Final Project Report

Document information	
Project Title	Enhanced Surface Safety Nets
Project Number	12.03.02
Project Manager	THALES
Deliverable Name	Final Project Report
Deliverable ID	D52
Edition	00.01.01
Template Version	03.00.04
Task contributors	
THALES.	

Abstract

As part of SESAR (Single European Sky ATM Research) programme, project 12.03.02 was focused on the enhancement of Surface Safety Nets for controllers. The project:

- derived the technical specifications of the concept described by operational projects,
- implemented and tested prototypes,
- supported the validation exercises carried out in SESAR.

The project contributed to SESAR solution #2 (Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances), providing detailed specifications of the Surface Safety Net server.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted] THALES	[redacted]	15/06/2015

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted] INDRA	[redacted]	04/07/2016
[redacted] DSNA		04/07/2016
[redacted] SELEX		04/07/2016
[redacted] NATMIG		04/07/2016
[redacted] DFS		04/07/2016
[redacted] EUROCONTROL		04/07/2016
[redacted] THALES		04/07/2016

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted] DSNA	[redacted]	06/07/2016
[redacted] THALES		06/07/2016
[redacted] INDRA		04/07/2016
[redacted] DSNA		04/07/2016

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] THALES	[redacted]	29/08/2016
[redacted] INDRA		29/08/2016
[redacted] DSNA		29/08/2016
[redacted] SELEX		29/08/2016
[redacted] NATMIG		29/08/2016
[redacted] DFS		29/08/2016
[redacted] EUROCONTROL		29/08/2016

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	15/06/2015	Draft	[redacted]	Draft for Gate 2015
00.00.02	15/06/2016	Draft		Version for internal review
00.00.03	04/07/2016	Draft		Version for external review

00.01.00	06/07/2016	Final	[redacted]	Version for delivery
00.01.01	29/08/2016	Update		Update after SJU assessment

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
A-CWP	Advanced Controller Working Position
ADS-B	Automatic Dependent Surveillance-Broadcast
ASTERIX	All Purpose Structured Eurocontrol Surveillance Information Exchange
ATC	Air Traffic Control
ATM	Air Traffic Management
A-SMGCS	Advanced Surface Movement Guidance and Control System
CATC	Conflicting ATC Clearances
CDG	Charles De Gaulle airport
CMAC	Conformance Monitoring Alerts for Controllers
E-OCVM	European Operational Concept Validation Methodology
IBP	Industry Based Platform
OI	Operational Improvement
PCP	Pilot Common Project
RPV	Runway Protected Volume
RTS	Real Time Simulation
SESAR	Single European Sky ATM Research
SSN	Surface Safety Nets
SJU	SESAR Joint Undertaking
TRL	Technical Readiness Level

1 Project Overview

In reference to the ATM (Air Traffic Management) Master Plan, the project 12.03.02 aimed at improving Surface Safety Nets functions for controllers providing better and safer surface traffic management and operations on the airport

The partners focused on defining the requirements and prototypes for the following functionalities:

- Runway Incursion
- Area Intrusion
- Conformance Monitoring Alerts for Controllers (CMAC)
- Conflicting ATC Clearances (CATC)

1.1 Project progress and contribution to the Master Plan

The scope of the project 12.03.02 was the specification and the development of a Surface Safety Net Server, as well as its corresponding technical verification. Project 12.03.02 also provided support to operational validations.

The main objectives of the project were to:

- Gather and list the Runway Incursion requirements from operational projects before SESAR, for completeness of definition of the SSN (Surface Safety Nets) server
- Perform an operational requirements analysis for Airport Safety Nets for Controllers;
- Develop technical specifications for new functions or the specification of enhancements to existing functions;
- Develop prototypes and verify the new functions and technical solutions;
- Verify enhancements to existing systems to fulfil new operational requirements.

