Final Project Report

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Abstract

This document reports the work performed by the project 09.14 (Airport Surface Alerts), from 2010 to 2016, in the frame of SESAR programme.
Project 09.14 was in charge of defining and validating two sets of alerts on airport surface, for mainline, regional and business aircraft:
- Initial step with "Traffic alerts on airport surface" including a V2 evaluation with system prototypes,
- Advanced step with "Conformance Monitoring alerts" (conformance to clearance, runway and taxiway compatibility) on airport surface.

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Acronyms

Acronym	Definition
A/C	Aircraft
ATM	Air Traffic Management
ADA	Architecture Definition Assumptions
ADS-B	Automatic Dependent Surveillance - Broadcast
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATSA_SURF	Enhanced Traffic Situational Awareness on the Airport Surface
CDTI	Cockpit Display of Traffic Information
FRD	Functional Requirements Document
HMI	Human Machine Interface
INTEROP	Interoperability Requirements document
NCA	Non-Compliance Alert
NOTAM	Notices To AirMen
NTC	Non-conformance from Taxi Clearance Alert
OFA	Operational Focus Areas
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PCN	Pavement Classification Number
PFD	Primary Flight Display
RTCA	Radio Technical Commission for Aeronautics
SPR	Safety and Performance Requirements
SPIR	Safety, Performance and Interoperability Requirements
SURF_IA	Surface Indication and Alerts
SURF_ITA	Surface Indications and Traffic Alerts. SURF ITA is the SESAR application

TVP	Technical Validation Plan
TVR	Technical Validation Report
VALP	VALidation Plan
VALR	VALidation Report
WA	Working Area

1 Project Overview

The aim of the Airport Surface Alerts function is to reduce the risk of conflict on the airport surface by alerting or indicating the flight crew if the function detects:

- A potential conflict with other traffic (applicable for WA 2.1 Mainline + WA 2.2 Business),
- Conformance Monitoring issues including:
  - non-conformance with the taxi clearance, i.e. an aircraft deviating from its cleared route (applicable for WA 2.1 Mainline + WA 2.2 Business + WA 2.3 Regional),
  - non-compliance issues between ownship state and properties of the airport surface (applicable to all working areas), like a PCN/ACN discrepancy, inappropriate width/wingspan, and permanent or temporary airport restrictions.

The Airport Surface Alerts project aimed at proceeding with the technical definition & validation of these topics. Two functional steps were defined for different maturity and implementation targets:
- Initial step: Traffic Alerts (on runway and/or taxiway),
- Advanced step: Conformance monitoring for Pilots.

The following companies took part in the project: HONEYWELL, THALES AVIONICS, FINMECCANICA Aircraft Division and AIRBUS (lead of the project)

1.1 Project progress and contribution to the Master Plan

The project was divided in several working areas (WA):

- The WA1 was common to all A/C types and aimed at defining the common functional requirements for both the initial and advanced steps of the project,

- The WA2.x defined the architecture and addressed the validation aspects for mainline A/C (WA2.1), Business A/C (WA2.2) and Regional A/C (WA2.3).

During the project lifecycle, a WA0 was created to address the operational concepts and related deliverables (OSED, SPR & INTEROP). They were initiated in the operational project P06.07.01 (Airport safety support tools for pilots, vehicle drivers and controllers) then transferred to P9.14 because mostly related to pilots.

Several trials were performed from 2010 to 2015 and have addressed the different Work Areas. These trials were real-time simulation using mock-ups, research simulators for each A/C type, for instance: EXE 9.14-VP-736,737,802 and real mainline prototypes (TCAS and EGPWS) for EXE 9.14-VP-673.

Results of these trials fed the operational deliverables (OSED, SPR and INTEROP) as well as the FRD and ADA documents.

