Final Project Report

Document information	
Project Title	TMA-2 Co-Operative Planning in the TMA
Project Number	05.04.02
Project Manager	DFS Deutsche Flugsicherung GmbH
Deliverable Name	Final Project Report
Deliverable ID	D15
Edition	01.00.01
Template Version	03.00.04
Task contributors	
DFS Deutsche Flugsicherung, NATS.	

Abstract

The project focused on Traffic Synchronisation and Demand Capacity Balancing (DCB) concepts applicable to a complex multi-airport TMA. Departure information accuracy has been investigated and a new demand prediction tool was assessed. Real-time-simulations with human in the loop were conducted to fully mature SESAR Solution #08 "Arrival Management into Multiple Airports". Work on integrating both arrival and departure information to resolve complex interacting traffic flows in the TMA focused on presenting to the E-TMA controllers accurately predicted sector entry times for aircrafts in all phases of flight.

Authoring & Approval

Prepared By - *Authors of the document.*

Name & Company	Position & Title	Date
███████ DFS	███████████	16/03/2016
███████ NATS		16/03/2016

Reviewed By - *Reviewers internal to the project.*

Name & Company	Position & Title	Date
███████████ DFS	██████████████	17/03/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*

Name & Company	Position & Title	Date
██████████	█████████	23/03/2016
██████████		11/04/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*

Name & Company	Position & Title	Date
██████████	██████████████	11/04/2016
████████ DFS		23/03/2016
████████ NATS		23/03/2016
████████ EUROCONTROL		16/03/2016

Rejected By - *Representatives of the company involved in the project.*

Name & Company	Position & Title	Date

Rational for rejection

None.

Document History

Edition	Date	Status	Author	Justification
00.00.01	10/12/2015	Draft	██████████	Initial draft
00.01.00	23/03/2016	Final		Update to reflect the final project deliverables. Use of new template
01.00.00	11/04/2016	Final		Update after WPL comments
01.00.01	15/05/2016	Final		Update after SJU review

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
A-CDM	Airport Collaborative Decision Making
AF	ATM Function
AMAN	Arrival Manager
ATC	Air Traffic Control
ATM	Air Traffic Management
CMAN	Centre-Manger
DCB	Demand Capacity Balancing
DFS	DFS Deutsche Flugsicherung GmbH
DPI	Departure Planning Information
EGGL	Heathrow Airport
ETFMS	Enhanced Tactical Flow Management System
E-TMA	Extended TMA
LTMA	London TMA
TMA	Terminal Manoeuvring Area
NATS	The main air navigation service provider in the United Kingdom
NM	Nautical Mile
OFA	Operational Focus Area
OI-Step	Operational Improvement Step
OSED	Operational Service and Environment Definition
RTS	Real-Time-Simulation (Human in the Loop)
SAR	Safety Assessment Report
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
TTL	Time to lose

1 Project Overview

The project focused on traffic synchronisation and Demand Capacity Balancing (DCB) concepts applicable to a complex multi-airport TMA.

Traffic synchronisation concepts seek to smooth traffic flows. Demand Capacity Balancing concepts seek to match capacity with demand. Where no further capacity can be provided, the aim is to modify the demand to match available capacity. The 05.04.02 Co-operative Planning in a TMA concept sits on the boundary of these two concepts. It requires the greater data accuracy and more precise measures associated with traffic synchronisation techniques, which are generally available for arriving aircraft which are airborne and predictable. However, it is recognised that information accuracy is not always sufficient, and so, especially in the case of departures which typically have a greater level of unpredictability, the aim is to maximise the flow rate while avoiding excessive controller workload, i.e. demand-capacity balancing.

1.1 Project progress and contribution to the Master Plan

The project followed the European Operational Concept Validation Methodology and applied the SESAR system engineering approach. As part of the Operational Focus Area 04.01.02 "Enhanced Arrivals and Departure Management in TMA and En Route" it contributed to both SESAR Step 1 and 2 and is aligned with the Integrated Roadmap Dataset 15.

The work on the SESAR Step 1 concept elements was organized in two activities focusing on a Multi-Airport TMA and its Arrivals and Departures, respectively. For the traffic synchronisation of aircraft in the arrival phase single day real-time simulations (RTS) with operational controllers have been conducted on a regular basis to evolve the concept and the tools. This eventually led to a mock-up based V2, and a prototype based V3 RTS validation exercise for Operational Improvement Step TS-0303 "Arrival Management into Multiple Airports" (SESAR Solution #08). For departures a data accuracy study was completed in order to determine the confidence level a controller may have in the data being supplied. From here several workshops were conducted and a prototype tool was developed and subjectively tested by operational controllers in order to validate Operational Improvement Step TS-0302-A "Departure Management Information from Multiple Airports ".

The project contributed to SESAR Step 2 Operational Improvement Step TS-0307 "Integrated Arrival Departure Management for traffic optimisation within the TMA Airspace" by conducting an early V2 RTS validation exercise.

