

Contextual note – SESAR Solution description form for deployment planning

Purpose:

This contextual note introduces a SESAR Solution (for which maturity has been assessed as sufficient to support a decision for industrialization) with a summary of the results stemming from R&D activities contributing to deliver it. It provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as additional activities to be conducted during the industrialization phase or as part of deployment. This contextual note complements the technical data pack comprising the SESAR deliverables required for further industrialization/deployment.

Improvements in Air Traffic Management (ATM)

The scope of this solution is limited to the SWIM Yellow Profile which defines a set of requirements for how SWIM services are to be implemented. These requirements include:

- which standards and protocols are to be used when communicating between service providers and consumers;
- a set of SWIM-Technical Infrastructure functions that are required to be implemented or used by the service providers and consumers.

The Blue and Purple Profiles are not included in this SESAR solution.

SESAR defines SWIM as follows 1:

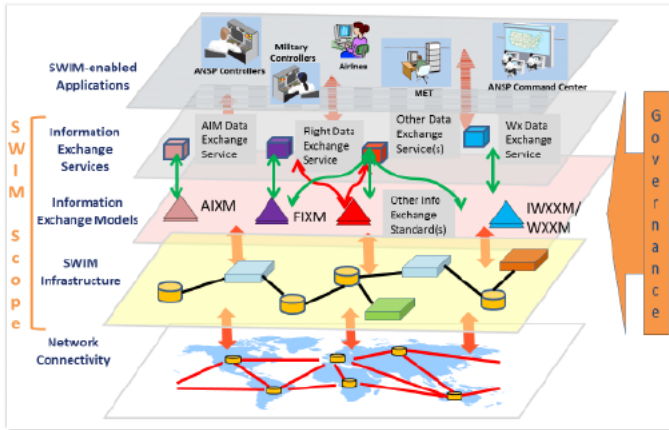
SWIM (System Wide Information Management) consists of standards, infrastructure and governance enabling the management of ATM information and its exchange between qualified parties via interoperable services.

This definition embodies the fact that Information Systems Interoperability, especially in the ATM context, is a complex topic that can be decomposed according to three different perspectives: systems, data and governance. Starting from data perspective different interoperability levels including (but not limited to) Semantic Interoperability, Syntactic Interoperability and Technical Interoperability can be identified. According to its definition, SWIM scope covers mainly (is not limited to) syntactical, semantic and technical interoperability levels (refer to figure here below).

¹ SESAR SWIM definition has also been adopted by ICAO
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As the SWIM definition highlights, different elements, targeting interoperability at different levels, need to be considered:

- ATM information model, representing the standard definition of all ATM information, through harmonised conceptual and logical data models. In the context of the SESAR Programme, this is instantiated in the AIRM (ATM Information Reference Model);
- ATM services model representing the logical breakdown of required information services and their behavioural patterns. These services are also called ATM-specific services. In the context of the SESAR Programme, this is instantiated in the ISRM (Information Service Reference Model);
- Information management functions (including governance), such as operational and organisational functions for the management of user identities, discoverability of resources, security aspects such as authentication, encryption and authorisation, notification services and registration. These functions need to be defined to support information sharing. The SWIM governance functions affect almost all of the roles and their interactions within the European ATM system;
- Physical infrastructure, named the SWIM Technical Infrastructure (SWIM-TI) in SESAR, which is the interoperable (runtime) infrastructure (ground/ground and air/ground) via which ATM services are provided and consumed. Its implementation may, depending on the specific SWIM profile, differ from one stakeholder to another, in terms of both the scope and the type of implementation. The SWIM Technical Infrastructure relies on the underlying IP Network infrastructure and will mostly be based on off-the-shelf (OTS) standards-based and interoperable products and services. It is however possible that in some cases specific software may need to be developed;
- SWIM-enabled applications: the application of SWIM standards and principles to the interfaces of ATM applications enables ATM business benefits by assuring the provision of commonly understood quality information to the right people at the right time.

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As depicted in the figure, the last point is not considered as part of the “SWIM” layer but it is anyway an essential point of the whole picture as the final aim of the “system” is to allow seamless interoperability among ATM applications (therefore, called “SWIM Enabled” applications).

