



Final Project Report

Document information

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Abstract

The purpose of the P10.02.05 was to define Technical Requirements derived from the operational requirements and develop verified prototypes for Interoperability in order to support validation exercises performed by Integrated and pre-operational validation & cross validation project and the Trajectory Management Framework Operational Focus Area.

The Interoperability and 'Flight Object' (FO) is a concept to support the sharing of consistent flight data between all stakeholders. Its purpose is to ensure that all systems have a consistent view of the flight, and that the data is widely and easily available

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
ADS-C	Automatic Dependent Surveillance-Contract
ANSP	Air Navigation Service Providers
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATSU	Air Traffic Service Unit
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
CTA	Controlled Time Arrival
DFS	Deutsche Flugsicherung
DSNA	direction des Services de la navigation aérienne
ENAV	Ente Nazionale Assistenza al Volo
EUROCAE	European Organization for Civil Aviation Equipment
FO	Flight Object
IBP	Industry Based Platforms
i4D	Initial four dimension
IOP	Interoperability
MUAC	Maastricht Upper Airspace Control
NM	Network Manager
OFA	Operational Focus Area
OLDI	On-Line Data Interchange
OIs	Operational Improvements
RBT	Reference Business Trajectory
RTA	Required Time of Arrival
SESAR	Single European Sky ATM Research
TMA	Terminal Manoeuvring Area

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TMF	Trajectory Management Framework
TS	Technical Specification
4D	Four Dimension

1 Project Overview

The main project objectives were:

- Demonstrate the suitability of the Flight Object to implement the SESAR Reference Business Trajectory within the En-Route and Terminal Manoeuvring Area domains.
- To provide prototypes to support the validation of the Operational Improvement regarding to the (initial Reference Business Trajectory) Agreed Reference/Mission Trajectory through Collaborative Flight Planning and the Operational Improvement Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue.
- To provide deliverables to support the implementation of ground-ground flight data exchange between Air Traffic Control units through the use of Flight Object services as defined by the Flight Object in EUROCAE Ed.133 [44] inside the Operational Focus Area related to the Trajectory Management Framework and System Interoperability with air and ground data sharing .

The project was focused on supporting validation exercises for validation seamless operation among different centres performing coordination and transfer functions, as well as Point and Skip functionality based on the flight object interoperability,.

The project also worked to support the Interoperability (IOP) allowing the sharing a whole common Flight Object (i.e. far richer information) instead of a specific subset of current flight plan information defined in several On-Line Data Interchange (OLDI) messages as well as supporting the Validation of the impact on the Air Traffic Controller activities due to the complete and continuous Flight Object synchronisation.

Finally the project also supported the availability of Initial 4D data and an improved mechanism to distribute information via the Flight Object (FO) provides an opportunity to feed Arrival Management systems with up-to-date flight information and to use the capabilities of Required Time of Arrival (RTA) equipped aircraft to fly very accurately to metering fixes in order to sequence the arrival flow.

For the specific i4D Data Link technology aspects (i.e. ADS-C and Control Pilot Data Link Communications compliant to Aeronautical Telecommunication Network (version B2) this project relied completely on the deliverables as provided by project regarding to the Enhanced Data link Features for all phase of flight.

1.1 Project progress and contribution to the Master Plan

The work undertaken by the project was done through three phases using the same pattern in all of them. First of all, the project worked analysing the operational documentation in order to translate the operational requirements into system requirements. Based on the technical specification and the requested capabilities to support the validation exercises (from the validation plans), prototypes were developed. After the verification of the prototypes the support to the operational validations started. During this step technical support was essential to integrate the prototypes into the industrial based platform used for the validation. After the validation exercises were finished and conclusions were ready, an update of the technical requirement was done if applicable.

During the first phase industry prototypes were defined addressing the baseline operational requirements from ANSPS included in the deliverable "TMF/IOP Technical Note for 2014" [43] developed by the SESAR pre-operational validation & cross validation operational Project dealing with the Trajectory Management Framework.

The elaboration of the Interoperability Technical Specification was done in an stepwise approach (6 Technical Specifications) , providing updated versions of the Interoperability Technical Specifications

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according with the Operational Requirements defined for each of the validation exercises performed by Integrated and pre-operational validation & cross validation project.