TS-0302-A has progressed from V1 to V2 with further development planned within SESAR 2020 to achieve V3. Whereas TS-0303 could be progressed from early V2 to V3 maturity, only initial steps were undertaken to mature TS-0307. It is expected that the scope of the latter OI will be subject to a substantial revision/extension within SESAR 2020.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
TS-0302-A	Departure Management Information from Multiple Airports	The project has developed an initial prototype which will enhance departure information provided to enable the TMA Supervisor to make a decision to manually adjust the departure sequence to enable a more consistent and manageable delivery into the En-route phase of	V1	V2

		flight.		
TS-0303	Arrival Management into Multiple Airports	The project contributed by conducting V2 and a SESAR Release 5 V3 exercises as well as producing OSED and SPR	V2	V3
TS-0307	Integrated Arrival Departure Management for traffic optimisation within the TMA Airspace	An initial OSED has been produced and a mock-up based V2 real-time simulation (RTS) conducted.	V1-V2	Early V2

1.2 Project achievements

SESAR Solution #08 "Arrival Management into Multiple Airports" / OI-Step TS-0303

AMAN capabilities were enhanced by a new function in order to enable the simultaneous optimisation of traffic streams to two airports only 30NM apart. Related ATC procedures were established allowing controllers of the adjacent E-TMA en-route sectors to provide the two approach controllers with optimized arrival sequences. It was found that an implementation of AMAN with TTL calculated based on runway TTL only is not sufficient in this operational environment. Additional TTL based on expected traffic in the E-TMA should be implemented allowing upstream sectors to support the implementation of TTL.

Operational activities have already started for a stepwise implementation of the results at the German Airports Düsseldorf and Köln/Bonn.

OI-Step TS-0302-A

The results of VP-449 data accuracy study showed that analysis confirms the provision of DPI messages improves accuracy. EGLL was the only A-CDM airport in the LTMA at the time of the analysis which provides EGLL with more DPI message data out to a greater look-ahead time. The accuracy of the EGLL messages in predicting both the fix arrival time and fix occupancy shows a clear improvement relative to the other LTMA airports from a look-ahead time of 60 minutes prior to fix arrival.

The remaining LTMA airports generate DPI messages out to a look-ahead time of approximately 15 minutes giving a very similar accuracy to EGLL in this window. Nonetheless, this analysis shows that accuracy of DPI messages is significantly improved when compared with the Flight Plan only data, and gave a level of confidence in the data being provided currently in this manner.

VP-450 involved an assessment of operational London TMA (LTMA) data sourced from the current prediction device used by NATS, compared with the TMA Manager prototype. In general the participants agreed that the tool showed promise, where it is as good as current day operations with the potential to be better. The TMA Manager had the potential to improve safety and would be at least as safe as current day. A clear direction has immerged in the display of information to the actor and what more can be provided to create benefit to that actor.

OI-Step TS-0307

The aim of the work on TS-0307 was to enable the controllers of highly complex extended-TMA sectors dealing with aircraft in all flight phases to implement AMAN advisories as well as efficient flight profiles by increasing their situational awareness. The focus in this early V2 phase was on presenting the E-TMA controllers accurately predicted sector entry times for all flights entering their sector.

Preparation of SESAR 2020

Both activities on OI-Steps TS-0302-A and TS-0307 set the ground for further work in SESAR 2020 where both OI-Steps will have to be further matured.

1.3 Project Deliverables

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

Reference	Title	Description
D04	Step 1 final OSED	This deliverable describes the Operational Service and Environment Definition for traffic synchronisation and Demand Capacity Balancing (DCB) concepts applicable to a complex multi airport TMA. It is issued in two volumes sharing the same deliverable ID. Volume 1 is dedicated to TS-0302-A focusing on outbound traffic, while Volume 2 addresses TS-0303 / SESAR 1 Solution #08 and focuses on inbound traffic.
D05	Step 1 final SPR	This document provides the safety and performance requirements for OI-Step TS-0303 / SESAR 1 Solution #08. It is based on safety assessment conducted by the project and draws from the outcome of two validation exercises performed within P05.04.02. As the extended AMAN horizon has been identified as an important means to support this OI-Step, both SAR and SPR build upon the work of projects 05.06.04 and 05.06.07
D34	Step 1 V3 VAL-Report TS-0303	This document describes the detailed validation results of the Step 1 V3 validation of OI Step TS-0303 realised in exercise VP-778. A Center Manager (CMAN) linked to individual AMANs to smooth arrival flows into the high traffic density multi airport TMA of Düsseldorf and Köln/Bonn was developed and assessed by the project. This report describes how objective and subjective data were collected during a two weeks Real Time Simulation and how they were analysed. The results obtained address Capacity, Efficiency, Environment, Human Performance and Safety.
D36	Step 1 V3 VAL-Report TS-0302-A	This document describes the P05.04.02 V3 (downgraded to V2) Step 1 validation results for OI Step TS-0302-A evaluated in EXE-05.04.02-VP-450. These are principally queue management/traffic synchronisation processes, utilizing ETFMS data. Validation results show the interaction of these processes in a complex TMA. NATS assessed whether there is the potential for departure sequence information from multiple airports in the high density London TMA to enable better matching of departure capacity to departure

