Final Project Report

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Abstract

The Iris Precursor service is designed to exploit an opportunity for early benefits in the 2017-2025 timeframe by deploying an aviation communications service based on the existing Inmarsat SwiftBroadband (SBB) service. This would augment existing VHF Datalink (VDL) capability in Europe to improve current datalink and planned initial 4D (trajectory predictions, enhanced with altitude and time estimates) Air Traffic Services (ATS) datalink services delivery through increased reliability and capacity, and help establish satellite communications as a key component in the future ATM communication landscape. The Iris Precursor service establishes the necessary communication infrastructure to support interoperable Oceanic and Continental i4D operations. In order to demonstrate that Satellite Communication through Iris Precursor service can support i4D operations, this project aims at developing and verifying Iris airborne prototypes.

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Acronyms

Acronym	Definition
ACARS	Aircraft Communications Addressing and Reporting System
ACSP	Aeronautical Communications Service Provider
A-G	Air-Ground
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSU	Air Traffic Services Unit
BGAN	Broadband Global Area Network
CPDLC	Controller Pilot Data Link Communication
EUROCAE	European Organisation for Civil Aviation Equipment
EYY	Airbus Internal Supplier - Avionics and Simulation Products
FANS	Future Air Navigation System
i4D	Initial 4D (Trajectory Management)
MASPS	Minimum Aviation System Performance Standards
MOPS	Minimum Operational Performance Standards
MUAC	Maastricht Upper Area Control Centre
OSI	Open System Interconnection
RBT	Reference Business Trajectories
RCP	Required Communication Performance
RCTP	Required Communication Technical Performance
RSP	Required Surveillance Performance
RSTP	Required Surveillance Technical Performance
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics

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SARPs	Standards and Recommended Practices
SATCOM	SATellite COMmunication
SBB	SwiftBroadBand (aeronautical derivative of the BGAN service)
SC	Sub-Committee
SDU	Satellite Data Unit
SESAR	Single European Skies ATM Research
TMA	Terminal Manoeuvring Area
VDLm2	VHF Data Link mode 2
VHF	Very High Frequency
WG	Working Group

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1 Project Overview

The goal of the SESAR project 15.02.05 was to develop airborne components (Air Traffic Service Unit (ATSU) and SATellite COMmunication (SATCOM) prototypes) and support the verification of Iris Precursor solution through different verification exercises. A first safety and performance analysis of the solution was performed.

Ultimate objective was to demonstrate that Iris Precursor solution is suitable to support i4D operations and the performance requirements associated.

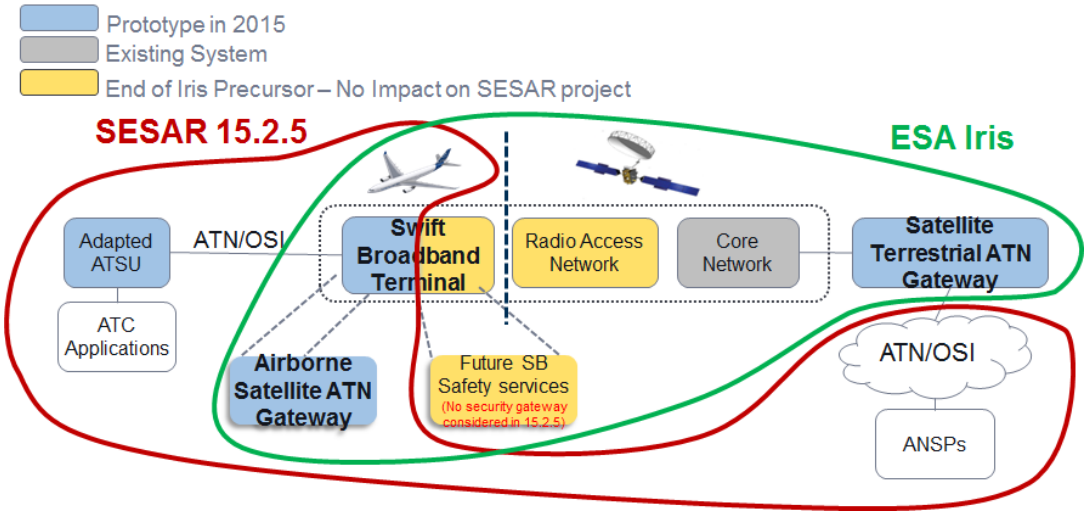
1.1 Project progress and contribution to the Master Plan

The Iris Precursor system developed by the project 15.02.05 consists of the following:

- SATCOM developed by Honeywell
- ATSU developed by EYY (Airbus internal supplier)

The SATCOM was adapted to include ATN capabilities through SBB network. ATSU development consisted to adapt the router module only because ATC applications were reused from a former SESAR project (9.01). Interfaces of SATCOM and ATSU were also modified so as to enable ATN communication between both systems.

