

System Wide Information Management (SWIM): Technical Architecture

Preliminary Draft

CAP 3310

Published by the Civil Aviation Authority 2026

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First published October 2026

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The latest version of this document is available in electronic format at: www.caa.co.uk/CAP3310

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Chapter 1

Introduction

Context

- 1.1 The implementation of System Wide Information Management (SWIM) in the UK is a critical component of the UK Civil Aviation Authority's (CAA) Airspace Modernisation Strategy (AMS) and a cornerstone of the transition towards a fully digital, information-centric airspace environment.
- 1.2 An introduction to SWIM, along with the CAA's plan and approach to enabling SWIM across aviation, is outlined in the SWIM Implementation Framework. Also, the Implementation Framework provides a detailed view of how the key SWIM artefacts (SWIM Implementation Framework, SWIM Architecture and SWIM Operational Scenarios) work together to enable SWIM in the UK.
- 1.3 The SWIM Technical Architecture assumes familiarity with the SWIM Implementation Framework, which should be read as a prerequisite to this document.
- 1.4 The SWIM Technical Architecture sets out the technical building blocks (e.g. standards, infrastructure and governance) to enable the standardised, secure and service-oriented exchange of information across all aviation domains. A further document, the SWIM Operational Scenarios, outlines **examples** of how these building blocks could be applied in a range of operational scenarios.
- 1.5 In this context, the SWIM Technical Architecture aims to provide the building blocks to incorporate uncrewed aircraft systems (UAS), remotely piloted aircraft systems (RPAS) and future innovative operations into the airspace in a controlled and scalable manner. It ensures that they are subject to the same levels of situational awareness, conformance monitoring and governance as traditional airspace users. The SWIM Technical Architecture should enable the onboarding of new entrants into the aviation system and establish interoperability pathways with existing air traffic management (ATM) systems, while aligning to the International Civil Aviation Organization (ICAO) SWIM vision.
- 1.6 It is recognised that the SWIM Technical Architecture will need to mature to provide the detail necessary to accommodate all aviation domains. However, the UK SWIM ecosystem is not yet at a level of maturity where an integrated Architecture encompassing all aviation stakeholders can be defined. As such, the approach taken in this preliminary draft version is to establish high-level overarching principles for all aviation stakeholders, with further detail for the uncrewed ecosystem, where applicable.
- 1.7 In line with the SWIM delivery roadmap (see SWIM Implementation Framework), we plan to publish an updated version of the SWIM Technical Architecture that

incorporates crewed airspace users in an integrated environment in 2027. We will continue to seek feedback from aviation stakeholders to mature the SWIM Technical Architecture.

Key Assumptions and Scope

- 1.8 This document does not replace or attempt to replicate ICAO SWIM documentation. In particular, it should be read alongside ICAO Docs 10039 and 10203, which provide manuals on the SWIM concept and SWIM implementation, respectively. The ICAO documents should always be referenced in any SWIM discussion. This SWIM Technical Architecture, in conjunction with the SWIM Implementation Framework, complements some of those concepts without attempting to replicate material. Importantly, this document defines the architectural approach, including referencing standards and exchange models, applicable to UK aviation.
- 1.9 This document enables the implementation of either a centralised or federated approach to SWIM. By its nature, SWIM focuses on the accessibility of consistent data and information. As a result, the UK approach is agnostic to specific implementation models.
- 1.10 Some states are progressing the strategic direction of a centralised approach to SWIM, commonly due to state-owned and/or singular air navigation service provider (ANSP) provision. The current direction in the UK is to enable a framework that does not prescribe a specific physical architecture. This approach aims to avoid hindering how the aviation ecosystem may evolve. Our view is that this architectural approach allows industry to develop solutions that realise the benefits envisaged by the ICAO SWIM concept.
- 1.11 We recognise that SWIM has been slow to materialise globally, and no precedent or pattern has been set around how SWIM will be delivered. Therefore, this architecture will iterate as SWIM evolves globally, maintaining in line with joint CAA and Department for Transport (DfT) priorities.
- 1.12 In line with the SWIM Implementation Framework, we have adopted gender-neutral terminology in this Technical Architecture where possible. Although we acknowledge that our use of non-gender specific terminology is a departure from the terminology used in legislation and by some stakeholders, the substance of the terminology is the same. Our use of gender-neutral terminology is for the purposes of the preliminary draft SWIM Implementation Framework and supporting artefacts only. We do not intend to pre-empt the terminology to be used in the drafting of any subsequent legislation. See the SWIM Implementation Framework for further detail.

Chapter 2

Conceptual Architectural Framework

SWIM Principles

- 2.1 At the heart of the UK SWIM framework are a set of key overarching principles. These principles combine the conceptual thinking underpinning the ICAO SWIM vision with principles tailored to UK SWIM delivery and the UK government's Future of Flight ambitions. These principles are discussed further below.

The Foundational Concept: Service-Orientated Architecture (SOA)

- 2.2 At the heart of the ICAO fundamental thinking behind SWIM is the concept of service-oriented architecture (SOA).
- 2.3 SOA is a software design concept that structures an application or system as a collection of loosely coupled, interoperable services. These services communicate with each other over a network and perform specific business functions. Transitioning to service-based systems brings an increase to scalability, enables the ability and agility to adapt, and facilitates interoperability across the whole of the aviation ecosystem.
- 2.4 SOA is a mature concept that encompasses a number of key design principles. Several of the core SOA concepts are introduced at a high-level in the table below. Further detail on how the concepts apply to the UK SWIM context is described later in the architecture.

Table 1 – Service Orientated Architecture Concepts

Concept	Description
Service	A self-contained, logical representation of a repeatable business activity (e.g. calculate flight plan). A Service must have a well-defined interface and be discoverable.
Service Provider	The entity that creates, maintains and executes the service and makes it available for consumption.
Service Consumer	This is the application or system that requires the capability (e.g. the service) that the Service Provider is making available. A Service Consumer invokes the service provided by the Service Provider.
Service Contract	The Service Contract defines the details of the service, including, for example, the interface, data types, protocols, quality of service and the rules of usage between the Consumer and Provider.

