Final Project Report

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Abstract

This Final Project Report is a summary of 04.02 goals and achievements throughout SESAR 1 Programme. 04.02 Project aimed at providing SESAR Community with a consolidated set of verified and validated requirements for En-Route domain, through operational description of the SESAR Concept (in DODs), as well as guidance for validation strategy (in VALS). It has acted as an efficient link for ensuring consistency and coherency between Top Level/ Transversal Projects and Research and Development Projects, in top-down as well as bottom-up flows for both requirement definition and Validation activities.

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Rational for rejection

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00.00.03	04/07/2016	Draft		Self assessment with SJU quality criteria Maturity assessment updated
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00.01.01	02/09/2016	Final		Revision following SJU assessment

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
4D	4 Dimensional
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance (Mode Broadcast)
AOM	Airspace Organisation and Management
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATS	Air Traffic System
AUO	Airspace User Operations
CM	Conflict Management
CONOPS	Concept of Operations Document
CPDLC	Controller Pilot Data Link Communication
CTO	Controlled Time Over (a waypoint)/
DOD	Detailed Operational Description
DS	DataSet
E-OCVM	European Operational Concept Validation Methodology
EHS	(Secondary Surveillance Mode-S Radar) Enhanced Surveillance
FIR/UIR	Flight Information Region/Upper Information Region
FPR	Final Project Report
iRBT/iRMT	initial Reference Business Trajectory/Mission Trajectory
IS	Information System
NM	Network Management
OI	Operational Improvement
OSED	Operational Service and Environment Definition

PoC	Point of Contact
SESAR Programme	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements Document
STCA	Short-Term Conflict Alert
TMA	Terminal Manoeuvring Area
VALS	Validation Strategy Document
WPL	Work Package Leader

1 Project Overview

04.02 was an operational project responsible for the Operational Concept of the En-Route domain (stretching from the end of the take-off and initial climb phase to the commencement of the approach and landing phase); primarily detailing the concept from the High Level CONOPS into description of the Operational Changes, Operational scenarios and requirements for En-Route, it also had a federating role in ensuring the overall coherency and consistency of the various contributions of other SESAR Projects, both in En-Route and with other domains (Airport, Network and TMA). In addition, 04.02 was responsible for the coordination and consolidation of the En-Route Operational Changes validation.

These objectives have been achieved through the delivery of DOD and VALS documents for En-Route.

1.1 Project progress and contribution to the Master Plan

Throughout SESAR 1 Programme, 04.02 Project has played a key role in the maintenance of the Master Plan, ensuring consistency between the Target concept and the validation activities conducted in En-Route domain, with the final objective to deliver SESAR Solutions which:

- will be safe in operations;
- will deliver the required performance;
- are achievable and affordable;
- will be usable and acceptable by the operational staff, pilots, controllers, etc., who will use them;
- will be compatible with other system elements, and
- will have no major unforeseen consequences.

These solutions are part of the Master Plan, which constitutes SESAR Target Concept.

04.02 has refined the description of this concept for En-Route in the DOD, which has been further detailed in OSED, SPR and INTEROP documents of the various Projects in charge of the validation of a specific SESAR Solution.

The En-Route Operational Changes which have been developed during the SESAR programme under the responsibility of WP4 are grouped within operational entities, named Operational Focus Areas, as listed below:

- Free Routing (including extension into the Network domain), to provide opportunity to airspace users to plan flight (and fuel) for optimal routes across FIR/UIR or ATS Unit boundaries;

- Ground-Based Separation Provision in En Route, to propose strategies and approaches (including advanced tools and procedures) to allow controllers to manage separation, in a safe orderly and expeditious way, in future environments;

- Enhanced Ground-Based Safety Nets (including extension to TMA domain), to ensure their continuous role of last ATC safety layer against the risk of collision (and other hazards) and their compatibility with Airborne Safety Nets, through the use of new surveillance means and wide information sharing, fully adapted to SESAR future trajectory management;

- Enhanced ACAS Operations, to accommodate the future separation modes identified by the SESAR Concept and to improve the collision avoidance performance, both through logic and surveillance enhancements;

- Trajectory Management Framework and System Interoperability with air and ground data sharing, to analyse the elements and structures required to achieve the safe and efficient creation, amendment and distribution of the Reference Business/Mission Trajectory (RBT/MT).

