Final Project Report

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THALES	

Abstract

The purpose of project 10.08.01 project was to define a set of requirements and to develop the SESAR pre-industrial systems to support the validation of the Local Traffic Complexity Manager concept defined by operational project 04.07.01.

Several traffic complexity metrics and complexity reduction actions were defined and implemented in order to assess and reduce ATCOs workload. These different assessments metrics and reduction actions were demonstrated through one V2 validation exercise and three V3 validation exercises in different platforms.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted] Thales	[redacted]	10/03/2016

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted] Indra	[redacted]	07/04/2016
[redacted] ENAIRE		11/04/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted] Thales	[redacted]	13/04/2016
[redacted] ENAIRE		12/04/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] Thales	[redacted]	15/04/2016
[redacted] ENAIRE		31/05/2016
[redacted] Indra		31/05/2016
[redacted] DSNA		31/05/2016

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
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
CM	Complexity Management
DCB	Demand and Capacity Balancing
D-DCB	Dynamic Demand an Capacity Balancing
DSNA	French ANSP
ENAIRE	Spanish ANSP
HMI	Human Machine Interface
IBP	Industrial Based Platform
INTEROP	Interoperability Requirements
IOP	ATC InterOPerability
LTCM	Local Traffic Complexity Management
LTM	Local Traffic Manager
MUAC	Maastricht Upper Area Control Centre
NM	Network Manager
OFA	Operational Focus Area
OI	Operational Improvement
OSED	Operational Service end Environment Definition
SESAR	Single European Sky ATM Research Program
SPR	Safety and Performance Requirements
SWIM	System Wide Information Management

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1 Project Overview

The main objective of the primary project 10.08.01 “Complexity Assessment and Resolution” was to achieve a set of requirements and to develop a Local Traffic Manager (LTM) support tool to be used in several validation activities. This tool is able to assess the traffic complexity in an ATC Centre, allowing monitoring and management of the ATC Centre complexity by providing mechanisms to the LTM manager to resolve any unexpected increase of the ATCOs workload in the next few hours (30min. to 180min.) .

1.1 Project progress and contribution to the Master Plan

The project was conceived in three different phases to allow staged development of the LTM tool according to evolving specifications and defined functionalities.

During the first phase two different prototypes were developed based on the consolidation of previous studies performed by the operational project. During the consolidation of previous studies task, several V3 maturity level algorithms to assess the complexity were identified.

Following a Bottom-up approach, the algorithms were specified and the first version of the Technical Specification and the Verification Plan were created. After the specification phase, a development phase took place to improve the algorithms and the HMI into V3 maturity level prototypes. Finally integration and verification phase were performed. At the end of the verification the prototypes were delivered to the operational project to perform the validation exercises.

The first LTM prototype was integrated at Maastricht ATC centre, where it supported testing the assessment of the complexity in a validation exercise.

The second LTM prototype was integrated at Reims ATC centre, where it supported testing the assessment of the complexity in a validation exercise.

In the phase 2 one new prototype was developed based on operational documentation produced by operational project.

Following a Top-down approach, the Operational specification was used as input to generate the Technical Specification and the Verification Plan. Then a development, integration and verification phase of the new prototype functionalities took place to deliver the prototype for a Step 2 V2 validation exercise.

In the final third phase the phase 2 prototype was improved to achieve V3 maturity level in a Step1 SESAR concept instead of Step2 previously planned.

This improved prototype was developed based on operational documentation produced by operational project implementing solution #19 (Automated Support for Traffic Complexity Detection and Resolution).

Following a Top-down approach, the Operational specification was used as input to generate the final Technical Specification for the Step 1. Then a development, integration and verification phase of the new prototype functionalities took place to deliver the prototype for a V3 validation exercise.

The third LTM prototype was integrated at Madrid ATC centre, where it supported testing the assessment of the complexity in a validation exercise.

