Final Project Report

Document information	
Project Title	CWP prototyping
Project Number	10.10.03
Project Manager	THALES
Deliverable Name	Final Project Report
Deliverable ID	D37
Edition	00.02..00
Template Version	03.00.04
Task contributors	
THALES	

Abstract

P10.10.03 is a technical project which focused on the implementation of HMI requirements and their integration in En-Route and TMA CWP prototypes to support validation activities in the operational thread of SESAR programme.

P10.10.03 is a transversal project with a supportive role, it provided HMI expertise and distributed support to WP10 projects in the development and integration of the HMI functional aspect of the technical enablers. In this way, it contributed to several technical enablers.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted] THALES	[redacted]	30/03/2016

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted] ENAV	[redacted]	08/04/2016
[redacted] DFS		07/04/2016
[redacted] INDRA		06/04/2016
[redacted] NORACON		08/04/2016
[redacted] SELEX (now FINMECCANICA)		07/04/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted] THALES	[redacted]	06/04/2016
[redacted] ENAV		06/04/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] ENAV	[redacted]	11/04/2016
[redacted] DFS		11/04/2016
[redacted] INDRA		11/04/2016
[redacted] NORACON		11/04/2016
[redacted] SELEX (now FINMECCANICA)		11/04/2016
[redacted] THALES		11/04/2016
[redacted] THALES		11/04/2016

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	25/03/2015	Draft	[redacted]	Initial Draft
00.00.02	30/03/2016	Draft		Second Draft
00.00.03	08/04/2016	Revised Draft		Document revision after reviews – Version for approval

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

00.01.00	11/04/2016	Final	[redacted]	Approved version for submission
00.02.00	04/05/2016	Final		Update after SJU review

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

Acronyms

Acronym	Definition
ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADS-C	Automatic Dependent Surveillance - Contract
AMAN	Arrival MANager
ASAS	Airborne Separation Assistance System
ASM	Airspace Management
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
CPDLC	Controller-Pilot Data-Link Communications
CTA	Controlled Time of Arrival
CWP	Controller Working Position
EPP	Extended Projected Profile
ETA	Estimated Time of Arrival
HF	Human Factors
HMI	Human Machine Interface
i4D	initial 4D
MTCD	Medium Term Conflict Detection
Mode S EHS	Mode S Enhanced Surveillance"
OI	Operational Improvement
RA	Resolution Advisory
RTA	Required Time of Arrival
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

STCA	Short Term Conflict Alert
TCT	Tactical Controller Tool
TMA	Terminal Manoeuvring Area
WP	Work Package

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

1 Project Overview

P10.10.03 is a technical project which focused on the implementation of HMI requirements and their integration in En-Route and TMA CWP prototypes in support to all WP10 projects.

1.1 Project progress and contribution to the Master Plan

P10.10.03 had a supportive role and provided HMI expertise and distributed support to WP10 projects in the following way:

- Work in close collaboration with WP10 technical primary projects for the implementation of the HMI elements of their prototypes.
- Continuous integration of developed HMI elements in consolidated En-Route and TMA CWP prototypes.
- Implementation of identified HMI gaps, ensuring the En-Route and TMA CWP prototypes satisfy validation platform needs to support the targeted validation exercises.

The approach was based on continuous development and integration per yearly cycles with an adaptive scope in support to Primary Projects and validation exercises in the operational thread of SESAR programme.

Along the yearly cycles the project worked in collaboration with P10.10.02 in charge of supporting the WP10 technical primary projects in the definition of technical HMI requirements in order to share the consolidated set of HMI/HF requirements collected by P10.10.02 as a reference for the HMI development.

P10.10.03 maintained the status of implementation and verification of the HMI requirements in the three industrial partners' En-Route and TMA CWP prototypes according to the consolidated set of HMI/HF requirements collected by P10.10.02 .

Along the yearly cycles, P10.10.03 contributed to support validation exercises through the provision of En-Route and TMA CWP prototypes by the industrial project partners. These validations contributed to the validation and maturity of several OIs and to different SESAR solutions. P10.10.03 had a contribution in the development of some technical enablers needed for the OIs implementation.

P10.10.03 is a transversal project with a supportive role and is not responsible of any technical enabler. But through its distributive support to WP10 projects in the development and integration of the HMI functional aspect of the technical enablers, it contributes to several technical enablers.

