Final Project Report

Document information	
Project Title	Enhanced Surface Guidance
Project Number	12.03.04
Project Manager	Selex
Deliverable Name	Final Project Report
Deliverable ID	D01
Edition	00.02.00
Template Version	03.00.04
Task contributors	
Selex	

Abstract

SESAR project 12.03.04 "Enhanced Surface Guidance" objective was to define technical specifications and develop prototypes a Surface Guidance Server (SGS) which manages the supporting functions for providing guidance information to the pilots and vehicle drivers on the ground according to the received clearances by the controller using data link communication and/or enabling automatic Airfield Ground Lighting (AGL). The project also addressed Virtual Block Control function enabling management of Virtual Stop Bars (VSB) as red stop lights (with related alerts of infringement) on the controller's display to reduce the block sizes for traffic organization during low visibility conditions.

The SESAR activities supported by Surface Guidance prototypes provided inputs to EUROCAE WG-78/RTCA SC-214 ("Standards for Air Traffic Data Communication Services") and EUROCAE WG-44/RTCA SC-217 ("Aeronautical Databases")..

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Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
00.00.01	28/08/2015	Draft	[redacted]	First version for 2015 gate meeting

00.00.02	05/05/2016	Draft	[redacted]	Usage of new template and completion of all the sections
00.00.03	19/05/2016	Draft		Version after project review
00.00.04	24/05/2016	Draft		Final Draft version for external review
00.01.00	06/06/2016	Final		Final Version after external review
00.02.00	05/08/2016	Final		Final Version after SJU assessment

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
AeroMACS	Aeronautical Mobile Airport Communication System
AGL	Airfield Ground Lighting
AoR	Area of Responsibility
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATM	Air Traffic Management
CWP	Controller Working Position
D-TAXI	Digital Taxi
EMMA2	European airport Movement Management by A-SMGCS, part 2
ESSIP	European Single Sky Implementation
EUROCAE	European Organization for Civil Aviation Equipment
FDP	Flight Data Processor
HMI	Human Machine Interface
ITWP	Integrated Tower Working Position by EUROCONTROL
LVO	Low Visibility Operations
OFA	Operational Focus Area
SGS	Surface Guidance Server
TCL	Taxiway Centre Lights
TRL	Technology Readiness Level
VDL	VHF Digital Link
VHF	Very High Frequency
VSB	Virtual Stop-Bar
WG	Working Group
WiMAX	Worldwide Interoperability for Microwave Access
WP	Work Package

1 Project Overview

The project has defined and developed a Surface Guidance Server that allows managing the complete Guidance Function, composed by D-TAXI (ground clearances and information to pilot through data link), data link for vehicle, automatic Airfield Ground and Virtual Stop Bar (VSB) for dynamic Low Visibility Operations (LVO).

1.1 Project progress and contribution to the Master Plan

The project has been organised in three iterative phases. Each of them used operational inputs to derive technical specifications and one or more software prototypes. The output of each phase has been used as input for the following in order to gradually improve the quality of work and the maturity of the concept.

The project used and contributed to evolve the concepts coming from projects previous to SESAR (like EMMA2 - European Airport Movement Management by A-SMGCS [4]) about Surface Guidance. The evolution has been realised thanks to the definition of more mature or new operational concepts by the project 06.07.03 ("A-SMGCS Guidance Function") and to technical improvements realised in this project.

Each phase has produced one or more software prototypes:

Phase 1

Selex prototype used in V3 Real Time Simulation trials managed by ENAV in November - December 2012 about initial D-TAXI concept using Milan Malpensa layout. A live test for vehicle data link using WiMax in Malpensa Airport was held in the same context.

Phase 2

NATMIG prototype integrated with EUROCONTROL ITWP and tower 3D simulator used in Real Time Simulation trials managed by EUROCONTROL in May 2015 about initial Guidance AGL concept using North part of Paris Charles de Gaulle as layout.

Phase 3

NATMIG prototype integrated with existing A-SMGCS in Riga International Airport (Latvia) used in live and shadow mode trials managed by EUROCONTROL in January - February 2016 about AGL, D-TAXI and vehicle data link concepts.

Selex prototype integrated with Airbus and Alenia cockpit simulators used in Real Time Simulation trials managed by ENAV in May 2016 about D-TAXI and Virtual Stop-Bar concepts using Milan Malpensa layout. A flight trial with an Airbus A320 on real Aeronautical Telecommunications Network (ATN) over VDL (VHF Digital Link) Mode 2 network and a live test for vehicle data link on AeroMACS were held in the same context.

Indra prototype used in Real Time Simulation trials managed by ENAIRE in February 2016 about D-TAXI concept in a complex layout (Barcelona - El Prat airport) with multiple Areas of Responsibility (AoR).

