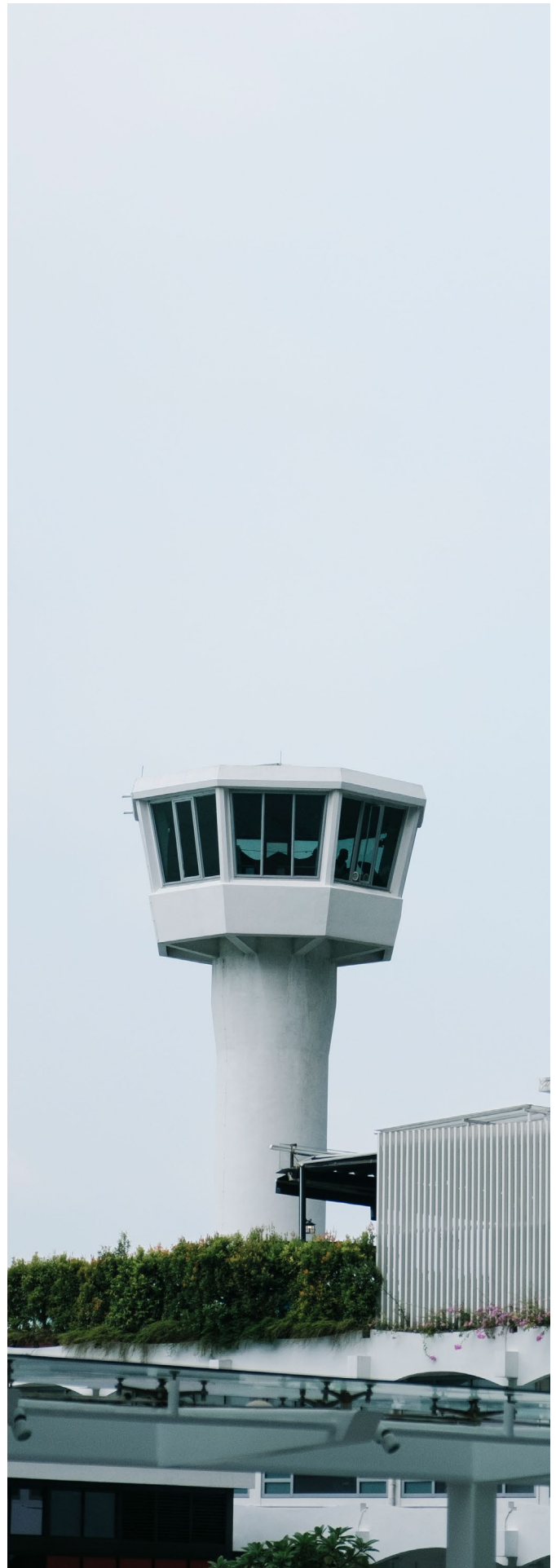


## Minimal SWIM Implementation

- Publish and consume information using Information Services with SWIM protocols (widely used, open standard APIs and protocols)
  - Deploy a SWIM TI on an Internet Protocol (IP) Network (The SWIM Tool is one such SWIM TI)
  - ISPs publish Information as a message with a message label for an Information Service using a SWIM protocol over an IP Network
  - ISCs consume Information from an Information Service (typically from a queue associated with an Information label) using SWIM APIs/protocols over an IP Network.
- Request and reply to requests using Information Services with SWIM APIs and protocols. Note that more resilient systems use publish and subscribe where possible to increase decoupling.
  - Deploy a SWIM TI on an IP Network (The SWIM Tool is such a SWIM TI)
  - ISCs send a request to a label from an Information Service using a SWIM protocol over an IP Network
  - ISPs consume, process and reply to requests with a label for an Information Service (typically from a queue associated with an Information label) using SWIM APIs/protocols over an IP Network.

## Federated SWIM

- This requires, at a minimum, a SWIM EMS deployed on-premises and optionally the cloud in multiple locations so that ISCs and ISPs can access information services. This creates a single SWIM information sharing backbone such as the [FAA describes](#).

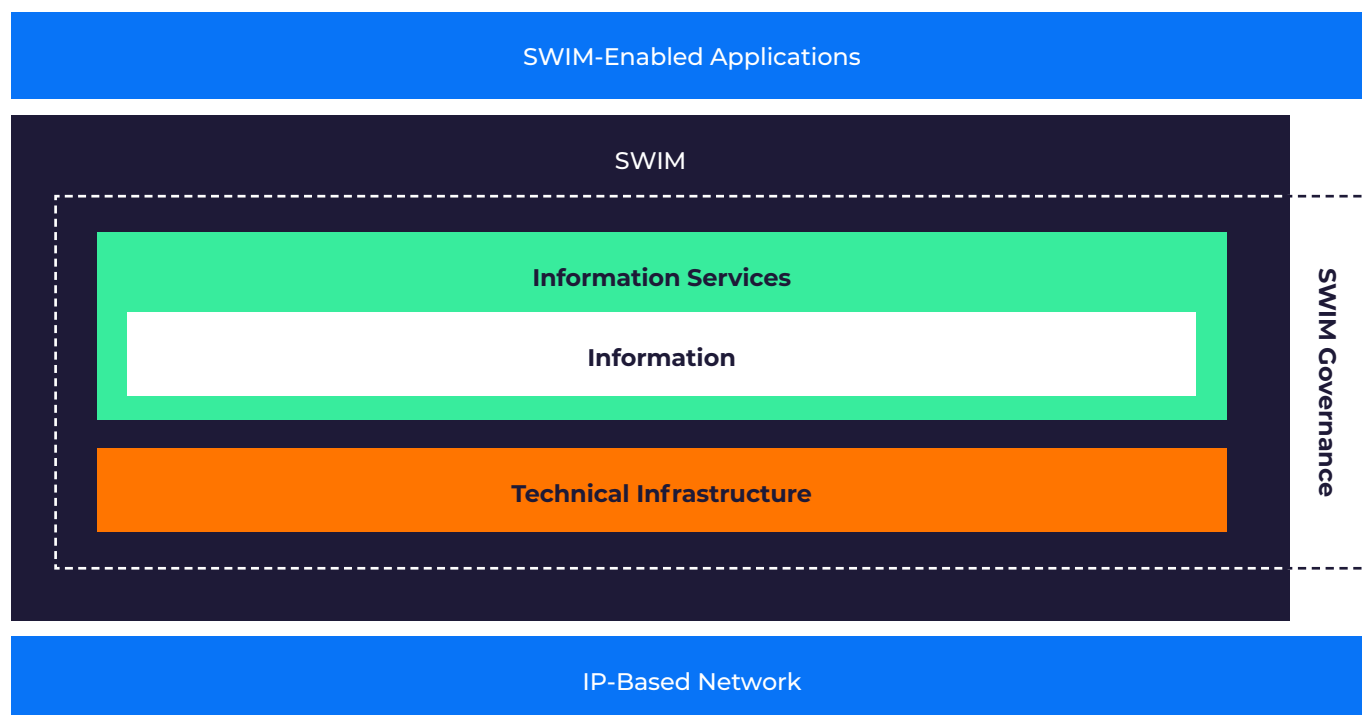


# 5. SWIM Concept and Requirements

## 5.1 SWIM Concept and Principles

SWIM requirements are gleaned from referenced documents. These cover primarily Ground-Ground SWIM and Air-Ground SWIM.

The SWIM Concept identifies four components: information, information services, technical infrastructure, and SWIM governance. Figure 10 depicts these components.



**Figure 10** – The SWIM concept

Global interoperability is aided by the six principles of information services stated in ICAO Doc. 10203 (Manual on SWIM Implementation). These drive the spirit of SWIM and PANS-IM provisions. The Global Interoperability Framework (GIF - see SWIM Concept in References) identifies different layers that relate SWIM-enabled applications, information services, information exchange models, technical infrastructure, and network connectivity. Interoperability is also dependent on standardisation and architecture. Open standards help create reusable building blocks while architecture provides the framework to identify and reuse these building blocks.

Metadata provides essential context about information resources and is foundational to effective information management, SWIM implementation, and system interoperability. When metadata is well-defined, it enables more efficient, high-performing, and agile interoperability across systems. Essential components where metadata play an important role include service overviews and SWIM Core Messaging.

Network connectivity is not considered within the SWIM scope, but information security requirements from the ICAO Trust Framework have application to SWIM and may extend to it. Information security is of urgent and increasing importance.

## 5.2 Requirements

The following PANS-IM standards and recommended practices are abbreviated for easier consumption. Please refer to the PANS-IM for the details around these requirements and advisements.

