



Final Project Report

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Task contributors

[THALES.](#)

Abstract

As part of SESAR program, project 12.04.04 was focused on integration of Departure, Surface and Arrival management. The project:

- derived the technical specifications of the concept described by operational projects,
- implemented and tested prototypes,
- supported the validation exercises carried out in SESAR.

The project contributed to SESAR solutions, providing conclusions and recommendations for the next studies on this matter.

Authoring & Approval

Prepared By - Authors of the document.		
Name & Company	Position & Title	Date
██████████ THALES	██████████	16/04/2016

Reviewed By - Reviewers internal to the project.		
Name & Company	Position & Title	Date
██████████ THALES	██████████	22/04/2016
██████████ INDRA		26/04/2016
██████████ DSNA		26/04/2016
██████████ SELEX		26/04/2016

Reviewed By - Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.		
Name & Company	Position & Title	Date
██████████ DFS	██████████	22/04/2016
██████████ DSNA		No answer
██████████ THALES		22/04/2016
██████████ INDRA		25/04/2016
██████████ INDRA		No answer

Approved for submission to the SJU By - Representatives of the company involved in the project.		
Name & Company	Position & Title	Date
██████████ THALES	██████████	26/04/2016
██████████ INDRA		26/04/2016
██████████ DSNA		26/04/2016
██████████ SELEX		26/04/2016
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Rejected By - Representatives of the company involved in the project.		
Name & Company	Position & Title	Date

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Acronyms

Acronym	Definition
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
A-SMGCS	Advanced – Surveillance Monitoring Guidance Control System
AMAN	Arrival MANager
CTOT	Calculated Take-Off Time
DMAN	Departure MANager
DFS	Deutsche Flugsicherung (German ANSP)
DSNA	Direction des Services de la Navigation Aérienne (French ANSP)
ELDT	Estimated Landing Time
EMMA	European Airport Movement Management by A-SMGCS
EMMA2	European Airport Movement Management by A-SMGCS - Part 2
EOBT	Estimated Off-Block Time
EXOP	Estimated Taxi Out Period.
ICAO	International Civil Aviation Organization
OFA	Operational Focus Area
RFSM	Runway Flow Surface Management
RTS	Real Time Simulation
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
TOBT	Target Off-Block Time

1 Project Overview

The 12.04.04 project was related to the activities leading to a full integration of 'departure management' (DMAN), 'surface management' and 'arrival management' (AMAN). It specified the technical requirements for the integration of departure management and surface routing management functions, and highlighted the information exchanges between these two functions. The same work was done on the Coupled AMAN/DMAN requirements, leading to a full integration of 'departure management', 'surface management' and 'arrival management'.

1.1 Project progress and contribution to the Master Plan

The scope of the project 12.04.04 was the specification and the development of a single supporting platform (AMAN, DMAN and/or Surface Management) as well as its corresponding technical and operational validation. The project 12.04.04 related to the Operational Focus Area "Integrated Arrival/Departure Management at Airports".

The main objectives of the project were to:

- Perform an operational requirements analysis for Departure Management / Surface Routing function integration and Coupled AMAN/DMAN;
- Develop technical specifications for new functions or the specification of enhancements to existing functions, leading to a single integrated platform for 'departure management', 'surface management' and 'arrival management';
- Develop prototypes and validate the new functions and technical solutions;
- Validate enhancements to existing sequencing tools to fulfil new operational requirements.

The project was decomposed in 3 phases during its initialisation.

Phase 1 focused on DMAN and Surface Management Integration, implementing requirement from operational experts. It addressed the following OIs (Operational Improvement):

- TS-0202: Pre-Departure Sequencing supported by Route Planning

The Phase 1 prototypes supported several validations exercises at various maturity level (see E-OCVM Version 3.0):

- V2 RTS (Real Time Simulation) led by DSNB with THALES prototype on CDG configuration. Subject was Basic DMAN-ASMGCS Step1 V2.
- V2 RTS led by ENAV with SELEX prototype. Subject was Basic DMAN-ASMGCS Step1 V2.
- V3 RTS led by ENAV with SELEX prototype on Milano Malpensa configuration. Subject was Surface Routing & D-Taxi.
- V3 RTS led by DSNB with THALES prototype on CDG configuration. Subject was Surface Routing & D-Taxi.
- V3 RTS led by ENAIRE with INDRA prototype on Madrid-Barajas configuration. Subject was Integration of Improved Surveillance Function for Surface Management.

Phase 2 and Phase 3 were focused on AMAN/DMAN Coupling, implementing requirements from operational experts. They addressed the following OIs (Operational Improvement):

- TS-0203: Departure Management supported by Route Planning and Monitoring

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- TS-0309: Sequence based Integration of Arrival and Departure Management

During phase 2, the project experienced some delays on the prototype development and on other projects dependencies. Therefore, the partners decided to carry on the prototypes development and merge Phase 2 and 3. At the end of Phase 3, the prototypes supported the following V3 validation exercises:

- V3 RTS led by ENAIRE with INDRA prototype in Q1 2016. Subject was integration of Coupled AMAN/DMAN prototype with Surface Routing in Barcelona airport.
- V3 RTS led by ENAV with SELEX prototype on Milano Malpensa configuration. Subject was Safety Nets, DMAN/SMAN and Airport FDP.
- THALES/DSNA validation exercise was finally cancelled, but replaced in Q1 2016 by a prototype verification closely coordinated with DSNA: RTS verification led by THALES with controllers from DSNA on Lyon configuration. Subject was Coupled AMAN/DMAN Step 2.

