Work Package Final Report

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Abstract

The SWIM Technical Architecture Work Package (WP14) has defined and verified the technical infrastructure solution for SWIM addressing the requirements received from WP8 (Information Management). This has been achieved in coordination with the system WPs to ensure that they develop appropriate interfaces with SWIM. The architecture is part of the overall technical architecture description in the European ATM Architecture (EATMA) managed by B04.03.

WP14 has contributed to the development of a first set of SWIM services.

It has supported the SWIM-enabled validation exercises and disseminated the results achieved on SWIM, thus turning the SWIM concept into first deployable solutions. Where needed, some solutions will be further matured in SESAR 2020.

It has also participated in the definition of the future SWIM governance.

WP14 has been managed by Thales, Selex and Indra, in close coordination with the SJU.

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
AF	ATM Functionality
AIRM	Aeronautical Information Reference Model
ATM	Air Traffic Management
ATMRPP	Air Traffic Management Requirements and Performance Panel
BP	Blue Profile
ConOps	Concept of Operation
COTS	Commercial Off The Shelf
DDS	Data Distribution Service
DS	Data Set
EATMA	European ATM Enterprise Architecture
ENB	Enabler
FAA	Federation Aviation Administration
IR	Industrial Research (SESAR 2020 projects)
IOP	Interoperability
ISRM	Information Service Reference Model
iSWIM	Initial SWIM
IT	Information Technology
OFA	Operational Focus Area
OI	Operational Improvement
OMG	Object Management Group
PCP	Pilot Common Project
PJ.nn	(SESAR 2020 Project No. nn
PKI	Public Key Infrastructure
PM	Project Manager
R&D	Research and Development

Rn	Release n
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SOA	Service Oriented Architecture
SWIM	System Wide Information Management
SWIM-TI	SWIM Technical Infrastructure
SWP	Sub Work Package
TAD	Technical Architecture Description
TM	Technical Manager
TRL	Technology Readiness Level
TS	Technical Specification
VLD	Very Large Demonstration (SESAR 2020 projects)
WP	Work Package
YP	Yellow Profile

1 Work Package Overview

The SWIM Technical Architecture Work Package (WP14) has defined and verified the technical infrastructure solution for SWIM addressing the requirements received from WP8 (Information Management). This has been achieved in coordination with the system WPs to ensure that they develop appropriate interfaces with SWIM. The architecture is part of the overall technical architecture description in the European ATM Architecture (EATMA).

WP14 has contributed to the development of a first set of SWIM services.

It has supported the SWIM-enabled validation exercises and disseminated the results achieved on SWIM, thus turning the SWIM concept into first deployable solutions. Where needed, some solutions will be further matured in SESAR 2020

It has also participated in the definition of the future SWIM governance, and the SWIM compliance framework.

Note: this report is aligned with the SESAR Program Baseline N°7.0 Release Note (29th January 2016 Ed 07.00.00) consistent with Dataset 15 [7].

1.1 Work Package contribution to the Master Plan

SWIM represents a complete paradigm change in how information is managed along its full lifecycle and across the whole European ATM system. Building on the best practices from different information communities, the aim of SWIM is to provide information users with relevant and commonly understandable information. SWIM is SESAR's most important enabler for assuring that the right ATM information will be available with the right quality to the right person at the right time, thus significantly improving decision-making by the Air Transport stakeholders during strategic and tactical phases of flight.

WP14 is part of the SESAR ENB02.01.01 SWIM "OFA".

WP14 has been a key contributor to the "Initial SWIM" solution (#46), which encompasses the development of information exchanges services and covers the following elements:

- SWIM governance,
- SWIM security,
- SWIM technical infrastructure and profiles,
- SWIM foundation,
- The ATM Information Reference Model (AIRM),
- The Information Service Reference Model (ISRM).

WP14 has mainly contributed to the OI Step IS-0901-A (SWIM for Step1) belonging to OFA ENB02.01.01 (SWIM), which includes the provision of the following capabilities:

- Ground-ground flight coordination and transfer functions between En-Route systems based on ED-133 flight object concept (ATC-to-ATC profile).
- Business-to-Business services to share traffic flow management information (including the capability to fill and validate flight plans) between the Regional NM / AM and APOC, FOC (CFMU B2B Profile).

- Business-to-Business services to share Aeronautical information between the EAD (as part of Regional NM / AM) and ER-APP-ATC, Airport Airside Operations, FOC/WOC (EAD B2B Profile).

- New information exchange standards.