Discovery	This is a central registry/directory where Service Providers register services and where Service Consumers can discover available services. This Discovery function can be dynamic, effectively automating a single process (i.e. a Service Consumer can query a service to discover it exists, use the information in the query result to bind to the service, and then invoke it). Alternatively, the Discovery function could be at design-time, meaning the registry is searched and the results are used in the design of an application.
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Loose Coupling

- 2.5 Loose coupling is a principle of SOA and is foundational to the ICAO SWIM vision, enabling an aviation ecosystem that is easier to maintain, opens the market and is easier to grow and change to meet the future needs of aviation.
- 2.6 Focussing on the services specifically within the loose coupling concept, they are designed to be independent of the applications that use them and other services. As a result, any changes to a service should not require changes to other services or consumers.
- 2.7 Loose coupling brings a system that is less fragile, easier to maintain, opens up redundancy and resilience options and allows for independent development and deployment.

Discoverability

- 2.8 As with loose coupling, discoverability is another key concept within SOA; however, the driver of discoverability in the context of SWIM is the concept of enabling an understanding of what information is available to the aviation ecosystem and how it can be consumed. The visibility of the information that is available creates the opportunity for industry growth, innovation and expansion.

Global Interoperability

- 2.9 One of the core benefits of ICAO's SWIM vision is enhancing and simplifying global interoperability between the various components of the ATM system. Aviation is global by nature and crosses geographical boundaries. As a result, the ability to interact across these boundaries in the simplest manner through agreed standards is key to both enabling global operations and enabling future required concepts, such as trajectory-based operations (TBO).

Data as the Lowest Common Denominator

- 2.10 Although not directly referenced by ICAO, a key principle underpinning the implementation of SWIM in the UK, is thinking about data as the lowest common denominator. Our view is that this principle is key to delivering the benefits of SWIM.
- 2.11 Making data accurate, secure, timely and easily accessible in an agreed and consistent format creates the conditions for the aviation ecosystem to operate more effectively. Crucially, it enables the aviation ecosystem to evolve, grow and adapt to future demands of the sector.

Question 1: *While SOA sits at the heart of ICAO's SWIM concept, the CAA recognises that architectural design approaches continue to evolve. Nevertheless, our view is that the core principles underpinning SOA remain central to the SWIM vision.*

Do you agree that the SOA approach and associated architectural principles described in this document provide an appropriate foundation for the effective implementation of SWIM in the UK? Please explain your answer.

Stakeholder Landscape

- 2.12 The ICAO SWIM concept does not directly exclude any aspect of the aviation ecosystem, with SWIM being focussed on the full breadth of ATM, including all the airborne and ground-based functions required to ensure the safe and efficient movement of aircraft during all phases of operations.
- 2.13 The Global ATM Operational Concept (Doc 9854) lists the members of the ATM community as: aerodrome community, airspace providers, airspace users, ATM service providers, ATM support industry, ICAO, regulatory authorities and states.
- 2.14 ICAO defines SWIM stakeholders as four groups, with two of those groups aligning to the SOA roles defined above (i.e. Service Provider and Service Consumer). The four SWIM stakeholder groupings are described further in the table below.

Table 2 – Stakeholder Landscape

Stakeholder	Role
Originator	Producing data and information as an information service payload.
Information Service Provider	Integrating, transforming and disseminating the payload via an information service or providing the technical infrastructure over which the information service is delivered.

Information Service Consumer	Using the information service or the technical infrastructure.
Regulator	Ensuring that policies are followed and requirements are met.

Note: stakeholders can and may take on multiple roles.

Stakeholder Landscape: UAS Architecture Specific

- 2.15 The [UTM Concept of Operations \(CAP 3273\)](#) defines the operational environment and the functional roles that the stakeholders within that environment fulfil.
- 2.16 This document is not designed to replicate that content; however, as a **high-level representational example to provide context**, the following functional roles enable uncrewed operations.

Table 3 – Stakeholder Landscape: UAS Architecture Specific

Stakeholder / Component	Role
UAS operators/aircraft	• Provide: flight intent, telemetry and status information. • Consume: flight authorisation, geo-consciousness, conflict management (and other operational data). • Comply with: strategic deconfliction requirements and traffic separation instructions.
Uncrewed Aircraft System Traffic Management Service Providers (UTMSPs)	• Provide: UTM services to mitigate mid-air collision risks and reduce unsafe operations. • Perform: inter-UTMSP coordination via Discovery Synchronisation Service (DSS) / Common Information Service Provider (CISP).
DSS	• Provides: inter-UTMSPs consistency of active flights, constraints and services.
CISP	• Provides: common information and surveillance data. • Facilitates: UTM↔ATM coordination and cross-ecosystem consistency.
ATM/ANSP	• Share: aeronautical/surveillance inputs.

	• Receive: UTM operational information for airspace the operation takes place in.
Ground infrastructure (GI) / UAS data service providers (UDSP)*	• Provide: cooperative/non-cooperative surveillance (ADS-B, MLAT, PSR/SSR etc.) and fusion outputs.
Crewed aviation	• Primary users of airspace whose surveillance/intent are inputs to the recognised air picture and separation assurance.

Note: the term UDSP is being reviewed as part of the UTM consultation (CAP3271).

2.17 Aligning the operational roles described above to the SWIM groupings is not always linear; for example, the UAS operator/aircraft could be an originator in terms of providing flight intent or telemetry, but also an Information Service Consumer to consume the service that allows them to submit flight intent, and indeed an Information Service Consumer also to obtain meteorological information. This indicates that stakeholders/components may perform multiple SWIM roles simultaneously and that the roles undertaken may vary depending on the scenario and operational context.

The SWIM Registry

- 2.18 As mentioned in the SWIM principles section, discovery is a key function of SOA and hence SWIM. Discoverability in SOA generally takes two forms, design-time or run-time.
- 2.19 Design-time is where services are discovered during the development of an application that will consume services. Run-time refers to services being discovered dynamically, with those services connected to and invoked as part of the run-time process.
- 2.20 The run-time concept is difficult to achieve and use in full operation. Due to this, but primarily due to international alignment, the UK approach for a Registry will be at design-time.

The UK SWIM Registry

- 2.21 Under ICAO guidance, each state must define where you can obtain information about SWIM services and the UK has chosen to use a registry for this purpose.

Where a registry is used, a state is not required to have their own registry. They can share a registry across multiple states, but they must define its location.