During the second phase industry prototypes were developed within the project:

- First prototypes were developed and verified addressing the system requirements defined for Air Traffic Control -Air Traffic Control Interoperability concept to support the seamless operation among different centres performing coordination and transfer functions as well as Skip an Air Traffic System Unit and Point Flight functionality.
- Prototype was developed and verified addressing the system requirements defined for Air Traffic Control -Air Traffic Control interoperability concept to support i4D exchanges in a cross border environment.
- Prototype was developed and verified addressing the Air Traffic Control - Network Manager Interoperability.

During the third phase the second above mentioned prototypes developed in the previous phase were updated to adapt it and integrate it into the specific ANSP's IBP in order to provide support for the execution of the different exercises belonging to the Integrated and pre-operational validation & cross validation project.

With the system requirements and the prototypes developed the project contributed to increase the level of maturity of the following Enablers included in DataSet15 [4]

Code	Name	Project contribution	Maturity at project start	Maturity at project end
ER APP ATC 160	ATC to ATC Flight Data Exchange Using The Flight Object	The project contributed with the support of a validation exercise by providing fully verified prototypes and platforms and by the definition of technical requirements related to the enabler.	TRL1	TRL4
ER APP ATC 162	ATC Flight Data Exchange with NM Using the Flight Object	The project contributed with the support of a validation exercise by providing fully verified prototypes and platforms and by the definition of technical requirements related to the enabler.	TRL1	TRL2

The Maturity at project end for the Enabler ER APP ATC 160 is TRL4 based on the results obtained during the execution of the several Interoperability exercises between Air Traffic Control Centres during the project.

The Maturity at project end for the Enabler ER APP ATC 160 is TRL2 based on the results obtained during the execution of one exercise regarding to the Interoperability between Network Manager and one Air Traffic Control Centre during the project.

Main SESAR Solutions which have been matured with project contributions is:

SESAR Solution #28 (Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing) inside the ENB03.01.01 TMF

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1.2 Project achievements

The project achievements were focused mainly in IOP prototypes definition and developments which can be broken down in the following threads:

- Elaboration of a Interoperability Technical Specification containing the system requirements to be implemented for Air Traffic Control-Air Traffic Control Interoperability, i4D operations and Air Traffic Control-Network Manager Interoperability in stepwise approach (6 Technical Specifications), to support the execution of the exercises regarding to the IOP Validation, Seamless Cross-border Operations, Air Traffic Control /Air Traffic Control Skip Air Traffic Service Unit and Point Flight Operations, Air Traffic Control Interoperability with i4D+Controlled Time Arrival and Air Traffic Controller-Network Manager Trajectory Alignment
- To develop and verify Interoperability prototypes to provide support to Air Traffic Control-Air Traffic Control Interoperability, Air Traffic Control-Air Traffic Control interoperability with i4D and Current Time Arrival (CTA) and Air Traffic Control -Network Manager exercises with incremental developments maturity and scope.
- To integrate into the specific Air Navigation Service Provider IBPs the Interoperability prototypes to support the execution of Air Traffic Control-Air Traffic Control Interoperability, ATC-ATC interoperability with i4D and Current Time Arrival and Air Traffic Control -Network Manager exercises.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D55	IOP ATC System Requirements (Final IOP TS)	<p>This document is the Final Technical Specification for Interoperability for SESAR1. This document is an incremental update from the previous technical specifications performed in the project. It includes system requirements mainly for ATC-ATC Interoperability.</p> <p>The document contains the technical requirements regarding to the ATC-ATC Interoperability regarding to the Coordination and transfer, Flight Data Manager, Flight Data Contributor and Flight Data User roles. Additional requirements are defined regarding to the What -if Flight Object concept and the exchange of the Flight Object within the System Wide Information Management infrastructure..</p> <p>The maturity of the Interoperability requirements is provided with two levels, TRL2 and TRL1.Regarding to the requirements with TRL2 level, these Interoperability requirements are fully agreed between all ANSPs and industries, and they are defined inside the chapter 3 of the deliverable D55.</p> <p>Regarding to the requirements with TRL1 level,</p>