04.02 also contributed to other areas impacting also En Route domain, although not in WP4 jurisdiction, such as:

- Business and Mission Trajectory, to study inter alia how mission trajectory could accommodate specific needs from military but also civil users, like training flights or aerial work,

- Enhanced Arrival & Departure Management in TMA and En Route, with a smoother and optimised management of Arrival extended to En-Route sectors,

- Enhanced ATFCM processes, where integration between Network and ATC planning functions provide opportunity for flight optimization and more efficient Demand and Capacity Balancing.

In these various operational areas, 04.02 has been an efficient link between Top Level/ Transversal Projects and the projects in charge of the validations, answering to "Moving from Airspace to 4D Trajectory Management" and "Conflict Management and Automation" Priority Business Needs.

In the frame of SESAR Programme lifecycle and validation roadmap, 04.02 Project has provided support and review for maturity assessment of the following SESAR Solutions:

- Trajectory Management Framework in SESAR 1;

- Airline Operations Centre Data Increasing Trajectory Prediction Accuracy;

- Free Route through the use of Direct Routing;

- Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level;

- Medium-Term Conflict Detection and Conformance Monitoring tools;

- Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing;

- Multi Sector Planning: Sector Team Operations Adapted to New Responsibilities in En Route, one Planning to two Tactical Controllers team structure;

- Sector Team Operations (Extended ATC Planning);

- Enhanced Short Term Conflict Alert (STCA) for Terminal Manoeuvring Areas (TMAs);

- Enhanced STCA with down-linked parameters;

- Enhanced Airborne Collision Avoidance System (ACAS);

- Airborne Collision Avoidance using surveillance data from passive sources;

- Display and use of ACAS resolution advisory downlink on the controller working position.

The SESAR Solutions are underlain by elementary operational concept improvements, called OIs (Operational Improvements), Research and Development Projects have to address from early operational detailed definition to pre-industrialization phase.

As the lead reviewer for ATM operational aspects related to En-Route domain in the SESAR Yearly System Engineering Review process, 04.02 Operational experts contributed to the final assessment for V3 Maturity of the proposed solutions, evaluating readiness to enter industrialization phase, according to the European Operational Concept Validation Methodology (E-OCVM [6]), as described in Figure 1.
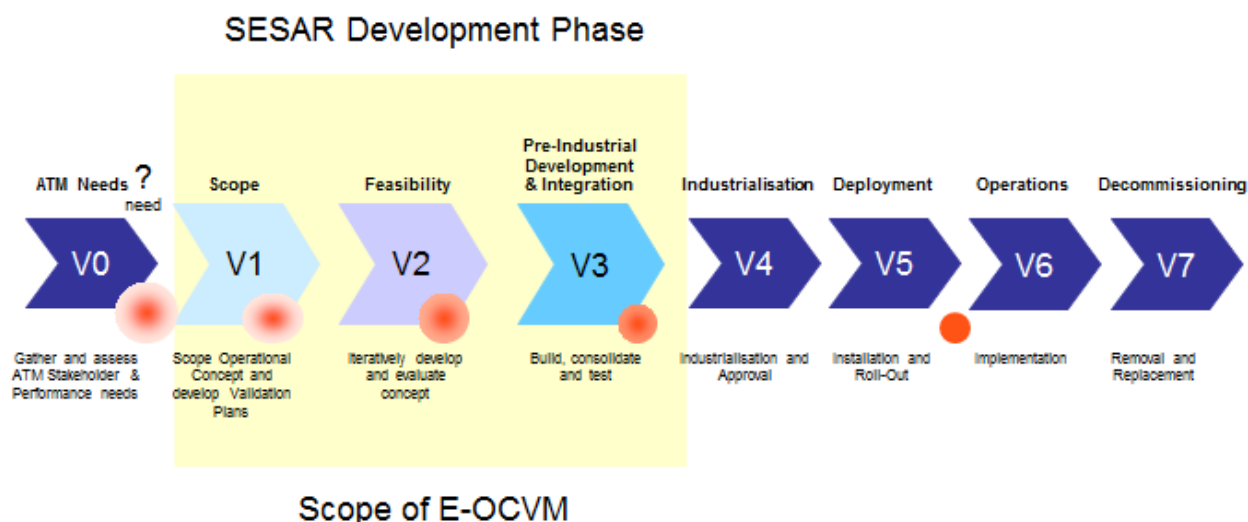
Figure 1 E-OCVM Maturilty Levels within SESAR