The project has addressed the following OI steps (Dataset14):

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AUO-0605	Traffic alerts for pilots on runway	Confirmation of the operational concept. Definition of high-level architecture assumptions for mainline and business A/C Validation activities using mock-ups		

		for business A/C and system prototypes for mainline A/C		
AUO-0614	Conformance and compliance monitoring	Confirmation and refinement of the operational concept Definition of functional requirements, applicable to mainline, business and regional A/C Definition of high-level architecture assumptions for mainline, business and regional A/C. Validation activities using mock-ups for mainline, business and regional A/C	V1	V2
AUO-0615	Traffic alerts for pilots for taxiway operations	Confirmation of the operational concept. Definition of high-level architecture assumptions for business A/C Validation activities using mock-ups for business A/C	V1	V2

SESAR solutions:

- PJ03b-03 "Conformance monitoring safety net for Pilots" is related to AUO-0614.

- PJ03b-05: "Traffic alerts for pilots for airport operations" is related to AUO-0605 and AUO-0615.

1.2 Project achievements

Through specific definition and validation activities, the project has defined, assessed and refined the concepts, as well as the corresponding safety, performance and interoperability requirements for the 2 steps of the project:

- Initial step (Traffic Alerts)

- Advanced step (Conformance and compliance monitoring for pilots)

About Traffic Alerts, 2 concepts of implementation have emerged from the overall concept presented in RTCA DO-323 document (ref [4]):

- "Basic SURF_IA" providing only warning level traffic alerts without traffic display; this could be implemented on most mainline A/C,

- "Full SURF_IA" including additional levels of alerts linked with a traffic display; this could be implemented on specifically equipped aircraft like business A/C.

The project has also achieved a common functional requirements description, applicable to all aircraft, for the initial step (Traffic Alerts) and the advanced step (Conformance Monitoring) of the project.

The basic SURF_IA function has been defined and partly validated for mainline aircraft through EXE-9.14-VP-673. For this exercise, real aircraft prototypes have been developed, integrated and tested.

Then, SURF_IA function has been described in the associated OSED and detailed in the functional requirement document (FRD).

Basic SURF_IA function validation will continue within SESAR2020 and RTCA & EUROCAE Working Groups have been contacted to push for standardization of this specific concept.

The other functions (full SURF_IA, Conformance Monitoring for pilots), have also been defined and validated through different exercises using mock-ups on research simulators, then described in respective OSED and in the common functional requirement document (FRD).

For each type of A/C (mainline, business and regional), high-level assumptions of architecture have been identified and reported in ADA (Assumptions Document for Architecture).

In addition to real-time exercise, a fast-time simulation also took place so as to assess the impacts of erroneous ADS-B data & spurious non-sense alerts using real ADS-B data.

The project P09.14 also supported the operational activities association and discussion with other stakeholders like ATCo in project 6.7.1 and OFA 01.02.01 along the lifecycle of the P9.14 project.

1.3 Project Deliverables

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

Reference	Title	Description
D06	WA2.1 High Level Architecture Definition Assumptions (ADA) - issue 3	This document describes the High Level Definition of Architecture Assumptions for mainline Aircraft
D08	WA2.1 Technical Validation Plan (TVP) - issue 2	This document is the final issue of the Technical Validation Plan for Mainline Aircraft and presents the validation strategy of project 9.14. It is linked to the status report D19
D09	'WA2.1 V3 Validation Plan for "Traffic Alerts for pilots"	This deliverable is the Validation Plan of the validation activities performed in the frame of project 09.14 WA2.1 “Mainline Aircraft” with real prototypes (V3 level). It deals with “Traffic Alerts for Pilots” as content of Initial Step of alerts and Airbus related implementation (‘basic’ SURF IA). It is related to EXE-9.14-VP-673 and linked to the VALR D11
D10	'WA2.1 V2 Validation Plan for "Conformance Monitoring" for pilots'	This deliverable consists of the WA2.1 V2 (using mock-up) Validation Plan for Conformance Monitoring for pilots. This is the Validation plan associated to EXE-09.14-VP-802. It is linked to the VALR D21
D11	'WA2.1 V3 Validation trials & Report for "Traffic alerts for pilots"' EXE-9.14-VP-673	This deliverable is the Validation Report for the V3 Validation activities performed in the frame of project 09.14 WA2.1 “Mainline Aircraft”. It deals with “Traffic Alerts for Pilots” as content of Initial Step of alerts and Airbus related