- 2.22 The UK narrowed its SWIM Registry options to two approaches: building its own registry or utilising the EUROCONTROL registry, with the UK being a member of EUROCONTROL. A detailed analysis was completed comparing the relative merits of the two options, and a decision was made to utilise the EUROCONTROL registry.
- 2.23 This decision has been formally added to the Aeronautical Information Publication (AIP). For context, the EUROCONTROL registry and further information about registering for use can be found at this URL: <https://eur-registry.swim.aero/home>.
- 2.24 Every UK SWIM-compliant service will include a service description and will be published in the service registry to enable discovery and assurance.¹ These will be published in alignment with the ICAO definitions and ICAO standardised data models.

Question 2: *Do you agree with the CAA's decision to adopt the EUROCONTROL SWIM Registry as the UK SWIM Registry? Please explain your answer.*

¹ The SWIM Implementation Framework provides the definition for 'SWIM-compliant'.

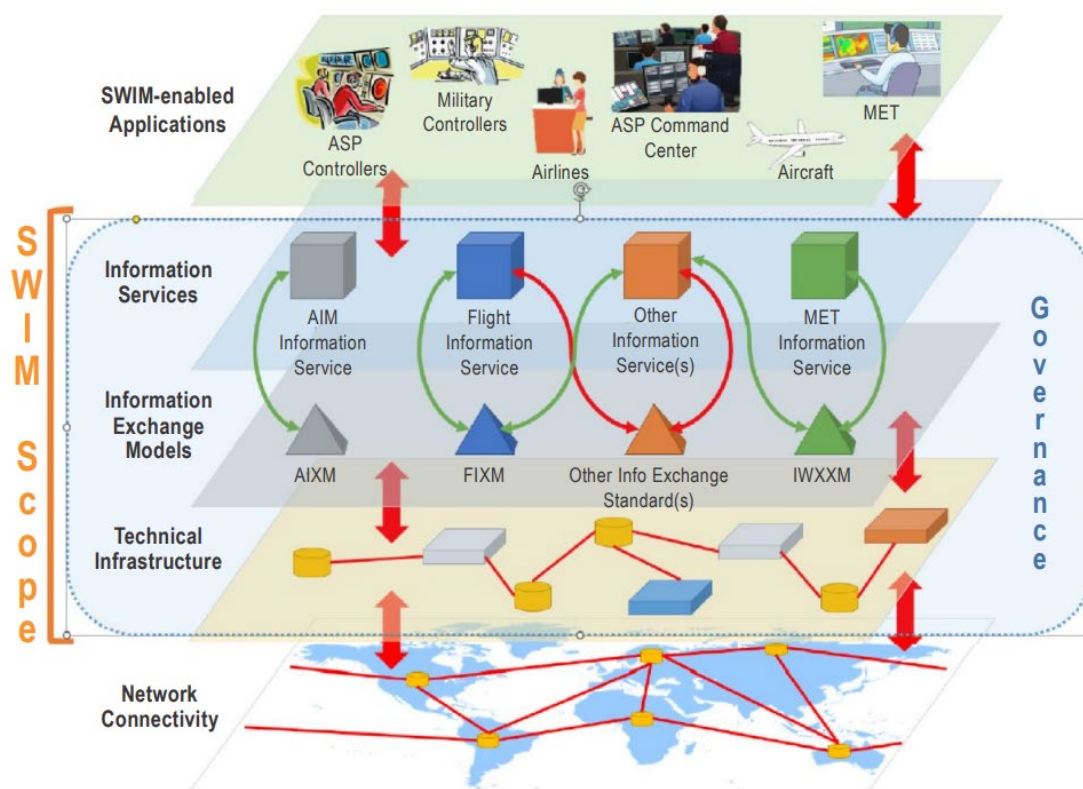
Chapter 3

Architectural Definition (The “What”)

Architectural Views: Generic

- 3.1 ICAO Doc 10039 and 10203 highlight the high-level architectural layers to illustrate the connectivity of the SWIM components. This is referred to by ICAO as the Global Interoperability Framework (GIF) and ICAO’s pictorial representation can be seen in the figure below.

Figure 1 – ICAO Global Interoperability Framework



Note: An ASP in the diagram refers to an ATM service provider

- 3.2 For UK SWIM, we will represent high-level architectural concepts in the same layered style to enable global consistency with SWIM architectures developed by other states. Although the ICAO diagram indicates ‘Network Connectivity’ and ‘SWIM enabled-applications’ are out of scope, the layers are not always clearly separable when considering the SWIM concept in practice. As an example, the dependency on an internet protocol (IP) network for SWIM to function is considered to be a key component of SWIM and indeed the applications developed are core to delivery of aviation. This document references these two aspects of SWIM where doing so provides additional clarity.

3.3 SWIM is expressed as five cooperating layers. Each layer is technology-profiled to maximise compatibility with European SWIM and to support the UK’s risk-based Future air traffic management and air navigation services (F-ATM/ANS) airspace architecture. The following layers are described in technical detail to give a clear view of what they consider and contain:

- **Network and transport:** this layer provides the fundamental connectivity, enabling information exchange across aviation domains. It encompasses:
 - IP connectivity across the crewed aviation network;
 - Uncrewed aviation network; and
 - A bridging domain, ensuring interoperability between both environments.
- **Messaging patterns:** this layer defines the interaction mechanisms between systems, enabling reliable and predictable information exchange. It covers:
 - Synchronous request/response;
 - Asynchronous publish/subscribe; and
 - These patterns are aligned to the EUROCONTROL SWIM Technical Infrastructure (TI) Yellow Profile interface bindings.² Further description of the Yellow Profile is provided below in the Technical Infrastructure section.
- **SWIM infrastructure services:** this layer constitutes the essential foundational core on which all SWIM-enabled services rely, including:
 - Service catalogue (SC): the central registry that lists all available services, their endpoints, bindings and models.
 - Service bindings (SB): define the technical options for accessing services.
 - Infrastructure bindings (IB): specify the concrete network and transport profiles used for communication.
 - Authorisation service: manages access control using OAuth2, with support for federated identity when required.
 - Conformance monitoring (CM): continuously checks interfaces, payloads and behaviours for conformance. It also provides audit and health reports.

