Final Project Report

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Abstract

The aim of the project 9.06 was to study the airborne implementation of the ASEP (ASAS Separation) applications. The ASEP applications are applications using ADS-B information from surrounding aircraft and ensuring separation of an aircraft from one reference aircraft during a limited period defined by the controller, either in oceanic or continental environment.
Based on the description of the operations and environment provided by the two operational projects linked to the ASEP topic (respectively 4.7.4b and 4.7.6), the project 9.06 proposes:
- a functional analysis of ASEP applications for both oceanic and continental operations,
- some first elements of functional architecture for mainline and business aircraft,
- a first set of safety analysis based on the preliminary elements provided for ASEP operations,
- and some thoughts for the implementation of ASEP on-board mainline, business and regional aircraft collected through evaluations made with pilots and supported by V1 mock-ups.
The results produced by the project 9.06 are feeding step 3 of SESAR and will need further refinement whenever the study activities on this kind of application starts again to reach V2 level of maturity.

Note that the project 9.06 activities were stopped before being fully completed due to the suspension of the two corresponding operational projects (4.7.4b and 4.7.6).

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1 Publishable Summary

The aim of the project 9.06 was to study the airborne implementation of the ASEP (ASAS Separation) applications. The ASEP applications are applications using ADS-B information from surrounding aircraft and ensuring separation of an aircraft from one reference aircraft during a limited period defined by the controller, either in oceanic or continental environment.

The OI steps to which the project 9.06 is associated are:

- CM-0701: Ad Hoc Delegation of Separation to Flight Deck - In Trail Follow & In trail Merge Procedure (ASEP-ITF & ITM)
- CM-0702: Ad Hoc Delegation of Separation to Flight Deck - Crossing and Passing (C&P)

And the enablers studied to answer those OI steps are:

- A/C-16a: Flight management and guidance to support ASEP-ITF/ITM
- A/C-16b: Flight management and guidance to support ASEP-C&P

Based on the description of the operations and environment provided by the two operational projects linked to the ASEP topic (respectively 4.7.4b and 4.7.6), the project 9.06 produced:

- a functional analysis of ASEP applications for both oceanic and continental operations,
- some first elements of functional architecture for mainline and business aircraft,
- a first set of safety analysis based on the preliminary elements provided for ASEP operations,
- and some thoughts for the implementation of ASEP on-board mainline, business and regional aircraft collected through evaluations made with pilots and supported by V1 mock-ups.

Summary of the results issued from 9.06 activities:

Cockpit Human Machine Interface and crew procedures:

All ASEP operations described in the 4.7.4b and 4.7.6 OSEDs were evaluated in cockpit V1 mock-up.
No blocking limitation was detected for cockpit operations in terms of display of information. Nevertheless, the elements presented only part of the crew procedures (only nominal procedures, no contingency procedures since none were defined whether for oceanic or for continental operations) moreover, they have not been evaluated in an operationally representative environment.

Aircraft systems architecture:

A preliminary Functional Hazard analysis highlighted a most important technical challenge: the impact on aircraft systems architecture might be significant to ensure a sufficient level of integrity whenever the responsibility of the separation is delegated to the airborne side (i.e. number of traffic Computers and interdependence/redundancy configuration):

- to ensure that the traffic taken as reference for the manoeuvre is safely identified and monitored by the system,
- to allow the flight crew endorsing the responsibility of the separation.

  This element is key to define the technical impact of ASEP operations on the aircraft architecture.

The main point to keep in mind about the results collected during the validation exercises is that the operational aspects have to be refined before getting deeper into the aircraft architecture design since many points remain to be clarified/consolidated concerning the ASEP applications; e.g.:

- the description of the environment where ASEP applications will be used (what tools will be available at that time? EPP, 4D, etc.);

- the applications to be considered, in particular in the oceanic environment, might be slightly different from the two ones proposed in the project 4.7.4b (e.g. see studies started on PTM – Pair-wise Trajectory Management in the RTCA/EUROCAE group SC186);
- the contingency procedures (what will the airborne side and the ground side do in case an ASEP operation can no longer be done?).

Note that the project 9.06 activities were stopped before being fully completed due to the suspension of the two corresponding operational projects (4.7.4b and 4.7.6).

