P04.07.08 Final Project Report

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NATS, ENAIRE, DSNA	

Abstract

The objective was to develop the concepts and necessary support tools which will allow a range of controller team structures to suit various traffic levels and complexities in Enroute airspace. Evolution of the roles was considered as the task becomes potentially less tactical and more strategic and human factors were considered. The impact of these changes on the information required for the controller safely to manage the traffic for which he is responsible was investigated.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted] NATS	[redacted]	11/12/2015

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted] ENAIRE	[redacted]	15/01/2016
[redacted] DSNA	[redacted]	15/01/2016
[redacted] / NATS	[redacted]	15/01/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted]	[redacted]	26/02/2016
[redacted]	[redacted]	18/01/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] ENAIRE	[redacted]	15/03/2016
[redacted] DSNA	[redacted]	14/03/2016
[redacted] NATS	[redacted]	18/01/2016

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

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Acronyms

A comprehensive list of applicable acronyms can be found in the SESAR ATM Lexicon. To aide readability of this document the prominent acronyms used herewith are provided in the below table.

Acronym	Definition
1P-2E, 1P-nE	One Planner Controller to 2 (or more) Executives in an MSP team
ACC	Area Control Centre
ASM	Airspace Management
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer (Controller)
ATFCM	Air Traffic Flow and Capacity Management
CB	Co-ordinated Boundaries (MSP)
CC	Collaborative Control (MSP)
CTO	Controlled Time Over
DAC	Dynamic Airspace Configuration
DCB	Demand Capacity Balancing
dDCB	dynamic Demand Capacity Balancing
E-AMAN	Extended Arrival Manager
EC	Executive Controller
EAP	Extended ATC Planning
HMI	Human-Machine Interface
iFACTS	Interim Future Area Control Tools Support
LAC	London Area Control (Centre)
MSP	Multi-Sector Planning
MTCD	Medium-Term Conflict Detection
OSED	Operational Service and Environment Definition
PC	Planning Controller
QW	Quick Win
STAM	Short-Term ATFCM Measures
TMA	Terminal Manoeuvring/Control Area
TTA	Target Time of Arrival

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V1, V2, V3	Validation maturity level

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1 Project Overview

Project 4.7.8 set out to develop, define and validate concepts operation (and associated functional requirements) for several advanced methods of allocating responsibilities to the Sector Team including the Multi-Sector Planner in a Co-ordinated Boundaries operation, the Multi-Sector Planner in a Collaborative Control operation, and the Extended ATC Planner.

1.1 Project progress and contribution to the Master Plan

Project 4.7.8 addressed three threads of concept development and validation. Within OFA03.03.01, the two threads of the Multi-Sector Planner as part of the ATC Sector Team were developed: Co-ordinated Boundaries and Collaborative Control. Within OFA05.03.04, the MSP external to the Sector Team was developed as the Extended ATC Planner. These threads are discussed below:

Co-ordinated Boundaries ("CB")

The Co-ordinated Boundaries ("CB") concept is considered the first step of an evolution thread from the traditional Planner-Executive (or Planner-Tactical) sector team that is by far the prevailing ATC structure adopted across en-route operations (albeit, with the ability to combine those roles at quiet times so that a single Controller operates the sector). In contrast with the Collaborative Control ("CC") more advanced concept described below, CB does not change the nature of inter-sector boundary co-ordination agreements within the multi-sector group, and the requirement for there to be an explicit boundary transfer level (be set by that standing agreement, agreed level, explicit co-ordination or other procedure): specifically, for every executive sector, there remains an explicit entry and exit level.

Two OIs encompass this thread: CM-0301 ("Sector Team Operations Adapted to New Responsibilities in En-Route, 1 Planning to 2 Tactical Controllers team structure") and CM-0303 ("Sector Team Operations Adapted to New Responsibilities in En-route") and these have been addressed as two threads, the latter building on the former.

