P09.40 Final Project Report

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Abstract

This deliverable comprises the P.00.09.40 Final Project Report aiming at defining airborne system improvements to support widespread use of Continuous Descent Operations. However, the project did not progress as expected on the different airborne improvements identified in the study. Indeed, the disconnection in terms of planning with operational project P.05.06.02 prevents from:

- Having a vision of step 2 environment (airspace design, ATCos ground tools)
- Defining a consolidated validation strategy

The project P.00.09.40 was put in stand-by in 2013 and formally closed in 2014.

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This deliverable consists of SJU foreground.

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1 Final Project Report

1.1 Project objective

The initial objective of project 09.40 was to define airborne solutions that will enable to compute and fly optimized arrival profiles (from top of descent to final approach fix) in medium to high traffic density environment by:

- Providing a state of the art of CDO implementation, airborne capacities, pilots & ATC practices.
- Defining airborne solutions helping pilots to fly CDA in medium to dense airspace environment.
- Assessing the acceptability of proposed solutions including operational reviews to select the most beneficial/viable solution.
- Developing a mock-up of the retained solution to assess operational acceptability of the solution.

The project targeted to reach V1 for airborne design.

1.2 Achievements

The project **PIR** was approved on March 2012 with an open item related to the definition of collaboration with operational project 05.06.02 (Improving vertical profile). When the project 09.40 started, operational project 05.06.02 has not defined its plan for advanced CDA related activities.

The **Execution phase** started on April 2012.

Task 001 was dedicated to the **state of the art** of CDO from different points of view (i.e. all stakeholders involved in these operations: pilots, ATCos, aircraft manufacturers…). Novair was involved as Airspace User to enrich the operational point of view (the way CDO are conducted from an airborne side and the limitations pilots are facing). Project 05.06.02 state of the art and other research projects deliverables were used as inputs for the ground perspective and procedure design tendency. D01 was delivered as planned and accepted.

Task 002: update of Airbus tool for **performance assessment** of an advanced airborne solution (A-FPA). The study allowed computing a set of descent profiles and quantifying the disparity introduced by this concept in terms of altitude and time. However, operational community expressed a low interest for this solution and it was decided during workshop held in January to discard it (cf. MoM of workshop 30-Jan-2013). This task was then put in stand-by.

Task 003: **study of airborne solutions** started in October 2012. Several workshops were held and allow proposing a set of airborne solutions. Meetings with Airspace users and ATCos allowed getting more data related to operational practices and preliminary feedbacks regarding studied solutions. Based on these feedbacks, one of the solution was discarded (A-FPA), while a short term solution (covering open loop scenario) was deemed interesting but raised questions regarding the relevance to study it in the frame of Sesar (long term ATM environment)

The most relevant improvements of embedded systems proposed in the frame of the project are presented below:

- Use of distance to destination

Based on a study done by project 05.06.02 in their validation report, in heavy traffic environment, closed loop CDO is not feasible. In that case, the tactical use of open loop CDO by ATC is necessary and requests to find out the best way to separate aircraft while maintaining CDO capability of all inbound traffic. Although radar vectoring is detrimental to CDO, project 09.40 proposed a solution using the distance to destination (DTG) information to mitigate the damages of radar vectoring intervention. This solution would permit aircraft to end approach as efficiently as possible even if radar vectored. Several steps were proposed to further study this proposal:
- basic solution / step 1: energy monitoring with HMI feedback for pilots awareness in order to be stabilized at 1000 feet above airport elevation.

- advanced solution / step 2: computation of a virtual lateral path and a vertical path based on current vector heading, aircraft altitude and the most probable ATC pattern path. The path could be validated by pilots or not depending of operation scenario encountered.
- complementary solution: all along the descent/approach path, to provide an efficient energy management through the use of a dedicated message indicating appropriate level of airbrake to be used regarding current aircraft situation.

This proposal was considered interesting by airspace users consulted in the frame of the project (Novair, DLH and IATA). But the proposed improvement raised several points:

- DTG is not a 100% reliable data, its accuracy depends on the way it is calculated.
- This proposal allows to cover open loop scenario but this is not compliant with the Sesar future airspace. Even if there is an interest to work on this item wrt. current ATCos practices, the project should focus on long term airspace environment assumption (closed loop only).