The following table presents the OIs (as described in Dataset 15 of the Master Plan) which belong to Operational Areas under 04.02 responsibility, and the progress in Maturity level throughout the life of the project.

Code	Name	Maturity at project start	Maturity at project end
AOM-0500	Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high complexity environments.	V2	Candidate for end of V3
AOM-0501	Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments	V1-V2	Candidate for end V3
AOM-0502	Free Routing for Flights both in cruise and vertically evolving within high complexity environments	V0-V1	V2
AUO-0205-A	ATC-ATC, ATC/Aircraft and ATC/NM Update and Revision of the Initial Reference Business/Mission Trajectory (iRBT/iRMT)	V0-V1	V2
CM-0105-A	Enhanced ATC processes by the use of new CPDLC messages and related procedures	V1	V2
CM-0105-B	Enhanced ATC processes by the use of new CPDLC messages and related procedures in Trajectory based operations	V0-V1	V1
CM-0201-A	Automated Assistance to Controller for Seamless Coordination, Transfer and Dialogue through improved trajectory data sharing	V1-V2	V3
CM-0205	Advanced Conflict Detection and Resolution in En Route	V1-V2	Candidate for end of V3
CM-0207-A	Advanced Automated Ground Based Flight Conformance Monitoring in En Route	V1-V2	V3

CM-0209	Conflict Detection and Resolution in En Route using aircraft data in Predefined and User Preferred Routes environments	V1	V2
CM-0210	Ground Based Flight Conformance Monitoring in En Route using aircraft data	V1	V2
CM-0301	Sector Team Operations Adapted to New Responsibilities in En Route, 1Planning to 2Tactical Controllers team structure	V1	V3
CM-0303	Sector Team Operations Adapted to New Responsibilities in En route, 1 Planning to several Tactical Controllers team structure	V1	V1
CM-0306	Sector Team Operations Adapted to New Responsibilities and Operating Procedures involving reduced Coordination in En route	V1	V1
CM-0403-A	Early Conflict resolution through CTO allocation in STEP1	V1-V2	V2
CM-0802	Display and use of ACAS resolution advisory downlink on the controller working position	V1-V2	Technological solution is ready but operational concept has not reached end of V3
CM-0807-A	Enhanced Short Term Conflict Alert using Mode S EHS data	V1-V2	V3
CM-0811	Enhanced STCA for TMA specific operations	V2-V3	V3
CM-0806-B	Improved Compatibility between STCA and ACAS in a Step 2 environment	V0-V1	V1
CM-0807-B	Enhanced Ground-based Safety Nets Using ADS-B information	V0-V1	V1
CM-0808	Enhanced Airborne Collision Avoidance adapted to Trajectory based operations	V0-V1	V2/partially covered
IS-0302	Use of Aircraft Derived Data (ADD) to enhance ATM ground system performance	V1-V2	V3
IS-0303-A	Downlink of onboard 4D trajectory data to enhance ATM ground system performance: initial and time based implementation	V1-V2	V3

Table 1 List of Operational Improvements under the responsibility of 4.2

04.02 contributed to the Master Plan maintenance through:
- Managing En Route concept updates through the Masterplan change control process; ensuring appropriate co-ordination with Top-Level Projects in charge of Target Concept and architecture maintenance, and Master Plan maintenance on one side, and Projects in charge of the validations on the other side.

- Initiating stakeholder engagement in respect of the En-Route Operational Changes and assisting SJU as necessary in any related Stakeholder buy-in activities, through workshops and various meetings.