**Note:** \* Indicates requirements implemented by the SWIM Tool.

### 5.2.1 PANS-IM – Standards (condensed)

Area (PANS-IM Sections, ...)	#	Standards
Quality (2.1, 2.2, 2.3, 2.4)	1	A QMS shall cover information collection and processing, information exchange, information, and information services. This includes meeting relevant information domain requirements, including for the design, development, implementation, and operation of an information service (see ISO 9000).
Global Interoperability – The 6 principles of information services (2.3.2)	2	*Use interoperable information services.
	3	*Separation of info provision and info consumption.
	4	*Loose coupling.
	5	*Discoverability of services via Web page at a minimum.
	6	*Use of open standards: APIs, protocols, security.
	7	*Secure information exchange (typically TLS 1.2+, but be aware of the ICAO Trust Framework as it develops).
Information Service Overviews (4.2, Table A Appendix 1)	8	*Service overviews as specified are required for each information service version and they must be made available to information service consumers.
Technical Infrastructure (5.2)	9	*The technical infrastructure shall use an IP-Based Network.
	10	*Interface bindings shall be based on standardised and widely used and supported protocols, which applies to both Service and network bindings.
Governance (6.3)	11	*Governance shall be addressed as an integral part of any SWIM implementation.
	12	SWIM governance activities shall be established at the national level and/or within a SWIM region.



## 5.2.2 PANS-IM – Recommended Practices (condensed)

Area (PANS-IM Sections, ...)	#	Recommendation
Information Services Publication (4.2, 4.3)	1	*An information service registry should be used and follow the recommendations.
	2	*Information service consumers should assess the fitness for purpose of an information service.
	3	If Information service overviews are present in a web page, this web page shall be published in an AIP.
	4	*The information service quality of service shall be validated and recorded. *Note – the SWIM Tool may be a vehicle to achieve this.
	5	*Access control shall be provided for information service overviews.
	6	*Information service overviews and their fields shall be searchable.
	7	*Notification should be made of information service overview and field changes. *SWIM Registries should be made publicly available.
Information Exchange (2.3.1)	8	*A minimum of information should be made available through information services.
Information Service Payload (3.1, 3.2, 3.3, 3.4)	9	*The encoding of the data exchanged in an information service payload should be based on a standardised exchange language such as <a href="#">AIRM</a> , <a href="#">AIXM</a> , <a href="#">FIXM</a> , <a href="#">IWXXM</a> , <a href="#">ASTERIX (semantics.aero)</a> .
	10	*Information metadata should describe the information service payload and the information service that delivers it.
	11	*Information metadata should be collected and based on the requirements of a particular information domain.
Information Exchange (Rationales)	12	*Information Exchange through Information Services.
Governance (6.4)	13	SWIM governance bodies and processes should be established at the corresponding applicable level.
	14	Identify and document the applicable standards for System Wide Information Management and additional standardisation needs.
	15	Develop and maintain policies and guidance in support of System Wide Information Management implementation.
	16	Document the roles and responsibilities of the various System Wide Information Management stakeholders acting as originator, service provider, service consumer and regulator.
	17	Address roles, responsibilities liabilities and accountabilities.

### 5.2.3 PANS-IM – Derived Standards

Area Requirement: # Advisement: #	#	Derived Standard
Information Services Publication Requirement: 2 Advisement: 4	1	*Information service message metadata standards shall be harmonised to make information services interoperable.
Transition to SWIM	2	*ISPs and ISCs will need to modify existing applications and services to support SWIM information services. ISPs and ISCs may decide to introduce a new application or service with its own framework, but it is not necessary.
	3	Encapsulate or gateway to the Aeronautical Fixed Telecommunications Network (AFTN) or ATM Message Handling System (AMHS).

Other global standards come from the ICAO PANS-IM, Annexes and other documents listed in the References section 13.5.

### 5.2.4 Approaches by Region

1. **APAC:** [ICAO APAC SWIM Task Force](#)
2. **Americas:** [FAA SWIM](#), [FAA SWIFT](#), [RTCA](#)
3. **Europe:** [EU 116/2021 Regulation \(CPI\)](#), [EUROCONTROL SWIM](#), [EUROCONTROL Yellow Profile](#), [EUROCAE](#), [GDPR](#)
4. **Africa:** [Mombasa ATFM Roadmap](#)

### 5.2.5 State Requirements

States and regions have their own regulatory requirements and provisions to support. This includes sovereignty protection, national, military, and regional requirements. Check with your State and Civil Aviation Authorities (CAA) for such requirements.

### 5.2.6 Domain Requirements

SWIM is implemented across specific information domains, most commonly: Aeronautical, Flight, and Weather. Each domain should leverage standardised information exchange models such as:

- **AIXM** (Aeronautical Information Exchange Model)
- **FIXM** (Flight Information Exchange Model)
- **IWXXM** (ICAO Meteorological Information Exchange Model)
- **AIRM** (ATM Information Reference Model)

These XML-based models (collectively referred to as the “XMs”) provide globally recognised schemas and semantics to ensure data consistency and compliance with ICAO standards, regardless of implementation method (e.g., file-based or service-based exchange).

# 6. SWIM Architecture

## 6.1 Logical Architecture

At a minimum, a SWIM implementation consists of the following components:

### 1. IP Network

A prerequisite that supports connectivity for all other components.

### 2. SWIM Technical Infrastructure (SWIM TI)

- Messaging capabilities (e.g., an Enterprise Messaging Service or EMS) to enable information exchange. Where applicable, these may align with implementation requirements architectures such as the EUROCONTROL Yellow Profile for ground-ground messaging, or the FAA SWIM model in the U.S. However, these are regional implementations, and new ANSPs are encouraged to consider multiple design-agnostic approaches when planning their SWIM infrastructure.
- Security capabilities, including identity management and encryption.
- Monitoring and management tools.
- Integration capabilities, including interoperability with legacy systems (AFTN, AMHS), cloud environments, and modern API-based services.

### 3. Information Service Provider (ISP)

Entities or systems that provide ATM-related information via SWIM services:

- Responds to requests.
- Publishes information.
- Makes information available via agreed interfaces.

### 4. Information Services

SWIM services that provide access to ATM-related information in a standardised, service-oriented manner.

- Examples include NOTAM distribution, FF-ICE flight plan filing, or MET data sharing.

### 5. Information Service Consumer (ISC)

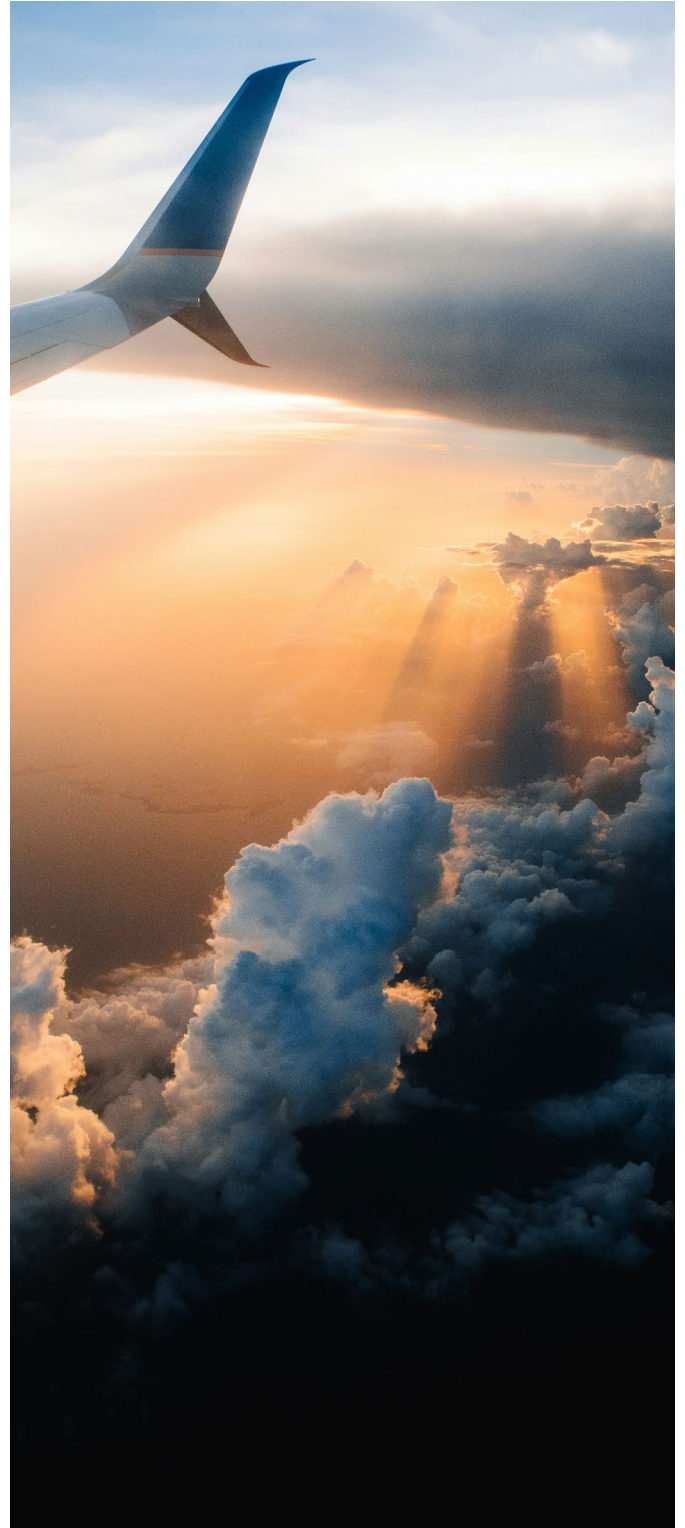
Applications or systems that consume information from ISPs using SWIM services:

- Subscribes to or requests information.
- Receives responses or published data.