An Iris Precursor project ordered by ESA was run in parallel of SESAR project. Both SESAR and ESA project had complementary objectives and provide complementary part of the datalink chain enabling Iris Precursor service. The figure below displays the sharing of activity between both project.



The verification exercises were split in several phases.

As mentioned above, Phase 1 was dedicated to system development. Phase 1.1 was related to ATSU and Phase 1.2 to SATCOM. For both systems a Purchaser Technical Specifications were produced in order to specify supplier development and the verification at supplier level was performed against these specifications. In addition a System Interface Document was also produced to specify the interface between the ATSU and the SATCOM enabling ATN capabilities.
Phase 2 was about system integration and also split in two. Phase 1.2 aimed at verifying the ATSU and SATCOM integration at Airbus laboratory. Phase 2.2 included a new element in the verification, which was the ATN ground gateway, counterpart to airborne one. The verification was still performed at Airbus Laboratory and the ATN ground gateway was located in partner premises', involved in the frame of ESA Iris Precursor project.

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Phase 3 was the first opportunity to be connected to Maastricht through the real SBB and real ATN network. On airborne side a full representativeness was also present, with a Flight Management System i4D capable.
Phase 4 was dedicated to the Flight Test on Airbus aircraft (A330, MSN871). A flight over Spain demonstrated the performance in a real environment of Iris Precursor services.

To complete phase 3 and phase 4, a strong coordination and synchronization was needed between all the companies involved in both SESAR and ESA Iris Precursor project. Up to 10 different companies were involved in the preparation of the final testing phases to ensure satellite, ground network and laboratory environment (Avionics and ANSP) matched with the expectations and that each component will interface and work correctly.

The list of relevant enabler is provided below

EN Code	EN Title	Project 15.02.05 Activities/Contribution	Maturity before Project	Maturity after Project
CTE-C02f	Future Satcom for ATM : Precursor /INMARSAT SBB - class B Satcom	Defines a new satellite A-G datalink to provide service redundancy to the existing terrestrial datalink VDLm2, adapting the existing commercial SATCOM systems (i.e SBB)	TRL3	TRL6

The list of potential Operational Improvements impacted by the project 15.02.05 are identified below.

OI Code	OI Title
AO-0105	Airport Safety Net for Vehicle Drivers
AO-0206	Enhanced Guidance Assistance to Airport Vehicle Driver Combined with Routing
AO-0215	Airport ATC provision of ground-related clearances and information to vehicle drivers via datalink
AOM-0208-B	Dynamic Mobile Areas (DMA) of types 1 and 2
AOM-0208-C	Dynamic Mobile Areas (DMA) of type 3
AUO-0302-C	Provision of clearances using Datalink: performance based implementation
CM-0105-A	Enhanced ATC processes by the use of new CPDLC messages and related procedures
CM-0105-B	Enhanced ATC processes by the use of new CPDLC messages and related procedures in Trajectory based operations
CM-0605	Separation Management in En Route using Pre-defined or User-preferred Routes with 2D RNP Specifications
CM-0606	Separation Management in the TMA using Pre-defined Routes with 2D RNP Specifications
CM-0607	Separation Management in En Route using RBTs with 2D RNP Specifications
CM-0608	Separation Management in the TMA using RBTs with 2D RNP Specifications
CNS-0001-B	Rationalisation of COM systems/infrastructure for Step2
CNS-0001-C	Rationalisation of COM systems/infrastructure for Step3

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The project contributed to the SESAR proposed Technological Solution "Iris Precursor".

1.2 Project achievements

The SESAR 15.02.05 project achievements are the following:

- Specification of prototype to enable ATN capability over SBB network. ATSU and SATCOM system specification and interface document has been produced.
- Verification activities satisfactorily concluded
  - Laboratory test - System integration then CPDLC and i4D exchanges with MUAC
  - Flight Test - CPDLC and i4D exchanges with MUAC in a real environment
- Performance assessment made on Iris Precursor technology
  - RCP130 compliance for CDPLC as per ED228 [11]

    The goal of the project was to assess the transaction time performance of the operational communication, called Required Communication Technical Performances (RCTP). The ED228 define the RCTP at 20s for 95% of CPDLC exchanges.

    The measured RCTP during the project is 16.06s so compliant with standard value.
  - RSP160 compliance for ADS-C as per ED228 [11]

    The goal of the project was to assessed the technical transit time performance of the surveillance data delivery, called Required Surveillance Technical Performances (RSTP). The ED228 define the RSTP at 90s for 95% of ADS-C successful report.

    The measured RSTP during the phase 4 is 19.11s so compliant with standard value.

Note: ED228 [11] is the EUROCAE Document defining the operational, safety and performance requirements for the implementation of data communication services that support Air Traffic Services Baseline 2.

Refer to D05 deliverable [10] for detailed performance assessment.

