Final Project Report

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Task contributors	
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Abstract

This document is the Final Project Report for P09.09.

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Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
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00.01.00	10/10/2014	Final	P09.09	Finalversion.

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Publishable Summary

Description of the “RNP transition to xLS” concept :

The “RNP transition to xLS” concept studied by project P09.09 consists in the use of Radius to Fix (RF) legs in the RNP part of an approach that can be directly connected to the Final Approach Point (FAP) of the xLS final segment, combined with a Continuous Descent Approach (CDA) in the RNP part and a short xLS final approach segment.

Expected Benefits of this concept :

The use of RF legs in the approach procedure, the reduction of the length of the last final segment and the use of CDA will lead to lower fuel consumption and optimized noise abatement procedures.

The use of RF legs can also enable to design approach procedures with lower minimas than existing procedures.

Main achievements of project P09.09 :

The main achievements of the project P09.09 are the followings :

- The description of the “RNP transition to xLS” operational concept and of the problematics from the airborne point of view.
- The functional analysis of this concept.
- The description of the aircraft architectures that enable to perform such “RNP transition to xLS” procedures.
- The development of an automatic transition for the “RNP transition to ILS” on a regional aircraft (ATR-600), and simulations of this automatic transition on an ATR-600 cockpit bench (VP-800). In this exercice, RNP to ILS transitions were performed in different “nominal” cases (with different wind conditions but without introducing a navigation system error).
- Simulations managed by Eurocontrol (VP-801). In the exercice, EUROCONTROL, in collaboration with the Technical University of Berlin, has conducted an experiment investigating the behavior of 6 different aircraft types when performing a RNP to ILS transition. Basic procedures were coded in ARINC 424 format whereby a Radius-To-Fix (RF) leg connected directly to the localizer/glideslope intercept point of a 3, 6 or 9 NM final segment. A set of alternative procedures were designed as well, which contained a short intercept leg with a defined intercept angle between the end of the RF and the final segment. To test the influence of navigation position errors on the xLS transition, lateral biases with various magnitudes up to 0.3 NM and in either northern or southern direction were introduced in the procedures (with the final approach course aligned to the east). The procedures were flown using RF capable certified full motion flight crew training simulators.

Main conclusions and recommendations :

The outcomes of project P09.09 provide a complete view of the airborne side of the “RNP transition to xLS” concept, with simulation results for the “RNP transition to ILS”. These outcomes should therefore be considered when designing “RNP transition to ILS” procedures.

The outcomes of projects P05.06.03 and P09.10 or P06.08.05 should also be considered when designing “RNP transition to LPV” or “RNP transition to GLS” procedures.

Project team :

The SESAR P09.09 project team was composed of EUROCONTROL, AIRBUS, ALENIA and THALES.

Acronyms

Term	Definition
GBAS	Ground Based Augmentation System
GLS	GBAS Landing System
ILS	Instrument Landing System
LPV	Localizer Performance with Vertical guidance
MLS	Microwave Landing System
RNP	Required Navigation Performance
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
xLS	x Landing System (ILS/GLS/MLS)

1 Final Project Report

1.1 Project progress and contribution

The activities addressed by P09.09 contributed to the following system Enabler :

EN Code	EN Title	P09.09 activities /contributions	Maturity before project	Maturity after project
A/C-07	Curved approach e.g. automatic RNP transition to XLS/LPV	Contribution to the definition of the concept . Airborne functional and architecture analysis. RNP transition to ILS simulations.	-	V2

Table 1 - List of enablers and project contribution

Level of maturity :

Project P09.09 contributed to the maturity of the airborne solution for the RNP transition to ILS, validated by the simulation exercices VP-800 and VP-801.

Operational Improvement :

The project P09.09 contributes to the Operational Improvement AOM-0605 : “Enhanced terminal operations with automatic RNP transition to XLS/LPV”.

OFA :

The project P09.09 is involved in the OFA02.01.01 : “optimised 2D 3D routes”. Refer to [5] for a description of this OFA. Refer to [6] for the maturity assessment of AOM-605 done by OFA02.01.01.

Note that the Operational Improvement AOM-605 and the enabler A/C-07 are also studied in the following projects (involved in the OFA02.01.01) :

- P05.06.03 and P09.10 for the “RNP transition to LPV”.
- P06.08.05 for the “RNP transition to GLS”.