## 6. Information Service Overview

Metadata that describes available SWIM services to support discovery and evaluation.

- These overviews should be accessible via URL (e.g., on a public web page), with the location published in an Aeronautical Information Publication (AIP).



## 1 SWIM Registry

- a. A SWIM registry is required to be addressable by a URL that is published in an AIP. It provides a directory of service overviews containing the metadata necessary to discover information services. When implemented as an application, it must meet the minimum feature set defined in PANS-IM.
- b. While not strictly required in the early stages of SWIM implementation, especially for organisations offering only a small number of services, a registry becomes increasingly valuable as the number and complexity of services grow. It is particularly beneficial at the regional level or for larger ANSPs (e.g., FAA, NAV CANADA) that manage extensive service portfolios.
- c. Although some early efforts to implement registries were seen as premature or costly, it is still considered best practice to introduce a lightweight or prototype registry early in the process. This allows organisations to test interoperability, establish publication and discovery workflows, and reduce the risk of costly rework as more services come online.
- d. When a SWIM registry is used, its URL shall be publicised in the Aeronautical Information Publication (AIP).



Figure 11 – SWIM architecture

## 6.1.1 Information Exchange

Information exchange in SWIM uses information services to share information via SWIM Core Messaging across silos and domains. Other industries such as capital markets have been using their own version of SWIM for many years with different information exchange models and use cases. Information sharing in capital markets has many parallels to modern ATM, often using the same standards, technologies, and products. For example:

- Flight tracking and market data have similar **temporal lifetimes**.
- Flight flow and deal flow (trades) have similar **State management**.
- Flight plans mirror stock exchange trading spikes creating **bandwidth spikes**.
- NOTAM and Weather feeds mirror News feeds, containing events that can have **significant impacts**.
- Common Information Exchange Requirements: High resilience & federation (local, regional, global).

## 6.1.2 Examples

Examples of SWIM and its mirror in finance illustrate similarities and see the opportunity to learn from them.

### 6.1.2.1 SWIM

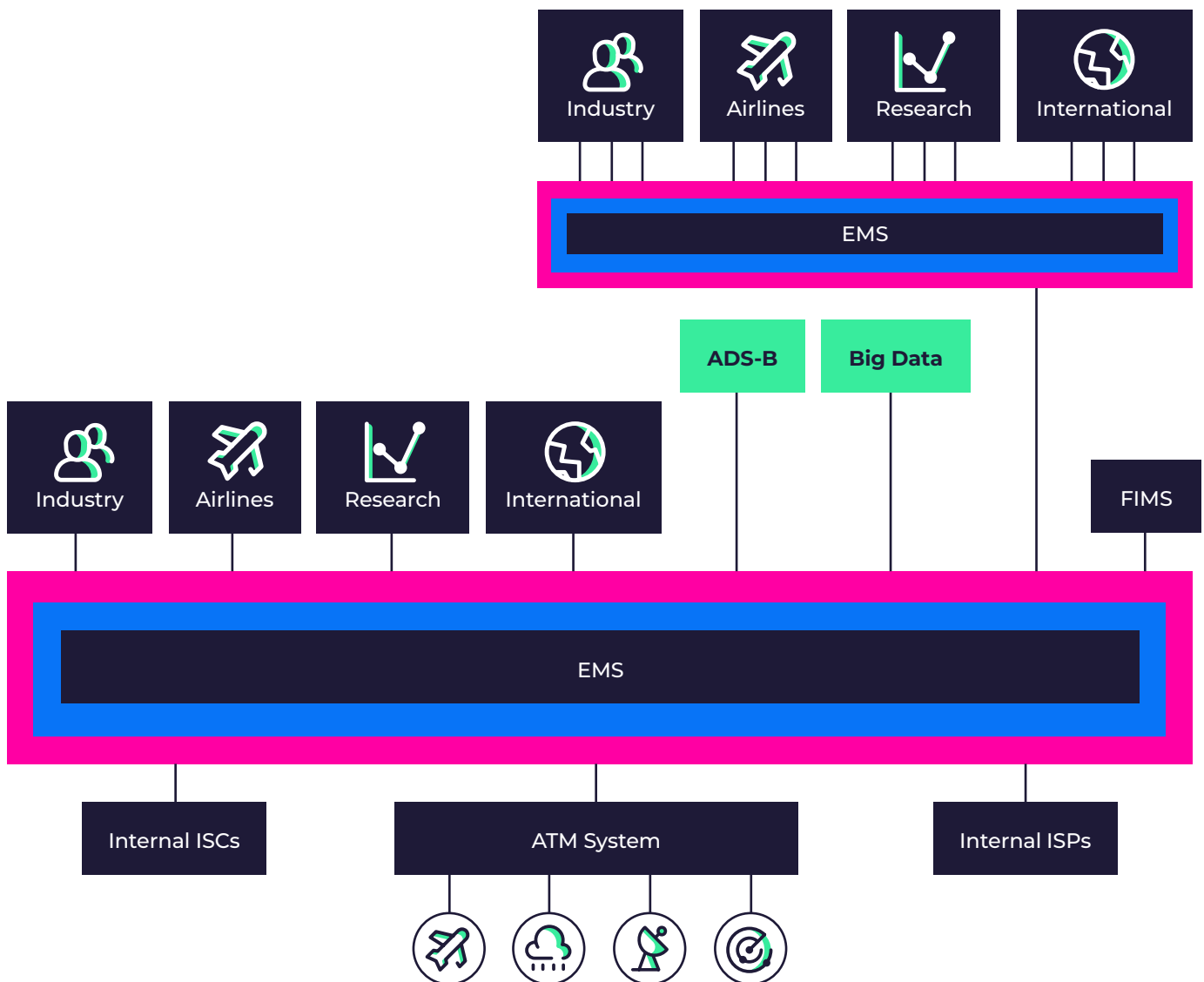


Figure 12 – SOA - ANSP SWIM

Figure 12 shows an on-premise SWIM EMS in the bottom, larger rectangle. Many ANSPs start with this while they develop and iterate over SWIM use cases. This is used for the exchange of sensitive and non-sensitive SWIM information across authorised participants. The applications and information services connected to the on-premise SWIM EMS can vary. Some commonly included SWIM stakeholders are shown.

The top right yellow cloud also contains a SWIM EMS. This SWIM EMS is running in a cloud which can be either private or public. This SWIM EMS is typically used for non-sensitive SWIM information exchange with external or test users. However, this can also be used as an extension of the on-premise EMS for the same SWIM community.

Both SWIM EMS locations can be run independently, but here they are connected. The on-premise SWIM EMS and the cloud SWIM EMS here work in concert with each other in what is commonly known as a hybrid architecture. This allows the on-premise SWIM EMS and the cloud SWIM EMS to provide SWIM EMS capabilities in each location and share information between each other as required and authorised. The participants and their entitlements in each location can be different. As mentioned, the cloud SWIM EMS is often used for less sensitive use cases and can be configured for a different type of participant.