The 12.03.02 project addressed the following OI (Operational Improvement):

- AO-0104-A - Airport Safety Nets for Controllers in Step 1,

and the following Enablers:

- AERODROME-ATC-03 – Surface movement control workstation equipped with tools for runway incursion detection and alerting (Baseline)
- AERODROME-ATC-06 - Surface movement control workstation equipped with tools for conflicting ATC clearances detection and alerting for Runway operations (Step 1)
- AERODROME-ATC-07 - Surface movement control workstation equipped with tools for detection and alerting of non-conformance to ATC (Air Traffic Control) instructions or procedures for surface movements, including apron and taxiways (Step 1)

The project was decomposed in 3 phases during its initialisation. Quickly, four types of alerts were identified in the Surface Safety Net server:

- Runway Incursion: Enhanced algorithms improve runway incursion detection involving each unauthorised entry by an aircraft or a vehicle in presence of contemporary movements within the Runway Protected Volume (RPV).

- Area Intrusion: Enhanced algorithms will improve the detection of unauthorised entry by an aircraft or a vehicle into predefined areas.
- Conflicting ATC Clearances (CATC): New algorithms detect conflicting ATC clearances input by the controller (i.e. when ATC provides clearances to a mobile that would result in a conflict with other mobiles).
- Conformance Monitoring Alerts for Controllers (CMAC): New algorithms and services to detect non-conformance to ATC instructions or aerodrome procedures.

Phase 1 focused on baseline requirements for Runway Incursion and Area Intrusion, implementing requirements from operational experts and other projects [4][5]. It also provided a first set of technical requirements for Conflicting ATC Clearances (CATC) and Conformance Monitoring Alerts for Controllers (CMAC). The Phase 1 prototypes supported several validation exercises, at various maturity levels (see E-OCVM Version 3.0), aiming at performing initial operational testing on new alerts. Phase 2 refined CATC and CMAC requirements with updated operational inputs following previous validations. Then it also supported several validation exercises.

During Phase 3, a third review on requirements was made. It supported several validation exercises at V3 maturity level (see E-OCVM Version 3.0):

- V3 RTS led by ENAIRE with INDRA prototype on Barcelona-El Prat configuration. Subject was Integration of airport safety nets, advanced surface routing in a CWP.
- V3 RTS led by ENAV with SELEX prototype on Milano Malpensa configuration. Subject was Airport Surface Management Integration including CATC and CMAC.
- V3 Live and Shadow Mode validations led by EUROCONTROL with NATMIG prototype at Riga International Airport. Subject was Integration of advanced CWP, Airport Safety Nets, and Surface Management functions.
- V3 RTS led by DFS with DFS prototype on Hamburg configuration. Subject was Integration of A-CWP and A-SMGCS (Advanced Surface Movement Guidance and Control System) Level III/IV (limited HMI aspects of CATC and CMAC).
- V3 RTS led by DSNA with THALES prototype on CDG configuration. Subject was validation of CMAC, CATC and routing, integrated in A-CWP.

Project 12.03.02 addressed the following SESAR solution:

- SESAR solutions #2 (Airport Safety Support Tools for Controllers) included in the PCP (Pilot Common Project)

The technical requirements developed by the project 12.03.02 supported the three enablers (from DS-15 [6]) described in the following table:

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AERODROME-ATC-03	Surface movement control workstation equipped with tools for runway incursion detection and alerting	For completeness of definition of SSN server, project gathered and improved the baseline requirements regarding Runway Incursion and Area Intrusion. Some more alerts were specified, to detect the potential conflicts even more in advance.	TRL 6	TRL 6
AERODROME-ATC-06	Surface movement control workstation equipped with tools for conflicting ATC clearances detection	The project defined and implemented the technical requirements regarding CATC. This functionality aims at comparing the	TRL 3	TRL 6

	and alerting for Runway operations	Flight Plan information and detects clearances that could lead to a conflict. This functionality was refined during the 3 phases: surveillance data was taken into account, and Conflicting ATC clearances were implemented in "predictive mode" (i.e. the controller is informed in advance, that the next clearance he is about to give, could lead to a conflict).		
AERODROME-ATC-07	Surface movement control workstation equipped with tools for detection and alerting of non-conformance to ATC instructions or procedures for surface movements, including apron and taxiways	The project defined and implemented the technical requirements regarding CMAC. This functionality aims at comparing surveillance data with flight plan or airport configuration information, and detects incoherencies.	TRL 3	TRL 6

1.2 Project achievements

With the goal of supporting the validation of concepts described by operational projects and therefore defining technical specifications for SSN server, project 12.03.02 developed:

- Several prototypes in Phase 1 on Surface Safety Net, implementing the concepts from operational projects and supporting validation exercises. The Technical Specifications for SSN server were initialized to develop these prototypes.