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		<p>these Interoperability requirements are pending an agreement between ANSPs and industries, these requirements are defined into the Appendix B.</p> <p>Additional issues about the Interoperability concept which are still pending to be discussed and agreed between ANSPs and industries are defined inside the Appendix B.</p> <p>Appendix C contains preliminary information as an input for the definition of the Interface Data Model in order to provide a common dataset structure to exchange the Flight Object between IOP stakeholders</p>
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1.4 Contribution to Standardisation

No direct contribution to standardisation from the project. However, the outcomes of produced Interoperability Technical Specifications are made available for supporting standardisation activities. For example to EUROCAE WG59, working on the ED133 EUROCAE [44], which may consider the results in their ED133 update process.

The project aimed to verified and validate the ED133 standard but it demonstrated the limitation of the existing standard (which is now considered 'Obsolete'); the project developed new requirements that are expected to be considered as an input for the future IOP standard.

The Flight Object (FO) is defined by document ED133 [44] issued by the EUROCAE standardisation Working Group 59. This Technical project contributes providing technical expertise and advice to the creation of the Technical Specifications. These Technical Specifications provided the implementation scheme for the exercises to fulfil ED133, where necessary using work around in order to clarify requirements and ensure progress under SESAR.

The project provides the final Technical Specification following the exercises. This final Technical Specification will be provided to WG59 as relevant input to the future updates of ED133 EUROCAE [44].

1.5 Project Conclusion and Recommendations

The project concluded that:

1. The project has been provided support to achieve maturity in the following SESAR Solution:

#28 (Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing)

2. An Interoperability Technical Specification is provided by the project, with a set of technical requirements agreed between all the members providing the description of the Air Traffic Control-Air Traffic Control Interoperability.

3. The Interoperability prototypes have provided support to the seamless operation among different centres performing coordination and transfer functions, based on the flight object interoperability and Point functionality. The prototypes developed by the project have shown the feasibility of the Interoperability concept.

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4. The IOP prototypes have provided support to the availability of Initial 4D data and an improved mechanism to distribute information via the Flight Object (FO) shows the feasibility of the IOP concept as an enabler to distribute specific information regarding to the Air Traffic Control-Air Traffic Control Interoperability with i4D and Controlled Time Arrival.

The project recommended that:

1. It should be useful to continue with the elaboration of new versions of the IOP TS in order to provide new inputs for the revision of ED133 EUROCAE [44].
2. It should be useful to persevere the maturity of the prototypes as well as in the predictability.
3. As a technical project one of the main tasks inside the lifecycle of the project was the Factory Testing, within this area it should be useful to improve the factory deployment in order to achieve a similar deployment than the ANSPs premises, to avoid unexpected behaviours on site. One of the improvements that could be useful for future Factory Testing activities inside the Interoperability exercises could be to deploy into the industries premises the Air Navigation Service Provider simulators.

Two main areas should be considered during the SESAR2020 programme to improve the Factory Testing deployment:

- ANSPs simulators availability

Inside the availability of the ANSPS simulators it should be useful to take into account the exercise generation, exercises modification as well as the alignment between the ANSP simulator at industry premises and the ANSP simulator at ANSP premises.

- Network infrastructure.

Inside the Network infrastructure to connect the ANSP simulators located into the industry premises it should be useful to consider the network security aspects.

The discussions on the Technical Specification are still taking place within the ad hoc appointed SESAR Interoperability team, which are planned to continue up till the end of SESAR1 and which are expected to smoothly be transferred and continue further during the SESAR2020 programme.