6.1.2.2 Foreign Exchange

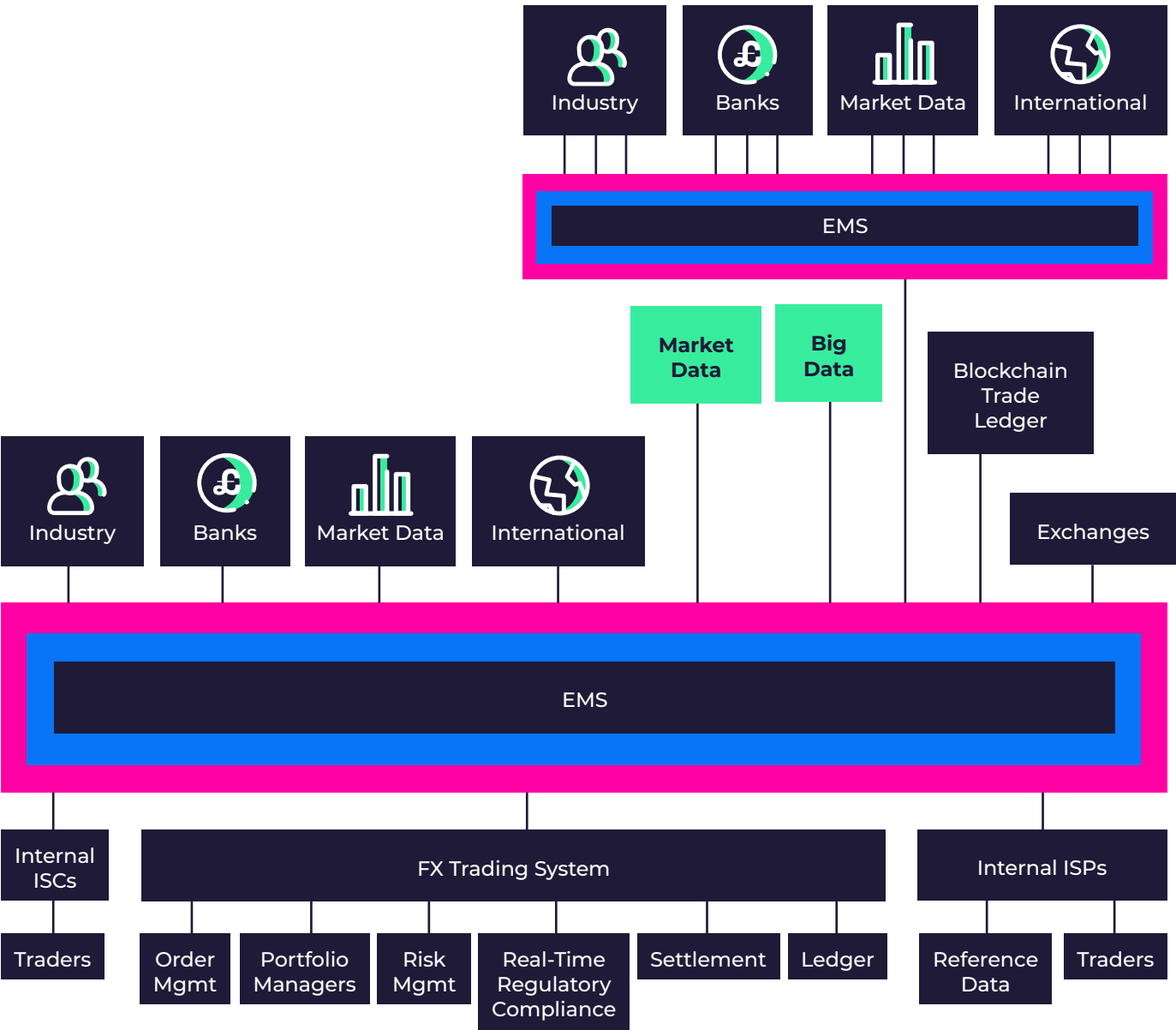


Figure 13 – SOA - Foreign Exchange Trading

Note the similarities of Figure 12 and 13. This figure, just like the one above, shows an on-premise SWIM EMS in the bottom, larger rectangle. Many financial institutions start with this as well. This is used for the exchange of sensitive and non-sensitive information across authorised participants. The applications and information services connected to the on-premise EMS can vary. Some commonly included stakeholders are shown.

The top right yellow cloud also contains an EMS. This EMS is running in a cloud which can be either private or public. This EMS is typically used for non-sensitive information exchange with external, test users, analytics, AI/ML or other systems. However, this can also be used as an extension of the on-premise EMS for the same community.

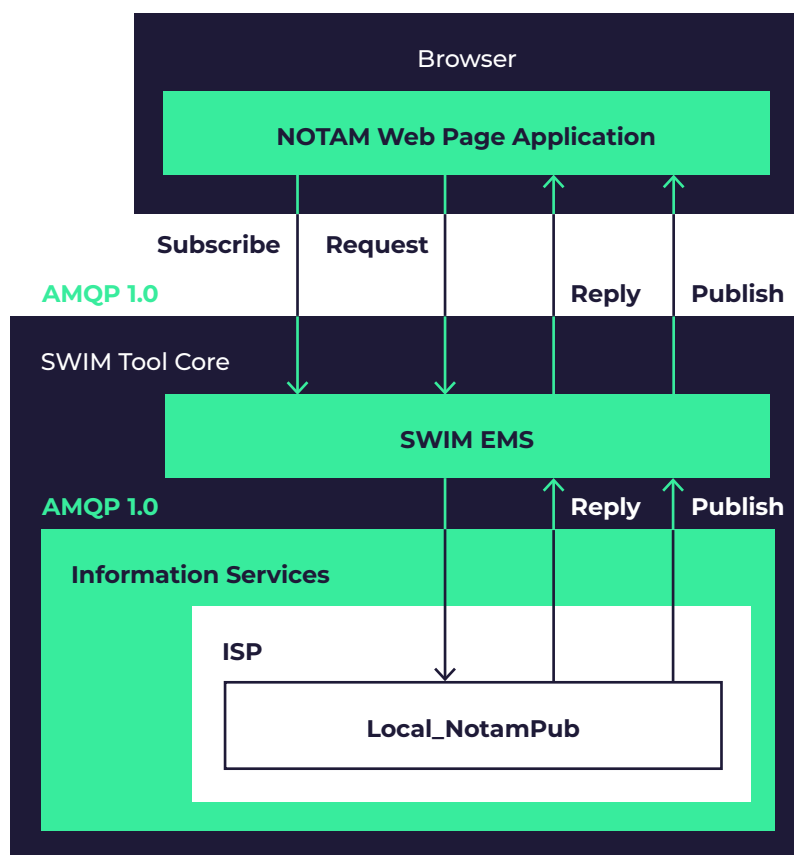
Both EMS locations can be run independently, but here they are connected. The on-premise EMS and the cloud EMS here work together in a hybrid architecture. This allows the on-premise EMS and the cloud EMS to provide EMS capabilities in each location and share information between each other as required and authorised. The participants and their entitlements in each location can be different. As mentioned, the cloud EMS is often used for less sensitive use cases and can be configured for a different type of participant.

## 6.2 Physical Architecture – SWIM Tool Example

The SWIM Tool is a starting point for SWIM physical architecture as shown in Figure 14. Note the separate processes in the SWIM Tool, in this case on-premises:

- ISC samples.
- ISP samples that implement Information Services.
- SWIM Tool Core which includes SWIM Core Messaging, Information Services and Core Information Services (registry and files).

Note that the SWIM Tool Cloud is remote and uses a dedicated SWIM Core Messaging instance, which is a best practice. The SWIM Tool can be used with a separate SWIM Core Messaging instance by simply changing the service interface in the corresponding service registry service overview.



**Figure 14** – SWIM tool architecture



# 7. SWIM Technical Infrastructure (SWIM TI)

## 7.1 Technical Infrastructure

### 7.1.1 Interoperability

To ensure interoperability, existing ANSP SWIM implementations and their technical infrastructures and standards will have to be accommodated by other ANSPs. Regional SWIM implementations may also dictate the technical infrastructure used for at least a subset of regional information services. Therefore, the minimum requirements for these SWIM implementations need to be accommodated to become interoperable with them.

A fully operational SWIM TI will require:

- PKI for encryption, OCSP and CRL for certificate governance.
- NTP or PTP to synchronise UTC time across message timestamps and logs across systems.

### 7.1.2 Network

An IP network is required. Support of IPv4 and IPv6 is needed. IPv6 is fast becoming a requirement for modern IT systems and is a requirement of the EUROCONTROL Yellow Profile and the ICAO Trust Framework Study Group.

### 7.1.3 Deployment Approach

There are many different deployment approaches that organisations around the world have used. ANSPs often start with one location. This usually includes an EMS that contains one Message Broker with high availability. Later, they expand to add multiple locations and the cloud for non-sensitive information services that external ISCs consume.

#### 7.1.3.1 State

##### 1. SWIM TI

- Initially for the EMS, a high availability (HA) single message broker instance is deployed at the primary site to provide internal information exchange using SWIM protocols.
- ANSPs with many Area Control Center (ACC) may consider deploying a SWIM TI in the primary ACCs or all ACCs.

- Later, another HA message broker may be added to the EMS at a new location to provide efficient information distribution to a large number of external ISCs. The cloud is often this new location.
- If business continuity is critical, a disaster recovery location is used to provide this EMS redundancy with another HA message broker at a secondary site.

#### 7.1.3.2 Regional

Centralised or distributed deployments have been used.

For example, Europe has used a centralised approach with EUROCONTROL while Asia has been testing distributed deployments. However, SWIM regions will need to interoperate as well, so global SWIM is a distributed deployment when taken as a whole.

#### 7.1.3.3 Global

As mentioned above, global SWIM must accommodate individual ANSPs and SWIM Regions. The interoperability of global SWIM is the subject of work being done in the ICAO IMP. Information service message metadata is a topic of research in this regard.

### 7.1.4 SWIM EMS (SWIM Core Messaging)

#### 7.1.4.1 Message Exchange Patterns (MEPs) required

##### 1. Request-Reply

- This is used to retrieve information at a moment in time. This is most appropriate for information that does not change frequently.
- Often REST or Web Services are used for this MEP but publish-subscribe can also be used.

##### 2. Publish-Subscribe

- This is used to provide information updates for information that changes frequently. It is also used to provide notification of events or alerts that are critical to process immediately.
- AMQP 1.0 is usually used for this MEP. MQTT is also a similar widely used open standard for such exchanges.

### 7.1.4.2 APIs/Protocols

No specific APIs or protocols are required, but widely used open standards are required. The following APIs and protocols are widely used across the world in SWIM implementations. ANSPs are advised to use the following APIs or protocols to support SWIM interoperability, simplify support and operation. APIs and protocols must support message properties to participate fully, therefore MQTT 3.x is not included in the table below.