The concept and functionality to address CM-0301 was developed in the first two years of P4.7.8 as the "iFACTS Quick Win" in which the NATS operational iFACTS tactical tools (NATS' version of the Tactical Trajectory Module that is in full operation in the London Area Control Centre) were complemented by a set of Planning Support Tools (developed under P4.7.2) and operated in a 1P-2E team structure in a full-scale controller-in-the-loop V3 validation based on several of the London ACC sector groups – this was Release 2 exercise VP-304. Subsequently, a VALR and OSED were both delivered as a result of this development and validation phase.

Collaborative Control ("CC")

Given the Collaborative Control concept, which is described later in section 1.2, to fulfil OI CM-0306 ("Sector Team Operations Adapted to New Responsibilities and Operating Procedures involving reduced Co-ordination in En-route"), the main effort was directed to validate the concept in its initial stages.

A table-top gaming validation exercise, V1 stage, was devised to gather evidence of the feasibility of the concept and the possible areas of benefit that could be expected from it.

Based on the results of the validation exercise and further analysis, the concept has been evolved (a V2 OSED has been produced) since then to a point where a V2 and V3 validation activities are deemed necessary to resolve system requirements and the design of the HMI to allow for the new roles of controllers to be executed with safety and efficiency.

Due to the timing of SESAR1, this concept will be fully demonstrated within SESAR 2020.

Extended ATC Planner ("EAP")

The concept was studied during brainstorming sessions between operational experts, developers, designers, ergonomists and decision-takers.

The objectives are:

- On one side: to support the Local Network Management in refining fine-tuned solutions to resolve hotspots and complexity issues through efficient and well-targeted Short Term ATFCM Measures on Airborne Flights compatible and efficient in a ATC planning perspective;
- On the other side: to assist ATCO thanks to complexity alleviation measures that are conflict free, compatible with traffic presentation and synchronization activities.

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The Extended ATC Planning function builds the bridge between Network Management and ATC Planning functions, for an optimised and seamless ATM layered planning process. It contributes to improve the global situation awareness and to increase ATC confidence in the dDCB process.

- An iterative cycle was set up in order to refine the concept, the working methods, the link with dDCB activities and the associated support tools. Those support tools were composed of dedicated HMI for the EAP with:
    - An Air Situation Display showing a two hour trajectory prediction based on ETFMS;
    - Functionalities for traffic assessment and complexity monitoring including enhanced Occupancy Counts and enhanced flight lists;
    - Functionalities to manage hotspots and share them with ATC;
    - Functionalities for the STAM management and coordination process;
    - Dedicated HMI for the CWPs to support hotspot situation awareness and STAM coordination process;
    - An asynchronous communication system between CWP and the central EAP position.

A special focus was indeed given to building a consistent design aiming at providing a friendly, usable, fast and integrated HMI both for the ATCOs and the EAP.

Several Live Trials were used to assess the concept, the working methods and the tools. When employing Live Trials, the KPA have to be interpreted depending on known differences (e.g. weather, human resources availability, operational system status) when it is possible to quantify their effect.

The following OIs/Enablers have been addressed by this project as defined by Integrated Roadmap Data Set 14:

Co-ordinated Boundaries (CB)

Code	Name	Project contribution	Maturity at project start	Maturity at project end
CM-0301	Sector Team Operations Adapted to New Responsibilities in En Route - 1 Planning to 2 Tactical Controllers team structure	Project validation addresses 1P to 2T controllers' team structure. ER ATC 95 - Provides underlying FDP functionality to allow MSP. HUM-004 - Human issues of the new Sector Team structure.	V1	V3
CM-0303	Sector Team Operations Adapted to New Responsibilities in En route	Project validation will address 1 Planning to several Tactical Controllers team structure. ER APP ATC 96 - Underlying system functionality to distribute flight data correctly in the MSP configuration. HUM-005 - Human issues of the new Sector Team structure for SPO.	V1	V1

Collaborative Control ("CC")