The main evolutions implemented in the prototypes were the implementations of new alert functionalities:

  - CATC: an alert was triggered when the controller gave 2 clearances on the same runway that could lead to a conflict (ex: crossing clearance and landing clearance at the same time). The prototypes triggered an alert after the controller made the inputs in the system.
  - CMAC: a first set of alerts was implemented and tested in validation exercises. The CMAC function is closely related to the routing function, as it checks for coherency between the position of the aircraft and the flight plan information.

Phase 2 and 3 activities refined the technical specifications of the Surface Safety Nets server following the results of previous validations (based on controller feedback, and replay analysis). Some alert cases had to be adjusted in order to avoid nuisance alerts, or fully removed because considered useless for controller (having too many alerts increases the controller workload, and therefore is counterproductive in terms of safety).

- Several prototypes were developed in Phase 2 and 3 supporting validation exercises described in the previous paragraph. The main evolutions were on the new functionalities were:
  - The implementation of CATC in predictive mode: the Controller was informed that the clearance he was about to give could lead to a potential conflict. This implementation of CATC allowed the controller to anticipate the dangerous situations.
  - More CMAC alerts were added according to the needs described by the operational projects.

Those prototypes were implementing SESAR solution #2 (Airport Safety Support Tools for Controllers), which reached full V3 maturity and was included as part of the PCP.

1.3 Project Deliverables

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

Reference	Title	Description
D37	Phase 3 - Support to Standardization Report	This document summarizes the support given by 12.03.02 project to EUROCAE WG-41 in charge of Surface Movement Guidance & Control System.
D64	Phase 3 - Technical Specifications - Final Report	The document describes the final technical requirements (functional and non-functional) of project 12.03.02 which guided the development and implementation of prototypes for a Surface Safety Nets Server. Such System Requirements are derived from the Operational Requirements collected by the specification of previous R&D projects and from SESAR project 06.07.01.

1.4 Contribution to Standardisation

During Phase 2, project partners used a technical study task to work on the standardization of alerts format. An analysis was made on the different ASTERIX (All Purpose Structured Eurocontrol Surveillance Information Exchange) categories that can be used for the alerts in the different systems. Its conclusion is that Categories 004 and 011 are official and fully operational, but they do not fully meet the need for a protocol to transmit SSN alert reports. However, for the current purposes of project 12.03.02, it is possible to use CAT 011 without modification to the standard, as long as CAT 011 Alert Reports are sent separately from the surveillance Target Reports. A standardized format for these messages has to be defined.

During Phase 3, project 12.03.02 had a Support to Standardization task. In 2015 and 2016, the project partners actively supported the EUROCAE working group WG-41 (Surface Movement Guidance & Control System). Partners participated to meetings, presenting SESAR results on Surface Safety Nets (CATC and CMAC) and contributing to documents elaboration (ED-87D: MASPS for Advanced Surface Movement Guidance and Control Systems).

This support will be continued until the end of 2016.

1.5 Project Conclusion and Recommendations

Surface Safety Net server was fully specified in project 12.03.02, with the final delivery of D64 Final Technical Specifications. The project delivered technical requirements on the 4 main SSN functionalities identified: Runway Incursion, Area Intrusion, Conflicting ATC Clearances and Conformance Monitoring Alerts for Controllers. Those requirements were elaborated from operational requirements in SESAR, and refined in an iterative way.

The prototypes developed with those specifications were successfully tested and accepted during Validations exercises. They reduced the conflicts, and increased the situational awareness on the

airport platform. The final technical requirements defined by the project take into account all verification conclusions agreed during the 3 phases. As the validation reports form operational projects are still under production, few misalignments in the specification status (either <in progress> or <validated>) are possible.

