Final Project Report

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Abstract

The project objective was to develop, integrate and verify prototypes and integrated pre-industrial platforms providing enhanced tools to support i4D/CTA operations implementation bringing the i4D/CTA concept enablers from V2 to V3 partial maturity level.

The project supported a stream of validations (Real Time Simulations and flight trials) aiming at validating and assessing the i4D/CTA concept in a medium density /medium complexity environment.

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Acronyms

Acronym	Definition
AMAN	Arrival Management
APP	Approach
ATC	Air Traffic Control
ATM	Air Traffic Management
CCD	Continuous Climb Departure
CDA	Continuous Descent Arrival
CTA	Controlled Time of Arrival
EPP	Extended Projected Profile
FDP	Flight Data Processing
FMS	Flight Management System
HMI	Human Machine Interface
IBP	Industrial Based Platform
MUAC	Maastricht Upper Area Control Centre
NORACON	NORth european and Austrian CONsortium
NUAC	Nordic Unified Air Traffic Control
OFA	Operational Focus Area
RTS	Real Time Simulation
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
TMA	Terminal Control Area
UAC	Upper Area Control

1 Project Overview

The Project addresses Operational Improvement TS-0103 “Enhanced Arrival & Departure Management in TMA and En Route” and related SESAR Solution #6 “Controlled Time of Arrival (CTA) in Medium density / Medium complexity environment”.

The project objective was to develop, integrate and verify prototypes and integrated pre-industrial platforms providing enhanced tools to support i4D/CTA operations. It has supported an iterative validation of concept elements and processes relating to the use of Controlled Time of Arrival (CTA) time constraints in the context of arrival management. The CTA concept being considered as one of the enablers of CDA operations.

Controlled Time of Arrival (CTA) is an important cornerstone of the SESAR future concept. Better integration of airborne and ground systems and functionalities, and a better accommodation of the airspace users wishes (even when operating to necessary ground constraints) are considered key features of the SESAR concept.

1.1 Project progress and contribution to the Master Plan

In its initial phase, the project had to support early validations and since no technical inputs were available from other technical projects, the project has performed a technical and an architecture feasibility study and has developed an initial technical specification for different required technical enablers to support first CTA concept validations in a medium complexity/density environment. This has been done in cooperation with related technical and operational projects.

Technical specification included datalink, flight data processing/trajectory prediction and arrival management requirements.

In the second phase, the project integrated prototypes from different technical projects responsible of each required technical enabler into one IBP to support the planned validations. The project ensured that the built platform meets the operational validation requirements.

In total the project has supported 4 validations exercises, two flight trials and two real time simulations:

Two flight trials with the objective to perform a gradual validation of trajectory exchange with the aircraft (2D/3D moving towards 4D) and to validate the concept of a shared trajectory to ensure

consistency of information between ground and airborne systems, as well as to explore how a CTA and its' associated i4D message set will be managed by the aircraft and the ground systems.

The project supported two Real Time Simulations as well. The aim was to assess the impact of i4D/CTA operations on the controller work. A total of nine controllers took part during the two week simulation. Many objectives were created to assess the concept and acceptability of i4D/CTA operations. The validation of these objectives was determined by a number of techniques including: Controller Opinion (in the form of questionnaires, debriefs and informal discussions); Workload measures; Situational Awareness Measures; and a number of logged metrics from the simulator platform e.g. Aircraft Track Data and AMAN logs

The project has contributed in maturing many enablers required for CTA operations implementation. It includes enablers for Air/Ground Data communication and the use of ADS-C EPP information in ground system. The project contribution was the review of technical requirements of the project responsible of each enabler (10.02.01, 10.07.01 and 10.09.02) and the support of validation exercises using prototypes implementing these technical enablers.

The project has actively participated (as technical member) to the Expert Group that was established within project 05.06.01 at its outset, intended to gather experts from different fields and domains to discuss and produce recommendations activities related to CTA within the project.

1.2 Project achievements

The project has contributed strongly to increase the maturity of CTA operational concept (OI TS-0103) bringing its maturity from V2 in the beginning of the project to a V3 Partial level at its end.