2 References

- [1] SESAR Programme Management Plan, Edition 03.00.01
- [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] B.01, Integrated Roadmap - DS15 Release Note, D83, 00.01.00, 21/12/2015
- [5] P10.02.5 IOP ATC System Requirements Baseline- Phase 1, D02, 30/07/2010
- [6] P10.02.05 Preliminary SWIM Services Definition, D03, 26/11/2010
- [7] P10.02.05 Coherent AIM and MET dataset for Phase 1 Prototypes, D04, 01/09/2011
- [8] P10.02.05 Integrated IOP iTEC Platform - Phase 1, D08, 20/12/2013
- [9] P10.02.05 Integrated IOP COFLIGHT Platform - Phase 1, D09, 24/01/2014
- [10] P10.02.05 Integrated IOP MUAC Platform - Phase 1, D10, 20/12/2013
- [11] P10.02.05 Verification Plan - Phase 1, D12, 21/10/2010
- [12] P10.02.05 Test Cases Specification - Phase 1, D13, 21/06/2011
- [13] P10.02.05 Verification Tests Reports - Phase 1, D14, 24/10/2013
- [14] P10.02.05 IOP ATC System Requirements - Final Release for Phase 1, D26, 01/12/2011
- [15] P10.02.05 Report of the Operational Validation Support for Phase 1, D28, 24/01/2014
- [16] P10.02.05 (VP-829) Technical verification of Flight Object Exchange with additional partners (NATS-MUAC) (Availability Notes), D31, 13/01/2016
- [17] P10.02.05 (VP-714) IOP ATC System Requirements (IOP-TS), D34, 06/11/2014
- [18] P10.02.05 IOP ATC System Requirements (IOP-TS) VP-22 Closure, D35, 22/10/2014
- [19] P10.02.05 (VP-711) IOP ATC System Requirements (IOP-TS), D36, 07/10/2014
- [20] P10.02.05 (VP-711) Adaptation Data (AIM) dataset document, D37, 12/08/2014
- [21] P10.02.05 (VP-711) Integrated IOP iTEC Platform (Availability Notes), D38, 21/04/2015
- [22] P10.02.05 (VP-711) Integrated IOP COFLIGHT Platform (Availability Notes), D39, 13/07/2015
- [23] P10.02.05 (VP-711) Integrated IOP MUAC Platform (Availability Notes), D40, 13/07/2015
- [24] P10.02.05 (VP-711) Verification Plan, D41, 21/11/2014
- [25] P10.02.05 (VP-711) Verification test Report, D42, 28/01/2016
- [26] P10.02.05 (VP-711) IOP ATC System Requirements (IOP-TS) post-exercise, D43, 07/01/2016
- [27] P10.02.05 (VP-711) Support Operational Validation Report, D44, 11/01/2016
- [28] P10.02.05 (VP-030) IOP ATC System Requirements (IOP-TS), D45, 30/06/2015
- [29] P10.02.05 (VP-030) Adaptation Data (AIM) dataset Document, D46, 15/01/2016
- [30] P10.02.05 (VP-030) Integrated Itec & MUAC Platforms (Availability Notes), D47, 24/06/2016
- [31] P10.02.05 (VP-030) Verification Plan, D48, 28/01/2016
- [32] P10.02.05 (VP-030) Verification Test Report, D49, 01/08/2016
- [33] P10.02.05 (VP-030) IOP ATC System Requirements (IOP-TS) post-exercise, D50, 23/09/2016
- [34] P10.02.05 (VP-841) IOP ATC System Requirements (IOP-TS), D52, 01/04/2016
- [35] P.10.02.05 10.02.05-D53-(VP-841) Availability Notes

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- [36] P10.02.05 (VP-841) Availability Notes, D54, 13/09/2016
- [37] P10.02.05 IOP ATC System Requirements (Final IOP TS), D55, 28/10/2016
- [38] P10.02.05 (VP-798) Support Operational Validation Report, D56, 29/07/2016
- [39] P10.02.05 (VP-829) Technical verification of Flight Object Exchange with additional partners Verification Exercise Report, D57, 22/10/2015
- [40] P10.02.05 Integrated COFLIGHT and NM (ETCL) platforms (Availability Notes), D58, 19/12/2014
- [41] P10.02.05 (VP-731) Support Operational Validation Report, D59, 22/04/2015
- [42] P10.02.05 (VP-841) Verification Plan, D64, 11/05/2016
- [43] 04.05.D822 edition 00.01.00 "TMF/IOP Technical Note for 2014
- [44] EUROCAE Working Group 59, Flight Object Interoperability Specification ED-133 V1.0, June 2009
- [45] SESAR Deliverable P10.01.07-D120 edition 00.01.00 Technical Architecture Description – Cycle 2015
- [46] SESAR Deliverable .5.1.1 D846 TMF INTEROP for Step 1-Final Release (5.5.1 Deliverable - 4.5 Contribution), November 2016

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