Final Project Report

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Abstract

The project objective was to develop Technical Specification for Arrival/Departure Management based on the operational inputs, and to build upon them verified prototypes able to support operational validations of related SESAR solutions.

This document is the Final Project Report which describes the methodology used to meet the project objective and provides a summary of the outcome, focusing on the contribution to the achievement of the ATM Master Plan in the frame of the SESAR Programme

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
AF	ATM Functionality
AMAN	Arrival Management
ATC	Air Traffic Control
ATM	Air Traffic Management
CTA	Controlled Time of Arrival
DMAN	Departure Management
E-TMA	Extended Terminal Area
KPA	Key Performance Area
i4D	Initial 4D
NM	Nautical Mile
PCP	Pilot Common Project
P-RNAV	Precision Area Navigation
SESAR	Single European Sky ATM Research
SWIM	System Wide Information Management
TMA	Terminal Area
TRL	Technology Readiness Level
TTL	Time To Lose
UAC	Upper Area Control
XMAN	Cross Border Arrival Management

1   Project Overview

The project objective was to develop Technical Specification for Arrival/Departure Management based on the operational inputs, and to build upon them verified prototypes able to support operational validations of related SESAR solutions.

1.1   Project progress and contribution to the Master Plan

To achieve its objective, the project developed system specification and interface requirements based on the operational requirements from related operational projects. The project has also contributed to the definition of Arrival Management related System Wide Information Management (SWIM) services.

It has developed pre-industrial prototypes and ensured they meet the requirements and delivered them to operational projects for validation activities.

The project focused on three main areas:

1 - Extended Arrival Management (AMAN):

The project has contributed to technical solution to support operations in the arrival management context taking into account:

- o   The extension of Arrival Management horizon into the en-route phase

- o   The concept of Controlled Time of Arrival (CTA), aiming at using airborne technology and i4D operations in improving ground arrival management

- o   The integration of traffic departing from nearby airports within the arrival management horizon into the arrival sequence

- o   The Cross Border Arrival Management

2 - Coupled AMAN/Departure Management (DMAN):

The main goal was to develop a technical solution providing an integrated arrival and departure sequence, fully optimized for runway throughput where all airport constraints (capacity, runway throughput, taxiways…) are taken into account

3 - Arrival Management into Multiple Airports:

The objective was to propose a technical solution that combines planning for several arrival streams into different airports by:

- o   Calculating the sequence of aircraft flying towards an area where their routes intersect.

- o   Imposing an adequate spacing of the aircraft in that area, a Time To Lose (TTL) for the appropriate Extended TMA (E-TMA) sector is calculated to meet this constraint.

To meet its objectives, 10.09.02 has been working with many other SESAR projects mainly linked to Traffic Synchronisation related projects mainly to collect and understand operational requirements and develop technical requirements for arrival management.

The project contributed to AF#1 (ATM Functionality) of the PCP (Pilot Common Project) related to Extended Arrival Management to En-route solution

It has contributed the following SESAR Solutions:

Solution ID	Solution Title
Solution 5	Extended Arrival Management
Solution 6	Control Time of Arrival (CTA) in medium density/medium complexity environment
Solution 8	Arrival Management into Multiple Airports
Solution 15	Integrated and throughput-optimized sequence of arrivals and departures
Solution 54	Flow based Integration of Arrival and Departure Management

It has also contributed to the following technical enablers (referenced in the Integrated Roadmap Dataset 15 [31]):

Code	Name	Project contribution	Maturity at project start	Maturity at project end
APP ATC 111	Enhance AMAN to extend arrival management to en-route airspace - single TMA	Technical requirements developed by the project Implemented in a prototype developed within the project and used in an operational validation.	TRL4	TRL6
APP ATC 148	System Support For Controlled Time of Arrival (CTA)	Technical requirements developed by the project Implemented in a prototype developed within the project and used in an operational validation.	TRL4	TRL5
APP ATC 158	Enhanced arrival management to cover ground holding at the departure aerodrome	Technical requirements developed by the project Implemented in a prototype developed within the project and used in an operational validation.	TRL2	TRL5
ER APP ATC 109	Support for Metering Of Interacting Arrival Flows to Multiple Airports Upstream of the TMAs	Technical requirements developed by the project Implemented in a prototype developed within an external SESAR project and used in an operational validation.	TRL2	TRL6
APP ATC 110	Enhance Arrival Management to collaborate with non-	Technical requirements developed by the project Implemented in a prototype	TRL3	TRL5

	local Departure Management	developed within the project and used in an operational validation.		
APP ATC 161	Enhance AMAN to support Flow based Integration of Arrival and Departure Management	Technical requirements developed by the project Implemented in a prototype developed within the project and used in an operational validation.	TRL3	TRL6
ER ATC 163	Support to En-route delay absorption for cross-border implementation of arrival sequence	Technical requirements developed by the project Implemented in a prototype developed within the project and used in an operational validation.	TRL2	TRL6

1.2 Project achievements

The project has supported various validation exercises related to Extended Arrival Management and Arrival and Departure Management Coupling. The table bellows summarizes the validations supported by one or more 10.09.02 prototypes:

Supported validations	SESAR Solution
Integration of AMAN and supporting functionalities with point P-RNAV (Precision Area Navigation) procedures in a complex TMA	Solution 5
AMAN Supporting Controlled Time of Arrival /Requested Time Of Arrival (RTA)	Solution 5 Solution 6
Validation of Advanced DMAN-Routing Step2 V2	Solution 15
Validation of Advanced AMAN-DMAN-Routing Step2 V2	Solution 15
Basic XMAN (Cross Border AMAN) V3 live Trials in Reims UAC	Solution 5
i4D Real Time Simulations supporting Step C	Solution 5 Solution 6