To enable proper information sharing, the SWIM-TI is built by specific technical elements identified and implemented in accordance with the needs of each ATM system and service. Given the complexity of the ATM (many different systems, data domains, different flight phases, etc.), the systems and services, based on their business needs, may not have the same requirements:

- heterogeneous involved stakeholders, financial and organisational capabilities;
- heterogeneous constraints from involved systems;
- competitive Requirements (e.g. Security versus performance, Reliability versus cost);
- in different contexts, multiple versions and configurations of the same standard technology could be used.

Taking into account the above considerations, one key principle of SWIM-TI design is: "One size does not fit all". A governance process takes all technical interoperability needs of the System of Systems (SoS) into consideration and segments these needs into smaller groups for each of which a satisfactory uniform solution can be defined. The results of this process is the profiling of SWIM-TI consisting of different set of requirements grouped in three different SWIM Profiles: Yellow, Blue and Purple profiles. In a wider setting, the SWIM Profiles are also used to assemble SWIM-TI functionalities into coherent ‘right-sized’ solutions that meet the needs of the stakeholders, systems and services. By doing that, unwanted or unnecessary functionality/complexity is not included in the scope of a given profile.

The above description and considerations apply in general to the SWIM-TI and to all the three Profiles defined in SESAR. However, this solution (“SWIM Technological solution”) holds all the various SESAR artefacts that, at the different levels defined before, allow a proper description of the so called **“SWIM Technological Solution” covers only the SWIM Yellow profile**, which is targeted at:

- support for a wide variety of interactions in a flexible manner and that is affordable for the service consumer;
- the interaction must be able to run over Internet and must be sufficiently secured;
- primarily, use of technology based on the Web Services stack of standards;
- the technology must be supported out-of-the-box by mainstream development frameworks as well as mainstream execution frameworks;
- keeping as many options open as possible with respect to the deployment

while explicitly not targeted at contexts that require/impose:

- real-time or near real-time uses;
- extremely high availability;
- severe constraints (e.g. available resources).

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The scope, rationale and structure of the Yellow Profile are detailed in the related SWIM Profile Assertion (SPA). The latter represents the top-level element driving the specification of normative requirements concerning the SWIM-TI technical view fitting the Yellow Profile scope.

Any implementation of the SWIM Yellow Profile should implement or make use of the following SWIM-TI functionalities:

Functionality	Brief Description	Applicable SWIM Profiles
<i>Messaging</i>	SWIM-TI Messaging aims at providing decoupled communication and interoperability between distributed systems including features for effective and reliable communication.	Blue Profile Yellow Profile Purple Profile
<i>Security</i>	SWIM-TI Security provides technical functions enabling the Access Control (AAA - Authentication, Authorization and Audit) and Data Protection in a federation of security domains.	Blue Profile Yellow Profile Purple Profile
<i>Supervision</i>	The SWIM-TI Supervision provides all SWIM related supervision functions collocated with the system	Blue Profile Yellow Profile
<i>Recording</i>	The SWIM-TI Recording includes the ability to collect, store and on demand retrieval of information related to communication being performed via the SWIM Interfaces and related to supervision actions and events	Blue Profile Yellow Profile
<i>Registry</i>	The Registry allows retrieving META Information about Services and ATM Information provided by them. It also provides discovery/subscription, publication, classification, management (including create, delete, updated, read) and deployment functions for diverse entities such as policies, standards, certifications and categories.	Blue Profile Yellow Profile Purple Profile

The technical view (the “what” and “how good”) of the Yellow Profile is built in accordance with the Profile Part ontology. The Yellow Profile is composed by one mandatory Profile Part (“Core”) and three optional Profile Parts: "Security+", "Advanced" and "Messaging+". The scope of each profile part and the way the different profile parts can be composed, are detailed in the Yellow Profile Technical Specification. Here below a summary is provided:

- "Core" YP:
 - Functional Requirements that can easily be met with out-of-box technology solutions;
 - Non-Functional Requirements based on what is commonly available today in a more or less out-of-the-box manner;
 - Broadly supported elements of the Web Service stack of standards;
 - Support for AMQP v1.0 messaging technology;
 - Support for big data sets and binary data;
 - Broadly supported compression techniques;
 - PKI based security solutions;
 - Support for message signing to satisfy integrity and authenticity needs.