1.2 Project achievements

The main achievements of the project P09.09 are the followings :

- The description of the “RNP transition to xLS” operational concept and of the problematics from the airborne point of view.
- The functional analysis of this concept.
- The description of the aircraft architectures that enable to perform such “RNP transition to xLS” procedures.
- The development of an automatic transition for the “RNP transition to ILS” on a regional aircraft (ATR-600), and simulations of this automatic transition on an ATR-600 cockpit bench (VP-800). In this exercice, RNP to ILS transitions were performed in different “nominal” cases (with different wind conditions but without introducing a navigation system error).
- Simulations managed by Eurocontrol (VP-801). In the exercice, EUROCONTROL, in collaboration with the Technical University of Berlin, has conducted an experiment investigating the behavior of 6 different aircraft types when performing a RNP to ILS transition. Basic procedures were coded in ARINC 424 format whereby a Radius-To-Fix (RF) leg connected directly to the localizer/glideslope intercept point of a 3, 6 or 9 NM final segment. A set of alternative procedures were designed as well, which contained a short intercept leg with a defined intercept angle between the end of the RF and the final segment. To test the influence of navigation position errors on the xLS transition, lateral biases with various magnitudes up to 0.3 NM and in either northern or southern direction were introduced in the procedures (with the final approach course aligned to the east). The procedures were flown using RF capable certified full motion flight crew training simulators.

These achievements answered the following R&D questions :

- Are these “advanced LPV” procedures feasible from the airborne side ?
- What are the airborne requirements to fly such “advanced LPV” procedures ?
- What are the differences between the different airborne systems ?
- What are the constraints from the airborne side on the design of these procedures ?
- Are there any operational requirements for flight crew to perform the transition?

Note : the project P09.09 did not quantify the benefits of the “RNP transition to xLS” concept.

Changes from the initial scope :

In the initial scope, it was planned to perform some flight test on an ATR-600 with the automatic transition developed for the “RNP transition to ILS”. Following CR 1666, these flight tests have been replaced by simulations on an ATR-600 bench.

Also, the simulations performed by Eurocontrol were not in the initial scope and have been introduced in CR 1666.

1.3 Project deliverables

A summary of the project deliverables is presented in the table below :

Del. code	Del.Name	Description	Assessment Decision
D01	High Level Functional Requirements - Operational	This deliverable is the initial version of the description of the “RNP transition to xLS” operational concept.	No reservation
D02	High Level Functional Requirements - Technical	This deliverable is the initial version of the functional analysis of the “RNP transition to xLS” (from the airborne side).	No reservation
D03	High Level Functional Requirements - Safety	This deliverable is a safety analysis of the “RNP transition to xLS” (from the airborne side).	No reservation
D04	High Level Functional Requirements - Regulation	This deliverable gathers the regulations constraints on the “RNP transition to xLS”..	No reservation (P)
D05	High Level Functional Requirements - Architecture	This deliverable is the initial version of the architecture analysis of the “RNP transition to xLS” (from the airborne side).	No reservation (P)
D06	Technical Specification for Airborne Avionics system definition - Airborne	This deliverable defines the best suitable architecture for RNP transition to xLS procedures fitted on a regional aircraft (ATR-600).	No reservation
D07	Technical Specification for Selected Aircraft definition - Configuration	This document defines the avionics architecture configuration for the RNP Transition to xLS function fitted on a regional aircraft (ATR-600).	No reservation
D08	Technical Specification for FMS Functional Requirements	This document defines the equipment technical specifications for the RNP to xLS transition on a regional aircraft (ATR-600).	No reservation (P)
D09	White Paper for prototype readiness	This document is the availability note of the initial versions of the avionics prototypes developed for the RNP to xLS transition on a regional aircraft (ATR-600).	No reservation (P)
D10	Equipment Functional Test Report	This document is the availability note of the matured versions of the avionics prototypes developed for the RNP to xLS transition on a regional aircraft (ATR-600).	No reservation (P)
D20	Final Project Report	The deliverable (this document) is P09.09 final project report.	
D21	Validation plan and selection of the procedure (for VP-xxx)	This deliverable defines the activities to be performed during the RNP to ILS simulations on Thales ATR-600 Bench (VP-800). In particular, the selection of the RNP to ILS procedure, among the existing procedures, compliant with the Operational Description of the “RNP transition to xLS” concept, is performed.	No reservation (P)

