Final Project Report

Document information	
Project Title	Tactical TMA and En-route Queue Management
Project Number	05.06.04
Project Manager	ENAV
Deliverable Name	Final Project Report
Deliverable ID	D72
Edition	01.00.00
Template Version	03.00.00
Task contributors	
ENAV, Eurocontrol	

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Abstract

Extension of the AMAN Horizon is expected to result in improved arrival flight trajectories for airspace users with efficiency and environmental benefits. The expectations have been demonstrated through Validation Exercises. The traffic presentation to the TMA is greatly improved with the bulk of traffic sequencing being conducted in the en-route and descent phases. This will result in more efficient terminal area operations with greatly reduced low altitude path stretching for sequence building purposes. Efficient overall management of the extended arrival operation is essential and this is addressed in sections on arrival management strategies and a description of the Sequence Manager role which takes on greater importance when AMAN operations are extended. In addition Extended AMAN has the supreme benefit of providing a set trajectory before ToD. This increases significantly the possibility for the AUs to perform the most optimum descend.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted]/ENAV>	[redacted]	<21/09/2015-05/11/2015>
[redacted]/ENAV>		<05/11/2015>

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted]/Eurocontrol>	[redacted]	<20/08/2015>
[redacted]/LFV>		<25/06/2015>
[redacted]/NATS>		<20/07/2015>

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted] NATS>	[redacted]	<20/07/2015>-29/09/2015>

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] NATS>	[redacted]	<29/09/2015>
[redacted]/NATS>		<20/07/2015>
[redacted]/NORACON>		<17/07/2015>
[redacted]Eurocontrol>		<20/08/2015>
[redacted]ENAV>		<15/07/2015>
[redacted]i/ENAV>		<15/07/2015>
[redacted]		<25/09/2015>

Rejected By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
<Name / Company>	<Position / Title>	<DD/MM/YYYY>

Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
01.00.00	12/07/2015	Final Version	[redacted]	First Version document for approval
02.00.00	22/07/2015	Final Version		Final Version fixed with minor changes
02.01.00	24/08/2015	Final Version		Final Version with integration of comments by Eurocontrol
02.02.00	21/09/2015	Final Version		Final Version integrated after 1st SJU assessment for review
01.00.00	05/11/2015	Final Version		Final Version after 2nd SJU assessment, edited 01.00.00

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Acronyms

Acronym	Definition
ATM	Air Traffic Management
KPA	Key Performance Area
AMAN	Arrival-Manager
OFA	Operational Focus Area
DS	Delay Sharing
ATCO	Air Traffic Controller Operator

1 Project Overview

The project belongs to OFA 04.01.02 Enhanced Arrival & Departure Management in TMA and En Route addressing Operational Improvements TS-0305-A [1]Arrival Management Extended to En Route Airspace - single TMA and related SESAR Solution #05- Extended Arrival Management (AMAN) horizon.

Queue Management consists of sequencing, spacing, delay attribution and delay implementation. As stated in the SESAR Concept of Operations: *"Queue Management is about fine-tuning the position of an individual aircraft into a stream that optimises the utilisation of a constrained resource. Queue Management is not about just managing delay; the accent is on optimising position in the queue and hence improving the overall outcome of the process".*

The Queue Management process is presented with traffic that is the result of Network Management processes and as such is dependent on the quality of that traffic. If the traffic delivery is significantly higher that the capacity of the resource (normally a runway) there is a limit to what queue management can achieve. However, if presented with traffic that is reasonably balanced with capacity tactical queue management can:

- assist in providing more efficient trajectories for Airspace Users by absorbing delay at more efficient altitudes thereby reducing fuel burn and CO_2 emissions
- improve the predictability of traffic delivery to the TMA;
- provide a traffic delivery that is optimised for wake vortex sequencing, thereby increasing runway throughput
- improve the organisation of the traffic delivery to the TMA, thereby decreasing TMA controller workload whilst minimising any increased task load on upstream sectors

The main method of achieving these aims is by earlier planning of arrival and related departure operations. This implies an extension of the AMAN Horizon.

Through its activities P05.06.04 provided several contributions to the validation of SESAR Solution #5 – Extended Arrival Management.