API/Protocol	Description
HTTP	An open standard wireline protocol with message properties (1.1 minimum)
REST	Utilises HTTP but without standardised use thereof
AMQP 1.0	An open standard wireline protocol with message properties for enterprise messaging
JMS	A standard Java-specific interface with message properties, though other languages have also adopted the same. Can be used over AMQP 1.0 or native wireline protocols
MQTT 5.0	An open standard wireline protocol with message properties, closer to AMQP 1.0

### 7.1.4.3 Message Metadata

Metadata greatly increases the security, performance and reliability of information when in motion. There are two types of metadata used for information in motion. They are:

- 1. Information Topics** – Implemented as Message Topics. These Information Labels are used by ISPs and ISCs to send or receive messages.
- 2. Information Properties** – These are implemented as Message Properties that make up a Message Header. To use this type of metadata, the protocols/APIs used by the system must support Message Properties. For example, MQTT 3.1 does not support Message Properties, but REST, JMS, AMQP 1.0 and MQTT 5.0 do.

### 7.1.5 SWIM Security

A system's resilience is the key to its security because if a system is not resilient it cannot secure itself. There are multiple components to consider when securing a system. Those are service security and information security.

#### 7.1.5.1 Service Security

- 1. Authentication** – This ensures a user is permitted to access the information service.
- 2. Authorisation** – These entitlements provide granular control over what a user is allowed to do with an information service. For example, subscribing to a specific topic that an information service publishes to, publishing to a specific topic on behalf of an information service. Even more basic entitlements prevent abuse of information services at the EMS level such as consuming from a queue, creating a queue, sending messages, or receiving messages.
- 3. Non-repudiation** – This ensures the integrity of information provided and its provider. Digital signatures and encryption are often used for this.

### 7.1.5.2 Information Security

Information security here refers to the SWIM-related and industry standards for ensuring information is protected from loss, exposure or tampering. Below are applicable security efforts and standards.

1. [ICAO Aviation Cybersecurity](#)
2. **Cyber Security Programs:** [ISO 27001](#)
3. **Information Sharing:** Routing, Filtering, Authorisation, High Availability, Replication
4. **Encryption:** TLS 1.2, 1.3
5. **Payload Signing:** Requires message properties in APIs and protocols

### 7.1.6 Integration

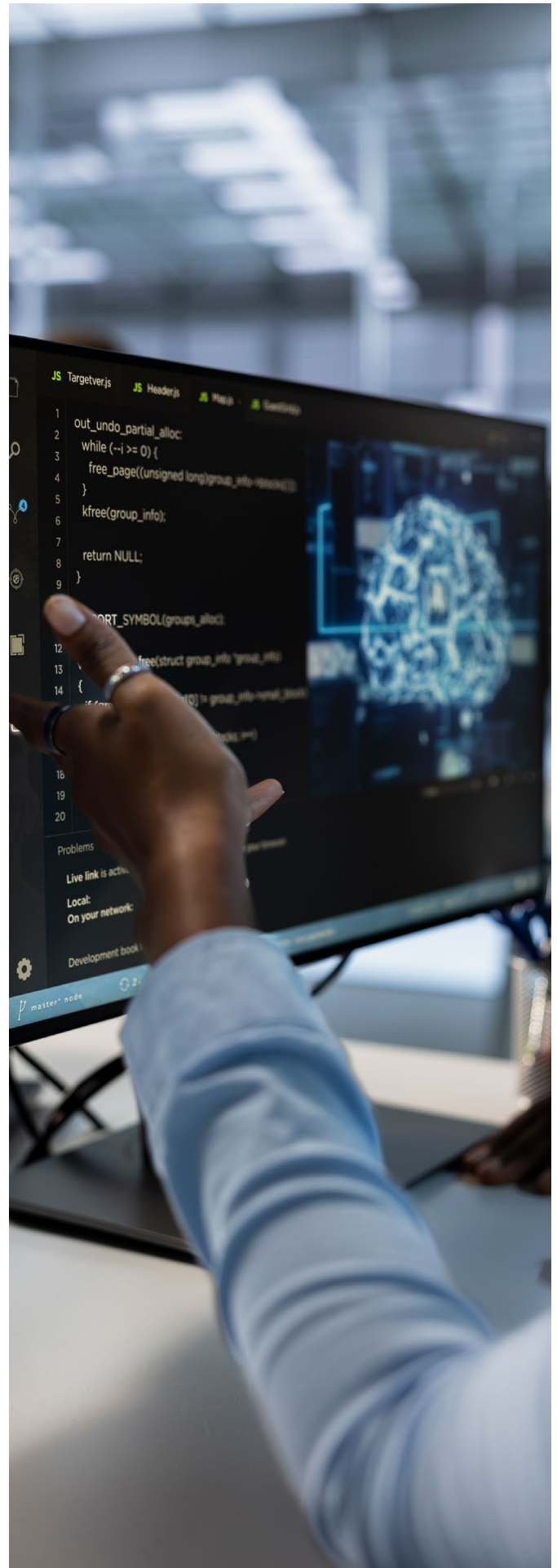
Integration is the act of making two different systems communicate. SWIM interoperability provides a seamless integration, but there are numerous systems that will take time to adapt to SWIM. This means that integration may be required in the interim.

#### 1. ATM Applications

- It is common for ANSPs to retrofit existing ATM applications, so they can invoke information services and publish and/or consume SWIM information.
- Creating a new service platform to host services or microservices may be desirable. However, it can be a large undertaking if the ANSP is not familiar with the underlying technologies required or commonly used. Such technologies include Docker, and Kubernetes among others.

#### 2. AFTN and AMHS

- AFTN and/or AMHS integration should be left to later iterations of minimal SWIM implementations due to the additional components, complexity and time involved. Ideally it is a parallel effort.



## 8. SWIM Information

In the context of this section, information is data combined with the metadata that describes it.

### 8.1 Information Access

Having access to information is the first step towards participating in SWIM. ATM applications provide access to this information. The information available in the ATM application needs to be onboarded and placed into a SWIM technical infrastructure so it can be returned to the original domain and made available to the other information domains in order to achieve the identified benefits. This is done by associating contextual metadata to the data. This enables the SWIM EMS to make this information available for sharing. This can be done by either modifying existing ATM applications or creating new applications or services.

Information Sharing Agreements are a necessary step in turning on information exchange. Existing information sharing agreements apply to SWIM as they would to any information sharing technology.

Information and metadata play an important role in the service model. Information exists in information exchange model form at rest and in motion, though information in motion may take different forms.

### 8.2 Information Exchange Models

Information exchange models based on the Aeronautical Information Reference Model or AIRM are expected, but not required, to be used for SWIM information exchange in their respective domains. The information exchange models commonly referenced in SWIM are [AIXM](#), [FIXM](#), [IWXXM](#) and ASTERIX. These exchange models are based on AIRM, but there are many others.

The standard SWIM information exchange models referenced above should be used, when possible, but do not allow them to be an obstacle to implementing SWIM. There will always be some information exchanged over SWIM that does not conform to the standard models. Service-oriented architecture is meant to break down large services into smaller ones that are independently developed and managed and to reduce dependencies to increase operational reliability and agility.





# 9. SWIM Information Services

## 9.1 Service Message Exchange Patterns

The following service types are implemented using a SWIM EMS.

### 9.2 Publish-Subscribe

Publish-subscribe information services provide unsolicited information to subscribers. This information may be critical, and it therefore must not be lost otherwise operational safety, or another critical capability may be impacted. Publish-subscribe services may be used to share time sensitive information and/or information that requires delivery in real-time.

Consider an ISC subscribing to a NOTAM update information service. NOTAM update messages are likely already being published. When the ISC subscribes to NOTAM updates, it will start receiving NOTAM update messages, until it unsubscribes to them. Other ISCs are likely already consuming these.

Many ANSP SWIM implementations use AMQP 1.0 to implement this message exchange pattern, though other widely used open standard messaging protocols can be used.

These types of messages are often set to expire after an interval of time due to their temporal nature and to preserve resources.

### 9.3 Request-Reply

Request-reply services provide a way to obtain information based on input parameters on demand.

Consider a web page request as an example. This is a synchronous type of request in which the ISC waits for the response. This message exchange pattern uses more resources than the publish-subscribe pattern above. It also retrieves a response valid for a moment in time. The information may change immediately after the reply, but the ISC will not be informed of this unless they either request it again or they subscribe to updates to this information.

Many ANSP SWIM implementations use HTTP to implement this message exchange pattern, though other widely used open standard messaging protocols can be used.

## 9.4 Information Services

### 9.4.1 Aeronautical Information Services

NOTAMs – The SWIM Tool provides a NOTAM search information service.

- Local\_Notam – Consume NOTAMs from a local SWIM Tool instance

### 9.4.2 Flight Information Services

Flight Tracking – Surveillance systems distribute flight tracking information using ground or satellite-based position updates.