D22	Report for the RNP to ILS simulations on Thales Bench (VP-xxx)	This deliverable is the report of the RNP to ILS simulations performed on Thales ATR-600 Bench (VP-800).	No reservation (P)
D23	Report for the RF legs simulations (VP-yyy)	This deliverable is the report of the RNP to ILS simulations managed by Eurocontrol (VP-801).	
D24	RNP to xLS Operational Concept Document - final	This deliverable is the final version of the description of the “RNP transition to xLS” operational concept.	
D25	RNP to xLS Functional Requirements - final	This deliverable is the final version of the functional analysis of the “RNP transition to xLS” (from the airborne side).	
D26	RNP to xLS Architecture - final	This deliverable is the final version of the architecture analysis of the “RNP transition to xLS” (from the airborne side).	

Table 2 - List of Project Deliverables

1.4 Contribution to standardization

P09.09 did not contribute to standardization activities.

1.5 Project Conclusions and Recommendations

The outcomes of project P09.09 provide a complete view of the airborne side of the “RNP transition to xLS” concept, with simulation results for the “RNP transition to ILS”. These outcomes should therefore be considered when designing “RNP transition to ILS” procedures.

The outcomes of projects P05.06.03 and P09.10 or P06.08.05 should also be considered when designing “RNP transition to LPV” or “RNP transition to GLS” procedures.

2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan, Edition 2

[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] Latest Project baseline : date : 10/07/2014, following CR 1666 approval

[5] OFA02.01.01 Optimised 2D 3D Routes Description, edition : 00.01.00, date : 20/08/2014

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[6] AOM-0605 - Maturity Assessment, edition : 00.01.00, date : 03/08/2014

https://extranet.sesarju.eu/releasehome/OFA02.01.01/Working%20Library/OFA%2002.01.01%20Working%20Area/AOM-0605%20-%20Maturity%20Assessment.xls

[7] P09.09-D01 : High Level Functional Requirements – Operational ; edition : 00.01.01, date : 28/08/2012

[8] P09.09-D02 : High Level Functional Requirements – Technical ; edition : 00.01.01, date : 28/08/2012

[9] P09.09-D03 : High Level Functional Requirements – Safety ; edition : 00.01.01, date : 20/11/2012

[10]P09.09-D04 : High Level Functional Requirements - Regulation ; edition : 00.01.00, date : 25/05/2012

[11]P09.09-D05 : High Level Functional Requirements - Architecture ; edition : 00.01.00, date : 29/06/2012

[12]P09.09-D06 : Technical Specification for Airborne Avionics system definition - Airborne ; edition : 00.01.01, date : 25/10/2012

[13]P09.09-D07 : Technical Specification for Selected Aircraft definition - Configuration ; edition : 00.01.01, date : 07/01/2013

[14]P09.09-D08 : Technical Specification for FMS Functional Requirements ; edition : 00.01.00, date : 26/07/2012

[15]P09.09-D09 : White Paper for prototype readiness ; edition : 00.01.00, date : 30/01/2013

[16]P09.09-D10 : Equipment Functional Test Report ; edition : 00.01.00, date : 29/03/2013

[17]P09.09-D21 : Validation plan and selection of the procedure (for VP-xxx) ; edition : 00.01.00, date : 25/07/2014

[18]P09.09-D22 : Report for the RNP to ILS simulations on Thales bench (VP-800), edition : 00.01.00, date : 25/07/2014

[19]P09.09-D23 : Report for the RF legs simulations (VP-801), edition : 00.01.00, date : 09/09/2014

[20]P09.09-D24 : RNP to xLS Operational Concept Document - final, edition : 00.01.00, date : 30/09/2014

[21]P09.09-D25 : RNP to xLS Functional Requirements – final, edition : 00.01.00, date : 30/09/2014

[22]P09.09-D26 : RNP to xLS Architecture – final, edition : 00.01.00, date : 03/10/2014

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