- "Security+" Profile Part for the YP:

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- Only depends on the "Core" Profile Part and it does not depend on any other set of requirements and can be combined with any other Profile Part in the Yellow Profile.
- Scope:
 - Support for Federated security and Policy Management;
 - (More) strictness on TLS (Transport Layer Security);
 - (More) strictness on symmetrical/asymmetrical Keys;
 - (More) strictness on security patching capabilities.
- "Advanced" Profile Part for the YP:
 - Only depends on the "Core" and it does not depend on any other set of requirements and can be combined with any other Profile Part in the Yellow Profile.
 - Scope:
 - Additional Messaging functional requirements (e.g. message persistence, subscriber persistence);
 - Higher availability;
 - Lower maximum transit time in the SWIM-TI.
- "Messaging+" Profile Part for the YP:
 - Only depends on the "Core" and it does not depend on any other set of requirements and can be combined with any other Profile Part in the Yellow Profile.
 - Scope: support for additional Message Exchange Patterns.

Operational Improvement Steps (OIs) & Enablers

- IS-0901-A SWIM for Step1

Relevant enablers are listed below:

- SWIM-INFR-05a: General SWIM Services infrastructure Support and Connectivity
- SWIM-SUPT-01a: SWIM Supporting Registry Provisions
- SWIM-SUPT-03a: SWIM Supporting Security
- SWIM-STD-04: SWIM Technical Infrastructure profiles

Applicable Integrated Roadmap Dataset is DS16.

Background and validation process

The SESAR Solution has been validated through a series of activities which include both "informal" (from the formal SESAR Programme Validation process point of view) initiatives and utilisation of the SWIM Technical Infrastructure in multiple (formal) validation exercises

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which were required to use SWIM Services. In the same way different SESAR logical services included in ISRMS have been used in some formal validation exercises.

From the start of the programme, in fact, multiple SESAR Programme internal and external interoperability demonstrations have been held. They include:

- Yearly WP14 SESAR Program internal SWIM Demonstrations;
- World ATM Congress SWIM Demo in March 2013;
- Yearly SWIM Master Classes (starting from 2012);
- Participation to MiniGlobal II and SWIM Global Demonstration (2016).

Nevertheless, SWIM Technical Infrastructure implementations have been used in a number of Validation Exercises which, while they were primarily targeting specific subjects (e.g. Airport systems, Integrated Briefing systems etc.), did also allow to validate the SWIM Technological solution and the adherence to the prescribed (SWIM) standards (spanning multiple levels – e.g. data representation, interface representation, transport level etc.).

Mainly starting from 2014, a number of “SWIM Enabled” Validation exercises have been executed in the programme which allowed to demonstrate, along their specific primary objectives, the maturity of this solution.

Examples of such exercises are:

- Basic XMAN (Extended Arrival Management) V3 live Trials held in DSNA, Reims;
- Advanced Short Term ATFCM including Network Supervision and interface with Local Tools, held in ECTL, Brussels;
- Digital Integrated Briefing for all phases of flight, held in Frequentis, Vienna;
- Close out Airport Integration through SWIM, held on ENAV, Milan Malpensa;
- MET-related Information & Alerting in the Management of Adverse Weather Conditions, held in ENAV, Rome;
- Airport Performance Monitor services and integration of AMAN (Arrival Manager) DMAN (Departure Manager) SMAN (Surface Manager) and RMAN (Runway Manager) information in the A-CDM and provision of Airport Operation and CDM alerts/warnings.

Results and performance achievements

The concept of ‘System Wide Information Management’ - SWIM - covers a complete change in paradigm of how information is managed along its full lifecycle, involving stakeholders from across the whole European ATM network.

SWIM is SESAR's most important enabler for assuring that the right information will be available with the right quality to the right person at the right time. It covers all ATM information, including aeronautical, flight, aerodrome, meteorological, air traffic flow, and surveillance. SWIM consists of standards, infrastructure and governance enabling the

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management of ATM information and its exchange between qualified parties via interoperable services.

Benefits

Safety – All stakeholders will share access to the information they need, including more reliable information about the future state of the ATM system and its environment. Greater automation of ATM will allow air traffic controllers to focus more on monitoring and contingency planning and this will also reduce data entry errors.

Cost efficiency – As the SWIM concept grows in maturity, standardisation and re-use of services between systems as well as the reduced duplication in managing the same information in multiple systems will bring down system operating costs for all ATM stakeholders.

Environmental impact – Increased predictability of air traffic movements and infrastructure usage at the airport will lead to optimised usage of resources which will have a positive impact on the environment.

Improved contextual awareness - Improved access to context will assure that the right information will be available with the right quality to the right person at the right time. Developed SWIM taxonomy and infrastructure/architecture makes this possible.