² [EUROCONTROL-SPEC-170 -EUROCONTROL Specification for SWIM Technical Infrastructure \(TI\) Yellow Profile | EUROCONTROL](#)

- **Information models and validation:** this layer ensures semantic consistency and safe interoperability through the use of shared information models. Payload messages are systematically validated at both ingress and egress points, with the conformance monitoring function providing additional oversight.
- **Operational and support services:** this layer exposes the reusable capabilities that underpin operational integration and collaboration, including reusable, SWIM-exposed capabilities such as traffic information and network Remote ID (NRID), ADS-B / surveillance exchange, inter-UTMSP and UTMSP–CISP/ATM coordination, meteorological feeds, and C2 status/health. Services declare their bindings and information models in the service catalogue.

Technical Infrastructure

- 3.4 The UK SWIM Implementation Framework discusses the regulatory and strategic alignment within the UK and globally. From an architectural aspect, the SWIM concept defines Technical Infrastructure (TI) more in terms of a noun (i.e. it being the place to obtain information about the technical aspects of standards, technology etc. to use).
- 3.5 Within EUROCONTROL, TI has been categorised into profiles, with the profiles being applicable to certain operating scenarios. At present, the Yellow Profile from EUROCONTROL is the only existing profile.
- 3.6 The UK CAA has reviewed the EUROCONTROL Yellow Profile and its applicability to the UK SWIM vision and Future of Flight ambitions, along with benefits of alignment to EUROCONTROL and its role with other European countries.
- 3.7 As a result of the review, the UK SWIM Technical Architecture will mandate alignment to the Yellow Profile for interface protocols and infrastructure capabilities (e.g. security and monitoring). Conformance implies using mainstream bindings (e.g. HTTPS/REST, SOAP, AMQP) and satisfying infrastructure security capabilities (e.g. authentication, authorisation, integrity, confidentiality, data protection and recording) referenced to recognised controls (e.g. NIST SP 800-53 / ISO 27001 lineage). This helps provide a common technical baseline aligned to European SWIM implementations.
- 3.8 An overarching UK security framework will be developed as the wider UK SWIM aviation requirements are understood (e.g. the appropriate UK PKI security framework).

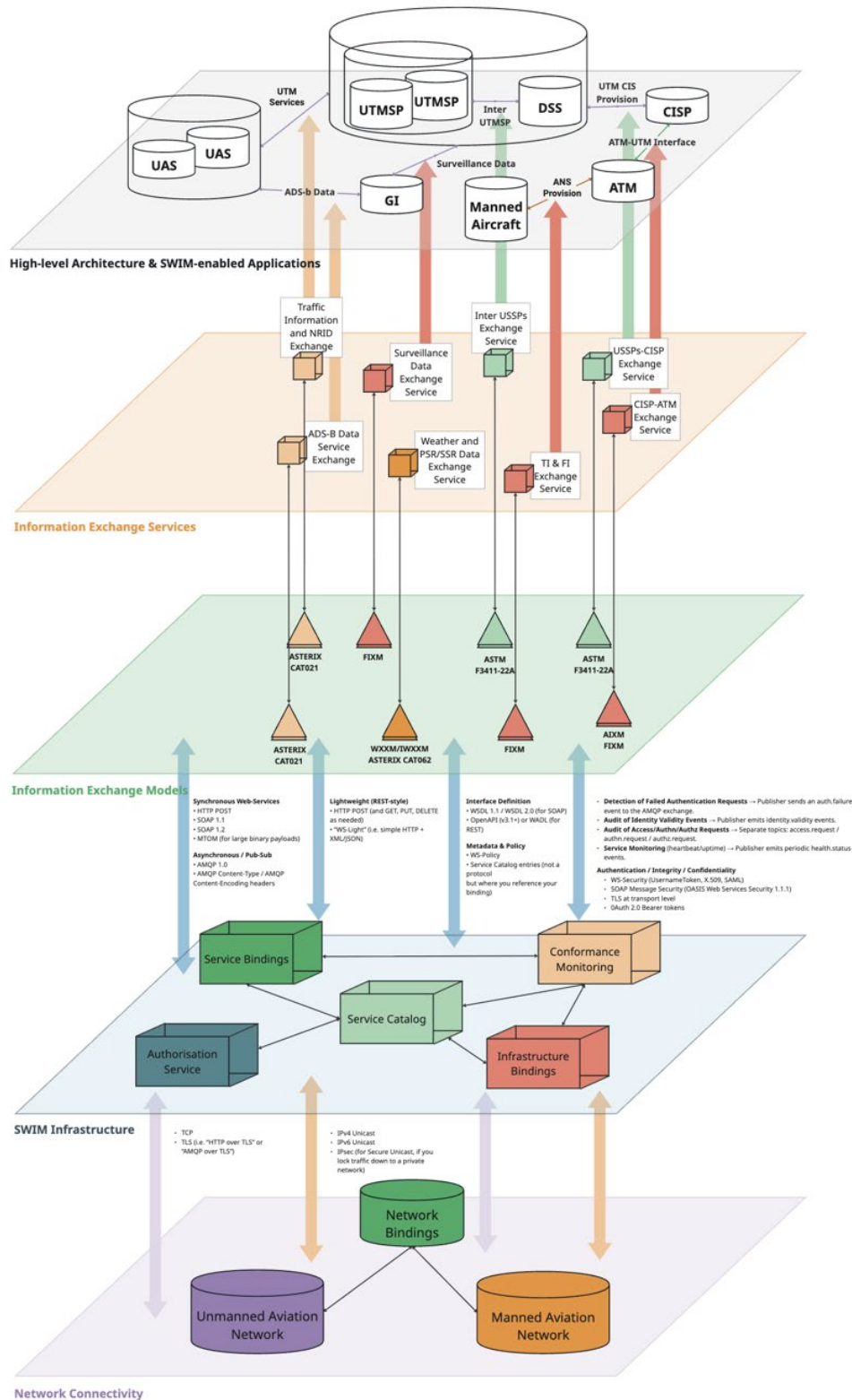
Information Definition

- 3.9 A significant benefit of ICAO’s SWIM vision is interoperability. In order to achieve interoperability, information must be exchanged without ambiguity and with a common understanding of its meaning.
- 3.10 There are many aspects to achieving this, but as a significant contribution to achieving semantic interoperability, UK SWIM will register and validate information definitions against AIRM-based models and associated exchange schemas (AIXM/FIXM/IWXXM/ASTERIX, etc.), following the EUROCONTROL SPEC-169 definition.