Project 10.08.01 has been the technical driver to create an enabling system of the SESAR Local Traffic Complexity Manager concept, defined by operational project. As a consequence, the different pre-industrial prototypes developed under the project have been used to demonstrate that the LTCM leads to:

- Improved situational awareness - complexity management monitoring leads to a better understanding of the operational situation for the LTM and the monitoring of forecasted complexity provides added value to the management of complexity/workload imbalances,

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- Improved decision making process - LTCM leads to a better understanding of the overall operational situation and contributes in an efficient way for LTM to make decisions more quickly and to agree on solutions improving the overall ATC centre capacity.

During its lifecycle, the project contributed to maturing the following Enablers referenced in the integrated roadmap version Data Set 14 [4] (see table below) through the development and testing of the prototypes.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
ER APP ATC 15	Flight Data Processing: support Dynamic Sectorisation and Dynamic Constraint Management	Project 10.08.01 contributed to the development in the maturity of this Enabler implementing three prototypes using different tools to dynamically manage of airspace/route structure. The prototypes provides support for decision making based on pre-defined sector sizing and constraint management in order to pre-deconflict traffic and optimise use of controller work force. These dynamic management of airspaces techniques have been validated in three different SESAR exercises with different operational contexts all of them in V3 maturity level.	TRL4	TRL6
ER ATC 92	ATC tools to re-organize traffic flows to reduce complexity	Project 10.08.01 contributed to the development in the maturity of this Enabler implementing one prototype supporting the ATCOs in identifying, assessing and resolving local complexity situations through assessment of evolving traffic patterns and evaluation of opportunities to de-conflict or to synchronise trajectories. The tool operates, up to circa 30 minutes before sector entry. The tool that assist in resolving complexity issues includes a 'What-if' capability where resolution strategies can be trialled before implementation and provides assistance in identifying the trajectory or trajectories that are causing the most complexity, through interactions.	TRL4	TRL6
APP ATC 92	ATC tools to re-organize traffic flows to reduce complexity	Project 10.08.01 contributed to the development in the maturity of this Enabler implementing one prototype supporting the ATCOs in	TRL4	TRL6

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		identifying, assessing and resolving local complexity situations through assessment of evolving traffic patterns and evaluation of opportunities to de-conflict or to synchronise trajectories. The tool operates, up to circa 30 minutes before sector entry. The tool that assist in resolving complexity issues includes a 'What-if' capability where resolution strategies can be trialled before implementation and provides assistance in identifying the trajectory or trajectories that are causing the most complexity, through interactions.		
ER APP ATC 93	Enhance Resource Management and Planning Tools to use Traffic Complexity Assessment	Project 10.08.01 contributed to the development in the maturity of this Enabler implementing three prototypes using different tools to optimise the airspace configuration in anticipation using predicted complexity. The prototypes provides information on upcoming congestions facilitating the decision making process to manage the Airspace. These monitoring and evaluation of traffic complexity techniques have been validated in three different SESAR exercises with different operational contexts all of them in V3 maturity level.	TRL4	TRL6

1.2 Project achievements

Project 10.08.01 has been the technical project to implement the Local Traffic Complexity Manager concept. To perform this task a Step 1 Technical Specification has been realized and three prototypes has been developed and delivered to the operational project to validate the concept in a V3 environment.

The LTCM prototypes created by the project provide the following functionalities:

- Prediction of air traffic complexity based on the following capabilities:
  - Air traffic complexity computation based on the flight plans information,
  - Computation of the contribution of each flight to the air traffic complexity,
  - Three approaches could be used to calculate the complexity:
    - Based on trajectory prediction processed by Fast time simulation,

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        - Based on the trajectory prediction using an Algorithmic approach (Deterministic and/or Lyapunov algorithms),
        - Based on the trajectory prediction using the Cognitive channels approach.
    - Three types of complexity indicators can be used to compute the traffic complexity:
        - Occupancy: The number of aircraft in the sector
        - Entry rate: The number of aircraft predicted to enter the sector within the next hour,
        - Workload: The workload for an operational sector.
- What-if sectorisation: Possibility to modify/propose a sector configuration (what-if sectorisation) followed by an assessment of the traffic complexity related to the new air traffic situation,
- What-if trajectory: Possibility to modify/propose a trajectory on a flight followed by an assessment of the traffic complexity related to the new what-if air traffic situation. The different what-if possibilities are:
    - Level capping,
    - Re-routing,
    - Departure delay.
- Sectorisation optimization: Support the LTM to find the optimal sectorisation solving imbalanced air traffic situations. An optimization algorithm proposes a set of ranged solutions to be evaluated.