Code	Name	Project contribution	Maturity at project start	Maturity at project end
CM-0306	Sector Team Operations Adapted to New Responsibilities and Operating Procedures	Project validation addresses new responsibilities and Operating Procedures involving reduced Coordination in En route. ER APP ATC 102 - Underlying system functionality to distribute flight data correctly in the MSP configuration.	V1	V1

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Extended ATC Planner ("EAP")

Code	Name	Project contribution	Maturity at project start	Maturity at project end
CM-0104-A (DS14)	Automated Controller Support for Trajectory Management	Project addresses new Extended ATC Planning function and the associated toolset to support the ATC team by identifying, assessing and resolving local complexity situations through assessment of evolving traffic patterns	V1	V2

1.2 Project achievements

Co-ordinated Boundaries ("CB")

The findings from the Quick Win Release 2 V3 validation (VP-304, alongside the P4.7.2 V2 validation of MTCD-based planning tools in VP-172) were that high levels of traffic could be controlled satisfactorily by a 3-person team of 1 Planner and 2 Executive Controllers, maintaining the traditional internal boundary co-ordination procedures for those flights that traversed both tactical-sectors (i.e. those flights that were controlled by both Executive Controllers). The validation involved 8 sector-valid Controllers from the London ACC and tested several MSP sector-configurations using 9 of the LAC sectors (high-level en-route and intermediate-level TMA-interface sectors).

What the findings did underline was the need for suitable and, for complex and dense airspace such as that in the London ACC, high-fidelity tools that support both the Executive and, crucially, the Planner so that the decision-making that the Planner is involved in supporting two Executives (which, themselves are working at busy levels of traffic) must significantly reduce the workload associated with the tasks of agreeing and setting suitable and safe co-ordinations with the surrounding sector teams (which, themselves, may be running in an NSP configuration). The performance demands (primarily, the balance between the tools identifying too many false-positives and failing to identify real problems – false negatives) are onerous and imply high-quality trajectory prediction and conflict detection algorithms allied with sophisticated filtering and distribution rules that closely match the operational responsibilities, even down to specific sector procedures.

Following the close-out of CM-0301, work turned to extending the CB concept from 1P-2E to 1P-nE (i.e. several Executive Controllers under a common Planner) – CM-0303. Project timescales precluded further validation of this OI, but an initial OSED describing the concept and operational requirements was published.

Collaborative Control ("CC")

The V1 validation activity was carried on in December 2013 and proved the feasibility of the collaborative control concept. It was performed with the participation of NATS (UK), NAV PT (Portugal) and AENA (Spain) ATCOs. The exercise took place in Barcelona ACC with a representation of Barcelona airspace that encompassed free sectors that covered both transition and en-route airspace (from FL 250 to FL465). The traffic type in that region of airspace is mainly climb and descents from and to the Balearic Islands and Barcelona TMA traffic together with cruising flights in north-south and east-west patterns. A remarkable characteristic of that flight is that it presents "bunching" due to the fact that tour operators companies use Palma Airport as a hub for their fleet operations, synchronizing arrivals and departures from LEPA to destinations in central and northern Europe.

This V1 validation activity was performed during 5 working days in a large room with a meeting table with the game elements (map and airplanes representations) and a set of big whiteboards along a wall representing the outputs of the system. Three ATCOs played the role of Executive Controllers and one ATCO played as a Multi-Sector Planner. One additional ATCO acted as a pilot. Two concept experts played the part of the System providing the indications of the interactions and risks on the whiteboards that represented the outputs of an MTCD while the requests of the ATCOs of what-if/what-else analysis were represented by schemes on preformatted paper sheets.

The V1 nature of the validation did not allow for conclusions about efficiency and capacity metrics, but it allows to get good feedback of human factors, specially the interaction between the different roles while performing their tasks, the dependency of the decision making processes from the availability and credibility of system predictions and gave clues for the evolution of the concept and system requirements. These conclusions are included in the VALR and were considered to establish the V2 Collaborative Control OSED (D68).