Architectural Views: UAS Architecture

- 3.11 Below is a diagrammatic representation of the SWIM UAS architecture aligned to the above-mentioned ICAO diagrammatic format (Figure 1). The diagram includes the cross relationship between layers. The “Application” layer at the top is used to represent a high-level architectural diagram of the UAS architecture to enable the representation of Information Consumers within that architecture. Table 4 that follows expands the detail of the diagram.

Figure 2 - UK SWIM UAS Architecture Aligned to ICAO GIF



Note: the High-level Architecture & SWIM-enabled Applications are conceptual and will be reviewed/iterated as part of the consultation process.

Table 4 – Supplementary Detail for Figure 2

Layer	Purpose	Key Components / Responsibilities	Typical Interface Bindings	Security and Identity	Assurance / Artefacts
High-level architecture and SWIM-enabled applications	Expose modular architecture enabled by SWIM support in F-ATM/ANS	SWIM Architecture	N/A	N/A	N/A
Information Exchange Services	Expose reusable services for operations	Traffic and network Remote ID; Surveillance exchange (ADS-B/MLAT/PSR/SSR); Aeronautical and MET feeds; Inter-UTMSP and UTMSP↔CISP/ATM coordination; C2/C3 status and health	REST/HTTPS, SOAP/TLS; AMQP 1.0 pub-sub	TLS; optional WS-Security; OAuth2 for API access	OpenAPI/WSDL; service description; runtime KPIs
Information Exchange Models	Ensure common meaning across domains	AIXM, FIXM, IWXXM/WXXM; ASTERIX CAT021/CAT062; ASTM F3411 (RID); schema validation and mediation	XML/JSON schemas	N/A	Schema repositories; validation reports
SWIM Infrastructure	Uniform infrastructure foundation for publishing, discovery, access and monitoring	Service catalogue (SC), service bindings (SB), infrastructure bindings (IB), authorisation, conformance monitoring (CM)	N/A (component functions)	Central auth (tokens/certs), role/policy enforcement	CM events, audit logs, conformance evidence
Network Connectivity	Provide reliable/secure connectivity across three domains	Uncrewed Aviation Network, Crewed Aviation Network, Bridging Domain; TCP + TLS; optional IPsec for private links	IPv4/IPv6 (secure/unicast)	TLS (server/mutual)	Network policy; connectivity tests

Note: see Annex A for the full list of abbreviations.

Chapter 4

Technical Infrastructure (The “How”)

SWIM Infrastructure Layer (SWIM TI)

- 4.1 The diagram above indicates five infrastructure layer components. Each component plays a distinct role in enabling secure, standardised and interoperable service exchange within a federated architecture. The table below provides a summary of each component's function, typical technical interfaces and artefacts, associated security and monitoring mechanisms and expected evidence of conformance as required for operational assurance.

Table 5 – SWIM Technical Infrastructure (TI)

Component	What it does	Typical Interfaces / Artefacts	Security and Monitoring	Evidence of Conformance
Service Catalogue (SC)	Central registry of all SWIM services, listing their endpoints, bindings, models and lifecycle details.	Service records; OpenAPI/WSDL; WS-Policy refs	Access-controlled queries; change notifications	Catalogue entries; approval workflow
Service Bindings (SB)	Define the technical options for accessing a service (e.g. REST/HTTPS, SOAP/TLS, AMQP topics).	Binding metadata; OpenAPI/WSDL; topic/queue maps	TLS; auth scopes attached to bindings	Interface test reports; schema checks
Infrastructure Bindings (IB)	Specify the concrete network and transport settings used for communication (e.g. ports, TLS modes, brokers/gateways).	NI binding profiles (IPv4/IPv6); gateway configs.	TLS/mTLS; optional IPsec; broker access control	Connectivity test logs; config baselines
Authorisation Service	Manages access control through OAuth2, acting as	OAuth2/JWT; mTLS; PKI artefacts	Failed-auth auditing;	Access audit trails; key/cert

	the gatekeeper for tokens and certificates, with support for federated identity.		role-based scopes	management logs
Conformance Monitoring (CM)	Continuously checks interfaces, payloads, and behaviours for compliance, providing audit logs and health reports.	Log streams; metrics; alerts	Monitoring alerts, log retention per TI Yellow Profile	Conformity checklist; monitoring dashboards

Technical Infrastructure Yellow Profile

4.2 The following table summarises the minimum technical and operational interface requirements expected for SWIM-compliant services and nodes. This baseline criteria defines the binding protocols, network connectivity standards and the security and monitoring mechanisms necessary to ensure reliable, secure and interoperable service delivery across the SWIM environment.

Table 6 – Minimal Technical and Operational Interface Requirements

Topic	TI Yellow requirement focus	What we implement
Service Interface Bindings	Must implement ≥ 1 service interface binding (e.g., WS-Light/REST, SOAP, AMQP).	REST/HTTPS for query/update SOAP where appropriate AMQP 1.0 for pub-sub
Network Interface Bindings	Must implement ≥ 1 network interface binding (IPv4/IPv6, secure/unicast).	IPv4/IPv6 TLS optional IPsec for private links
Security	Transport and/or message-level security; authn/authz; confidentiality and integrity.	TLS 1.2/1.3 mTLS WS-Security where end-to-end is needed

Monitoring	Alerts on threshold violations; service monitoring; persistent logging and retention	CM alerting Service health Configurable retention
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Technical Infrastructure Yellow Profile

- 4.3 The table below describes the three primary network domains relevant to SWIM deployment and their associated roles within the federated environment. Each domain supports specific stakeholders and technical functions, with clear trust boundaries and interface mechanisms defined to ensure secure and scalable interoperability across both legacy and emerging aviation systems.

Table 7 – Primary Network Domains

Domain	Role ⁸	Typical Placement	Notes
Uncrewed Aviation Network	UTM/UTMSPs, UAS, GI, C2	IP Network/Cellular/satellite/hybrid	Optimised for mobility and secure remote access.
Crewed Aviation Network	ATM/ANSP systems, certified ground links	High-assurance links; NM B2B, Radio Communications	Legacy interoperability via gateways.
Bridging Domain	Secure inter-domain data exchange	Brokers, gateways, VPNs	Enforces trust boundaries and policy.