Collaborative Decision Making – SWIM creates collaboration opportunities between all the ATM stakeholders to address the aviation’s problems to be discussed together and allows them to decide together when required.

Recommendations and Additional activities

The following activities are relevant once transitioned to industrialization (V4):

- Definition of the required standardisation framework. This means that, in particular from an Industrial point of view, it will be important to precisely formalize which are the standards/requirements the industry will be expected to implement. As already mentioned, as SWIM spans multiple levels, it is important to fix at which extent the SWIM Technological solution will be governed and constrained by which standards.
- Recommend the Stakeholders to use the SWIM Compliance Framework to ensure compliance for SWIM Service and/or SWIM Technical Infrastructure.
- It is recommended that future evolutions (e.g. standardization, industrialization, SESAR2020, etc.) will be carried on by applying the same criteria, principles and design process adopted in SESAR 1. In other words, even if the SWIM-TI ontology

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and SWIM Profiles may be further refined, it is recommended to avoid changes that may violate constitutive aspects/elements.

- It is recommended that future evolutions will be carried on by applying the same approach of governed logical services, based on a governed foundation, as in SESAR.
- Refine security aspects in the context of industrialization and deployment phases.

Actors impacted by the SESAR Solution

SWIM spans all roles/actors in the ATM Domain. At the moment, anyway, only the Aircraft is considered not directly impacted by this Solution (SWIM Purple Profile, which will be further progressed in SESAR2020, will allow direct inclusion of the aircraft in SWIM).

Impact on Aircraft System

No direct impact foreseen.

Impact on Ground Systems

New and future ATM services provided by (ground) ATM systems should be designed in accordance with:

- At logical level: ISRM Foundation and, where already available, ISRM services
- At technical level: appropriate “Profile Part” and “Interface Bindings” (i.e. to functional, non-functional and interface requirements) as included in [9].

Regulatory Framework Considerations

EU already published in 2014 a dedicated regulation (EU I/R 716/2014) which includes provisions, applicable to the different stakeholders specified in the regulation itself, related to SWIM and SWIM Yellow Profile in particular.

Furthermore, EASA Rulemaking Programme includes rulemaking projects necessary to support the regulatory needs stemming from the PCP/SESAR deployment, in particular RMT.0682 to enable the timely deployment of the ATM functionalities and other operational changes stemming from SESAR and the European ATM Master Plan, if/as needed.

Standardization Framework Considerations

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In order to guarantee a successful deployment of the solution a number of standardisation efforts will be required. Such efforts can span at different levels as SWIM, by its nature, embraces ATM Domain at multiple levels.

A non-exhaustive list of initiatives that could be further expanded/complemented depending on stakeholder's needs and willingness (e.g. depending on future SWIM Governance body "decisions") is provided hereafter:

- EUROCAE WG-104 (AMAN SWIM Service) – similar Working Groups could be activated for other SWIM services.
- Standardisation of SWIM Profiles (specifically for this solution, the SWIM Yellow Profile)². EUROCONTROL officially kicked off the SWIM standardisation activity on September 7th, 2016, calling for EUROCONTROL Specifications and Guidelines on SWIM Foundation, AIRM, AIRM Rulebook, ISRM Rulebook, SWIM Compliance and TI Yellow Profile, with the objective to launch public consultation for the EUROCONTROL Specifications and relevant Guidelines.

Considerations of Regulatory Oversight and Certification Activities

This kind of considerations should be in charge to the "SWIM Governance Body" currently executing under the umbrella of the SESAR Deployment.

Solution Data pack

The Data pack for this Solution includes the following documents:

- [1] 08.01.01-D55 SWIM Registry design-time requirements
- [2] 08.01.03-D47 AIRM v4.1.0 (for global reference)
- [3] 08.03.10-D65 ISRM v2.0 (for global reference)
- [4] 14.01.03-D30 SWIM (GG AG) Architectural Definition - Final
- [5] 14.01.03-D39 SWIM Profiles - Final
- [6] 14.01.04-D44-001 SWIM-TI Technical Specifications Catalogue
- [7] 14.01.04-D44-002 SWIM-TI Identity Management Technical Specification
- [8] 14.01.04-D44-004 SWIM-TI Yellow Profile Technical Specification

² According to the (EC) No 716/2014 – Article 4(B) Eurocontrol will be responsible from the standardization activities.

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