ASAS Key Issues: from concept to implementation, questions and possible answers

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Abstract: This talk outlines some of the fundamental issues that are still under investigation with respect to the use of airborne surveillance. The ongoing work within FAA/EUROCONTROL AP23 will result in a deliverable, D5, which will provide a list of topics that must be investigated as a priority. It is not the intention to provide solutions to the problems identified but rather to indicate work that is required to provide solutions**.**

The topics include ATCO & Flight crew roles and responsibilities, transition towards airborne separation (ASEP) and self-separation (SSEP), airborne separation minima values, regulatory aspects and operational benefits**.**

Keywords: ASAS, airborne surveillance, airborne separation, roles and responsibilities for ATCO and flight crew

1 INTRODUCTION

The purpose of the presentation is to highlight generally universal issues that do not have a local flavor but a fundamental one with respect to the nature of airborne separation.

The main points are extracted from "D5 - Airborne separation applications: Issues paper" currently under development within FAA/EUROCONTROL AP23 team.

2 BACKGROUND

The operational scope of AP23 is focused on the longer term airborne surveillance (AS) and ground surveillance (GS) applications of common interest between FAA and EUROCONTROL, beyond those already covered by the RFG (ASAS Package 1).

2.1 Operational role of airborne surveillance in separating traffic (D3)

AP23 already produced deliverable D3 [1] which is a concept document that provides an overview of the concept of airborne separation and the operational use of ASAS (airborne separation and self-separation applications), in the context of the potential evolution of ATM within different timeframes: 2010 / 2020 / 2030.

In high level summary, airborne surveillance will be established for situational awareness applications shortly after 2010. By 2020 it will be used more positively, with aircraft providing their own spacing and separation either for tasks such as following a preceding aircraft or overtaking another aircraft in an ordered stream of traffic. However, controllers will still have overall responsibility for managing the traffic, using either trajectory management or conventional techniques, and supported by ground-based surveillance or using procedural control. By 2030, many aircraft will be self-separating. It is likely that procedural airspace will have largely disappeared for most commercial traffic, which will be self-separating in areas without ground surveillance in exactly the same way as they will where there is such coverage.

SESAR and NextGen discuss the use of ASAS in Trajectory Management environment and emphasize new ASAS-based separation modes. AP23 considered these new SESAR and NextGen operational concepts and improvements, and discussed airborne separation and self-separation in different environments (terminal areas, en-route, procedural airspace and surface).

Airborne separation and Trajectory Management are complementary concepts, each enhanced by the other.

2.2 Proposals for a second set of ADS-B/ASAS applications (D4)

AP23 is preparing deliverable D4, which is a draft proposal for advanced Application Elements and ASAS Functions:

Application Elements are basic ASAS-enabled (operational) capabilities of the subject aircraft that cannot easily be subdivided further into more basic elements.

ASAS Functions are the processes, calculations, and monitoring tasks that must be supplied by the ASAS avionics system to enable application elements.

Application elements and ASAS functions are used to streamline standardization process.

Currently, D4 does not propose a firm set of ''Package 2'' applications. It describes a method to be followed to build an ASAS application: an application encompasses a set of Application Elements and ASAS Functions together with applicable environment.

When completed, D4 will highlight key applications that will enable all the required elements and functions to be analyzed in the most demanding context, in order to derive ASAS requirements that will be robust on the longer SESAR and NextGen timescales.

3 ASAS KEY ISSUES

These are mostly the key questions that everybody asks in relation to Airborne Separation Assistance Systems (ASAS) with sensible answers as far as practicable:

3.1 Change to ATCO/Flight Crew role and procedures and related human factors issues

Paradigm change = new way of providing separation with ASEP applications.

The basic operational principle is as follows: the ATCO will detect one conflict suitable for delegation and will delegate the resolution to the flight crew. The ATCO is still responsible for the remainder of the traffic. The flight crew must accept the delegation and use the airborne system (ASAS) to resolve the conflict, and report when resuming ATC clearance.

This raises in particular the following issue

- **The delegation of responsibility must be clear at each moment**

The operational procedure must be decomposed in phases (as seen in Fig. 1) in order to support clear and unambiguous role of actors.

With ASEP, traffic situational awareness is increased in the cockpit, but possibly decreased on the ground.

Data link can be used extensively to inform the "reference aircraft" of the ASEP procedure, to exchange technical data or more complex messages and to inform ATC of aircraft intentions during the manoeuvre. However, it is debatable whether this information should be displayed to the ATCO.

Ground tools to determine the opportunity for the ASEP procedure are probably required.

The operational benefit is clearly for the controller with a potential reduction of workload due to less conflict resolution and less monitoring activities. However, monitoring aids could be proposed for further reduction of workload.