Technical Infrastructure Yellow Profile

- 4.4 The Yellow Profile section above indicates generic standards and what the UK will implement. The table below narrows this down to the specific functions and candidate standards of the future UAS vision.
- 4.5 These functions represent the foundational capabilities required for UAS and UTM integration, and their alignment with SWIM is guided by standardised models, interfaces and registry mechanisms. Each entry includes implementation considerations to support the transition from functional capability to service realisation within the SWIM framework.

Table 8 – Technical Standards for UAS

Layer	Function	Candidate standards / implementations	Notes for SWIM realisation
UAS Information Exchange Services	Remote ID data distribution	ASTM F3411 (RID)	Publish via AMQP; REST for history and queries.
UAS Information Exchange Services	Surveillance data fusion	ADS-B, MLAT, PSR/SSR; fusion	Declare ASTERIX categories; Expose fused tracks.
UAS Information Exchange Services	Geo-awareness services	AIXM; constraint APIs	Versioned constraints; Digital NOTAM alignment.
UAS Information Exchange Services	C2 link monitoring	Telemetry schemas	Surface QoS and alarms to CM.
UTM Infrastructure	Service discovery and registry	Catalogue/registry	Mapped to SC entries with lifecycle.
UTM Infrastructure	Authorisation management	OAuth2 / PKI	Token scopes per service binding.
UTM Infrastructure	Multi-provider coordination	DSS / inter-UTMSP protocols	SWIM topics for mission/constraint sync.
UAS Information Exchange Models	UAS flight data extension	FIXM extension	Document semantic correspondence.

Question 3: Do you agree with the CAA’s proposed approach to the adoption of technical standards, protocols and the EUROCONTROL SWIM Technical Infrastructure Yellow Profile for the implementation of SWIM in the UK? Please explain your answer.

Chapter 5

Governance and Management

Governance Overview

- 5.1 The SWIM Implementation Framework introduces the proposed governance framework for SWIM. It also defines the stakeholder roles and responsibilities within SWIM, with these referenced earlier in this document.

In this Technical Architecture, we propose further detail on the high-level governance framework from a technical standpoint, which includes initial thinking on potential roles and committees that could make decisions on the implementation of SWIM in the UK.

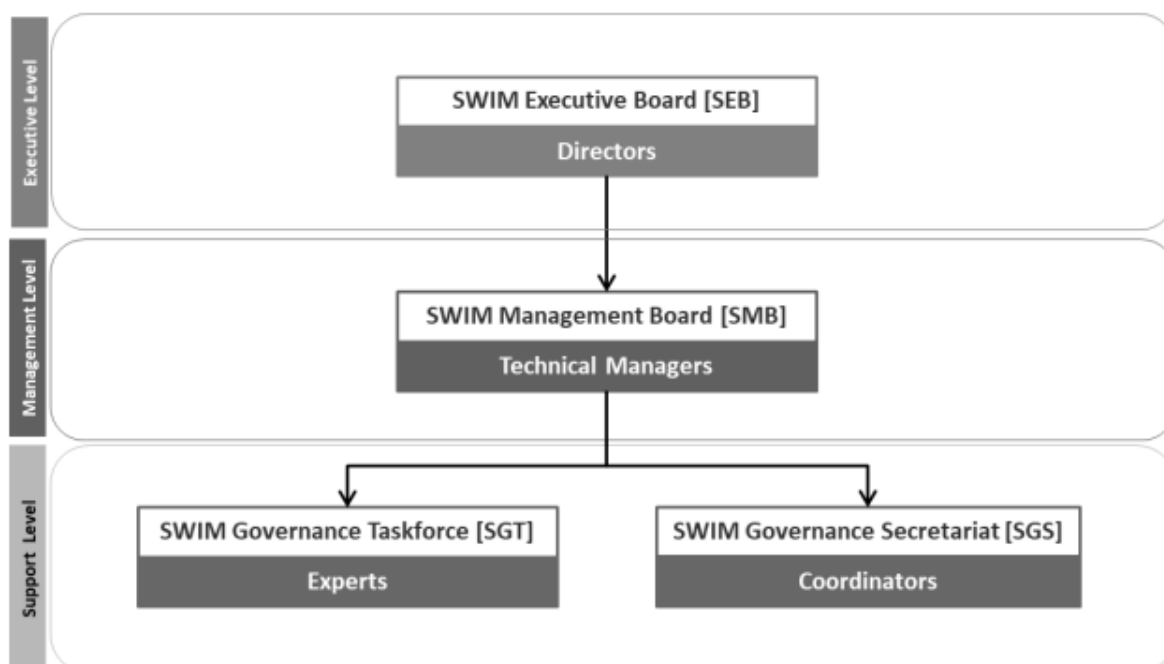
Please read this section in conjunction with the Governance section in the SWIM Implementation Framework document (CAP 3309).

- 5.2 Consistent with ICAO Doc 10203, governance is defined as:

“The set of bodies, standards, policies and processes that ensure globally interoperable information is provided by reliable and trusted services”.

- 5.3 ICAO defines an example governance structure as per the following diagram:

Figure 3 – ICAO Example of Governance Bodies



- 5.4 The **initial** UK SWIM governance framework will likely follow the example structure above. We will evolve the governance approach towards the model described in the SWIM Implementation Framework, as the subject matures and real-world challenges with implementation help to define governance requirements. Please read this section as a complementary further example of areas/considerations to be applied to the overarching SWIM governance framework found in the SWIM Implementation Framework. This architecture provides an example of how governance processes may operate in light of tangible real-world considerations.
- 5.5 At this stage, the governance framework within this preliminary draft Technical Architecture is focussed solely on the uncrewed ecosystem, including new entrants such as UTMSPs and UAS operators. Although, the intent is to accelerate implementation of an industry wide SWIM governance framework on the back of this initial consultation to ensure governance is in place early in the UK SWIM journey.
- 5.6 It is recognised that the governance framework will need to mature to accommodate existing institutional arrangements, for example, across ATM, aeronautical information management (AIM) and meteorological information (MET) domains. However, the UK SWIM ecosystem is not yet at a level of maturity where an integrated governance framework encompassing all aviation stakeholders can be defined. As such, the approach taken in this version is to establish initial governance principles for uncrewed operations, while recognising further work will be required to develop the overall national governance framework that is domain agnostic. The aim is to publish an updated governance framework in the next version of the SWIM Implementation Framework and supporting artefacts in 2028.