Project 12.03.04 has had an important role within the Operational Focus Area (OFA) 04.02.01 "Integrated Surface Management" coordinating the technical development of SESAR Solution #23 "D-TAXI service for CPDLC application" (for the ground component of this solution), #47 "Guidance Assistance through Airfield Ground Lighting", #48 "Virtual Block Control in Low Visibility Procedure". The project provided the prototypes used for validation activities and technical feedback to the operational projects for improving the quality and usability of the operational requirements.

The Project contributed to maturing the Enablers referenced in the Integrated roadmap version DS15 **Error! Reference source not found.** through the technical specification, development and testing of the prototypes. In turn the Enablers supported the development and maturity of the Operational Improvement Steps also described in the table.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AERODROME-ATC-02a	Surface movement management tools updated to provide the D-TAXI information to the pilot in Step 1	The project contributed to the evolution of the technical enabler by defining and developing a SGS which is able to manage the data link dialogue between controllers and flight crews about clearances and information related to the ground operations (e.g. push-back, taxi). On the one hand, the SGS receives the ground clearances given by the controllers via their HMI and translates them into dedicated messages to the flight crew. On the other hand, the SGS receives the requests and replies from the pilot and forwards them to the Controller HMIs.	TRL 3	TRL 5
AERODROME-ATC-14	Surface movement management tools updated to provide ground clearances and information to the vehicle driver	The project contributed to the evolution of the technical enabler by defining and developing a SGS which is able to manage the data link dialogue between controllers and vehicle drivers about clearances and information related to the operations in manoeuvring area (e.g. tow, proceed). On the one hand, the SGS receives the ground clearances given by the controllers via their HMI and translates them into dedicated messages to the vehicle drivers. On the other hand, the SGS receives the requests and replies from the vehicle drivers and forwards them to the Controller HMIs.	TRL 3	TRL 4
AERODROME-ATC-61	Enhanced surface guidance management services to process the automatic triggering of airport ground signs according to the route issued by ATC	The project contributed to the evolution of the technical enabler by defining and developing a SGS which is able to translate the ground clearances and routes received from the controller HMIs (e.g. taxi, line-up, cross) into commands to the airfield ground lights, like stop-bars and taxiway centre line lights (TCL). The SGS automatically triggers the switching on/off of the airport lights taking into account the actual positions of the mobiles (aircraft and	TRL 3	TRL 5

		vehicles), realising the AGL concept.		
AERODROME-ATC-67	Surface movement control workstation equipped with tools for management of Virtual Block Control supporting LVP	The project contributed to the evolution of the technical enabler by defining and developing a SGS which is able to manage specific locations on the aerodrome movement area called Virtual Stop Bars. The SGS receives the taxi route from the routing function and the ground clearances from the controller HMI and switches on/off the relevant VSB (as the limit of the taxi clearance) for the specific flight. In this way the controller is able to implement enhanced block control procedures in low visibility conditions.	TRL 3	TRL 5

1.2 Project achievements

The main achievement of 12.03.04 was the evolution in maturity of the Surface Guidance function through the development of systems for the following SESAR Solutions:

D-TAXI (SESAR Solution #23 "D-TAXI service for CPDLC application")

Management of digital dialogue between controllers and flight crews about ground clearances. The Surface Guidance Server receives the downlink requests from the flight crews translating them into messages to the Controller Working Position (CWP) and receives the clearances from the CWP translating them into uplink messages to the flight crews.

Airfield Ground Lighting (SESAR Solution #47 "Guidance Assistance through Airfield Ground Lighting"

Management of AGL realising the "follow-the-greens" concept. The SGS receives the cleared taxi route from the A-SMGCS Routing and Planning function, the position of the mobile from the A-SMGCS Surveillance function and automatically sends the commands of switching on/off the Taxiway Centre Line Lights and Stop Bar Lights, in order to indicate the taxi route to pilots and vehicle drivers. Specific algorithms to control the spacing between mobiles on the same taxiway and/or on the crossing have been realised.

Virtual Stop Bar (SESAR Solution #48 "Virtual Block Control in Low Visibility Procedure")

Management of specific locations on the aerodrome movement area called Virtual Stop Bars. The SGS receives the taxi route from the A-SMGCS Routing and Planning function and the ground clearances from the CWP and switches on/off the relevant VSB (as the limit of the taxi clearance) for the specific flight. Specific alerting rules about violation of virtual stop bar for specific flights are included.

Data Link for Vehicle (no existing SESAR Solution - activities merged in SESAR2020)

Management of digital dialogue between controllers and vehicle drivers about operations in the movement area. The SGS receives the downlink request from the vehicle translating into messages to the CWP and receives the clearances from the CWP translating them into uplink messages to the vehicle.

The project has defined the Surface Guidance Server allowing the described functions on its technical specification document [33]. Most of defined requirements were considered as "validated" because

they were successfully verified and then used in at least one validation trial involving one of the implemented prototypes.