Recommendations of the project for the next steps are:

- Testing and validating the alerts in real environments (as most of the validation exercises were in a simulated environment) during a sufficiently long period. As the validation exercises were mainly conducted in a simulated environment, those new alerts still need to be tested on real conditions and on a long term basis (several months).
- Project 12.03.02 worked on the server part, generating and ending the alerts. The HMI part for display and alert prioritisation was handled in a separate project. A close coordination between server and HMI specifications will still be needed in the future to finalize the elaboration of new alerts.
- Surface Safety Nets server performance depends on the surveillance performance of the airport. With the alert number increasing, and the hazardous situations detected more in advance, the performance of the surveillance system has to be strongly considered in order to mitigate the risk of false alerts. The level of surveillance performance for the A-SMGCS will be more demanding with this new SSN.

This research and development work will be pursued in SESAR 2020.

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] EMMA - Air-Ground Operational Service and Environmental Description – D.1.3.1.u OSED-update - www.dlr.de/emma - April 2006

[5] EMMA2 - A-SMGCS Services, Procedures, and Operational Requirements (SPOR) – Version 1.0 – December 2008

[6] B.01-D83 Integrated Roadmap DS15 Release Note, 00.01.00, 22/12/2015

[7] 12.03.02 Phase1 - System specification Baseline, D01, Edition 00.01.00, 10/06/2011

[8] 12.03.02 Phase1 - Architecture Assessment, D02, Edition 00.01.00, 10/06/2011

[9] 12.03.02 Phase1 - Technical study Report, D03, Edition 00.01.00, 19/07/2011

[10] 12.03.02 Phase1 - Prototype Documentation (Thales), D04, Edition 00.01.00, 02/04/2012

[11] 12.03.02 Phase1 - Prototype Documentation (SELEX), D05, Edition 00.01.00, 30/05/2012

[12] 12.03.02 Phase1 - Prototype Documentation (NATMIG), D06, Edition 00.01.00, 30/03/2012

[13] 12.03.02 Phase1 - Prototype Documentation (DFS), D07, Edition 00.01.00, 30/03/2012

[14] 12.03.02 Phase1 - Specific Tests Reports (Thales), D08, Edition 00.01.00, 01/03/2012

[15] 12.03.02 Phase1 - Specific Tests Reports (SELEX), D09, Edition 00.01.00, 27/04/2012

[16] 12.03.02 Phase1 - Specific Tests Reports (NATMIG), D10, Edition 00.01.00, 30/03/2012

[17] 12.03.02 Phase1 - Specific Tests Reports (DFS), D11, Edition 00.01.00, 30/03/2012

[18] 12.03.02 Phase1 - Support to Operational Validation (SELEX) - Report, D13, Edition 00.01.00, 22/01/2013

[19] 12.03.02 Phase1 - Support to Operational Validation (NATMIG) - Report, D14, Edition 00.01.00, 22/01/2013

[20] 12.03.02 Phase1 - Support to Operational Validation (DFS) - Report, D15, Edition 00.01.00, 08/01/2013

[21] 12.03.02 Phase1 -Common Verification strategy, D16, Edition 00.01.00, 07/10/2011

[22] 12.03.02 Phase1 -Consolidated verification report, D17, Edition 00.01.00, 01/08/2012

[23] 12.03.02 Phase2 - System specification, D18, Edition 00.01.00, 16/01/2013

[24] 12.03.02 Phase2 - Technical study Report, D20, Edition 00.01.00, 12/04/2013

[25] 12.03.02 Phase2 - Prototype Documentation (Thales), D21, Edition 00.01.00, 06/03/2014

[26] 12.03.02 Phase2 - Prototype Documentation (SELEX), D22, Edition 00.01.00, 02/10/2013

[27] 12.03.02 Phase2 - Prototype Documentation (NATMIG), D23, Edition 00.01.00, 29/10/2013

[28] 12.03.02 Phase2 - Prototype Documentation (DFS), D24, Edition 00.01.00, 23/04/2014

[29] 12.03.02 Phase2 - Prototype Documentation (INDRA), D58, Edition 00.01.00, 27/09/2013

[30] 12.03.02 Phase2 - Specific Tests Reports (Thales), D25, Edition 00.01.00, 06/03/2014

[31] 12.03.02 Phase2 - Specific Tests Reports (SELEX), D26, Edition 00.01.00, 02/10/2013