Governance Structure: UTM

- 5.7 Governance within the UK's uncrewed SWIM environment defines the institutional, procedural and operational framework through which trusted, interoperable and high-quality digital information is exchanged between all participants in the uncrewed ecosystem.
- 5.8 The governance structure in this version of the SWIM Technical Architecture ensures that new entrants, including UTMSPs, UAS operators and supporting entities, participate safely and equitably in an interoperable information environment, complying with ATM and CAA regulatory oversight requirements.

- 5.9 In accordance with ISO/IEC 18384-1, services in an SOA must be manageable (i.e. capable of being operated and governed to demonstrate adherence to agreed policies and agreements).³
- 5.10 In this context, 'governance' is not external to SWIM, but a core enabling layer of SWIM itself. The governance model for uncrewed SWIM supports the following strategic objectives in the table below.⁴

Table 9 – Governance Strategic Objectives

Objective	Description
Collaborative implementation	Establish a transparent, coordinated approach to the deployment and evolution of uncrewed information services across all relevant stakeholders.
Assured interoperability	Guarantee that uncrewed information services (e.g. aeronautical, surveillance, flight, meteorological and operational) can exchange data seamlessly with ATM through common standards and models.
Trust and accountability	Build confidence among stakeholders through consistent policies, certification mechanisms and verifiable conformance with agreed data and service standards.
Operational scalability	Ensure the governance model supports incremental service expansion from localised UTM environments to national and international integration.
Alignment with national and international frameworks	Remain coherent with ICAO, EUROCONTROL and Single European Sky ATM Research (SESAR) governance principles, and aligned with the UK Airspace Modernisation Strategy (AMS).

- 5.11 The uncrewed SWIM governance model will initially operate within a three-level structure derived from the ICAO SWIM Implementation Framework:

³ [ISO/IEC 18384-1:2016 - Information technology — Reference Architecture for Service Oriented Architecture \(SOA RA\) — Part 1: Terminology and concepts for SOA](#)

⁴ It is fully noted there is no direct alignment at this stage to the overall SWIM governance process defined in the SWIM Implementation Framework.

Table 10 – Uncrewed SWIM Governance Model: Three Level Structure

Level	Entity (UK context)	Primary Function
Executive Level	UK SWIM Executive Board (SEB)	Strategic direction, AMS alignment, endorsement of standards, regulatory coordination (CAA, DfT).
Management Level	Uncrewed SWIM Management Board (USMB)	Operational delivery management, risk coordination, approval of profiles, monitoring of performance and conformance.
Support Level	SWIM Governance Secretariat (SGS) & Uncrewed SWIM Taskforces (USTFs)	Secretariat support, documentation, issue management, expert taskforces (Data Quality, Security, Registry, UTM/ATM Interface).

5.12 The USMB functions as the core operational governance body for uncrewed SWIM. It ensures that UTM implementation activities, including service discovery, data exchange and UTM–ATM integration, comply with both UK and international standards.

Governance Process

5.13 Governance processes ensure that the system remains manageable and adaptable to operational evolution. These include:

- **Policy development:** drafting by USTFs → validation by community → approval by USMB → endorsement by SEB.
- **Standards maintenance:** continuous update of profiles aligned with AIXM, FIXM, IWXXM and relevant UTM data models.
- **Service admission:** verification of conformance, cybersecurity posture and data integrity before onboarding into SWIM registries.
- **Change control:** structured versioning, deprecation and migration plans to maintain backward compatibility.
- **Incident and performance management:** coordinated monitoring and escalation using a central observability and audit stack.

Mixed ATM/UTM Operations

- 5.14 The governance processes that impact both ATM and UTM operations will require a clearly defined hierarchy of responsibility to ensure safety and interoperability:
- **Tactical control:** remains the responsibility of the ANSP or air traffic control officer (ATCO) for crewed operations and the UTMSP for uncrewed operations within UTM-ATM integrated airspaces.
 - **Strategic coordination:** managed via the SWIM information exchange layer, ensuring shared situational awareness between ATM and UTM actors.
 - **Conflict resolution:** when a decision impacts both domains, escalation to the USMB is required for resolution under predefined coordination procedures.
 - **Priority notifications:** the ANSP retains authority in controlled airspace and where necessary, immediate priority notifications are issued in a SWIM-compliant manner to the UTMSP.
- 5.15 In 2026, the CAA published a consultation series to seek feedback on the proposed architecture and regulatory requirements to implement UTM in the UK.^{5,6,7} The concepts described above will be refined as feedback to the consultation is analysed and fed into policy development.
- 5.16 The CAA is also consulting on the role of the CISP in the UK, which may impact how these concepts are described in future iterations of the SWIM Technical Architecture.

Standards, Policies and Guidance

Standards

- 5.17 Uncrewed SWIM governance ensures compliance with both global SWIM standards and UTM and UAS specific data models:

⁵ [Unmanned Aircraft Systems \(UAS\) Traffic Management Certification Consultation \(CAP3271\)](#)

⁶ [Unmanned Aircraft Systems \(UAS\) Traffic Management Policy Concept \(CAP3272\)](#)

⁷ [Unmanned Aircraft Systems \(UAS\) Traffic Management Concept of Operations \(CAP3273\)](#)

- **Core standards:** AIXM (aeronautical), FIXM (flight), IWXXM (meteorological).
- **Extensions:** UTM and UAS interfaces data exchange schemas (e.g. inter-UTMSP, UTM to UAS operator, network Remote ID, flight authorisation, geofencing, C2, etc.).
- **Supporting standards:** OGC web service standards, ISO 19100 series, ISO/IEC 18384-1, and ASTM F3411-22A for identification data flows.

Policies

5.18 The following proposed policies are maintained under USMB control:

- **Data Governance Policy** (quality, lineage, privacy, retention).
- **Service Lifecycle Policy** (registration, change control, conformance).
- **Security and Trust Policy** (authentication, identity federation, resilience).
- **Versioning Policy** (interoperability, compatibility windows).
- **Incident Management Policy** (notification and resolution procedures).