Whenever the activities related to ASAS-Separation start again (e.g. within SESAR2020), the following activities should take place:

- Review of some recommendations about 4.7.6 Fast Time Simulation validation report and 4.7.4b benefits analysis. These elements are gathered in 9.06 D05 (First elements of high level architecture document).
- Collection of operational inputs: several operational elements have been missing since the beginning of the project, and they have been scarcely addressed because operational projects have been put in early stand by. A summary of these missing elements can be retrieved in the document “Operational information missing in OSEDs according to 9 06” ”, available as annex of the deliverable 9.06.D01.
- Due to the closure of operational projects 04.07.06 (and 04.07.04b) prior to P09.06, the external reviews of the following deliverables will still be required to be performed. On resumptions of activities, the 04.07.06 OSED should be updated to take into account the regional aircraft results as appropriate. The 9.06 additional deliverables to consider include:
  - D12 (preliminary High level Architecture for Regional aircraft),
  - D43 (Verification & Validation Plan for Regional aircraft V1 mock-up) and
  - D45 (V1 functional test report for regional aircraft).

2 Final Project Report

The aim of the project 9.06 was to study the airborne implementation of the ASEP (ASAS Separation) applications as they could be implemented in oceanic environment and in continental environment. The ASEP applications are applications using ADS-B information from surrounding aircraft and ensuring separation of an aircraft from one reference aircraft during a limited period defined by the controller, either in oceanic or continental environment.

2.1 Initial objective of ASEP in SESAR

The OI steps to which the project 9.06 is associated are:

- CM-0701: Ad Hoc Delegation of Separation to Flight Deck - In Trail Follow & In trail Merge Procedure (ASEP-ITF & ITM)
- CM-0702: Ad Hoc Delegation of Separation to Flight Deck - Crossing and Passing (C&P)

And the enablers studied to answer those OI steps are:

- A/C-16a: Flight management and guidance to support ASEP-ITF/ITM
- A/C-16b: Flight management and guidance to support ASEP-C&P

Based on the description of the operations and environment provided by the two operational projects linked to the ASEP topic (respectively 4.7.4b for oceanic environment and 4.7.6 for continental environment), the project 9.06 proposed the following analyses:

- a functional analysis of ASEP applications for both oceanic and continental operations (based on the OSEDs produced by projects 4.7.4b ref.[8] and 4.7.6 ref[9]) where the conclusion was that many points have to be clarified (a list of open points was created in order to trace all the clarifications needed for the airborne side and is available in SESAR extranet 9.06 site: ref [7]):
    - D01: First elements of functional definition document (all A/C types)
- First elements of functional architecture for mainline and business aircraft (including analyses and recommendations associated with the 4.7.4b benefits analysis –ref [5]- and recommendations and questions for the 4.7.6 FTS validation –ref [6]-) ;
    - D05: First elements of high level architecture document (mainline + business A/C)
- a first set of safety analysis based on the preliminary elements provided for ASEP operations:
    - D34 pFHA – issue 1;
- some thoughts for the implementation of ASEP on-board mainline, business and regional aircraft collected through evaluations made with pilots and supported by V1 mock-ups:
    - Global validation plan for all aircraft types:
        - D15: Verification & Validation Plan - issue 1;
    - Validation activities of mainline A/C
        - D19: V1 Mock-up delivery form for 4.7.6;
        - D20: V1 - Functional test report for continental applications (4.7.6 ASEP)
    - Validation activities of regional A/C
        - D12: High level Architecture for Regional A_C (preliminary document)
        - D43: Verification & Validation Plan Document - (for V1 Regional A/C Mock-up)
        - D44: V1 Mock-up Availability Note - Regional A/C
        - D45: V1 ASEP Functional Test Report - Regional A/C

Note that more activities were planned to be executed in the frame of the project 9.06 in order to reach V1/V2 level of maturity on ASEP applications but they had to be stopped due to the suspension of the corresponding operational projects (4.7.4b and 4.7.6): as there was no longer any possibility to refine the operational descriptions and no means to execute the validation exercises, all what deals with functional definition, design of an airborne function, production of mock-ups and implementation of a solution on an A/C research simulator could either not be done or only partially. However, V1 level of maturity could be reached in this project. The refinements needed for ASEP definition will be part of V2 activities.

2.2 Activities put on hold and not executed in SESAR.

Here are the activities that could **not** be executed in the frame of SESAR 9.06:

- Production of the FHA after the pFHA since no sufficient operational discussions could be held with the operational projects. The list of open points that need to be clarified about ASEP operations (oceanic and continental operations) is available in Appendix A of the 9.06 deliverable D01 (First elements of functional definition),
- Functional definition of ASEP on-board architecture,
- Research simulator update for the real time simulation planned by the 4.7.4b,
- Research simulator update for the real time simulation planned by the 4.7.6,
- SPR analysis of the operational projects (4.7.4b and 4.7.6) since no SPR were produced,
- Performance model to support performance assessment to be done in the operational projects (4.7.4b and 4.7.6): activity initiated but stopped almost immediately.