- Use of deceleration rate imposed by procedure

The proposal “Adaptive-FPA” consists in computing a vertical descent/approach profile with deceleration imposed by the published procedure. The nominal deceleration rate could be in CAS, in TAS, or in Ground Speed and its value could be around -4kts/10sec in order to ensure a comfortable deceleration. In order to maintain the specified deceleration rate on each segment, the resulting slope predicted by the embedded system would therefore be adapted to the performances of each aircraft, according to the aerodynamic configuration, speed, and conditions of the day (weather, weight, etc…). With Adaptive-FPA solution, the required deceleration rate would impose different rates of descent according to aircraft performances. Vertical profile would be different according to aircraft performance and weight. ATCos would not be able to manage those restrictions. Solution A-FPA was discarded due to several drawbacks (eg. separation management should be ensured) and would not be compatible with other concepts.

- Optimization of computed descent/approach path

The deliverable “state of the art” produced in the frame of the project shows that vertical descent/approach path computed by the Flight Management System could be optimized. Some improvements were identified but further study of such item would require dedicated prototypes. The scope of the project did not include prototyping activities.

1.3 Difficulties encountered

The project started with an open item related to the coordination with operational project 05.06.02 (improving vertical profile) as there was no visibility concerning step 2 activities of project 05.06.02 and thus, no possibility for project 09.40 to define a consolidated validation strategy. OSED 05.06.02 step 2 (D05 “step 2 advanced concept of operations”) was expected to be used as input for the study of airborne solutions. But due to stand-by of project 05.06.02 step 2 activities in 2012, this deliverable was postponed, then expected in December 2014 which was not compatible with project 09.40 planning (since to be able to conduct project 09.40 task 003, the vision of “advanced CDO” in dense traffic environment – OSED step 2- should have been used as input by defining the context where the studied airborne solutions lie).

The initial scope of the project defined mock-up as the mean to mature airborne improvements. But the nature of identified improvements would require system prototypes to efficiently converge to a relevant design and derisk implementation.

1.4 Deliverables

Del. code	Del.Name	Description	Assessment Decision
D10	Final Progress status report	The deliverable (this document) comprises the P00.09.40 Final Project Report	
D01	State of the art	The deliverable provides a state of the art of: CDO implementation, ATM context expected in the frame of future SESAR ATM concepts & airspace in medium to high density traffic environment, airborne systems CDO capability.	No reservation
D02	Advanced CDA performance assessment *Initially planned in April 2013*	This deliverable aimed at covering A-FPA performance study to assess acceptability of the solution. However, after exchanges with airspace users and ATCos, the solution was discarded due to the lack of interest of operational community. Efforts were consumed for the update of an Airbus performance tool and assessment of impact of this solution on vertical profile.	Not submitted
D03	Functional requirements for advanced CDA and compatibility of these functions with steeper approach concept *Initially planned in May 2013*	Some airborne improvements were proposed but the activity was put in stand-by due to the disconnection in terms of planning with operational project 05.06.02	Not submitted

1.5 Project Conclusions and Recommendations

The analysis of CDO implementation (state of the art) showed a disparity:

- In ATCos practices
- In procedure design
- In embedded system capabilities

To allow a more widespread use of optimized profile, the definition of embedded improvements requires to know future airspace design and envisaged future system support tools for air traffic controllers. The definition of these future concepts is not yet fully available. For the time being, project 05.06.02 considered procedural and airspace design improvements (step 1). However, step 2 activities are currently re-scheduled with scope under discussion. The objective is to develop an advanced concept and aimed at overcoming current limitations through the definition of new system support tools for air traffic controllers:

- Tools to increase confidence in the possibility for simultaneous CDOs
- Tools to enable monitor arrival and display level of interaction

For the time being, even if proposed, step 2 activities have not started.

The non-availability of operational requirements prevented project 09.40 to define appropriate improvements of embedded systems.

In addition, to further study system improvements proposed in the frame of project 09.40, prototypes would have been more relevant (wrt. mock-up as initially identified) to fully assess the benefits, drawbacks of the solutions and also to identify difficulties in terms of implementation.

Some embedded improvements related to the Flight Management System were however identified and worked with project 09.40 partners. These solutions would have been worth studying with appropriate validation strategy supported with prototyping activity.

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] Project 09.40, State of the art study, 09.40.D01, Edition 00.00.04, September 2012

[5] Project 05.06.02, State of the art report, 05.06.02.D01, Edition 00.01.00, April 2011

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