The Technical Enablers of OI step IS-0901-A (Dataset 15 [7]) to which WP14 contributed is summarized in the following table.

EN Code	Name	WP14 contribution
A/C-57	On-board migration from existing air-ground data link to air-ground SWIM for AIS/MET services	P14.02.01 - SWIM Middleware It provided inputs to implement a test bed enabling to assess A/G SWIM Deployment Options.
ER APP ATC 160	ATC to ATC Flight Data Exchange Using Flight Object	Indirect contribution from P14.02.09 - SWIM Platform development and Demonstrator delivery (Main contribution: P10.02.05).
GGSWIM-10c	SWIM Supervision for Step3	P14.02.03 - SWIM technical supervision
GGSWIM-51c	SWIM Ground-ground messaging services in Step3	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-APS-05a	Provision and Consumption of Flight Object Sharing services for Step 1	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-APS-05b	Provision and Consumption of Flight Object Sharing services for Step 2	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-INFR-01a	High Criticality SWIM Services infrastructure Support and Connectivity	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-INFR-01b	High Criticality SWIM Services infrastructure Support and Connectivity	P14.02.09 - SWIM Platform development and Demonstrator delivery

EN Code	Name	WP14 contribution
SWIM-INFR-05a	General SWIM Services infrastructure Support and Connectivity	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-INFR-05b	General SWIM Services infrastructure Support and Connectivity	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-INFR-06b	AIR/GROUND SWIM Services infrastructure Support and Connectivity	P14.02.09 - SWIM Platform development and Demonstrator delivery
SWIM-SUPT-03a	SWIM Supporting Security Provisions	It has contributed to SWIM-SUPT-03a - SWIM Supporting Security (SWIM Technical infrastructure to support transport and message level security, identity management (local and federated) to provide authentication and authorization, use of public key cryptography (PKI).
SWIM-SUPT-03b	SWIM Supporting Security	It has contributed to SWIM-SUPT-03b - SWIM Supporting Security (SWIM Technical infrastructure to support transport and message level security, identity management (local and federated) to provide authentication and authorization, use of public key cryptography (PKI).
SWIM-SUPT-06b	SWIM Supporting Supervision	It has specified the SWIM supervision at local level for the following functionalities: Configuration Management, Fault Management, Performance Management, Security, Legal Recording).

1.2 Work Package achievements

WP14 has contributed to:

- Technical SWIM-TI reference specifications which constitute the reference for future implementation of SWIM Technical Architecture (at least in Europe) as required by the PCP. This reference baseline is broken down as follows:
    - SWIM Technical Infrastructure (SWIM TI) architectural/design definition made of Functional Blocks associated with capabilities (Messaging, Security, Supervision, Recording, Shared Object, Registry, Public Key Infrastructure, and Bridge Certification Authority),
    - SWIM profiles (Yellow, Blue) 1,

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1 The SWIM-TI profiles define a coherent grouping of communication middleware functions and services for a given set of technical constraints. The Blue Profile targets real-time or near real-time

- o Agreed terminology and definitions of the terms used for SWIM,

- o Functional and Non Functional requirements for the SWIM-TI and its interfaces,

- o Design principles (e.g. Accessibility, Equity, Flexibility, Performance, etc.) consistent with the Service Oriented Architecture (SOA) main concepts,

- o Technical Specifications applicable to the Identity Management, Run-Time Registry, Yellow Profile, Blue Profile and Purple Profile).

- SWIM-TI compliant Prototypes implementing the Yellow and Blue profiles, supporting numerous SWIM-enabled Validation Exercises and Demonstration activities. The number of these exercises significantly increased in 2015 and 2016, reflecting a growing interest of the operational projects for SWIM.

- Evaluation of different SWIM-TI architectural solutions, including on early implementations of cyber-security functions.

- Delivery of the iSWIM (initial SWIM) Technology solution (SESAR solution #46) as part of the PCP (Pilot Common Project) to the Deployment Manager for a first deployment of SWIM (AF#5):

- o The Yellow SWIM Profiles has reached Technology Readiness Level 6 (TRL6) maturity,

- o The SWIM-TI Blue Profile has achieved TRL5,

- o WP14 contributed to the SWIM design-time registry (for discovering and managing access to SWIM services) which has reached TRL6.

- Inputs for Standardisation and contributions to standardisation bodies (refer to §1.4).