This new mode of operation raises another potential issue associated with **Human Factors**: In ASEP, a pair of aircraft is treated differently by the ATCO and the impact has to be assessed, in particular on the HMI, and possibly on the ground tools. However, such adaptation to a specific conflict/pair of aircraft could have an impact on the safety assessment.

In addition, the duration of delegation might have an impact on mental picture and on traffic situational awareness.

For all ASEP applications, is it always ATCO initiation or can it be on pilot request? This is under way in oceanic airspace where the flight crew might request the responsibility for separation for flight efficiency.

3.2 Separation and collision avoidance

This is a well known contradiction: IAPA Project [2] (EUROCONTROL – 2005) showed that interactions between ASAS applications and TCAS can occur. For crossing encounters at less than 5NM separation, resolution advisories (RAs) can occur. For crossing encounters at less than 7NM separation, traffic advisories (TAs) can occur.

ASAS procedure and ASAS logic must absolutely be designed "TCAS RA proof".

What about TAs? This is more open. On the one hand, for improved compatibility with ATM, pilots tend to reduce Vertical Speed on TA today in a level off geometry (ICAO REC) which can be seen as an evolution path towards enhanced TCAS (SESAR request). On the other hand, if TAs are more frequent with ASAS applications, they can become a show stopper. (The repetitive TAs of the early days of RVSM with TCAS v6.04A should not be seen again.)

In conclusion, maybe **a redesign of TCAS is preferable**.

3.3 Transition towards airborne separation and self-separation

Certain applications can be defined in airborne spacing (ASPA) and in airborne separation (ASEP); the typical example is Sequencing & Merging operations with either instructions to the flight crew to achieve and maintain a given spacing larger than ATC separation minima or clearances to the flight crew to achieve and maintain a given airborne separation using its ASAS.

It seems useful to implement ASPA-XXX before ASEP-XXX to gain experience in AS applications and to consolidate realistic validation scenarios. It may not be necessary for each application.

In addition, at initial implementations, confidence and predictability may still be under evaluation and the operational procedures may be more stringent or less efficient (typical example: it is suggested to provide the SEP value in the clearance, which could be the same value as the ground separation minima)

Similarly, lessons from airborne separation on specific airspace can help for implementation of self separation in low density: it is likely that after achieving conflict resolution with one or two aircraft, it will be thinkable to deal with all aircraft and conduct a SSEP operation.

It is noted that conflict detection is primarily on the ground for ASEP and in the air for SSEP. There is of course a conflict detection function in the air even for ASEP but possibly with less stringent requirements or complementary to the ground system.

It is foreseen a changing operational environment, supporting the new operational concepts & improvements planned in SESAR and NextGen programmes.

3.4 Transition strategy

#1: ANSP way of implementation: Identify applications that are locally beneficial and permit a gradual introduction of ASAS, or

#2: Airline operators and avionics industry: Envisage end state that meets SESAR and NextGen objectives, and provide a basis for developing systems that will be in use beyond 2030.

Analogy with ILS implementation: ILS is an airborne system supported by ATC for operations under specific conditions and constraints. In Cat I, minimum is required from the airborne side in terms of automation whereas in Cat III, a system is required on the ground, the flight crew and the aircraft must be qualified and certified for such operations.

ANSPs are clearly in their role with Cat I while some airline operators may require Cat III even with more sophisticated equipment, more crew qualifications and training.

In conclusion, the mutual benefits should be expected based on common assessment of the situation and agreement on the timescale for implementation.

3.5 Airborne separation minima

Can we introduce ASEP application without the determination of airborne separation minima?

If the separation minima is based on airborne surveillance, is it aircraft dependant rather than airspace dependant?

Do we need a set of values (3, 6, 9 NM) with respect to aircraft performance ?

(Required Surveillance Performance associated with Required Navigation Performance and Required Communication Performance?)

If the airborne separation minima are too different from ground separation minima, is it operationally viable?

If Ground SEP are grater than Airborne SEP then why not implementing SSEP? (eg oceanic airspace, where mixed mode could be more complicated than segregated airspace with self-separation operations)

If Ground SEP are smaller than Airborne SEP then why delegate separation? (eg ASEP in terminal areas may be inefficient compared to current ATC practices optimizing runway throughput with strict trajectories.)

3.6 Regulatory and safety case

ICAO provisions are sufficient to enable ASEP and SSEP. The operational procedure must be crystal clear on the delegation of responsibility. Contingency procedures must be developed relying on the airborne side solely. In any event, the ATCO can only recover responsibility when ground separation minima are met.

ANSP will establish a safety case for a given application and a given airspace. The Regulatory authority will have to approve it for certification.

What will be required for this approval? (case study, simulations, …) Will it be based on a mandatory or voluntary equipage? What about the airspace which is either segregated (in NextGen) or non-segregated (in SESAR)?

