ASAS Thematic Network

Seminar Report
11-13th October 2004, Brighton

ASAS: Time for Decisions – The Way Forward

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1. Introduction

The Airborne Separation Assistance System Thematic Network (ASAS-TN) seminar “ASAS:Time for Decisions – The Way Forward” was held from the 11th to 13th October 2004 at the Old Ship Hotel, Brighton (UK).

This seminar was the culmination of the work of the ASAS-TN and reported on the ASAS implementation strategy work of the project. The ASAS-TN material was underpinned by an ASAS tutorial and augmented by additional presentations that gave the context for ASAS applications.

The aim of the seminar was to present the key issues in the realisation of ASAS. This report contains a summary of the key issues raised as a result of the presentations and the discussions at the event.

The format or the seminar was the following:

- Day One consisted of a tutorial session (see chapter A).
- Day Two presented a summary of the work of the ASAS-TN, the current status of ASAS applications and the implementation strategy document developed by the ASAS-TN consortium. The presentations were followed by a chaired discussion session of around one-hour led by an invited panel of experts (see chapter B).
- On Day Three, issues relevant to the environment in which ASAS applications will operate were presented (see chapter C).

The last chapter of this document (see D) presents recommendations and conclusions elaborated by the ASAS-TN consortium to conclude the project.

2. What is the ASAS-TN?

ASAS-TN is a two-year project that is primarily a stakeholder communication activity. The ASAS-TN is sponsored by the European Commission (DG Research).

ASAS-TN is a stand-alone project arising out of the ASAS work within the programme of Co-Operative Actions of R&D in EUROCONTROL (CARE/ASAS). It is organised within the work programme for Competitive and Sustainable Growth of the European Community, Key action 4, New Perspectives in Aeronautics, Target Platform 4, “More Autonomous Aircraft in the Future Air Traffic Management System”.

The ASAS-TN objective is described as:

The main objective of the ASAS Thematic Network is to accelerate the implementation of ASAS applications in European Airspace, taking into account global applicability, in order to increase airspace capacity and safety.

The work of the ASAS-TN is threefold:

- Three workshops and a seminar;
- Web-based documentation and discussion forums; and
- Development of implementation and standardisation strategy.

The ASAS strategy work identifies and produces guidelines regarding the operational and technical standards affected by ASAS applications. It produces guidelines on further activities and ASAS-related projects that will be required for ASAS implementation. The workshops provided input to this work.

The ASAS-TN is managed by EUROCONTROL and a partnership consisting of BAE SYSTEMS, ENAV, LFV, NLR, THALES ATM and THALES Avionics. In addition to the above organisations, the ASAS-TN involves a very wide range of organisations (e.g. ATM stakeholders, Universities) including Pilot and Controller professional associations (ATCEUC, IFATCA, IFALPA and VC).

A. Day One - ASAS Tutorial Session

1. Introduction

This section reports on the tutorial session on Day One of the seminar, which presented an overview of ASAS applications and enabling technologies.

This session was chaired by Phil Hogge with Bill Booth as the secretary.

The presentations were:

- ASAS and ADS-B History (Eric Hoffman, EUROCONTROL)
- Enabling Technologies (Pierre Gayraud, THALES Avionics)
- ASAS Application Categories (Francis Casaux, DGAC/CENA)
- Applications from Package I to Package III (Chris Shaw, EUROCONTROL)

Followed by:

- Questions and Answers
- Wrap-up by Chairman

2. Review of the briefings

Four presentations were given followed by a question/answer session. The purpose was to provide the participants with a good understanding of language, history, enabling technologies, and applications related to ASAS and ADS-B:

- **ASAS – Some key dates** – by Eric Hoffman (EUROCONTROL): From November 1994 where the ASAS concept was presented to the ANAE et FSF International Symposium (Toulouse – France) to the ICAO Air Navigation Conference in September 2003 (Montreal – Canada) where several recommendations related to ASAS and ADS-B were endorsed, the presentation introduces the major milestones in the development of ASAS.
- **Enabling technologies** by Pierre Gayraud (THALES Avionics): The key characteristics of technologies enabling ASAS applications are reviewed: ADS-B data-links (Mode S Extended Squitter, VDL Mode 4, UAT), TIS-B, as well as on-board sensors and displays
- **ASAS application categories** by Francis Casaux (DGAC/CENA): Action Plan 1 of the FAA/EUROCONTROL R&D Committee developed the document 'Principles of Operation for the Use of ASAS' (PO-ASAS) – Version 7.1 – 19 June 2001'. ASAS applications are classified in four categories. The presentation gives key definitions followed by a brief description of the main characteristics of each category.
- **Application from Package I to Package III** by Chris Shaw (EUROCONTROL): ASAS and ADS-B applications have been grouped into three set of applications called 'Package I', 'Package II' and 'Package III'. A short description of the twelve applications included in 'Package I' is provided with illustrations. The key characteristics of 'Package II&III' applications are given.

A question and answer session allowed time to clarify some misunderstandings and to bring additional information. Discussions continued during the coffee break and after the tutorial session.

2.1 Demonstrations

To illustrate the ASAS and ADS-B applications, several demonstrations were made by ASAS-TN members.

2.1.1. ASAS Avionics Suite by NLR

ASAS Avionics Suite: “Fly yourself all elements of ASAS in a realistic environment”.

The Airborne Separation Assistance System (ASAS) consists of:

- Cockpit Display of Traffic Information (CDTI) on Navigation Display (ND)
- Predictive ASAS (PASAS)
- Conflict Detection and Resolution (CD&R) algorithms, symbology and alerting logic

Various scenarios are available to demonstrate ASAS Awareness, Spacing (Sequencing & Merging), Separation (Crossing & Passing) and Self-Separation modes in real-time from the cockpit perspective.