The project has contributed to the production and review of technical requirements for technical enablers to support the implementation of CTA concept. The project has contributed strongly in maturing them:

- Datalink :
    - ER APP ATC 119 : Enhance Air/Ground Data Communication for Step 1
    - ER APP ATC 149a : Air-Ground Datalink Exchange to Support i4D - Extended Projected Profile (EPP)
    - ER APP ATC 149b : Air-Ground Datalink Exchange to Support i4D - ETA min/max
    - ER APP ATC 149c: Air-Ground Datalink Exchange to Support i4D - Controlled Time of Arrival/Overflight (CTA/CTO)
- FDP/Trajectory Prediction
- Arrival Management
    - APP ATC 111: Enhance AMAN to extend arrival management to en-route airspace - single TMA

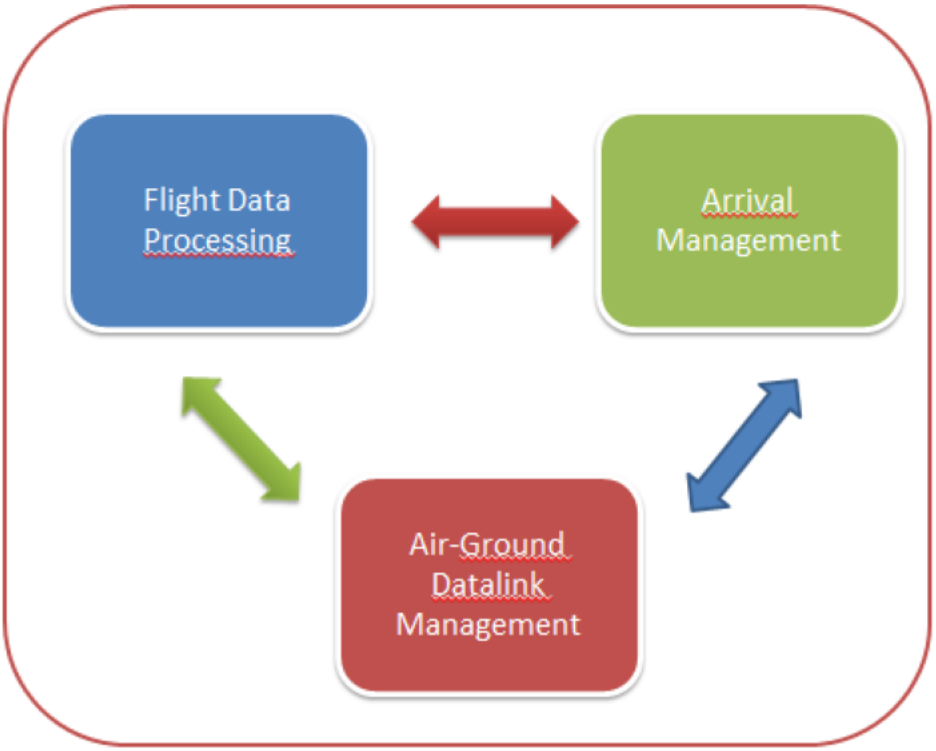

Figure 1 : Overview of the Functional blocks the project has contributed to

It has contributed to the review of technical specifications produced by 10.02.01 ([9]), 10.07.01 ([8]) and 10.09.02 ([7]).

The project has developed and integrated prototypes from different related technical project. These prototypes and the integrated validation platform have been matured along with the validations lifecycle to reach a good level of maturity of the validation platforms demonstrating the technical implementation feasibility of the concept and allowing CTA.

1.3 Project Deliverables

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

Reference	Title	Description
10.09.04-D10	System requirements definition for ATC support to CDA-CCD - Phase 1	The document contains technical requirements that have been developed by 10.09.04 based on operational requirements to support i4D/CTA operations in the context of arrival management. It includes technical requirements related to datalink communication, HMI, trajectory management and to arrival management.
10.09.04-D19	Indra prototype developed (for phase 1) - DEL	INDRA prototype Availability Note
10.09.04-D33	Thales prototype developed (for	Thales prototype availability Note. It has been used to support i4D/CTA flight trial (EXE-05.06.01-

	phase 1) - DEL	VP-203)
10.09.04-D37	Thales - Testing platform & tools requirements-development phase 1 - DEL	The document describes the Testing platform and testing tools which will be used for the verification of Thales' prototype developed in phase 1 used to support i4D/CTA flight trial (EXE-05.06.01-VP-203)
10.09.04-D98	Thales - Support to the concepts operational validation (phase 1) - Availability Note VP-477	Availability Note of the Thales Prototype resulting from the integration of 10.02.01, 10.07.01 and 10.09.02 Thales prototypes. The prototype has been used to support i4D/CTA validation exercise (EXE-05.06.01-VP477)