1.2 Project achievements

As a federating operational project, 04.02 has cascaded and refined high-level requirements from the CONOPS and Validation objectives down to Research and Development projects in a top-down flow. It has also consolidated and made consistent requirements and Validation reports coming from the Research and Development projects, in a bottom-up approach. As a result of these activities, mutual reviews and coordination meetings have lead to a consistent set of consolidated requirements in 04.02 DOD, VALS and En-Route Projects OSED and SPR documentation.

The refinement of the description of the En-Route Operational Changes on the operational perspective, i.e. how each improvement impacts operational procedures, roles and working methods, and what operational benefits are expected for the different stakeholders, can be found in 4.2 DOD documents.

As regards the progress of the maturity of the solutions towards readiness to enter industrialization and deployment phases, the VALS deliverable aims at giving:
- clear guidance to Projects in charge of the Validations to ensure a full coverage of the scope and support assessment of validation outcome, thanks to Validation Objectives associated with Validation Criteria, in link with the Performance expectations defined at higher level in the programme;
- in a bottom-up flow, VALS document also reflects the outcome of validation activities, to support final maturity assessment.

As a result, 04.02 deliverables D98, D08 and D97 offer a mature description of SESAR Target concept for SESAR 1 in En-Route domain and the validation activities required to reach V3 maturity level allowing for start of pre-industrialization phase.

In short, 04.02 contribution to the definition of SESAR En-Route Operational Changes and Validation is reflected in:

- CONOPS documents, where 04.02 has ensured bottom-up integration of refined understanding of Target Concept for the En-Route domain,

- ATM Masterplan updates for Datasets 9 to 16, where 04.02 has reviewed all proposed changes to the concerning En Route operations (i.e. coordination of all change requests concerning Operational Improvements and Enablers linked to En Route).

- Various Task Force Reports, (e.g. Free Route Task Force, EPP Task Force, Trajectory Management Framework Task Force…), aiming at clarifying specific pieces of concept in a coordinated way within SESAR Programme.

- Yearly System Engineering Review Reports, where 04.02 contributed as formal reviewer to assess the maturity of the different solutions related to En-Route operations to deliver beneficial solutions ready to enter pre-industrialization phase.

- the diagrams and description of operational activities regarding En-Route domain, gathered in the European ATM Architecture portal [7], where 04.02 has actively contributed to the design of the following diagrams: Provide Early Conflict resolution, Provide planning separation Assurance, Provide Tactical Separation Assurance, Ensure Trajectory Adherence, Perform Short-Term Conflict Management, Manage Imminent Mid-Air Collision.

- 'Transition CONOPS' and 'Transition VALS', where 04.02 was actively involved in writing and consolidating different sections linked to En-Route domain, in order to facilitate efficient and smooth transition towards the next phase of the Programme.

1.3 Project Deliverables

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

Reference	Title	Description
04.02-D98	04.02-Dxxx-En Route Detailed Operational Description Step1_update	22/06/2015 This DOD is the final En Route Detailed Operational Description deliverable for "Time Based Operations" SESAR 1 step. It has been updated on a regular basis to take into consideration not only the Research and Development Projects' validation results, but also the outputs of the issue management processes, the CONOPS updates and other on-going work. This final version is aligned with Dataset #13 and integrates outputs from Consistency & Coherency workshops with High Level Operational Projects as well as General Aviation needs workshops.
04.02-D08	WP4 Detailed Operational Description (DOD) Step 2	27/06/2014 This document details and refines En Route Operational Concept for "Trajectory based operations" SESAR 1 step. "Trajectory Based Operations" is focused on safety, flight efficiency, predictability, environmental impact, cost effectiveness and capacity. The goal is a trajectory-based ATM system where partners optimise "business and mission trajectories" through common 4D trajectory information and users define priorities using the ATM network. Updated version aligned with DataSet #12, Integrating outputs from the Free Routing issue management process & Free Routing task force workshops.
04.02-D97	04.02 Concept Validation Strategy document Step 1	19/06/2015 This document is the final En-Route Validation Strategy deliverable for SESAR 1 "Trajectory based operations" step, based on the SESAR Master Plan Dataset #13. The purpose was to guide in their validation activities the Research and Development Projects contributing to the operational areas under 04.02 responsibility and to address further needs for integrated validation. It reports the outcome of a top-down approach completed with bottom-up information based on inputs from Research and Development Projects.
B.04.02-D106	Transition ConOps SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects	30/06/2016 04.02 has contributed to this consolidated deliverable