		implementation (‘basic’ SURF IA). It is related to EXE-9.14-VP-673 and linked to the VALR D09
D14	WA2.3 High Level Architecture Definition Assumptions (ADA) - Issue 2	This document describes the High Level Definition of Architecture Assumptions for regional Aircraft
D16	WA2.3 Technical Validation Report (TVR)	This document is the technical Validation Report (TVR) following tests on FINMECCANICA flight simulator, for regional A/C It is related to EXE-09.14-VP-737 and linked to the TVP D32
D19	WA2.1 Status report on mock-up trials (initial step of alerts)	This document is a status report on mock-up trials on Research simulators, addressing mainline A/C and the initial step of alerts (Traffic Alerts for pilots). It provides the global achievements and outcomes of the trials. It is linked to the TVP D08
D21	'WA2.1 V2 Validation trials & Report for "Conformance Monitoring for pilots"'	This deliverable presents the Validation Report related the Validation Exercise EXE-09.14-VP-802 of the Airport Surface Alerts functionality for Work Area WA2.1 of project 9.14 dedicated to mainline Aircraft. It is linked to the VALP D10
D23	WA2.2 High Level Architecture Definition Assumptions - release 3 (ADA_R3)	This document describes the High Level Definition of Architecture Assumptions for business Aircraft
D26	WA2.2 Technical Validation Plan - release 2 (TVP_R2)	This deliverable defines the validation objectives for system and HMI validation for business A/C. Also it also describes validation methods, procedures and means. It is linked to the exercise EXE-9.14-VP-736 and TVR D28
D28	WA2.2 Technical Validation Report 2 - release 2 (TVR_R2)	This deliverable contains results of the second evaluation of the system and HMI validation process for business A/C. It is linked to the exercise EXE-9.14-VP-736 and the TVP D26
D32	WA2.3 Technical Validation Plan- (TVP) issue2	This document is the technical Validation Plan (TVP) for the tests planned on FINMECCANICA flight simulator, for regional A/C It is related to EXE-09.14-VP-737 and linked to the TVR D16
D36	Final OSED for "Traffic Alerts for pilots" following V3 trials	This document is the final OSED for "traffic Alerts for pilots" function, following the last trials (EXE-9.14-VP-673)