- Dissemination of the main outcomes of the SESAR SWIM activities within and outside the SESAR community, thanks to a wide range of efficient communication actions which have enabled to progressively involve more and more stakeholders in the uptake of SWIM and its early deployment. This has been achieved through a number of different channels and initiatives like "fact sheets", publication of news on Social Media, participation to or organization of workshops and large international "events" which attracted a number of stakeholders (e.g. World ATM Congress SWIM Demo, SWIM Master Class events, participation in FAA Mini Global II and SJU SWIM Global Demonstration).

WP14 has contributed to positively influencing evolution of ATM operations or bringing additional operational services which have a direct impact on ATM operations.

It has contributed to increasing the following performance characteristics:

- Cost Effectiveness: SWIM deployment will provide all the ATM stakeholders with a common interoperability solution reducing eventually the total cost of ownership of the external communication means of their systems.

- Access & Equity: The overall SWIM solution brings an equal access to the shared information to any stakeholder that is connected. The access cost is independent of the stakeholder and minimised by the use of a commonly deployed solution.

- Interoperability: SWIM will accelerate the level of interoperability between systems through the adoption of standards, infrastructure and governance by all the stakeholders.

- Security: SWIM deployment will conduct to a harmonisation of security solutions implemented in ATM systems in Europe. Security related risks added specifically by the introduction of SWIM will be addressed ensuring the solution does not degrade the current situation.

communications with demanding performance and security requirements, whereas the Yellow Profile targets less demanding communications.

## 1.3 Work Package Deliverables

The following table presents the relevant deliverables that have been produced by the Work Package management team (if any).

Reference	Title	Description
[4]	14.00 D15-005, Work Package Management Plan (WMP), Edition 00.01.00, 21/12/2015	Management Plan for WP14 – System-Wide Information Management, 5th and last release. The WP14 MIR Management Initiation Report, SESAR JU Plans and Guidelines, and previous WP 14 Management Plan were initially used as inputs to build this WMP. The WMP defines in more detail the organisation of the WP, the roles and responsibilities of Management Team members (GM, TM and SWPMs) and a number of processes and guidelines to be applied within the Work Package on issues such as, but not limited to, reporting, meetings, data management, communication, quality and management of actions.
[5]	14.01 D06, Work Package Management Plan (WMP), Edition 00.01.00, 28/01/2013	Management Plan for SWP14.01
[6]	14.02 D09-001, Work Package Management Plan (WMP), , Edition 00.01.00, 02/05/2011	Management Plan for SWP14.02

1.4 Contribution to Standards and Reference Material

ICAO adopted the SESAR (WP14) definition of SWIM: "SWIM consists of standards, infrastructure and governance enabling the management of ATM-related information and its exchange between qualified parties via interoperable services".

This definition reflects the importance of standardisation in the different SWIM layers (SWIM TI, Information, services) in order to ensure interoperability, and for the governance. SWIM standardisation builds upon an already sound basis of already proven mainstream IT standards supported by COTS or open sources.
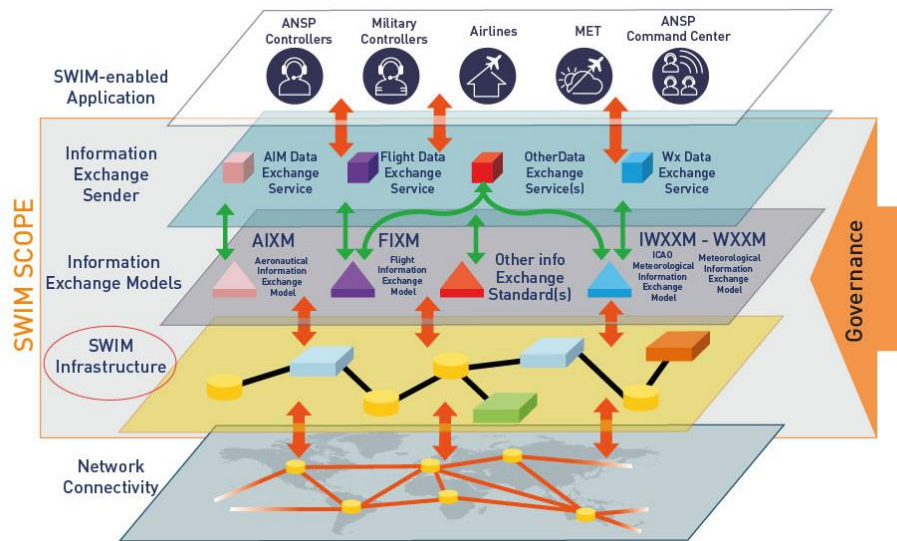
Several years of active R&D by key players, in particular in Europe (SESAR) and in the US (NextGen) have enabled to start coordinated standardisation (e.g. through ICAO), aligned with the SESAR Master Plan.