Information concerning the task 046:

This task was created in the change request 1308 in order to gather all the efforts that would not be spent in the project 9.06 as a consequence of the suspension of the operational projects 4.7.4b and 4.7.6. In the frame of the implementation of the Re-allocation process (2013), the efforts allocated to task 46 have been set to 0 in the Change Request#1680. As a consequence, the efforts associated to task 046 won't be claimed in the project 9.06.

2.3 Achievements and challenges

Operational aspects:

The early suspension of associated Operational projects did not permit to identify benefits. According to involved Airspace Users, the most promising operations could be in Oceanic environment where ASEP could give more flexibility in climbing and descending phases or in their routing and therefore contribute to improve flight efficiency (either by flying at a more optimal level or flying more direct routes).

Moreover, the operations could not be refined in the light of the feedbacks obtained during the V1 evaluations

Cockpit Human Machine Interface and crew procedures:

All ASEP operations described in the 4.7.4b and 4.7.6 OSEDs were evaluated in cockpit V1 mock-up. No blocking limitation was detected for cockpit operations in terms of display of information. Nevertheless, the elements presented only part of the crew procedures (only nominal procedures, no contingency procedures since none were defined whether for oceanic or for continental operations) moreover, they have not been evaluated in an operationally representative environment.

Aircraft systems architecture:

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- to ensure that the traffic taken as reference for the manoeuvre is safely identified and monitored by the system,
- to allow the flight crew endorsing the responsibility of the separation.

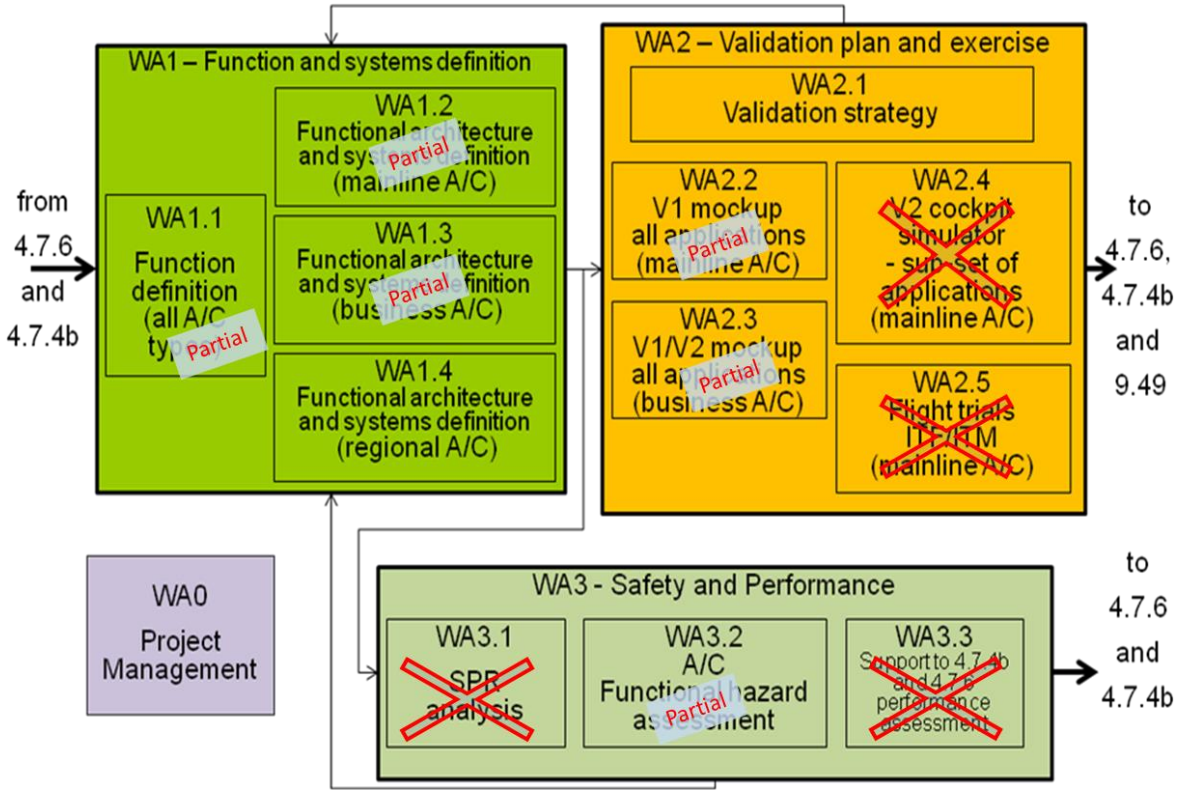
This element is key to define the technical impact of ASEP operations on the aircraft architecture.