1.3 Project Deliverables

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

Reference	Title	Description
D02	Iris Precursor Verification Strategy	This document defines the high level verification strategy and objectives for the following verification phases: airborne systems development, systems integration and Flight Trials.
D03	Iris Precursor Security, Safety and Performance analysis	This document is based on a detailed analysis of Safety and Performance Requirements documentation developed by the Eurocae/RTCA. The ED228 document is used to provide the capability for users and providers to support validation activities associated with the data communications needs of future Air Traffic Management concepts.

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D04	System Interface Requirements Iris Precursor	This document defines and allocates the set of requirements applicable to the Iris Precursor system for the ATSU-SATCOM interface aspects for implementations of data link services supporting ATS in continental or oceanic airspace.
D05	Iris Precursor Verification Report	This document provides the Verification report from Project 15.02.05 on the Iris Precursor system. It describes the results of verification exercises defined in 15.02.05-D02 and how they have been conducted. Iris Precursor integration and testing activities includes: airborne systems verification, Laboratory SATCOM-ATSU integration verification, Iris Precursor system laboratory test verification and Iris Precursor System flight test verification.

All the deliverables have been accepted by SESAR JU.

1.4 Contribution to Standardisation

As of today, SATCOM use for ATM operation is reserved for oceanic airspaces. Those kind of SATCOM are so called SATCOM class A. Next development of ATM would like to authorize SATCOM communication for ATM in continental airspaces to support ATN B2 deployment. SATCOM that would be able to operate ATM services in continental airspace are SATCOM class B.

The project 15.02.05 aimed at prototyping a SATCOM class B and demonstrate the level of performance is sustainable

Thus, the project 15.02.05 contributed to standardisation in the joint group EUROCAE/RTCA WG-82/SC-222. Its results from verification exercises were used as inputs for the redaction of the following standards:

EUROCAE SATCOM Class B MASPS (RTCA reference - DO343)

EUROCAE SATCOM Class B MOPS (RTCA reference - DO262)

These two documents will be officially released by end 2016.

1.5 Project Conclusion and Recommendations

Globally speaking the SESAR 15.02.05 project results are aligned with objectives defined at the beginning of the project, both in term of maturity at system level and performance regarding ED standards.
The main objectives of the project were:
- To develop Airborne components (prototypes) with good level of maturity to allow Flight Testing
- To integrate the ground and airborne systems with the ESA Iris Precursor air-ground network, and respectively with the ground communications networks and with the airborne avionics architecture.
- To act as an integrator of the SESAR (step 1) ATM services with the Iris Precursor solution and validate this integration
- To validate that the solution is suitable to support i4D operations
- To assess the performance of the Iris Precursor solution and the compliance to the performance requirements for I4D operations

From prototype point of view a good level of maturity has been achieved throughout the project as there is no blocking anomaly and very few remaining open problem on both prototypes.

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From performance perspectives, the compliance to RCP130 and RSP160 was demonstrated during tests performed in laboratory and Flight test. This level of performance is the expected one for ATN baseline 2 services defined in the ED228.

The conclusion of the SESAR 15.02.05 is that all the objectives set were fulfilled.

On recommendation side, the verification exercises performed in SESAR 15.02.05 project had some limitations that temper the conclusions stated in the previous paragraph. Indeed, the project was attached to demonstrate that satellite communication using Iris Precursor service could support i4D exchanges and comply to associated performances. All the verification exercises were performed with the SATCOM as the only ATN communication means on-board, i.e. VHF was disabled for the sake of the testing objective. It is not realistic to imagine that Iris Precursor will be embedded on aircraft as a standalone solution, i.e. without VHF VDLm2 capability. So multilink problematic arise.
Plus, all the test were done with only one Iris Precursor user meaning that the network availability, capacity and load was not stressed out. To make an analogy with VDLm2, it is necessary to know when the Iris Precursor service will be overloaded, congested and what the timeframe is.

Global project recommendations would be then, to address particularly the verification exercise on multilink aspect and assess the Iris Precursor sustainability in time performing global simulation (including VDLm2 models) and/or Very Large scale Demonstrations.

That is why such area are recommended to be dealt with in SESAR 2020 project.

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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] Integrated Roadmap Applicable Dataset (DS15)

[5] 15.02.05, D02, Iris Precursor Verification Strategy, Ed. 00.01.01, 2015

[6] 15.02.05, D03, Iris Precursor Security, Safety and Performances analysis, Ed. 00.01.00, 2015

[7] 15.02.05, D04, System Interface Document Iris Precursor, Ed. 00.01.02, 2015

[8] 15.02.05, D05-001, Iris Precursor Verification Report issue 1, Ed. 00.01.00, 2015

[9] 15.02.05, D05-002, Iris Precursor Verification Report issue 2, Ed. 00.01.00, 2016

[10] 15.02.05, D05, Iris Precursor Verification Report, Ed. 00.01.00, 2016

[11] ED228 Safety and Performance Standard for Baseline 2 ATS Data Communications, EUROCAE, March 2014

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