WP14 has focused its contribution to providing inputs for the standardisation of the SWIM TI, in addition to its participation in the working groups dealing with the other layers and the governance.

In particular, WP14 has contributed to the following working groups:

- EUROCAE WG-59 ED-133 (Flight Object Interoperability Specification),

- EUROCAE SWIM Task Force (update of the strategic line),

- EUROCAE WG-104 (AMAN SWIM Service),

- SESAR IOP Analysis team: in charge of baselining the IOP specifications which will be used by the SESAR2020 IOP-related projects and will later feed EUROCAE WG-59 for the revision of ED-133. WP14 has participated in the specification and verification of the IOP middleware (SWIM Blue Profile).

- DDS (Data Distribution Service) Security related requirements. The DDS middleware is used in the SESAR Blue Profile to distribute the Flight Objects between stakeholders. The DDS security specification deals with the encryption of the Flight Object transmission. The testing of the implementation unearthed incompatibilities which were raised to OMG for correction in the DDS specification.

In addition, WP14 has played a key role by developing SWIM Systems Engineering deliverables (Technical Architecture Document, SWIM-TI Technical Specifications, and SWIM Profiles Instantiations) that are key inputs to SWIM standardisation. It is expected that those deliverables will be translated into EUROCONTROL standards as they are already "binding" at SESAR Deployment level.

1.5 Work Package Conclusion and Recommendations

SWP14.00 has contributed to the appropriate management of its different projects, supporting and guiding them into the appropriate integration and contribution to the programme.

Overall, WP14 has delivered in line with its objectives set out at the beginning of SESAR concerning SWIM Technical Infrastructure as a key component to support Information Management and

Information Exchange Services, with some tuning to adapt to the feedbacks received during the course of the programme.

WP14 has produced an agreed reference technical specification (design/architecture, SWIM Blue / Yellow and Purple profiles, and technical specifications) of the SWIM-TI which will be a key input for concrete implementations.

WP14 has been a major actor in the development of SWIM solutions, and in particular initial SWIM ("iSWIM") combining information exchanges services, SWIM governance, SWIM security, SWIM technical infrastructure and profiles, SWIM foundation, ATM Information Reference Model (AIRM) and Information Service Reference Model (ISRM). This iSWIM technological solution is part of the Pilot Common Project (PCP) and is included in the "SESAR Deployment Programme 2015" thus complying with the "Commission Implementing Regulation (EU) No 716/2014".

Regarding SWIM supervision, it has been specified so far at local level (Configuration Management, Fault Management, Performance Management, Security, and Legal Recording).

WP14 recommendations are as follows:

- Take forward in SESAR 2020 the solutions that did not yet achieve TRL6 maturity by undertaking the following SWIM TI related R&D activities:

    o Integration of the military actors using SWIM,

    o Enhancement of the air-to-ground capabilities,

    o Development of the SWIM run-time registry,

    o Cyber security work to contribute to solutions reducing SWIM exposure to threats.

- Support the SESAR 2020 IR and VLD projects to ensure that SWIM will be used as an integral part of their solutions involving multiple ATM stakeholders. This will enable them to take benefit of the integration of SWIM services and prototypes in ATM systems.

- Pursue the communication and dissemination activities to maximize the impact of the results of SWIM on the future users, in particular:

    o Keep the other relevant SESAR2020 projects updated of the SWIM achievements,

    o Coordinate with the Deployment Manager to support the deployment of SWIM-related solutions, and take benefit of the feedback on the already delivered SWIM-enabled solutions.

    o Strengthen global SWIM cooperation and standardisation with international bodies involved in the SWIM area (e.g. FAA, ICAO for global interoperability and the SWIM Governance body).

    o Continue to organise or participate in communication actions such as those carried out in SESAR1, and in particular develop communication material for distribution at exhibitions, workshops and other events.

2 References

[1] SESAR Programme Management Plan

[2] European ATM Master Plan

[3] Multilateral Framework Agreement ("MFA") signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

[4] 14.00 D15-005, Work Package Management Plan (WMP), Edition 00.01.00, 21/12/2015

[5] 14.01 D06, Work Package Management Plan (WMP), Edition 00.01.00, 28/01/2013

[6] 14.02 D09-001, Work Package Management Plan (WMP), Edition 00.01.00, 02/05/2011

[7] B.01 D83, Integrated Roadmap - DS15 Release Note, Edition 00.01.00, 21/12/2015

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