[32] 12.03.02 Phase2 - Specific Tests Reports (NATMIG), D27, Edition 00.01.00, 09/12/2013

[33] 12.03.02 Phase2 - Specific Tests Reports (DFS), D28, Edition 00.01.00, 23/04/2014

[34] 12.03.02 Phase2 - Specific Tests Reports (INDRA), D59, Edition 00.01.00, 08/11/2013

[35] 12.03.02 Phase2 - Support to Operational Validation (THALES) - Report, D29, Edition 00.01.00, 05/03/2015

[36] 12.03.02 Phase2 - Support to Operational Validation (SELEX) - Report, D30, Edition 00.01.00, 21/02/2014

[37] 12.03.02 Phase2 - Support to Operational Validation (DFS) - Report, D32, Edition 00.01.00, 16/01/2015

[38] 12.03.02 Phase2 - Support to Operational Validation (INDRA) - Report, D60, Edition 00.01.00, 11/06/2015

[39] 12.03.02 Phase2 -Common Verification strategy, D33, Edition 00.01.00, 11/06/2013

[40] 12.03.02 Phase2 -Consolidated verification report, D34, Edition 00.01.00, 27/08/2014

[41] 12.03.02 Phase3 - System specification, D35, Edition 00.01.00, 14/11/2014

[42] 12.03.02 Phase3 - Support to Standardization - Report, D37, Edition 00.01.00, 28/06/2016

[43] 12.03.02 Phase3 - Prototype Documentation (Thales), D38, Edition 00.01.00, 07/01/2016

[44] 12.03.02 Phase3 - Prototype Documentation (SELEX), D39, Edition 00.01.00, 01/10/2015

[45] 12.03.02 Phase3 - Prototype Documentation (NATMIG), D40, Edition 00.01.00, 11/06/2015

[46] 12.03.02 Phase3 - Prototype Documentation (DFS), D41, Edition 00.01.00, 29/09/2015

[47] 12.03.02 Phase3 - Prototype Documentation (INDRA), D61, Edition 00.01.00, 30/09/2015

[48] 12.03.02 Phase3 - Specific Tests Reports (Thales), D42, Edition 00.01.00, 27/01/2016

[49] 12.03.02 Phase3 - Specific Tests Reports (SELEX), D43, Edition 00.01.00, 23/02/2016

[50] 12.03.02 Phase3 - Specific Tests Reports (NATMIG), D44, Edition 00.01.00, 25/08/2015

[51] 12.03.02 Phase3 - Specific Tests Reports (DFS), D45, Edition 00.01.00, 29/09/2015

[52] 12.03.02 Phase3 - Specific Tests Reports (INDRA), D62, Edition 00.01.00, 11/12/2015

[53] 12.03.02 Phase3 - Support to Operational Validation (THALES) - Report, D46, Edition 00.01.00, 11/03/2016

[54] 12.03.02 Phase3 - Support to Operational Validation (SELEX) - Report, D47, Edition 00.01.00, 13/04/2016

[55] 12.03.02 Phase3 - Support to Operational Validation (NATMIG) - Report, D48, Edition 00.01.00, 12/04/2016

[56] 12.03.02 Phase3 - Support to Operational Validation (DFS) - Report, D49, Edition 00.01.00, 04/05/2016

[57] 12.03.02 Phase3 - Support to Operational Validation (INDRA) - Report, D63, Edition 00.01.00, 06/04/2016

[58] 12.03.02 Phase3 -Common Verification strategy, D50, Edition 00.01.00, 30/04/2015

[59] 12.03.02 Phase3 -Consolidated verification report, D51, Edition 00.01.00, 03/06/2016

[60] 12.03.02 Phase3 - Technical Specifications - Final Report, D64, Edition 00.01.00, 06/07/2016

[61] 06.07.01 Final OSED for Conflicting ATC Clearances and Conformance Monitoring for Controllers, D32 OFA01.02.01, v0.4

[62] 06.07.01 SPR for "Conflicting ATC Clearances" and "Conformance Monitoring for Controllers", D29 OFA01.02.01, Edition 00.01.00, 19/12/2014

[63] E-OCVM Version 3.0, European Operational Concept Validation Methodology, February 2010

-END OF DOCUMENT-