The Surface Guidance function has been generally considered mature enough to be considered as delivered SESAR Solutions. These have been defined as "operational and technological improvements developed by SESAR members and partners which aim to contribute to the modernisation of the European and global ATM system" [40].

The activities related to D-TAXI highlighted that Solution #23 "D-TAXI service for CPDLC application" reached a V3 level and it is ready for deployment with some limitations:

- The simple messages (e.g. push-back, start-up, contact) have been successfully validated and considered operationally relevant
- The composite messages (e.g. taxi clearance, revised taxi clearance) have been raised some difficulties in airports with a complex layout , with more than one area of responsibility. In this case, the limitation is restricting the use of taxi clearance in airports with simple layout.

The activities related to Airfield Ground Lighting and to Virtual Stop Bar highlighted that Solution #47 "Guidance Assistance through Airfield Ground Lighting" and Solution #48 "Virtual Block Control in Low Visibility Procedure" reached V3 level and they are operationally relevant with some limitations about the needs of an accurate surveillance with full coverage at the airport..

The activities related to Vehicle Data Link, instead, highlighted that additional work in research is needed. In fact, the existing SESAR solution "Improved Vehicle Guidance" has been removed and merged into SESAR2020 solution pj03a-01.

In terms of further research, this project and the rest of the projects belonging to "Integrated Surface Management" area are the starting point of the SESAR 2020 activities related to Surface Management. There, the work performed in SESAR will be continued and more complex scenarios will be investigated, live/shadow mode trials are expected to be conducted in order to use real surveillance, and more integration of sub-systems working together is expected.

1.3 Project Deliverables

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

Reference	Title	Description
D40	Technical Specification - Final Update	The objective of this document was to describe the technical requirements (functional and non-functional) that specifies the behaviour and the implementation of the Surface Guidance Server. All the interfaces were identified, as well as the external conditions and inputs affecting its operations. The document was an evolution of the Phases 1 to 3 documents and it was based on the analysis of the operational requirements from SESAR projects 06.07.02 and 06.07.03. The last update identified the requirements considered as V3 validated at the end of the SESAR programme, under the caveat that the analysis of the latest validation results were not finalised at the time of production of D40.

1.4 Contribution to Standardisation

The validation activities supported by Surface Guidance prototypes have provided valuable inputs to EUROCAE WG-78/RTCA SC-214 ("Standards for Air Traffic Data Communication Services") [5],[7] for the definition and review of the set of messages composing the D-TAXI service.

D-TAXI validation activities allowed to provide inputs and recommendations about consistency of ground and airborne databases to RTCA SC-217/EUROCAE WG-44 ("Aeronautical Databases").

1.5 Project Conclusion and Recommendations

The project has made a significant progress on the maturity of the A-SMGCS Surface Guidance function. The D-TAXI and the AGL services, together with other A-SMGCS functions, have been tested and validated several times along SESAR programme. The enhancement of Guidance function has contributed to:

- receiving the alerts related to deviation from taxi route and infringement of active stop bars from Surface Safety Nets (Conformance Monitoring function) to switch off the AGL associated to the particular movement.
- receiving planned and cleared taxi route from Surface Routing and ground clearances from Aerodrome FDP to build D-TAXI and vehicle data link messages, to command the AGL and VSB.
- receiving mobiles' position from Surveillance to properly command the AGL and VSB.

The project recommends further activities related to the integration of the different services related to Surface Guidance. Within SESAR programme, indeed, the described services (D-TAXI, vehicle data link, AGL, VSB) were mostly tested independently, so the interaction among the functions should be addressed. In addition, the integration with Routing function should be further explored, evaluating the effects of the Guidance data to Routing (e.g. failure of AGL lamps or status of Virtual Stop Bars). In addition, the influence on the taxi speed of aircraft due to potential use of AGL should be evaluated to greatly improve the predictability of the surface movements managed by the routing function in terms of taxi times.

Further studies about the Dynamic Virtual Block Control by means of Virtual Stop Bars on the integration with D-TAXI service and real AGL on the airport surface are needed. These kind of studies could provide benefits on traffic predictability and efficiency also during low visibility conditions.

Additional live trials campaigns could produce valuable results with use of real surveillance data and communication infrastructure. Within SESAR, only two validation exercises (section 1.1) have been conducted through live trials (one for AGL and one for D-TAXI). The AGL exercise was held in a medium size airport (Riga, Latvia) with a simple layout and about 30 movements per hour. The use of larger airports with complex airport layouts and different scenarios is recommended prior to full implementation of automatic AGL concept. The D-TAXI exercise was held in Milan Malpensa with a single aircraft in two sessions (taxi-out session and taxi-in session). The use of more than one mobile in different scenarios and management of contemporary data link and voice dialogues is recommended prior to fully deploy the D-TAXI service.

2 References

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