The main point to keep in mind about the results collected during the validation exercises is that the operational aspects have to be refined before getting deeper into the aircraft architecture design since many points remain to be clarified/consolidated concerning the ASEP applications; e.g.:

- the description of the environment where ASEP applications will be used (what tools will be available at that time? EPP, 4D, etc.);
- the applications to be considered, in particular in the oceanic environment, might be slightly different from the two ones proposed in the project 4.7.4b (e.g. see studies started on PTM – Pair-wise Trajectory Management in the RTCA/EUROCAE group SC186);
- the contingency procedures (what will the airborne side and the ground side do in case an ASEP operation can no longer be done?).

3 Actual scope compared to the intended scope of project 9.06:

The scope of the project 9.06 as described in the change request CR1380 (after BAFO 1&2 reallocation) was as follows.



Due to 4.7.4b and 4.7.6 suspension, the activities of the 9.06 were drastically reduced.

The red crosses indicate the activities that could not be done and the indications “partial” show the activities partially done but not finalised.

The results produced by the project 9.06 are feeding step 3 of SESAR; they will need further refinement whenever the study activities on this kind of application starts again.

The project 9.06 was including the following tasks as per the latest change request (CR1680):

Work area 0

- T001 Overall coordination management of the project;

Work area 1

- Task T002 Input analysis and first elements of functional definition (SESAR operational projects, AP23, ASSTAR)
- Task T006 First elements of functional architecture and impact on systems
- Task T010 Preliminary functional architecture for business aircraft
- Task T013 High level Architecture for Regional A_C (definition)

Work area 2

- Task T016 Verification & Validation Plan writing (1)
- Task T043 Verification & Validation activities planning (for V1 regional A/C Mock-up)
- Task T020 V1 Mock-up preparation for 4.7.6 WS3 V1

- Task T021 9.06 functional evaluation + Support to 4.7.6 design exposures to pilots on V1 mock-
- Task T044 V1 Mock-up Preparation - Regional A/
- Task T045 V1 ASEP Functional Evaluation - Regional A/

Work area 3

- Task T035 Preliminary functional hazard assessment of ASEP airborne application (based on SA/LR architecture for ASPA applications
- Task T039 Preparation of an A_C model for performance assessment (4.7.4b SPR issue 0.1

Out of work area – task created to gather efforts not used in 9.06:

- Task T046 Tasks suppressed - efforts avail for reallocation .

4 Recommendations

- Whenever the activities related to ASAS-Separation start again (e.g. within SESAR2020), the following activities should take place:
    - Review of some recommendations about 4.7.6 Fast Time Simulation validation report and 4.7.4b benefits analysis. These elements are gathered in 9.06 D05 (First elements of high level architecture document).
    - Collection of operational inputs: several operational elements have been missing since the beginning of the project, and they have been scarcely addressed because operational projects have been put in early stand by. A summary of these missing elements can be retrieved in the document “Operational information missing in OSEDs according to 9 06” ”, available as annex of the deliverable 9.06.D01.
    - Due to the closure of operational projects 04.07.06 (and 04.07.04b) prior to P09.06, the external reviews of the following deliverables will still be required to be performed. On resumptions of activities, the 04.07.06 OSED should be updated to take into account the regional aircraft results as appropriate. The 9.06 additional deliverables to consider include:
        - D12 (preliminary High level Architecture for Regional aircraft),
        - D43 (Verification & Validation Plan for Regional aircraft V1 mock-up) and
        - D45 (V1 functional test report for regional aircraft).

5 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] SCH_09_06 Latest Approved Baseline, issue 00.00.04 (13/06/2014)

Deliverables produced in the frame of the OFA (projects 9.06, 4.7.4b and 4.7.6.)

[5] 4.7.4b Benefits analysis, 4.7.4b D15

[6] 4.7.6 FTS validation, 4.7.6 D08

[7] Operational information missing in OSEDs according to 9.06_v3.xls

[8] 4.7.4b OSED

[9] 4.7.6 OSED

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