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Extended ATC Planner ("EAP")

This thread allowed validation of the first part of the EAP concept in SESAR 1 environment, focused on processes and tools assessment:

- STAM procedures and workings methods supported by computers, using asynchronous communication between ATCO and EAP
- EAP dedicated tools for analysis and prediction : occupancy curves, Flights Lists, Air Situation Display with conflicts highlights and features such as visualisation of the air situation up to 2 hours in the future
- EAP dedicated monitoring and management tool for STAMs

It has been achieved through the organisation of pre exercise, brainstorms, workshops and V2 exercise:

- In June 2014 a pre Live Trial organized in Reims to prepare the future V2 validation allowed to collect feedback on early versions of tools and refine concepts, working methods and interfaces
- During the years 2014 & 2015, several workshops and brainstorms with operational actors, mainly FMPs, have been held to develop the prototype interfaces and EAP working methods
- And finally, in June 2015, the 6 days Live Trial in Reims ACC has been held (V2 exercise), with the integration and validation of all the feedback from previous sessions.

Thanks to the very good results of the June 2015 Live Trial, an urgent demand raised to get EAP and ATCO communication tools in operation. Thus DSNA is industrializing a platform, derived from the prototype, for its 5 ACCs and Paris-CDG. This local dynamic-Demand Capacity Balancing (dDCB) tool is named SALTO for Swift ATFCM/ ASM Local Traffic Optimizer and will be delivered ready for operational use and progressively enriched with incremental steps. The first build is planned to be deployed by summer 2016 with EAP tools for analysis and prediction. The communication feature between EAP and control working positions will be implemented in the SALTO Build 3 planned for June 17.

1.3 Project Deliverables

The project performed its validation(s) as part of OFA03.03.01 and OFA05.03.04 The following table presents the deliverables that have been produced by the project activities.

Reference	Title	Description
D03	OSED (QW)	V3 validated OSED emanating from the Quick Win task (the validation was performed on a local research prototype as it is Concept Step 1). The OSED includes system, architectural and HMI requirements, operating procedures and Human Factors considerations. As this is the Quick Win, the OSED is targeted at the development of MSP for the London ACC using its iFACTS system and is limited to 1P to 2Ts, although potential migration to multiple Tacticals may be included if the underlying architecture allows
D04	State of the Art Information Paper	Document presenting the output of the State of the Art analysis.
D07	Acceptance Test Report (QW)	Acceptance test report for the Quick Win simulations QW1 and QW2. The report documents the status of the research-prototype software against the various requirements and specifications which ensure that the system is fit to be used for a real-time simulation validation activity. Its signing represents the delivery of the research prototype software.
D09	High Level Validation Plan	Validation Plan (VALP) for the V3 Quick Win simulation describes the validation exercise. The airspace, traffic, simulation layout, timetable etc, are detailed and the framework analysis presented and the validation requirements determined. The applicability of the concept, user acceptance, workload and/or productivity gains and an assessment of the overall suitability of the concept and its associated automated support tools (given the maturity level) are described.

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D10	Validation Report (QW)	The results and analysis of the V3 Quick Win simulation are presented along with conclusions and recommendations for the subsequent phases of the work. The report focuses on applicability of the concept, user acceptance, workload and/or productivity gains and an assessment of the overall suitability of the concept and its associated automated support tools (given the maturity level).
D68	Step 1 V2 Initial OSED (Collaborative Control)	Initial V2 OSED emanating from the first phase of En-route concept development in the Collaborative Control thread of MSP.
D76	Step 1 V2 Final OSED (extended ATC Planner)	V2 OSED document (initial) summarizing the concept and requirements for the Extended ATC Planner and associated roles.
D77	Step 1 V2 Preliminary OSED (Co-ordinated Boundaries)	Initial V3 OSED emanating from the first phase of En-route concept development in the Co-ordinated Boundaries thread of MSP.
D78	Step 1 V2 Validation Report (Extended ATC Planner) VP-687	VALR from the V2 simulation exercise for the EAP initial concept.

1.4 Contribution to Standardisation

The project is essentially developing novel ways of distributing operational resource within an ACC and the procedures and tools that support those responsibilities. There is no impact on standardization.