05.02-D109	Transition Validation Strategy for SESAR 2020	30/06/2016 04.02 has contributed to this consolidated deliverable

Table 2: List of 04.02 last Deliverables

Please refer to the references for the full list of 04.02 Deliverables.

1.4 Contribution to Standardisation

Contribution to standardisation as such was not part of 04.02 responsibility. Lower level Research and Development Projects, working on a more relevant level of granularity, covered the interaction with standardisation groups outside of SESAR.

1.5 Project Conclusion and Recommendations

CONCLUSIONS

Through the production and maintenance of DOD and VALS documents for En-Route, as well as active contribution to CONOPS, 04.02 successfully completed its project objectives and has made a significant contribution to the success of the Programme, as an efficient link between the top-level operational projects and the SJU on the one hand, and the lower-level Research and Development Projects on the other hand.

Thanks to its full operational view of En-Route environment, 04.02 has supported SESAR Operational Projects and the SJU by identifying the most important dependencies, integrated validation needs and gaps, to be addressed along the Programme lifecycle.

Increased coordination across operational domains (En-Route, Network, Airport and TMA) towards the end of SESAR Programme has proved to be beneficial for common understanding and sharing of a consistent and pragmatic approach to steer both concept and validation strategy definition, and make them more usable for the Projects in charge of the validations. More particularly, 04.02 has actively contributed to strengthen the synergy with Network and TMA domains, where integrated activities are particularly called for.

RECOMMENDATIONS

Regarding future Research and Development activities, Synergy across domains (e.g. En-Route and TMA, as well as En-Route and Network) is to be encouraged, in order to avoid unnecessary duplication of efforts and address operational changes in their full scope.

Integrated validations will need to be facilitated and reinforced to better address potential interaction of the operational changes, and optimise deployment strategies.

Fragmented approach cannot lead to significant results nor pave the way for effective deployment; a coordinated and large-scale involvement of SESAR partners from all ATM domains is an essential pre-requisite for future activities.

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] B.04.02 SESAR Concept of Operations Step 1 Final Edition, D124, v00.01.00, 30/07/2015

[5] B.04.02 SESAR Concept of Operations Step 2 Edition 2014, D105, v02.02.00, 21/12/2014

[6] E-OCVM - European Operational Concept Validation Methodology, version 3.0, February 2010

[7] European ATM Portal

[8] 04.02-D98-En Route Detailed Operational Description Step1_update, D98, v00.07.01, 22/06/2015

[9] 04.02 - D58 - Step 1 WP4 Validation Strategy (VALS), D58, 00.00.04, 25/02/2011 (initial release)

[10] 04.02 - D59 - 04.02 Concept Validation Strategy document Step 1, D59, 00.03.00, 31/08/2012 (interim release)

[11] 04.02-D07-En Route Detailed Operational Description Step1, D07, 00.06.00, 31/05/2013

[12] 04.02 - D100 - 04.02 Concept Validation Strategy document Step 1, D100, 00.01.00, 30/01/2014 (interim release)

[13] 04.02 - Dxxx - En Route Concept Validation Strategy Step 1_update, D97, v00.01.01, 19/06/2015

[14] WP4 Detailed Operational Description (DOD) Step 2, D08, v00.02.00, 27/06/2014

[15] 04.02 Concept Validation Strategy document Step 2, D60, v00.00.07, 01/02/2013

[16] B.04.02 Transition ConOps SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects, D106, v00.01.00, 30/06/2016

[17] 05.02 Transition Validation Strategy for SESAR 2020, D109, v00.01.00, 30/06/2016

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