Project 12.04.04 addressed the following SESAR solutions:

- SESAR solutions #53 (Pre-Departure Sequencing supported by Route Planning) included in the PCP (Pilot Common Project) and related to TS-0202 (Pre-Departure Sequencing supported by Route Planning)
- SESAR solution #14 (Departure Management integrating Surface Management constraints) related to TS-0203 (Departure Management supported by Route Planning and Monitoring)
- SESAR solution #15 (Integrated and throughput-optimised sequence of arrivals and departures) related to TS-0309 (Sequence based Integration of Arrival and Departure Management)

The technical requirements developed by the project 12.04.04 supported to the four enablers (from DS-15 [6]) described in the following table:

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AERODROME-ATC-18	Interfacing between DMAN and Routing module	Enhanced the DMAN and routing integration by providing to DMAN an accurate estimated taxi-time before push-back	TRL 3	TRL 6
AERODROME-ATC-09b	Sequence-based Improvement of operational orchestration among arrival / departure management and surface management services	Modification of surface movement information processing system for integration with Departure Manager, Arrival Manager (via Runway Usage Manager) and En-Route FDPS in order to improve the aerodrome throughput, especially at airports with runways used for both arriving and departing flights using a new calculation algorithm for sequencing optimization (considering minimum separations).	TRL 3	TRL 5
AERODROME-ATC-44a	Departure sequence updated taking into account surface management information	More efficient departure sequence thanks to more accurate information regarding optimized taxi time before pushback, and real time update of remaining taxi time	TRL 3	TRL 5

AIRPORT-33	Provision of departure and arrival constraints to the Aerodrome ATC surface management	More accurate traffic planning thanks to stable TSAT and TTOT provided by the DMAN.	TRL 3	TRL 6
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1.2 Project achievements

With the goal of supporting the validation of concepts described by operational projects, P12.04.04 developed:

- 3 prototypes in Phase 1 on DMAN and Surface Management integration, implementing the concepts from operational projects and supporting validation exercises described in the previous paragraph.

The two main evolutions implemented in the prototypes were:

- For the Surface Routing Server to provide an optimised taxi time (more precisely defined as the EXOP) and the dynamically updated "remaining taxi time" to the departure management (that can use it to build a more reliable pre-departure sequence)
- For the departure management to provide more stable TSAT and TTOT that the surface routing function can use to build more realistic traffic forecasts.

Those prototypes were implementing SESAR solution #54 (Pre-Departure Sequencing supported by Route Planning), which reached full V3 maturity and was included as part of the PCP.

Step 2 activities regarding Surface Management and DMAN integration were supported by other technical projects.

- 3 prototypes in Phase 2/3 on Step 2 Coupled AMAN/DMAN supporting validation exercises described in the previous paragraph. From Step 1 specifications (made in another technical project) where the coupling between AMAN and DMAN is driven by the arrival flights sequence, project 12.04.04 implemented Step 2 Coupled AMAN/DMAN where the coupling function is taking into account both departure and arrival sequence, to find the best integrated sequence taking into account :
 - Runway Schedule and capacities;
 - The Arrival and Departure traffic volumes;
 - The Flight data for arrivals including ELDT;
 - The Flight data for departures including (EOBT, CTOT, TOBT...);
 - The planned and remaining taxi times from Surface Management.

Those prototypes were implementing SESAR solution #14 (Departure Management integrating Surface Management constraints), and SESAR Solution #15 (Integrated and throughput-optimised sequence of arrivals and departures).

The project also supported and specified the architecture choices made by high-level project with the creation of a new domain system: Sequence Management system and one functional block Runway Flow Surface Management (RFSM). Project 12.04.04 aligned the documentation with the needed architecture.

1.3 Project Deliverables

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

Reference	Title	Description
D01	System requirements definition STEP 1 (Phase 1)	Created on the beginning of the project, this document describes the Phase 1 System Technical requirements. It is based on the analysis of operational requirements coming from previous projects (EMMA2), as well as operational requirements available at this stage from SESAR projects. It is the starting point for the development of Phase 1 industrial prototypes.
D02	Technical Architecture report STEP 1 (Phase 1)	This document describes the system technical architecture including interface descriptions with other concerned components and with external systems.
D38	System requirements Final S2V3	This document contains the finalised S2V3 System Technical Requirements for the integration of Departure Management and Surface Routing functional blocks and the information exchanges between these two functions. It describes also the Coupled AMAN/DMAN requirements, derived from the specific requirements for this integration developed by operational projects.

1.4 Contribution to Standardisation

During the project, there was no standardisation activity with respect to the integration of DMAN and Surface Management, or to the coupled AMAN/DMAN.

1.5 Project Conclusion and Recommendations

Regarding Step1 DMAN and Surface Management integration, both predictability and efficiency performances benefit from the integration between DMAN and A-SMGCS Routing and Planning function. The more accurate taxi time provided by the Routing and Planning function leads to an increase of accuracy of the target times calculated by the DMAN and to a reduction of the waiting times and delays due to a smoother departure traffic flow. Solution #53 reached V3 maturity and is part of the PCP.

The development of Step 2 Coupled AMAN/DMAN prototypes was challenging, as it was a new concept. The prototypes implemented new algorithm that fully integrated the departure and arrival sequence. First conclusions of the projects are that:

- The sequencing of departure flights mixed to arrival flights is too fluctuating at a close horizon of the runway threshold.
- The coupled sequence must be based on actual traffic not only on predictions.

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The prototypes still need to be adjusted in order to fix those issues. A fine tuning of some configuration parameters (ratio computation period, runway pressure, taking into account ATOT...) could lead to a better stability and usability of the system. This work will be pursued in SESAR 2020 in project PJ02 Solution 8 - Traffic optimisation on single and multiple runway airports. SESAR Solutions #14 and #15 did not reach V3, and are not yet ready for deployment.

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