The table below summarizes the HMI contribution provided by P10.10.03 support to WP10 projects in reference to the SESAR solutions, OIs and enablers addressed by the supported validations. For each supported solution, among the enablers associated to the OIs of the solution, only the enablers with an HMI impact are listed in the fourth column. The information is given according to Dataset14 solution, OI, enabler definition ([4]).

P10.10.03 contributes to an enabler for HMI part but is not responsible of the enabler globally and of the assessment of its maturity at start/end of SESAR. There is no notion of TRL maturity for the HMI part of the enabler, thus no TRL maturity is mentioned in the table below. The assessment of enabler TRL maturity level is under the responsibility of the system project in charge of the enabler.

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

Solution	OI	HMI contribution provided by P10.10.03 support	Enabler
#05 - Extended Arrival Management (AMAN) horizon	TS-0305-A - Arrival Management Extended to En Route Airspace - single TMA	Display relevant arrival management information in CWP (Track label, Flight list) Integration of AMAN time-line displays on relevant CWPs	APP ATC 111 - Enhance AMAN to extend arrival management to en-route airspace - single TMA
#06 - Controlled Time of Arrival (CTA) in Medium density / medium complexity environment	TS-0103 - Controlled Time of Arrival (CTA) in medium density/complexity environment	Implement the HMI support for i4D/CTA operations (support for new ADS-C and CPDLC ATN-B2 exchanges, display CTA information, ETAmin/max information,) Display information from airborne downlinked trajectory (EPP, discrepancies from the planned trajectory) HMI support to handle mixed fleet equipage in CTA operations (i4D capable, RTA capable, conventional a/c).	APP ATC 148 - System Support For Controlled Time of Arrival (CTA) ER APP ATC 149a - Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)
#16 - ASAS Spacing applications Remain behind and Merge behind	TS-0105-A - ASAS Spacing - target direct to merge point (Speed/simple geometry)	Implement the HMI support for ASAS Spacing applications Support for CPDLC exchanges of clearances or instructions for ASAS Spacing Identify when a flight crew has been instructed to maintain time-based spacing, and the other flights against which the flight crew is to achieve and/or maintain the spacing	APP ATC 144 - TMA Controllers are able to issue instructions to the pilot via CPDLC messages to maintain time-based spacing against other identified aircraft APP ATC 61 - System Support for ASAS Spacing for Step 1
#27 - MTCD and conformance monitoring tools	CM-0205 - Advanced Conflict Detection and Resolution in En Route CM-0207-A - Advanced Automated Ground Based Flight Conformance Monitoring in En Route	Display conflict information for each type of conflicts (sector entry, in-sector, and exit conflicts, as well as conflicts for aircraft on open clearances or deviating from their planned trajectory. Support to manual management of conflicts. Resolution is assisted by indicating available and occupied levels (what-else support) and allowing the user to probe for conflicts on a selected clearance (what-if support) HMI support to the advanced conformance monitoring functions in an en-route environment.	ER ATC 157 - ATC System Support for Medium-Term Conflict Detection and Resolution in Enroute Airspace ER ATC 91 - ATC System Support for Advanced Conformance Monitoring in Enroute Airspace
#31 - Variable profile military reserved areas	AOM-0202-A - Automated Support for strategic, pre-tactical	Display actual airspace status data in the CWP ensuring shared situational	ER APP ATC 77 - ATC Systems enhanced to

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

and enhanced (further automated) civil-military collaboration	and tactical Civil-Military Coordination in Airspace Management (ASM).	awareness.	exchange real-time (tactical) airspace status data with ASM support system
#32 - Free Route through the use of Direct Routing	AOM-0500 - Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high & very high complexity environments.	Provide CWP integrating HMI support to separation tools (MTCD, TCT) and monitoring tools. Tools from Sol#27 were used for validation of free route solution.	ER ATC 157 - ATC System Support for Medium-Term Conflict Detection and Resolution in Enroute Airspace ER ATC 91 - ATC System Support for Advanced Conformance Monitoring in Enroute Airspace
#33 - Free Route through Free Routing for Flights both in cruise and vertically evolving above a specified Flight Level	AOM-0501 - Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments	Provide CWP integrating HMI support to separation tools (MTCD, TCT) and monitoring tools. Tools from Sol#27 were used for validation of free route solution.	ER ATC 157 - ATC System Support for Medium-Term Conflict Detection and Resolution in Enroute Airspace ER ATC 91 - ATC System Support for Advanced Conformance Monitoring in Enroute Airspace
#58 - Display and use of ACAS resolution advisory downlink on the controller working position	CM-0802 - Display and use of ACAS resolution advisory downlink on the controller working position	Display the RA (resolution advisory) alert information associated to a flight. Implement the required controller interactions associated to RA.	ER APP ATC 68 - Enable Controller workstation to indicate when aircraft systems indicates an RA occurrence.
#69 - Enhanced STCA with down-linked parameters	CM-0807-A - Enhanced Short Term Conflict Alert using Mode S EHS data	Provide CWP integrating standard STCA Alert management display	-