3.7 Implementation and operational benefits

It is pointless to address operational benefits without an environment because the results are used to support decision making. Typically, the ANSP will choose an AS application adapted to a local and specific environment.

ATCO and flight crew acceptability cannot be dissociated from operational benefits such as safety, flight efficiency. It is therefore difficult to evaluate benefits brought by ASAS in isolation when the ASAS application is one element of a more and more complex ATM system.

Two examples can be provided:

- NATS evaluated ASEP-ITP/ITF/ITM in North Atlantic airspace (ASSTAR project)
- DSNA evaluated ASPA-S&M in Paris (PALOMA and CRISTAL PARIS project)

For ASPA S&M, the key questions under evaluation were related to the airspace design and to the need for mandatory carriage:

- Can we have benefits without changing the Paris TMA? YES but not much
- What level of partial equipage starts to bring benefits? > 70%
- Is a mandate necessary? NO but how long to reach 70% of the traffic

For ASEP-ITP in oceanic, what are the gains compared to ATSA-ITP? Only marginal additional benefits with a more complex equipment

However, more additional benefits could be brought by the combination with other applications such as ASEP-ITF, ASEP-ITM.

4 CONCLUSIONS

There are still a number of questions and issues related to ASAS implementation even if the operational concept and principles are well established.

The need for R&D is still important for determination of separation minima and for appropriate support tools, compatible with existing systems in particular with safety nets.

The main conclusion could be to have confidence that the interest of the ATM community in ASAS matters is such that no issue will be forgotten. The important role of ASAS in SESAR and NextGen concepts provide further confidence on its future both for local implementation at first and for regional or global implementation later.

5 REFERENCES

[1] AP23 team, "D3 – Operational Role of Airborne Surveillance in Separating Traffic", FAA/EUROCONTROL, December 2008 – http://www.icao.int/anb/panels/scrsp/indexp.html

See "Information/Documents"

[2] "Implications on ACAS Performance due to ASAS implementation", EUROCONTROL IAPA Project 28/10/2005http://www.eurocontrol.be/msa/public/standard_page/ACAS_Safety_Studies.html

CURRICULUM

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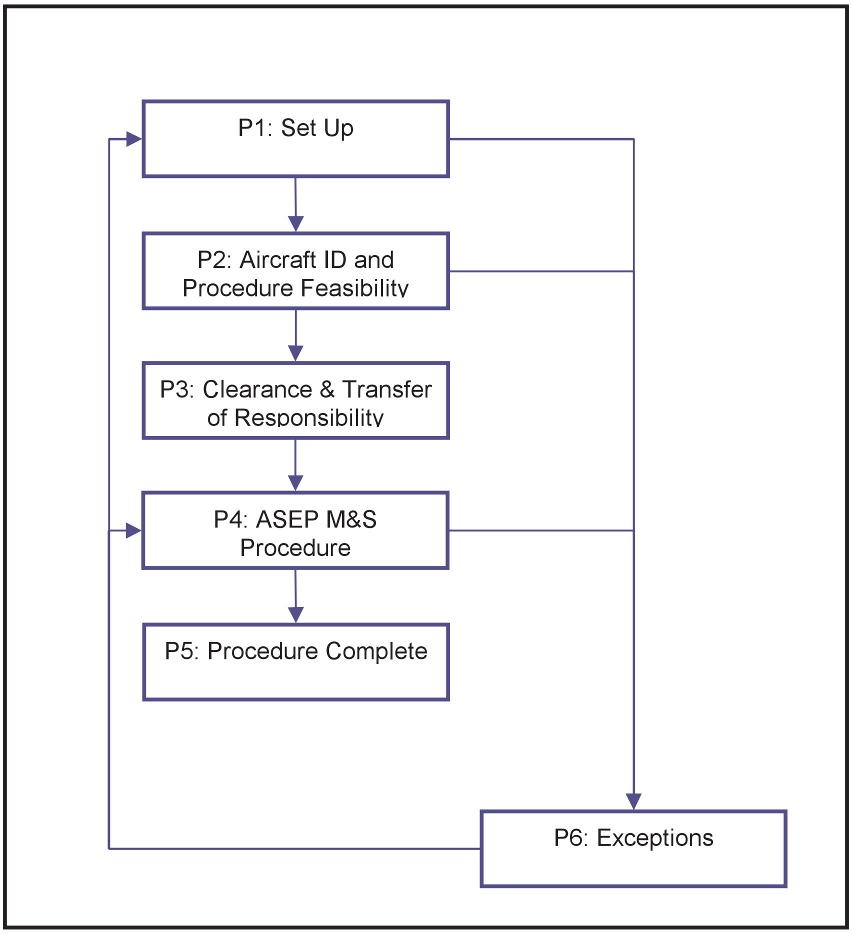

Figure 1 – Successive Phases of an ASEP application