- Local\_FlightTracking – Consume flight tracking events from a local SWIM Tool instance
- FF-ICE/R1 – may be provided in the future

### 9.4.3 Weather Information Services

Several existing reference materials and resources can support the development and implementation of weather information services within SWIM. These include:

- **ICAO Doc 10003 – Manual on IWXXM**, which provides guidance on the use of the ICAO Meteorological Information Exchange Model (IWXXM).
- **ICAO EUR Doc 033 – IWXXM Exchange Guidance**, offering regionally focused recommendations for the exchange of meteorological information using IWXXM.
- The **World Meteorological Organization (WMO) IWXXM portal**, which contains detailed information on IWXXM models and their application: <https://community.wmo.int/en/activity-areas/wis/iwxxm>
- A **dedicated EUROCONTROL SWIM MET Services wiki page**, which outlines MET service definitions that support implementation of the European Common Project 1 (CP1) regulation: <https://swim-eurocontrol.atlassian.net/wiki/spaces/MSS/overview>
- The **European SWIM Registry**, where multiple MET services have already been published and can be referenced as examples of weather information services in a SWIM environment: <https://eur-registry.swim.aero/services>

## 9.4.4 Core Information Services

Information services such as a registry information service are considered core information services because they are part of the SWIM TI or are fundamental building blocks to domain information services.

## 9.5 Information Service Metadata

Metadata is used to describe data that is both static and dynamic, although metadata is used differently in each case. For example, the Service Overview for an information service is a type of static metadata, while the Message Header used in the SWIM Tool is a type of dynamic metadata. The Message Header provides a way to harmonise metadata for information in transit by decoupling it from the service interface and its specific protocol or API. This requires the use of message properties and therefore requires a protocol and/or API supporting such as a best practice.

## 9.6 Service Overviews

The service overviews below provide general descriptive metadata for information services. This metadata is static, meaning it does not change frequently.

Service overview fields required by PANS-IM are described below (see the PANS-IM for more detailed descriptions of these terms):

Field Name	Description
Information Service Name	Title of the service for reference by stakeholders
Information Service Version	Release information for the service in the overview
Provider Organisation	Name of organisation responsible for information service provisioning
Provider Point of Contact	Point of contact for the information service provider organisation
Brief Description	Summary of the service offering
Lifecycle Information	Indication of which service development lifecycle stage service is in
Geographical Extent of Information	Geographic coverage details of information provided by the service
Quality of the Service	Qualitative & quantitative information for service performance characteristics
Access Restrictions	Description of access constraints the service
Message Exchange Pattern	Message Exchange Pattern used by the service
Information Exchange Model	Information exchange models adhered to by the service
Information Service Validation Type	Validation method used to assess a service (e.g., SWIM Tool Core)
Additional Service Information	Location at which more information, potentially including more detailed technical information on a service may be found
Information 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
Source 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)

## 10. SWIM Governance

ANSPs should have a SWIM governance body. The following section discusses State and regional governance.

A SWIM governance body may not be needed during initial SWIM implementation efforts if a sufficient informal governance structure is present, but it will be needed as an ANSP further develops its SWIM system. For example, as the ICAO Asia and Pacific Region SWIM Task Force evolves, each State in that region and the region will need such a SWIM governance body.

Each of the following areas should be regulated by a SWIM governance body:

1. **Policy Making**
2. **SWIM Implementation Roadmap**
3. **Change Management**
4. **Service Model**
5. **Levels of Service:** Some SWIM implementations have two levels of service. One is provided from a private network VPN at its primary site. The other is via the cloud for non-sensitive information services.
6. **Service Level Agreements (SLAs):** [EUROCONTROL SWIM](#) and [FAA SWIM](#)

## 11. SWIM Best Practices

### 11.1 First SWIM projects

The following best practices should be considered before attempting to implement your initial SWIM Project.

1. Drive from use cases, preferably bottom-up.
2. Use tools and SWIM resources to start quickly.
3. Pick a use case where something is marked for replacement due to obsolete components, upgrades, technology refreshes planned, IP network migration, cloud analytics, airlines, and airports information distribution.
4. Get management buy-in to a SWIM implementation project. Migration will be a long-term effort.
5. Very large financial benefits onboarding ISP and especially ISCs.
6. Start with a bottom-up approach if possible.
  - a. Identify a simple SWIM business use case to prove value.
  - b. Start small, iterate - Reduce time, complexity, risk, upfront cost.
7. If Top-Down is required, use above to research to validate the use case.
8. Use resources, tools, products, and services to quickly prove use case.
  - a. SWIM Kit, EUROCONTROL NM Jumpstart Kit, FAA SWIFT (aka SCDS).
  - b. Use free products that use broadly accepted SWIM open standards.
  - c. Run on-premises or cloud and federate later.
9. Safety by Design – Safe, shared information drives managed services.
10. Cybersecurity – Security by Design.
11. Consider the increased bandwidth requirements of XML.
12. Create a service registry once ready.
13. Understand that SWIM is a journey that all ANSPs continue. For example, Information Models change over time.



## 11.2 Information Sharing Best Practices

The following best practices are especially relevant and important to efficiency-critical and safety-critical systems. Keep in mind that an Information Service that may not be critical initially may become used by a critical system later.

1. Simplicity is key.
2. Consider widely used SWIM service bindings: AMQP 1.0, JMS, HTTP, MQTT 5.0.
3. Use Service Bindings that support message properties.
4. Consider SLAs and Information Sharing Agreements.
5. Security by Design: TLS 1.2+, etc.
6. Strive for resiliency with business continuity by selecting SWIM components with High Reliability, High Availability, and Disaster Recovery.
7. Avoid fragile dependencies.
8. Avoid adding new points of failure.
9. Interoperability validation across apps, vendors.
10. Save messages at State boundaries for sovereignty, auditing, and analytics reasons.
11. Don't use a database as core messaging.
12. Look for solutions to provide in-service upgrades.
13. Compress information at the source.
14. Leverage intelligent routing for efficient dynamic message routing.
15. Metadata in Motion.
  - a. Standardise Information Label metadata for seamless and efficient information authorisation, routing, filtering, replication, and processing.
  - b. Standardise Information Header metadata for efficient processing.
16. Carefully choose the messaging type that is fit for purpose.
  - a. For example, at least once versus fire and forget.

## 11.3 Best Practices for Information Payloads

1. Use standard information exchange models when ready, start with existing ones. You do not have to use AIXM, FIXM, IWXXM/WXXM except when exchanging to other SWIM stakeholders. Data elements should align with the AIRM.
2. Information formats are much larger than pre-SWIM.
3. Bandwidth requirements higher.
4. Microbursts from batched flight plans from source systems.
5. NOTAMs are very large messages now.
6. Consider other formats (JSON, protocol buffers) if needed. This is still SWIM if fields conform to AIRM for semantic interoperability.
7. Do not interpret information payloads in core messaging. This requires business logic which violates the separation of concerns. A business logic change requires a release of core messaging in this case.
8. Payload interpretation and synchronous communications (like some Request-Reply information services) should be moved to the edges of the system if possible. The edges are Publish-Subscribe information services, its providers, and its consumers. Modern iPaaS and API Management vendors have realised this in 2021 and 2022. This directly affects information distribution efficiency.

## 11.4 Best Practices for Transitioning to SWIM

Encapsulate existing legacy systems, applications, and services so that they may coexist with SWIM and be converted and transitioned over time without major development. This applies to AFTN and AMHS for example.

One ANSP has developed its own AFTN services for this purpose. Separating out such services allows their functionality to be packaged in different ways. If this functionality resided in a complex gateway, it would be difficult to share or repackage the functionality and stay true to service-oriented architecture principles.

## 11.5 Best Practices for Collaboration

1. Early Collaboration with stakeholders, get buy-in
2. The feasibility of provisioning an information service and realising its value is dependent on collaboration. This takes many forms, but the service overview is one mechanism for this between ISP and ISC.

## 12. SWIM Implementation Checklist

These checklists serve as a very simple way to get a SWIM information service up and running.

### 12.1 Document the Information Service

1. Record the information service overview and any additional information on a website accessible by the Information service consumer.

### 12.2 Run the SWIM TI

2. Run SWIM TI instance (Core SWIM Messaging) supporting the information service network binding and message exchange pattern.
3. Authorise the ISP for the information service on this SWIM TI instance.
4. Authorise the ISC for the information service on this SWIM TI instance.

### 12.3 Run the the Information Service Provider

6. Run the ISP configured for information service and the running SWIM TI instance.
  - a. Authenticate with SWIM TI instance
  - b. Provide information service (this may be listening for a request to respond to or publishing information)

### 12.4 Run the the Information Service Consumer

7. Run information service consumer configured to information service network binding and the running SWIM TI instance.
  - a. Authenticate with SWIM TI instance
  - b. Access information service (this can be simply listening on a queue, topic or a response after sending the corresponding request)
  - c. Consume information service information
  - d. Verify consumption is successful

## 13. Additional Resources

### 13.1 Additional Tools

#### 13.1.1 Solace sdkperf tool

The Solace sdkperf tools ([download](#)) can be used as an ISC or an ISP.

The Solace sdkperf\_jmsamqp can be used as an ISC using JMS over the AMQP 1.0 protocol. The following commands are used for the corresponding Information Service.