1.4 Contribution to Standardisation

No standardisation activities have been performed within the scope of the project. No Standards and Norms have been produced.

1.5 Project Conclusion and Recommendations

Thanks the continuous enhancements brought to the prototypes developed or integrated by the project along with the validations lifecycle, we have reached a good level of technical maturity of the systems used to support the validations. Controllers expressed their satisfaction with regards to the provided systems and considered the system support good enough to allow an easy implementation of CTA operations.

The level of information available to the controllers is considered as satisfactory allowing having a good situation awareness which makes the tested non-nominal situations handling manageable.

When using CTA operations, smoother traffic flow was delivered to the TMA and flights profiles are more efficient thanks to the self-management of the trajectory.

One major outcome of the activities performed by the project was the need of a good integration between Trajectory Management and Arrival Management functions. The use of ADS-C EPP in the trajectory management helped in making the trajectory prediction more precise which led to a stable, accurate and easy to implement arrival sequence. Thus the project recommends the use of ADS-C EPP information in the trajectory prediction to enhance Arrival Management process in general and to make CTA operations feasible and viable.

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] 10.09.04 System requirements definition for ATC support to CDA-CCD- Phase 1, D10, 00.01.00, 31/05/2011

[5] B.01.D82 Integrated Roadmap - DS14 Release Note, edition 00.01.00, 29/06/2015

[6] 10.01.07 D115 -Technical Architecture Description - Cycle 2014-, edition 00.01.01- 20/05/2015

[7] 10.09.02 D55 Step 1 Technical Specification, edition 00.04.00 – 04112015

[8] 10.07.01 D75 AGDL System Requirements - TS 2015, edition 00.00.04, 23/03/2015

[9] 10.02.01 D87 Updated Step 1 ATC TM System Requirements - Cycle 2, edition 00.01.00, 24/06/2015

[10] 10.09.04 – D98 Thales - Support to the concepts operational validation (phase 1) - Availability Note VP-477, edition 00.03.00, 24/06/2015

[11] 10.09.04 – D97 Thales - Support to the concepts operational validation (phase 1) - Availability Note VP-478, edition 00.01.00, 04/11/2013

[12] 10.09.04 – D17 Integration and verification test report phase 1 – DEL, edition 00.00.01, 03/01/2012

[13] 10.09.04 – D25 Indra - Specific Integration & Verification Tests Report phase 1 – DEL, edition 00.01.00, 14/12/2011

[14] 10.09.04 – D21 Indra - Specific Tests cases and scenarios phase 1 – DEL, edition 00.01.00, 01/12/2011

[15] 10.09.04 – D19 Indra prototype developed (for phase 1) – DEL, edition 00.01.00, 28/11/2011

[16] 10.09.04 – D39 Thales - Specific Integration & Verification Tests Report phase 1 – DEL, edition 00.01.00 18/11/2011

[17] 10.09.04 – D35 Thales - Specific Tests cases and scenarios phase 1 – DEL, edition 00.01.00, 18/08.2011

[18] 10.09.04 – D37 Thales - Testing platform & tools requirements-development phase 1 – DEL, edition 00.01.00, 10/08/2011

[19] 10.09.04 – D13 Verification Exercise Plan Phase 1 – DEL edition 00.01.00, 28/07/2011

[20] 10.09.04 – D33 Thales prototype developed (for phase 1) – DEL, edition 00.01.00, 05/07/2011

[21] 10.09.04 – D12 Verification Strategy – DEL, edition 00.01.00, 01/07/2011

[22] 10.09.04 – D10 System requirements definition for ATC support to CDA-CCD - Phase 1, edition 00.01.00, 31/05/2011

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