The main project achievement is the development of Arrival Management Technical Specification (10.09.02-D64) agreed by all ATC system providers participating in the project, containing technical requirement for all the SESAR solutions the project has contributed to. It is one of the key documents of the SESAR Solution 5 Data Pack which is part of the first set of SESAR solutions that have been packaged by the European Commission into the Pilot Common Project for synchronised deployment for an extended AMAN horizon of between 180 and 200 nautical Miles (NM) at 24 European airports

across Europe by 2024. This Technical Specification contains new requirements developed and validated as part of SESAR addressing Extended and Cross Border Arrival Management. It includes also technical requirements for Solution 6 and Solution 8.

The project has also developed Coupled Arrival and Departure Management requirements.

1.3 Project Deliverables

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

Reference	Title	Description
D64	Step 1 Technical Specification	The document is the Technical Specification (TS) for AMAN for SESAR Step1, based on operational requirements. It covers all the AMAN enhancements addressed in SESAR Step1. It includes final technical requirements for SESAR solutions 5 (Extended Arrival Management horizon) and 54 (Flow based Integration of Arrival and Departure Management), and requirements for solution 6 (Controlled Time of Arrival in Medium density / medium complexity environment) and requirements for Solution 8 (Arrival Management into Multiple Airports)

1.4 Contribution to Standardisation

No specific standardisation or regulation activities were performed within this project.

1.5 Project Conclusion and Recommendations

A summary of the main conclusions and recommendations related to the three topics addressed by the project are presented below:

1 - Extended Arrival Management:

The technical solution developed by the project to support Extended AMAN is considered mature and allows an implementation of the operational concept.
The accuracy of information provided to AMAN has a significant impact on sequence stability no matter how good the algorithm is if the trajectory predictor is not accurate enough.

In the context of validations carried out and addressing Cross Border Arrival Management, it was noted that the lack of flight data synchronisation between upstream ATC unit and downstream ATC unit led to inconsistency resulting in a limitation of the expected benefits from the extension of the Arrival Management to the En-Route sectors.

It was noted that the way the flights departing from nearby airports located within the Extended AMAN horizon, are inserted into AMAN sequence and the flight data exchanges between Departure Management tools and AMAN (driven by the operational procedures) led to a reduced level of flexibility and to an instable sequence when the calculated plan is not followed.

For Cross Border Arrival Management, the project recommends to build a two-ways (Downstream / Upstream centres) synchronisation including trajectory information and controllers control actions information exchange.

The project recommends further investigation on the management of traffic flows departing from nearby airports. The strategy and approach to handle flights departing from these airports need more attention on the operational side and thus technical side.

2 - Coupled AMAN/DMAN:

The technical maturity of the prototypes developed by the project was sufficient for the controllers to make evaluations on the overall concept.
The Trajectory Predictor used in the calculations needs to have high accuracy, especially for arrivals, to fulfil the needs for acceptable quality of predicted times at the runway threshold. The accuracy of the Trajectory Predictor should also be known to the system with warning for deviations.
When performing a combined runway sequence for both arrivals and departures there is a need to have good quality information, any limitations will risk disturbing calculations for an optimal runway sequence with acceptable stability and accuracy.

It is agreed that the target technical solution (in combination with operational procedures) shall allow a balance between the three main KPAs: Predictability, Environment/Fuel Efficiency and Capacity (runway throughput) to obtain expected results. It was discussed that the balancing can be different depending on airport priorities and set in various ways depending on traffic load, environmental constraints, time of day and weather etc. There can be a further improvement to define and use a number of off line predefined settings to accommodate ability to use preferred weight on selected objectives for adaptation to airport preferences.

The project recommends further development and investigation on the synchronisation of Arrival and departure technical management processes especially when integrating the Coupled AMAN/DMAN concept and other concepts such as i4D/CTA.

3 - Arrival Management in Multiple Airports:

The main technical outcomes of the supported validation exercises were the need to improve AMAN information display and processing.

The project recommends to include departures (including from small neighbouring airports) in the sequence presented to the controller to improve controller air situation display. In addition a technical solution allowing the controller to assess feasibility of workload for upstream en-route sectors is required and shall be developed in the future.

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

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[21] P10.09.02, Phase B- NATMIG Airport Proto Validation Support Report, D56, 00.01.00, 24/02/2015

[22] P10.09.02, Phase B -THALES AMAN Proto Validation Support Report, D29, 00.01.00, 24/02/2015

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[26] P06.08.04, S01V3 Final INTEROP, D82, 00.01.01, 21/07/2015

[27] P06.08.04, S01V3 Final SPR, D18, 00.01.11, 28/09/2015

[28] P05.06.07, Update of 5.6.4 OSED – Step 1, D15, 00.01.01, 30/09/2015

[29] P10.09.02, Step 1 Technical Specification, D55, 00.05.00, 04/11/2015

[30] P10.09.02, Thales P4 AMAN prototype availability notice, D65, 00.02.00, 21/12/2015

[31] B.01.D83, WPB.01 Integrated Roadmap Dataset15 Release Note, edition 00.01.00, 21/12/2015

[32] P05.06.07, Update of 5.6.4 SPR-INTEROP - Step 1 - Edition 2, D53, 00.01.00, 28/01/2016

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