##### 13.1.1.1 NOTAM Updates (Subscribe via AMQP 1.0)

- sdkperf\_jmsamqp
- -cip=mb.swimaas.org:5672
- -cu=swimtool@default
- -cp=simple
- -sql=swimtool\_notam
- -sd=10000
- -qb
- -md

##### 13.1.1.2 Flight Tracking Updates (Subscribe via AMQP 1.0)

- sdkperf\_jmsamqp
- -cip=mb.swimaas.org:5672
- -cu=swimtool@default
- -cp=simple
- -sql=swimtool\_tracking
- -sd=10000
- -qb
- -md

#### 13.1.2 SWIM Sandboxes

A SWIM Sandbox provides a playground for experimenting with a SWIM TI. The ICAO APAC SWIM TF [2024 SWIM Working Session](#) used such a SWIM Sandbox.

#### 13.1.3 SWIM Feed Handler

An application that allows a user to consume System Wide Information Management (SWIM) data. Available on [github](#).

### 13.2 What Procurement Guidance is available?

Consider using digitisation and modernisation budgets for SWIM.

## 13.2.1 Cost-Benefit Analysis

Area	Impact
Participant onboarding	<p>When compared to the traditional onboarding processes, benefits include:</p> <ul style="list-style-type: none"><li>• Interface Definition Contracts can be consolidated to use SWIM standards instead of many different ones.</li><li>• One ANSP saves \$100,000 per SWIM participant onboarded with reduced complexity and much faster onboarding. This is a direct result of replacing point to point connections with network-centric ones and using open standard connectivity.</li><li>• <a href="#">FAA SCDS</a> – SWIM decoupling allows non-sensitive SWIM information to be easily routed to, and distributed from, public clouds. This makes the ICD integration process simple and takes minutes instead of weeks or months.</li></ul>
Auditing	<ul style="list-style-type: none"><li>• Much easier to monitor, support and optimise participants since they now.</li><li>• Connect to each other through a decoupling component, such as a SWIM EMS, instead of hidden, private peer to peer connections.</li></ul>
Risk	<ul style="list-style-type: none"><li>• ISPs and ISCs are dependent on far fewer external systems since communications are decoupled (network-centric). This reduces their attack surface and down time.</li><li>• Modern security controls such as PKI (TLS, OCSP, CRL) protect the attack surface to lower risk.</li></ul>
Sample: FAA	<p>“SWIM reduces both the number and types of unique communication interfaces, reduces redundancy of information, and better facilitates information sharing, improves predictability and operational decision-making, and reduces cost of service. The improved coordination that SWIM provides allows for the transition from tactical conflict management of air traffic to strategic trajectory-based operations. SWIM provides the foundation for greatly enhanced information exchange and sharing with other agencies. SWIM provides policies and standards to support data management, secure data integrity, and control data access and use.”</p> <p><a href="#">(FAA FY 2023 Budget Estimates)</a></p>

## 13.2.2 Tenders

ANSPs can have individual tenders for Minimal SWIM systems or simply SWIM EMS alone. This is common in finance and some ANSPs where such infrastructure components are viewed as part of the foundation of a critical system.

### 13.2.3 SWIM Procurement

SWIM procurement should reflect the principles of modularity and flexibility. Breaking large procurements into smaller, targeted acquisitions helps mitigate risk, enables incremental implementation, and promotes interoperability across diverse systems and vendors. While this approach may require additional administrative coordination, the long-term benefits—resilience, adaptability, and cost efficiency—are well worth the investment.

An important lesson learned from early adopters is that starting small, with clearly defined use cases, is more effective than attempting to procure an all-encompassing solution upfront. While many implementations begin with a SWIM Enterprise Messaging Service (EMS)—particularly in architectures favouring publish-subscribe or event-driven models—this is not a one-size-fits-all starting point. In some contexts, data exchange can be achieved through alternative technologies such as REST, SOAP, or other API-based approaches. Therefore, the selection of SWIM components should be driven by the intended use case and organisational context.

That said, where an EMS is appropriate, it can serve as a foundational element not only for ATM digital transformation, but also for broader enterprise IT modernisation efforts. In such cases, cross-functional funding opportunities may be leveraged to support EMS procurement and integration.

For regions like Europe and APAC, the EUROCONTROL SWIM Technical Infrastructure Yellow Profile (YP) has been adopted for Ground-Ground SWIM. EMS products intended for use in these environments should support YP-specified standards—such as AMQP 1.0 for publish-subscribe message exchange patterns (MEPs). While other protocols like MQTT 5.0 may be supported by some EMS vendors, they are not currently specified in the YP.

### Functional requirements for a SWIM EMS may include:

1. Support for publish-subscribe and request-reply MEPs.
2. High availability and fault tolerance.
3. Disaster recovery capabilities (including support for site failover).
4. Federation capabilities across geographically distributed environments and cloud platforms.
5. Support for future safety-critical use cases.

### Non-functional requirements may include:

1. High reliability (e.g., compatibility with NewPENS' 99.999% uptime expectation).
2. Alignment with State, regional, and global SWIM performance and security standards.

As the SWIM infrastructure may eventually support safety-critical applications, thoughtful procurement decisions now will help avoid costly changes later. Organisations should evaluate both immediate and future requirements when selecting SWIM components, ensuring a balance between scalability, compliance, and innovation.

### FAQ

1. What about bandwidth? AIRM-based information payloads are large, so this question is asked often.
  - a. Internally, you may use more compact payload formats for lower bandwidth such as Google Protocol Buffers
  - b. Your ISCs, ISPs or EMS may compress messages to save bandwidth. Consider using a message header to indicate in what form the content is compressed
  - c. Bandwidth can be saved across locations by federating SWIM EMS messaging products across these locations with compressed bridges
  - d. Dynamic routing, if available in your EMS, can ensure information does not cross locations if no one is requesting it there
  - e. You can place critical information payload fields in the topic for more efficient routing, filtering, and processing. Message properties can also be used to reduce or remove payloads.

## 13.3 Glossary

Refer to the ICAO [IMP](#), [SWIM Concept](#) and PANS-IM for authoritative definitions.

1. **API** – Application Programming Interface.
2. **Core Information Services** – Foundational information services used for SWIM TI capabilities and building blocks for ATM information services.
3. **EMS** – Enterprise Messaging Service is an infrastructure service composed of one or more components, supporting information exchange.
4. **Federation** – in the context of information technology, operational across locations and platforms.
5. **Information** – Metadata and the data it refers to together.
6. **Information Service** – Information Service Providers implement these services to Exchange Information.
7. **Information Service Definition** – A template for a commonly provided information service to provide consistency and broad interoperability across ANSPs. Development of these is ongoing in the ICAO IMP. Europe has started using these.
8. **Information Service Provider (ISP)** – A service provider making information available to information service consumers using information services. (ICAO Doc 10203).
9. **Information Service Consumer (ISC)** – A service consumer receiving information from information service providers using information services. (ICAO Doc 10203).
10. **Information Exchange Model** – Information schemas such as AIXM, FIXM, IWXXM.
11. **MEP** – Message Exchange Pattern.
12. **Message Broker** – Trusted Information Exchange and Sharing intermediary for Information Service Providers and Consumers. In this context it supports SWIM requirements in proven SWIM implementations and supports major SWIM implementations and their regional and state regulations. This means it supports Message Exchange Patterns (Publish-Subscribe, Request-Reply, Fire-Forget), Message Topics and Queues, Message Properties.
13. **Message Header** – A collection of message properties.
14. **Message Label** – The information used to route information, typically a topic.
15. **Message Metadata** – There are generally two forms of message metadata, the topic and message properties (commonly referred to as the message header).
16. **Message Property** – A data element name and value pair.
17. **Message Topic** – A hierarchical, ordered list of string values like a URL path or file path, typically using a forward slash “/” delimiter.
18. **Message Topic Model** – A topic design specifying what each ordered data value within a topic represents.
19. **Metadata** – Data about data. Metadata + Data = Information.
20. **Minimal SWIM Implementation (MSI)** – The simplest set of requirements, architecture, infrastructure, services, and governance that satisfies global and most regional SWIM regulations and requirements.
21. **Resilience** – The ability to always provide successful service to specifications and SLAs. This requires the use of robust High Availability and Disaster Recovery capabilities.
22. **Service Description** – Describes the information service details required to implement and use an operational information service.
23. **Service Overview** – Service metadata that describes an information service for the purpose of discovery by ISCs.
24. **SWIM API** – This is API commonly used in SWIM and compatible with SWIM provisions that use SWIM protocols to communicate. Examples of widely used open standard APIs used in large SWIM implementations are REST and JMS. They support one or more MEPs, TLS 1.2+ and message properties.
25. **SWIM EMS** – SWIM Enterprise Messaging Service. This provides messaging products in one or more locations and platforms for information exchange.
26. **SWIM Protocol** – This is the network protocol that an ISC or ISP use to communicate over the network with Information Services. Examples of widely used open standard SWIM protocols used in large SWIM implementations are HTTP, AMQP 1.0 and MQTT 5.0. They support one or more MEPs, TLS 1.2+ and message properties.
27. **SWIM Core Messaging** – Also known as SWIM EMS with one or more messaging products.
28. **SWIM Requirements** – PANS-IM, regional and State regulations, and derived requirements.
29. **SWIM TI** – SWIM Technical Infrastructure