The contribution of this project goes mainly towards the validation of Solution #19 (Automated support for Traffic Complexity Detection and Resolution). Within this solution, work has been mainly focused on the validation of complexity assessment and resolution support tools, as well as the validation of automated tools to monitor sector demand and evaluation of ATC workload including traffic complexity. The work performed in project 10.08.01 has allowed to mature the solution from a V2 to a V3.

As this Final Project Report will be delivered before the last V3 validation exercise results draft is made available, it is not possible to detail the conclusions obtained from that activity. To complete the information regarding the contribution of LTCM to the maturity of the operational concept, it will be necessary to check the respective validation reports where LTCM was used (primarily EXE-04.07.01-VP-005).

1.3 Project Deliverables

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

Reference	Title	Description
D18	Step 1 final Technical Specification	This document describes the Technical Specification for a sub-system required to ensure the Local Traffic Complexity Management functional block in the context of Step1 V3 of the SESAR Validation and Verification Storyboard. It addresses the sub-system required to ensure the support at local/sub-regional level of complexity assessment processes. The sub-system will provide assessment features through what-if functionalities and sector optimization to support the user on the resolution of imbalance air traffic situations.

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D11	Step 2 preliminary Technical Specification	This document describes the Technical Specification for a sub-system required to ensure the Local Traffic Complexity Management functional block in the context of Step2 V2 of the SESAR Validation and Verification Storyboard. It addresses the sub-system required to ensure the support at local/sub-regional level of complexity assessment and resolution processes. The sub-system will provide assessment features through what-if functionalities and sector optimization to support the user on the resolution of imbalance air traffic situations.

1.4 Contribution to Standardisation

Project 10.08.01 has not contributed to any standardisation activities and its results did not have an impact on standards.

1.5 Project Conclusion and Recommendations

Project 10.08.01 has served as a technical enabler to validate the SESAR Local Traffic Complexity Manager concept mainly defined by project 04.07.01, through different operational validation exercises.

The main objectives of the project have been fulfilled: Step 1 Technical Specification and the associated prototypes to perform the Step 1 V3 validation exercises.

The following recommendations are made in order to contribute to the improvement of the operational concept:

- The Collaborative tools between LTM and ATCOs (i.e.: chat, notifications, blinking events) should be part of the LTCM and should be specified to reach a complete development,
- Link between LTM and NM should be specified and implemented to improve the overall performance,
- Coordination between LTMs of different ATC centres for resolution purpose ('inter-centre what-if') should be specified and implemented,
- Post operational analysis needs to be further developed to determine the success variables assessment that could be used in future cases,
- Further research and development work should aim towards achieving the integration of traffic performance concepts, notably Network Dynamic DCB (D-DCB) concepts,
- The use of data provided by SWIM network (Flight Object, Weather…) should be used to improve data accuracy.

According to the results and recommendations obtained, the project has been key to demonstrating the evolution and maturity of SESAR Solution #19 ‘Automated support for Traffic Complexity Detection and Resolution’ through the coordination and delivery of a V3 pre-industrial prototype to support ‘Enhanced ATFCM processes’, and participating in the relevant V3 exercises to validate this operational concept.

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The initial work performed with the project's prototypes in Step2, has paved the way for future developments and implementation required to achieve the next maturity level for solutions that are not yet at V3 maturity level.

Therefore project 10.08.01 has made its contribution in establishing the baseline for future developments and implementation related to the SESAR Local Traffic Complexity Manager concept, which are expected to occur through activities in the 'Advanced DCB' project (PJ09) in the SESAR 2020 Programme.

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