1.1 Project progress and contribution to the Master Plan

5.6.4 progress has been mainly based on the results of V3 validation exercises carried out by the project in SESAR Release 1 and Release 2. Additional activities have ensured consistency of outputs (OSED,SPR/INTEROP, OI maturity level assessment). Real time simulation were carried out to produce the results related to the concept applied, supported by complementary Fast Time Simulation activities.

The simulations focused on which method of delay absorption was most appropriate in a variety of operational circumstances in particular the main technique used by controllers was the application of appropriate speed reduction measure. Four validation exercises in Release 1 and 2, undertaken by ENAV, LVNL, NORACON and NATS." were carried out in the context of P05.06.04 at European Level.

[1] Integrated Roadmap Dataset 12

The following KPAs have been assessed to express validation output:

- Efficiency/Environment
- Predictability
- Capacity
- Cost Effectiveness
- Human Performance

The main Real Time Simulation Platform and Tools used in the Project for the R1 and R2 exercise were:

- En-route TMA/APP platform called “4 Flight Foundation” (4FF)
- E-AMAN tool
- ACE Platform
- NLR NARSIM
- NORACON IBP AAVIP
- The BARCO OSYRIS AMAN
- iFACTS (interim Future Area Control Tools Support)

P 05.06.04 has been considered the main driver for Step1 TS0305-A improvement within OFA 4.1.2 V&V roadmap.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
TS-0305-A	Arrival Management Extended to En Route Airspace - single TMA	R1,R2 validation exercises TS-0305-A operational improvement assessment	V2	V3

Table 1

The project has contributing to achieving E-OCVM V3 maturity for SESAR Solution #05. Further extensions of the concept are proposed, for example to cover even greater AMAN horizons, and to make greater use of airborne data. These will be developed further in SESAR 1 through other projects and potentially in SESAR2020.

1.2 Project Achievements

The project addressed the following targets:

- Tactical management of queues in descent flight phase
- Arrival Management Horizon extended to the En-route phase of flight
- Departures within the horizon as part of the arrival sequence at destination
- Techniques to tactically manage queues to deliver pre-sequenced traffic to TMAs
- Use of aircraft derived data to improve trajectory prediction

- Expected performance benefits
- Improve the overall efficiency and predictability of flight trajectories
- Reduce the environmental impact

The main results per KPA of P05.06.04 from the validation campaigns were:

Predictability

Analysis of outputs in terms of predictability suggests that predictability of the trajectory improves with the use of E-AMAN mainly in high traffic load conditions.. The concept is very much built around increasing predictability through closed-loop arrival trajectories and early sequence stability. Predictability for the arrival phase is improved allowing a better optimisation of the descent phase and also higher accuracy of the anticipated landing times.

Environmental Sustainability & Flight efficiency

Regarding flight efficiency, the use of E-AMAN brings benefits in terms of reduction of Track. Path stretching reduction in TMA sectors has been highlighted during the validation campaign.

Due to the application of extended horizon arrival management concept lower fuel consumption and distance flown have been assessed according to the results of validation campaigns. The results highlight that an accurate arrival management over traditional routing, enabled by E-AMAN concept, is potentially beneficial for the environment. Benefits in terms of Fuel burn and CO2 Reduction have been assessed.

Human Performance

The E-AMAN concept and the delay sharing technique (DS) were considered acceptable by ATCOs as potential improvement for the traffic synchronization in TMA. It was found that Extended AMAN led to a slight increase in En-Route workload and a decrease in TMA workload.

1.3 Project Deliverables

The following table lists the key deliverables from the project:

Deliverable	Name	Description
D35	Consolidated OSED	Last version of OSED. It builds on the foundations of the Preliminary OSED (D28) and Updated OSED (D32) and now includes a more mature vision of the Extended Arrival Management concept in which a simple extended horizon out to 200nm is described as well as proposals for long range arrival management out to 400-500nm. The content of the document has been developed on the basis of the results of validation exercises carried out by P5.6.4 and others during 2011 and contains the updates related to the validation exercises carried out by 5.6.4 during 2012.
D31	Release 2 Validation Report	The document is the Validation Report for exercises VP-244 and VP-244bis conducted under the 05.06.04 project in the context of Release 2 Plan. The aim of the exercise is to assess the actual improvement of traffic synchronisation in TMA through the extension of arrival management (provided by AMAN tool) into the en-route phase of the flight. The exercise investigates two options of AMAN Horizon, both addressing TS0305-A: VP-244 examined an Extended AMAN Horizon at 250 NM in an Italian Operational Environment, and EXE-244-bis examined a Long Range Extended AMAN Horizon at 550 NM in a United Kingdom operational environment.
D34	Consolidated SPR INTEROP	This document contains Safety, Performance and Interoperability Requirements for QM-4 – Tactical TMA and En-route Queue Management in OFA04.01.02 in Step 1 operations. The document addressed Operational Improvement TS-0305-A at the E-OCVM V3 phase. It is based on safety assessment conducted by the project and reported in D34-001 Safety Assessment Report. It further draws from outcomes of a series of validation exercises executed in projects 05.06.04 and 05.06.07. Also Appendix C "INTEROP" is included in the document. It provides interoperability requirements for the Extended Arrival Management within OFA04.01.02 Enhanced Arrival and Departure Management in TMA and En-Route. The operational scope is comprising Extended AMAN operations covered by operational improvement step TS-0305-A.

D26	Release 1 Validation Report (Package)	05.06.04 contributed to Release 1 Plan with 4 validation activities which took place in different geographical areas to evaluate different operational environment and deliver solutions independent from a specific context. The outputs of each activity are contained in stand-alone R1 Validation Reports (D21-D22-D23). This document provides the summary and an integrated picture of the results coming from 05.06.04 Release 1 validation campaign supporting the overall AMAN Extended Horizon concept.

Table 2

1.4 Contribution to Standardisation

The project results did not have an impact on standards.

1.5 Project Conclusion and Recommendations

The project has developed the Tactical TMA and En-route Queue Management Concept by means of modelling and validation exercises. The 1 achievements and outcomes show:

It is clear the E-AMAN concept and the Delay Sharing technique (DS) are considered acceptable by ATCOs as potential improvement for the traffic synchronization in TMA. Controllers agree that it is appropriate to involve the upstream sectors in pre-sequencing traffic. ATCOs highlight that this strategy effectively support their job, providing the TMA with a smoothed and ordered traffic flow compared to the standard way of working (NO E-AMAN).

The delay sharing technique and the associated working methods also gained a high level of acceptability among ATCOs. In particular qualitative data show that the time management advisories provided relevant information in the E-TMA sectors, where they help controllers in synchronizing and ordering the descending traffic (although requiring additional effort). Interestingly, the DS technique - and in general the use of E-AMAN-was perceived by ATCOs as a useful tool providing the advantage of the implicit (and silent) support for planning a common strategy across sectors. On the other hand, ATCOs suggest to customize the implementation criteria for the DS technique. In terms of mental workload impact E-AMAN showed is maintained at acceptable levels.

In terms of Environmental Sustainability, the assessed fuel burn in validation exercises was significantly lower working with E-AMAN. The results highlight that per each of assessed exercises the fuel burnt is reduced with use of E-AMAN and flight time and track miles are decreased due to accurate arrival management over traditional routing. A better management of arrival therefore led to a reduction in distance flown and a reduction of the path stretching (and in some cases holdings) with the consequence of saving in fuel burnt.

All project activities are part of the strict coordination process that has already been established between P5.6.4 and P5.6.7, by means of 5.6.4 documental provision (OSED,SPR), for future improvement of E-AMAN in the ATM system by means of further validations, in integration with different ATM tools (i.e. ASAS, i4D) .

According to the results and recommendations obtained, the project has been key to demonstrating the maturity of SESAR Solution #5, which is a required part of the PCP. The baseline for E-AMAN which is thus established also provides a starting point for further development.

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] 5.6.4 Latest Project baseline

[5] P05.06.04, Release 1 Validation Report, D26, 01.00.00, 06/04/2012

[6] P05.06.04, Release 2 Validation Report, D31, 04.00.00, 30/05/2014

[7] P05.06.04, Consolidated OSED, D35, 02.00.00, 30/09/2014

[8] P05.06.04, Final SPR-INTEROP, D34, 01.01.00, 18/05/2015

[9] Integrated Roadmap Dataset 12

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