D37	Consolidated Final SPR for "Traffic Alerts for pilots" following V3 trials	This document is the final SPR for "traffic Alerts for pilots" function, following the last trials (EXE-9.14-VP-673)
D38	Consolidated Final INTEROP for "Traffic Alerts for pilots" following V3 trials	This document is the final INTEROP for "traffic Alerts for pilots" function, following the last trials (EXE-9.14-VP-673)
D39	Updated OSED for "Conformance Monitoring for pilots" following V2 trials	This document is the final OSED for "Conformance Monitoring for pilots" function, following the last trials (EXE-9.14-VP-802)
D40	Consolidated Updated SPR for "Conformance Monitoring for pilots" following V2 trials	This document is the final SPR for "Conformance Monitoring for pilots" function, following the last trials (EXE-9.14-VP-802)
D41	Validation Plan for Non-conformance Alerts (phase 3)	This document is the final validation plan of WA2.2 Business Aircraft for Non-conformance Alerts concept, which provides the crew with alerts in potentially conflicting situations during taxi, take-off and landing. It is related to EXE-09.14-VP-768 and linked VALR D42
D42	Validation Report for Non-conformance Alerts (phase 3)	This deliverable reports the last validation activities of WA2.2 Business Aircraft, which focused on non-conformance alerts for pilots during surface operation and took place in September 2014 at Honeywell laboratories in Brno, Czech Republic It is related to EXE-09.14-VP-768 and linked VALP D41
D43	Assessment of impact of erroneous ADS-B data & spurious non-sense alerts using real ADS-B data - Technical report	This report investigates the performance of the taxiway traffic alerting algorithm developed as part of SESAR 9.14 with Automatic Dependent Surveillance Broadcast (ADS-B) data collected at the Frankfurt airport by Deutsche Flugsicherung GmbH (DFS). The report also includes an analysis of the quality of the ADS-B data that was collected
D44	Verification Plan for traffic alerts using V3 prototype	This document describes the Verification Plan for hardware-in-the-loop verification of the Airport Surface Alerts (ASA) system using WA2.2 cockpit prototypes with Traffic Computer and Enhanced Ground Proximity Warning System (EGPWS) simulator. It is linked to VR D45
D45	Verification Report for traffic alerts using V3 prototype	The purpose of the document is to describe the Hardware-In-The-Loop (HITL) verification results of the Airport Surface Alerts (ASA) system using the WA2.2 cockpit prototypes (real systems) with Traffic Computer and Enhanced Ground Proximity Warning System (EGPWS) simulator. It is linked to VP D44

D46	WA1 High Level Functional Requirements Definition (FRD) - issue 4 - update with EXE-9.14-VP-673 results	This document provides the Functional Requirements for the Airport Surface Alerts Function, in the frame of 9.14 project. This document is common to WA2.1 (mainline aircraft), WA2.2 (business aircraft), and WA2.3 (regional aircraft).

1.4 Contribution to Standardisation

An initial reference is the RTCA DO-323 SURF-IA SPIR (ref [4]) that covers the full implementation. Within the project, partners have initiated a discussion with EUROCAE representatives to promote the basic SURF-IA concept in view of a much broader implementation. It is now expected to resume the discussion and push for standardization activities in SESAR 2020 as some ADS-B performance aspects are being consolidated during the final phase of SESAR 09.14 project.

1.5 Project Conclusion and Recommendations

This project has contributed to make significant progress on the definition of alerts for pilots during airport operations in both fields of traffic conflicts on runway and operations on taxiways. Derived from principles exposed in RTCA DO-323 (ref [4]), 2 types of implementation for traffic alerts on runway have been identified and their associated operational concept has been validated. The possible implementations allow addressing a large number of aircraft for retrofit or forwardfit. Architectures have been defined for mainline and business aircraft and a prototype for mainline aircraft has been realized and used during operational evaluations. This is a significant step forward in favour of safety regarding the increasing risk connected with increasing traffic and operations on airports. It needs to be completed during SESAR 2020 by going further in the functional definition, identifying the quality of data exchanged by datalink, standardize the possible implementations; expose the obtained system in real conditions of airport environment to cover corner cases in order to lower the false alerts, and nuisance alert rate.

Dealing with Conformance Monitoring for pilots, it addresses a number of potential issues occurring during airport operations due to a lack of awareness of the current situation of the airport. This addresses safety and efficiency of taxi operations that can be degraded by errors, then causing delays and / or safety issues (eg: use of an inadequate taxiway, non-respect of taxi clearance). Conformance Monitoring covers different functions that could be deployed according to their respective maturity and enablers' availability. 09.14 project focuses on an easiest solution based on an EFB implementation using AMDB populated with permanent limitation. This solution has a limited impact on aircraft, is compatible with retrofit and can be easy deployed. However, this solution cannot solve safety issue. 09.14 project demonstrated that the resolution of safety issues can only be done by Avionics Systems. This implementation will be further studied in SESAR 2020 (PJ03b-03). Even if EFB implementation does not solve safety issues, it contributes to increase safety.

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] RTCA DO-323 SURF-IA SPIR, Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA) prepared by SC-186, issued 08-Dec-2010

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