## 13.4 References

1. **CANSO:** SWIM Implementation Kit, [SWIM White Paper](#), [CATS](#).
2. **EUROCONTROL:** [European ATM Master Plan](#), [SWIM](#), [SWIM Technical Infrastructure \(TI\) Yellow Profile \(ref2\)](#), [EUROCONTROL Network Manager](#), [EUROCONTROL Service Access Form](#), [EUROCONTROL NM Agreements](#), [SWIM Wiki - SWIM Wiki - SWIM Confluence](#).
3. **FAA:** [SWIM](#), [SWIFT](#), [SWIFT Portal](#), [SWIM Governance](#), [FAA SWIM Data Sharing Agreements](#).
4. **ATIEC** (Air Transportation Information Exchange Conference) is a regular event (organised by FAA and EUROCONTROL) covering the current state of SWIM development, applications and information services.
5. **ICAO** [GATMOC](#), [GANP](#), [PANS-ATM](#), Annexes: 1, 15.
6. **ICAO** [IMP](#).
  - a. Manual on the System-wide Information Management Concept ([Doc 10039](#)).
  - b. Procedures for Air Navigation Services-Information Management (PANS-IM) ([Doc 10199](#)).
  - c. Manual on the System-Wide Information Management (SWIM) Implementation ([Doc 10203](#)).
  - d. [FF-ICE \(FIXM\)](#).
  - e. [Trust Framework](#).
7. **ICAO** [APAC SWIM](#), [WP/IP Template](#).
8. [ISO/IEC 18384-1](#) standard 534 “Reference Architecture for Service Oriented Architecture”.
9. **SESAR:** [SWIM Governance](#), [Airspace Architecture Study](#), [European SWIM Deployment Status](#).
10. **Standards:** [AIRM](#), [AIXM](#), [FIXM](#), [IWXXM](#), [ASTERIX](#), [RTCA](#), [EASA](#), [EUROCAE](#), [semantics.aero](#).
11. **SWIM EMS:** [ActiveMQ Artemis/Classic](#), [Solace PubSub+ Event Broker](#).



# Appendix A - Information Service Message Metadata

Global SWIM interoperability requires SWIM TI interoperability. This is required when two ANSPs, or other SWIM stakeholders with SWIM TI implementations, use SWIM to communicate with each other. Information Service Definitions (ISDs) are under development, but they do not currently consider global SWIM TI interoperability. Much like routing a physical package, information service messages need standardised labels (like bar codes) and headers (like manifests) to provide an interoperable SWIM at all levels: global, information domain, information service type (ISDs are relevant here), information service, and potentially request type and message type.

## A.1 Information Service Message Labels

Topics and queues are commonly used in an EMS as for ISPs and ISCs to provide and consumer respectively. Significant advantages are found when an ISP sends to a topic that is attracted to an ISC's queue. Some of these advantages are:

- Granular topic entitlements can be applied that provide great control over
  - What topics an ISP can send upon
  - How to route and filter messages
  - Dynamic Distribution

Once a message is labelled using a topic, it can be attracted to one or more queues that have permission to receive it via topic subscriptions. New queues can join or exit such participation dynamically. Each queue can also have different topic subscriptions that only attract a subset of the messages sent by an ISP. If an ISP sends to a queue, and another queue arises that requires the message, the ISP will have to change to:

- Send to this additional queue
- Distinguish what messages to send to which queue based on their interest
- Be responsible for ensuring both queues get every message or none

Standardising on one or more topic models for SWIM results in a significant improvement in global SWIM interoperability. Further work continues in this area in the ICAO IMP and ATMRPP.

## A.2 Information Service Message Headers

The standardised message header provides a messaging protocol-agnostic method of communicating message metadata to the ISC. This is especially helpful when the source location and destination location are implemented with different messaging protocols and potentially different SWIM TIs. It abstracts away from protocol-specific APIs making it simpler with fewer dependencies while facilitating interoperability. It is commonly used in the finance world for just this reason.

A message header is represented by message properties. This requires the SWIM service interface protocol used to support message properties. AMQP 1.0 and HTTP support these, as does MQTT 5.0 for example.

The SWIM Tool uses a standardised message header adapted from APAC region testing driven by the ICAO APAC SWIM Task Force. If this "SWIM" message header is used, the required fields should be present. Optional fields are only present if set.





# Appendix B - Sample Information Service Topic Model

The following example was used during an ICAO APAC SWIM Task Force Working Session in November, 2024. Note that the names are not present in a message topic. The order of their values dictates their identity. The root This topic model was used for a workshop.

The recipient elements are present primarily for legacy compatibility and request-reply exchanges. This is why these fields are the last elements. Version 2 of this topic model may remove them for example.

The format of a topic, an instance of a topic model, is the same as a URL or file path. Below is a topic that follows the sample global SWIM topic model below.

**Jakarta/1/ANSP/WS\_CAAS/0/FLT/FLIGHT\_STATUS/FILING\_STATUS/ACCEPTABLE/0/0/0**

Name	Description	Required	Example
Global (SWIM)			
Topic Model Name	Topic model in use	Y	Jakarta
Topic Model Version	Topic model version	Y	1
Source Type	ANSP, AO, AU, etc.	Y	0, ANSP
Source Id	APAC test values	Y	0, WS_CAAS, ...
Source Client Id	Client Id	Y	0
Information Domain	AER, FLT, MET	Y	AER
Request Type	FLIGHT_STATUS, NOTAM	Y	FLIGHT_STATUS
Message Type	FILING_STATUS, D-NOTAM	Y	FILING_STATUS
Event	N, R, C, ACCEPTABLE, ...	Y	ACCEPTABLE
Recipient Type	ANSP, AO, AU, etc.	Y	0, ANSP
Recipient Id	APAC test values	Y	0, WS_CAAS, ...
Recipient Client Id	Client Id	Y	0

Each category for this example is the information domain (AER, FLT, MET, SUR). The topic extends with its own domain-specific topic model suffix, or extension. Ideally this would have its own topic model name and version elements, but here they were left out for simplicity. The topic includes optional topic elements in strict order without any missing previous optional topic elements.

A NOTAM may have the topic elements shown below after the green heading. Flight and weather would have different ones. It is likely that these would change for different request types and message types at an even more granular level. However, it is important to keep topics short. Once reaching a topic length of 200 characters, remaining elements should be placed in the message header. Topic elements are a high priority form and the most efficient form of message metadata used primarily for routing. Message header elements are used by the consumer for context and internal processing.

### Examples:

1. Jakarta/1/ANSP/VT\_AEROTHAI/0/AER/NOTAM/D-NOTAM/N/0/0/0/VTBB/VTSS/QPIXX
2. Jakarta/1/ANSP/VT\_AEROTHAI/0/AER/NOTAM/D-NOTAM/N/0/0/0/VTBB/VTSS/QPIXX/52.38833/-31.94944

Name	Description	Required	Example
NOTAM			
FIR	Affected FIR	Y	VTBB
ICAO Location	ICAO Location	Y	VTSS
Q Code	Q Code	Y	QPIXX
Id	NOTAM Id	N	NOTAM_1_44798905
Latitude	Latitude	N	52.38833
Longitude	Longitude	N	-31.94944
Radius	Radius	N	001

## Appendix C - Sample Information Service Message Header

Message headers are made up of message properties. Unlike topic elements, a message property specifies a name and its value without specifying order. An example of a message property is a name=value like “fir”=“WSJC”. This means the message property name should be made unique to prevent any intermediate systems, APIs or protocols from having overlapping names. This is why the “swim” prefix is present here.

Note that it is not required for a topic to be provided for a message, though it is a best practice. A topic element may also be placed in the message header. Each message header element name and value use precious space and bandwidth.

Message properties not required in the table may be required depending on the Information domain.

Below is a sample set of message properties that have been used for experimenting with message headers. The fewer message properties the better because they take up valuable space and bandwidth.

Name	Description	Required	Example
<b>Global (SWIM)</b>			
swimDateSent (TIMESTAMP)	Date sent from source	Y	2020-04-09T21:11:26.227Z
swimOrig	Originator	Y	AEROTHAI
swimConType	content type	Y	XML
swimConSch (CATEGORY)	content schema	Y	FIXM
swimConSchVer (CATEGORY_VERSION)	content schema version	Y	4.3
swimConEnc	content encoding	Y	gzip
swimDest	Topic or queue	Y	
swimSvc	information service	Y	
swimSvcVersion	information service version	Y	
swimOperation	information service operation	Y	
swimReqType	Request Type (Topic)	Y	
swimMsgType (MESSAGE_TYPE)	Message type (Topic)	Y	
swimMsgId	source generated GUID	Y	

Name	Description	Required	Example
<b>Global (SWIM)</b>			
swimRecipients* (RECIPIENT_LIST)	Recipients (legacy, FF-ICE)	N	
swimMsgIdRef	reference message id	N	GUID
swimRoutingKey	custom routing (e.g., Qline)	N	
swimRoutingType			
swimSyntheticType	information partly or wholly generated by AI or interpolation	N	AI, Interpolated
swimMsgReplyTo	REQ-REP: Reply topic or queue	*	Topic or Queue
swimMsgCorrid	GUID - Required for Request-Reply	*	
swimSignatureType		*	
swimSignature		*	