1.2 Project achievements

P10.10.03 contributed to the development and integration of the HMI functional aspects of several technical enablers. Through its support to WP10 primary projects, the project has provided HMI enhancements integrated in En-Route and TMA CWP prototypes which were used in the operational

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

validations contributing to several SESAR solutions as presented above in the table of previous section.

The project has also performed verification of some En-Route and TMA CWP prototypes.

With the introduction of the new capabilities in En-Route and TMA CWP such as support for i4D/CTA operations, support for ASAS spacing applications, support for separation tools P10.10.03 delivered tools built to fit the needs and to support operations in more complex environment, as experimented in the operation validations.

The activities planned along P10.10.03 yearly cycles have been performed, according to the initial plan with a scope and planning adapted to the needs and planning of the supported WP10 projects and the targeted validation exercises.

The activities performed in P10.10.03 to enhance the En-Route and TMA CWP are summarised in the Synthesis reports of each cycle.

1.3 Project Deliverables

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

Reference	Title	Description
D89	Synthesis report – Cycle 3	This report summarizes the activities performed in P10.10.03 Cycle 3 to enhance the En-Route and TMA CWP. For each of the three En-Route and TMA CWP prototypes, the activities and scope of CWP enhancements are presented according to the supported operational validation exercises. It provides the statuses of implementation and verification of HMI requirements in the three En-Route and TMA CWP prototypes at the end of the Cycle 3
D77	Synthesis report – Cycle 2	This report summarizes the activities performed in P10.10.03 Cycle 2 to enhance the En-Route and TMA CWP. For each of the three En-Route and TMA CWP prototypes, the activities and scope of CWP enhancements are presented according to the supported operational validation exercises. It provides the statuses of implementation and verification of HMI requirements in the three En-Route and TMA CWP prototypes at the end of the Cycle 2.
D67	Synthesis report – Cycle 1	This report summarizes the activities performed in P10.10.03 Cycle 1 to enhance the En-Route and TMA CWP. For each of the three En-Route and TMA CWP prototypes, the activities and scope of CWP enhancements are presented according to the supported operational validation exercises. It provides the statuses of implementation and verification of HMI requirements in the three En-Route and TMA CWP prototypes at the end of the Cycle 1.

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

1.4 Contribution to Standardisation

The project has not made any contribution to standardisation activities. No standardisation activities were foreseen in the CWP ATC domain.

1.5 Project Conclusion and Recommendations

P10.10.03 contributed to the development and integration of the HMI functional aspect of several technical enablers. Providing these HMI enhancements integrated in En-Route and TMA CWP prototypes used in validation exercises in the operational thread of SESAR programme contributed to the validation and maturity of several OIs and the development of SESAR solutions. En-Route and TMA CWP with enhanced tools to support the new SESAR solutions will allow ATCOs to operate in an increasingly complex environment.

P10.10.03 cooperative and distributed support to WP10 projects has been efficient and fruitful. Direct involvement of P10.10.3 in support to HMI elements design and implementation facilitated and improved the development of HMI elements for WP10 prototypes to ensure their easier integration in a consolidated CWP prototype and their better adequacy to the targeted validation exercises.

In future projects organisation it may be worth to group in a unique project all the activities relative to an enabler development and to not separate the HMI part from the rest of the enablers since it has been proven that the HMI cannot be developed and verified in an autonomous way and only in a close cooperation with the functional part.