1.5 Project Conclusion and Recommendations

The conclusions and recommendations of each of the threads are outlined below.

Co-ordinated Boundaries ("CB")

The main findings of the Co-ordinated Boundaries thread were that, given suitable system support for the Planner, significant traffic levels can be safely worked in a 1P-2E team structure. It remains to be validated whether that view pertains to a 1P-nE team (i.e. more than two Executives to a single Planner), but, depending on the particular airspace, it is expected that teams of three or four Executives and a Planner might well be feasible. However, unless the operation is significantly systemized (e.g. TMA, TMA-interface) with a low proportion of explicit co-ordination tasks for the Planner (e.g. most sector entry/exit co-ordination is through standing agreement), the ability for a single MSP to cope with the increasing internal sector co-ordination workload becomes unsustainable, so for a greater ratio of Executive Controllers to a Planner, the Collaborative Control concept becomes necessary as described below.

Recommendations:

1. Validate the MSP "CB" concept in an organization of 1P-nE (n>2) in low, medium and high traffic densities and complexities.
2. Validate the MSP "CB" concept for application to a systemized airspace environment (e.g. TMA-interface).

Collaborative Control ("CC")

The V1 nature of the validation (there was no real system involved) did not allow for conclusions about efficiency and capacity metrics, but it allows to get good feedback of human factors, specially the interaction between the different roles while performing their tasks, the dependency of the decision making processes from the availability and credibility of system predictions and gave clues for the evolution of the concept and system requirements. These conclusions are included in the VALR and were considered to establish the V2 Collaborative Control OSED.

V2 and V3 validation activities will have to be performed to fully validate the concept during SESAR 2020.

Recommendations:

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1. Perform further concept development and V2 and V3 validation of the MSP “CC” concept for a range of operational environments
2. Explore the potential to extend the breadth of the “CC” concept beyond just MSP operations

Extended ATC Planner (“EAP”)

The main findings from the validation exercises can be summarised as follows:

- An increased confidence in the dDCB process allowing more STAM to be implemented with a much better accuracy, less regulations (or with higher rates), and consequently delay reduction.
- By resolving residual complexity issues and smoothing traffic for ATC, EAP contributes to increase punctuality, thanks to less delays due to regulations, while maintaining a high level of safety. Improved mutual situation awareness :
    - Hotspot declarations disseminated to each ATCO on duty, made ATCOs aware of the workload on the different CWPs, what they integrate in their ATC planning activities.
    - STAM were disseminated to both On-Loaded and Off-Loaded actors
- ATCOs reported that EAP STAM proposals were compatible with their workload, were more efficient, and easier to implement because conflict free. Coordination process was effective and easy to manage regarding ATCO environment.
- ATCOs workload decrease: compared to the paper method, they are indeed more able to manage their time because they are less under the pressure of the FMP who is no longer standing by them, awaiting their answer.
- Very good feedbacks on support tools and in particular on functionalities covering hotspots and STAM management, and coordination and implementation processes between EAP and ATCO
- Potential improvement on cost effectiveness has been observed with a slight reduction of total man-hour of ATCO during the time with an EAP vs without.

Recommendations:

1. Perform further concept development and V2 validations to work out the full EAP scope (complexity management with assessment of the best performing options between capacity and flow/trajectory measures (Decomplexification / de-confliction / synchronization / sequencing) in an INAP environment; enhanced coordination and situation awareness on both DCB and ATC sides, including XMAN & extended AMAN). Clarify roles and responsibilities in that integrated context as well as data update and exchanges.
2. Explore already tested V2 concepts in other environments (Free Route, inter-ATSUs,..)
3. Undertake further concepts and V3 validations based on feedback and results collected in SESAR1 (tools ergonomic and features enhancement, working method,…)

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2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan (Reference Data Set 14)

[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] P4.7.2 OSED "Separation Task in En-Route Trajectory Based Environment"

[5] Step 1 V2 Final OSED (Extended ATC Planner), P04.07.08, D76, DSNA, Edition 00.01.04.

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