		demand.
D09	Updated Step 2 OSED	This OSED describes the initial concept for SESAR Step 2 Operational Improvement Step TS-0307 "Integrated Arrival Departure Management for traffic optimisation within the TMA Airspace" in the scope of Operational Focus Area (OFA) 04.01.02 "Enhanced Arrival and Departure Management in TMA and En Route".
		The concept enables the controllers of highly complex extended-TMA sectors dealing with aircraft in all flight phases to implement AMAN advisories and efficient flight profiles by increasing their situational awareness. The focus in the early V2 phase is on presenting the controllers accurately predicted sector entry times for all flights.
D08	Step 2 V2 VAL-Report TS-0307	This document describes the detailed validation results of the 05.04.02 Step 2 V2 validation for OI Step TS-0307 realised in exercise VP-825.
		An eight days Real Time Simulation was conducted in the geographic area around Dusseldorf and Cologne, Germany. This report describes how objective and subjective data were collected and analysed. The results obtained address Capacity, Efficiency, Human Performance and Safety.

1.4 Contribution to Standardisation

The project did not conduct or contribute to standardisation activities.

1.5 Project Conclusion and Recommendations

The project contributed to the validation of Traffic Synchronisation and Demand Capacity Balancing (DCB) concepts applicable to a complex multi-airport TMA as part of the Operational Focus Area 04.01.02 "Enhanced Arrival & Departure Management in TMA and En Route".

With regards to the departures, the TMA Manager will provide a more accurate view of predicted demand in the TMA at user defined hotspots where typically, two or more departure routes will converge. The initial impressions of TMA Manager were generally positive. Whilst the tool still requires development, potential was evident that it was to be an improvement on the current day. In general, it was found that the TMA Manager had the potential to improve safety and would be at least as safe as today's operations while allowing for efficient decision making in both high density and high complexity ATC environments.

With regards to the next phase of development, testing of further TMA Manager concepts such as Offload SIDs and Tactical Parallel Offsets should be considered to ensure the concepts are robust enough to support future tool development.

When considering SESAR 2020, further development of the TMA Manager tool is required to exploit its potential to increase the capacity of the TMA. For example;

- Functionality needs to be addressed and further explored

- Real time testing in TMA sectors would be of benefit, and having a full set of data of departures and arrivals.

- The alerts for flow/workload etc. were felt to be too limited.

In case of a multi-airport TMA, the capabilities of present AMAN systems are not sufficient to cope with the complexity of traffic and airspace. To avoid spontaneous increases in complexity and thus workload in the E-TMA en-route sectors, an add-on to the AMAN that helps to prevent overload in sectors with converging inbound flows (CMAN) has been successfully validated. The extended AMAN horizon has been identified as an important means to support this concept. This SESAR Solution #08 brings the benefits of AMAN, e.g. more accurate metering, less need for tactical interventions and en route delay absorption, to complex multi-airport TMAs.

The work on integrating both arrival and departure information to resolve complex interacting traffic flows in the TMA focused on presenting to the E-TMA controllers accurately predicted sector entry times for aircrafts in all phases of flights. Compared to the reference, which needed additional delay to be absorbed in the upstream sectors of the E-TMA, the controllers were able to achieve similar results without imposing additional workload on the upstream controllers. However, further work is necessary as the full benefits of the concept are only expected to be realized if the predicted sector entry times are used by the planner controller to optimize and smooth the workload of the executive controller.

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]　P05.04.02, Preliminary OSED Step 1, D01, 00.03.02, 05.11.2013

[5]　P05.04.02, V3 Validation Plan Step 1, D02, 00.01.00, 14.02.2014

[6]　P05.04.02, Step 1 V2 VALR TS-0303, D03, 00.01.00, 08.08.2014

[7]　P05.04.02, Step 1 Final OSED, D04, 00.01.00, 22.03.2016

[8]　P05.04.02, Step 1 Final SPR, D05, 00.01.00, 22.03.2016

[9]　P05.04.02, Step 2 Initial OSED, D06, 00.01.00, 08.10.2015

[10]　P05.04.02, Step 2 V2 VAL-Plan TS-0307, D07, 00.01.01, 21.10.2015

[11]　P05.04.02, Step 2 V2 VAL-Report TS-0307, D08, 00.01.00, 29.02.2016

[12]　P05.04.02, Updated Step 2 OSED, D09, 00.01.00, 09.03.2016

[13]　P05.04.02, Step 1 V2 VAL-Report TS-0302A, D32, 00.01.02, 25.03.2015

[14]　P05.04.02, Step 1 V3 VAL-Plan TS-0303, D33, 00.01.01, 29.01.2015

[15]　P05.04.02, Step 1 V3 VAL-Report TS-0303, D34, 00.01.02, 08.12.2015

[16]　P05.04.02, Step 1 V3 VAL-Plan TS-0302A, D35, 00.01.00, 18.09.2015

[17]　P05.04.02, Step 1 V3 VAL-Report TS-0302A, D36, 00.01.00, 15.03.2016

-END OF DOCUMENT-