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

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.01, Integrated Roadmap - DS14, D82, 00.01.00, 30/06/2015

[5] 10.10.03 - D37 - Final Project Report - Ed 00.01.00 - 08/04/2016

[6] 10.10.03 – D89 - Synthesis report – Cycle 3 – Ed 00.01.00 – 11/04/2016

[7] 10.10.03 – D84 INDRA Prototype Engineering activity report – Cycle 3, Ed 00.01.01, dated 08/03/2016

[8] 10.10.03 – D85 SELEX Prototype Engineering activity report – Cycle 3, Ed 00.01.00, dated 30/03/2016

[9] 10.10.03 – D88 THALES Prototype Engineering activity report – Cycle 3, Ed 00.01.00, dated 14/03/2016

[10] 10.10.03 – D86 SELEX CWP Prototype EXE798 Verification Report, Ed 00.01.00, dated 15/04/2016

[11] 10.10.03 – D90 SELEX CWP Prototype EXE798 Availability Note, Ed 00.01.00, dated 15/04/2016

[12] 10.10.03 – D87 SELEX CWP Prototype EXE805 Verification Report, Ed 00.01.00, dated 15/04/2016

[13] 10.10.03 – D91 SELEX CWP Prototype EXE805 Availability Note, Ed 00.01.00, dated 15/04/2016

[14] 10.10.03 – D77 - Synthesis report – Cycle 2 – Ed 00.01.00 – 27/02/2015

[15] 10.10.03 – D74 INDRA Prototype Engineering activity report – Cycle 2, Ed 00.01.00, dated 28/01/2015;

[16] 10.10.03 – D75 SELEX Prototype Engineering activity report – Cycle 2, Ed 00.01.00, dated 30/01/2015;

[17] 10.10.03 – D76 THALES Prototype Engineering activity report – Cycle 2, Ed 00.01.00, dated 30/01/2015.

[18] 10.10.03 – D73 - Common Verification strategy Report - Cycle 2, Ed 00.01.01 dated 06/02/2015

[19] 10.10.03 - D64 SELEX Prototype Availability Note - Cycle1 - Ed 00.01.01 dated 07/07/2014

[20] 10.10.03 - D63 SELEX Prototype Verification Report - Cycle 1 - Ed00.01.00 dated 28/04/2014

[21] 10.10.03 – D67 - Synthesis report – Cycle 1 – Ed 00.01.01 – 17/07/2014

[22] 10.10.03 – D62 INDRA Prototype Engineering activity Report – Cycle 1, Ed 00.01.00, dated 07/02/2014

[23] 10.10.03 – D65 SELEX Prototype Engineering activity Report – Cycle 1, Ed 00.01.00, dated 07/02/2014

[24] 10.10.03 – D66 THALES Prototype Engineering activity Report – Cycle 1, Ed 00.01.00, dated 07/02/2014

[25] 10.10.03 – D61 Common Verification strategy Report - Cycle 1, Ed 00.01.00, dated 07/02/2014

[26] 10.10.03 – D10 Validation support report- INDRA prototype - Step1, Ed 00.01.02 dated 29/06/2012

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

[27] 10.10.03 – D11 Validation support report- SELEX prototype - Step1, Ed 00.01.01 dated 09/03/2012

[28] 10.10.03 – D12 Validation support report-THALES prototype - Step1, Ed 00.01.01 dated 08/03/2012

[29] 10.10.03 – D09 Verification reports synthesis – Step1, Ed 00.01.00 dated 02/02/2012

[30] 10.10.03 – D06 Verification report - INDRA prototype - Step1, Ed 00.02.01 dated 23/03/2012

[31] 10.10.03 – D07 Verification report- SELEX prototype - Step1, Ed 00.01.01 dated 07/10/2011

[32] 10.10.03 – D08 Verification report-THALES prototype - Step1, Ed 00.01.01 dated 21/11/2011

[33] 10.10.03 – D05 - Delivery sheet and User documentation-THALES prototype - Step1, Ed 00.02.00 dated 21/11/2011

[34] 10.10.03 – D04 - Delivery sheet and User documentation- SELEX prototype - Step1, Ed 00.01.01 dated 07/10/2011

[35] 10.10.03 – D03 - Delivery sheet and User documentation- INDRA prototype - Step1, Ed 00.01.01 dated 08/12/2011

[36] 10.10.03 – D02 Common test Case and scenario specification - Step 1, Ed 00.02.01 dated 12/07/2011

[37] 10.10.03 – D01 Input Requirements Assessment report - Step 1, Ed 00.01.01 dated 14/07/2011

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged

-END OF DOCUMENT-

©SESAR JOINT UNDERTAKING, 2015. Created by THALES for the SESAR Joint Undertaking within the frame of the SESAR Programme co-financed by the EU and EUROCONTROL. Reprint with approval of publisher and the source properly acknowledged