Guidance

5.19 Supporting documents provide non-binding explanatory material such as:

- Templates for service descriptions and onboarding.
- Data quality scoring and remediation workflows.
- Examples of cross-domain interoperability between ATM and UTM.

Compliance Oversight, Audits and Reporting

5.20 Oversight and assurance activities could include:

- **Conformance oversight:** conducted by CAA through scheduled reviews of registered UTMSPs and associated services.
- **Audits:** risk-based audits to verify compliance with SWIM policies, covering information integrity, availability and security controls.
- **Performance reporting:** quarterly reports to the USMB summarising:
 - Service uptime and latency metrics;

- Data quality indicators;
- Incident and corrective-action tracking; and
- Stakeholder engagement outcomes.

5.21 Findings are escalated to the SEB and integrated into continuous improvement cycles.

Governance Artefacts

5.22 The following artefacts formalise the governance structure of uncrewed SWIM. These documents will be created in line with appropriate UK aviation material (e.g. CAPs).

Table 11 – Governance Artefacts

Document	Purpose
SWIM Standards & Profiles Catalogue	Defines mandatory and optional profiles, reference standards and migration plans.
SWIM Service Catalogue	Repository of active and approved uncrewed information services.
Governance Policy Compendium	Consolidates applicable policies (e.g. security, data, lifecycle and change).
Conformance Assessment Framework	Describes testing, certification and audit procedures.
Operational Playbooks	Define escalation, continuity and emergency response mechanisms.
Quarterly Governance Report	Summarises conformance and performance outcomes for transparency.

Governance Principles and Evolution

5.23 The governance structure for uncrewed SWIM is founded on the following principles:

- **Transparency:** all governance decisions, standards and metrics are published and accessible.

- **Accountability:** every stakeholder has a defined role and measurable responsibility.
- **Interoperability:** policies and standards ensure seamless data exchange across domains.
- **Trustworthiness:** all information is exchanged through certified and auditable services.
- **Adaptability:** governance processes are iterative, evolving with technology and operational maturity.

5.24 The governance framework will evolve through defined review cycles:

- **Annual review:** coordinated by the USMB, incorporating feedback from all participating entities.
- **Event-driven reviews:** triggered by significant policy updates, operational incidents or regulatory changes.
- **Continuous improvement:** outputs from performance reporting and audits will inform revisions to policies, processes and technical standards.

Governance and Management Summary

5.25 The governance model for uncrewed SWIM in the UK establishes the institutional and procedural backbone for a trusted, interoperable digital ecosystem. It integrates established ICAO principles with the UK's national regulatory context, ensuring that UTM services can operate safely, efficiently and transparently within the broader airspace modernisation framework.

5.26 By embedding governance directly into the SWIM environment, the framework ensures accountability, manageability and long-term scalability as the UK transitions toward a fully integrated digital aviation ecosystem.

Question 4: *Do you agree with the CAA's proposed initial SWIM governance framework for uncrewed operations? Please explain your answer, including whether there are any stakeholders, standards, policies, guidance materials or other elements that you believe are missing from the proposed framework, any structures such as stakeholder-specific forums and views on SWIM decision-making processes. There is no need to repeat comments made against the governance section of the SWIM Implementation Framework (CAP 3309).*

Question 5: *Stakeholder feedback will play a critical role in ensuring that the SWIM Architecture develops in a way that supports the effective and practical implementation of SWIM in the UK. We are seeking honest and constructive feedback on the proposed direction of travel and components needed in the SWIM Architecture.*

Do you have any other views you would like to share on the proposed SWIM Architecture that have not been captured in your responses to the previous questions. Please explain your answer.

ANNEX A

Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
AIP	Aeronautical Information Publication
AIRM	ATM Information Reference Model
AIM	Aeronautical Information Management
AMQP	Advanced Message Queuing Protocol
AMS	Airspace Modernisation Strategy
ANSP	Air Navigation Service Provider
API	Application Programming Interface
ASTERIX	All Purpose Structured EUROCONTROL Surveillance Information Exchange
ATM	Air Traffic Management
ATCO	Air Traffic Control Officer
C2	Command and Control
C3	Command, Control and Communications
CAP	Civil Aviation Publication
CISP	Common Information Service Provider
DfT	Department for Transport
DSS	Discovery and Synchronisation Service
eVTOL	Electric Vertical Take-Off and Landing
F-ATM/ANS	Future Air Traffic Management / Air Navigation Services
FIXM	Flight Information Exchange Model
GI	Ground Infrastructure
GIF	Global Interoperability Framework
HTTPS	Hypertext Transfer Protocol Secure

IB	Infrastructure Bindings
ICAO	International Civil Aviation Organization
IP	Internet Protocol
IPsec	Internet Protocol Security
ISO	International Organization for Standardization
ISO/IEC	International Organization for Standardization / International Electrotechnical Commission
IWXXM	ICAO Weather Information Exchange Model
JSON	JavaScript Object Notation
JWT	JSON Web Token
KPI	Key Performance Indicator
MET	Meteorological Information
MLAT	Multilateration
mTLS	Mutual Transport Layer Security
NIST	National Institute of Standards and Technology
NM	Network Manager
NRID	Network Remote Identification
OGC	Open Geospatial Consortium
OAuth2	Open Authorization 2.0
PKI	Public Key Infrastructure
PSR	Primary Surveillance Radar
QoS	Quality of Service
REST	Representational State Transfer
RID	Remote Identification
RPAS	Remotely Piloted Aircraft System

SB	Service Bindings
SC	Service Catalogue
SEB	SWIM Executive Board
SESAR	Single European Sky ATM Research
SGS	SWIM Governance Secretariat
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SWIM	System Wide Information Management
TCP	Transmission Control Protocol
TBO	Trajectory Based Operations
TI	Technical Infrastructure
TLS	Transport Layer Security
UAS	Uncrewed Aircraft System
UDSP	UAS Data Service Provider
USMB	Uncrewed SWIM Management Board
USTF	Uncrewed SWIM Taskforce
UTM	Uncrewed Aircraft System Traffic Management
UTMSP	UTM Service Provider
VPN	Virtual Private Network
WSDL	Web Services Description Language
XML	Extensible Markup Language