All these ASAS modes are integrated in a desktop flight simulator, featuring the exact same software as the NLR full-flight simulator GRACE.

2.1.2. Enhanced General aviation Operations (EGOA) by LFV

The EGOA project, Enhanced General Aviation Operations by ADS-B, will implement and validate a surveillance tool in Östgöta TMA. General aviation such as gliders, parachutes, balloons and flight schools are frequenting this airspace. EGOA is a two-year project running from January 2003 until January 2005. The service could be compared with SSR radar of today, but with better performance at a significantly lower cost. Furthermore a number of applications for enhanced general aviation operations, e.g. weather info and airspace configuration distributed via FIS-B, will be developed. Airborne equipment, transponders and cockpit displays (CDTI), as well as equipment for ground, up to four towers and the approach control for the related airspace, will be upgraded/developed to support ADS-B over VDL Mode 4.

Approximately 40 aircraft will be equipped with ADS-B/VDL Mode 4 transponders; some aircraft will also have a CDTI. Equipment for position monitoring will also be installed e.g. at flying clubs. Operational scenarios will be developed for this program and will be the cornerstone and baseline for the project directions. The concept will be demonstrated and evaluated by conducting large-scale trials and scenarios throughout the project.

2.1.3. In Trail Separation (ITS) experiments during 2000-2002 by LFV

The live ITS demonstration was based upon two earlier simulations addressing ITS for Stockholm Arlanda Approach and a Flight Deck Simulation also addressing ITS using full motion MD-80 simulator comprising up to six aircraft in a "chain" that maintained separation to each other during approach.

At the end of January 2002, two Mitsubishi MU-2 aircraft departed Stockholm-Skavsta airport with destination Malmö-Sturup. These aircraft were equipped with cockpit displays for traffic information (CDTI). Further, these aircraft were supposed to demonstrate ITS using ADS-B technology distributed over the North European ADS-B Network (NEAN). This means that the aircraft positions were solely based upon ADS-B position report distributed over the network.

As the aircraft entered the Malmö airspace the responsible controller used a customised phraseology to guide the aircrafts for approach to Malmö-Sturup. The controller pointed out the first aircraft in sequence for the number two in sequence. Number two acknowledged the instructions and confirmed locked on target. Hence the instructions were given to manoeuvre and maintain a certain time to the preceding aircraft. Then the responsibility to maintain separation from now on was delegated to the number two aircraft. The pilot in the number two aircraft used the information presented on his CDTI to maintain separation in terms of seconds to the preceding aircraft. The pilot in the first aircraft was first vectored and then joining a Standard Arrival Route.

The controllers and pilots demonstrated that delegation of separation to cockpit is possible when the proper equipment, phraseology and procedures are available.

2.1.4. HYBRIDGE project by Cambridge University

Distributed control and stochastic analysis of hybrid systems supporting safety critical real-time systems design.

The HYBRIDGE project builds the necessary bridge between control theory and stochastic analysis of hybrid systems on one hand and the design of real-time distributed control systems for safety critical operations on the other hand, and demonstrates this for advanced design of air traffic management.

In order to lay the foundations for a systems theory for safety critical complex uncertain systems, the challenging developments are organised in clusters of innovative areas:

- Characterise in mathematical terms the relations between various mathematical models that are in use by the various hybrid systems researchers. Key examples are Automation models, Petri net models, Piecewise Deterministic Markov Processes and Stochastic Differential equations on an hybrid state space and Hierarchical control models;
- Develop architectures and algorithms for distributed conflict control and error evolution control for safety critical systems which are embedded within safety management;
- Development of stochastic analysis based accident risk assessment methodology which supports the design of distributed control of complex systems for safety critical operations.

2.1.5. MA-AFAS project by BAE SYSTEMS

BAE SYSTEMS provided two demonstrations. The first demonstration made use of the experimental FMS developed under the 5th European Framework Programme, MA-AFAS (More Autonomous Aircraft in the Future Air Traffic Management System). The FMS is representative of a fully integrated system that included ADS-B surveillance functions (CDTI), 4D trajectory generation and ASAS. The demonstration showed how the 4D capability of an FMS combined with a manoeuvre generation function could be used to plan and execute ASAS merge, a pass behind and an in trail climb manoeuvres.

The second demonstration showed a potential implementation of ASAS for the retrofit market. This solution makes use of an ASAS control and display unit (ACDU) and a separate ASAS Guidance instrument (AGI). The ACDU provides a CDTI and a softkey menu structure to support ASAS operations (including target aircraft selection). The demonstration showed how a merge manoeuvre could be executed using the autopilot by providing speed guidance cues to the pilot on the AGI while maintaining FMS control for lateral guidance.

2.1.6. FALBALA demonstrator by CENA

As a colourful and animated outcome of the FALBALA Project, CENA presented illustrations of traffic situational awareness during flight operations for four different environments (Paris, London, Frankfurt & Toussus-le-Noble (VFR)). In fact, it was merely the assessment of traffic information possibly displayed on a Cockpit Display of Traffic Information (for VFR & IFR) in a context where all aircraft are ADS-B equipped. The use of real radar data enables to assess current airborne traffic situation.

The demo showed some possible additional features such as size and type of symbols, label information with call sign and airspeed, and sizeable relative speed vectors. Due to the possible enormous amount of information to display, the main purpose is to call for "intelligent filtering" which should be associated to the operational procedure.

2.1.7. CoSpace real-time simulation by EUROCONTROL

CoSpace: Getting down to final approach with ASAS - Controller November/December 2003 experiment replays

Principles: A new allocation of spacing tasks between controller and flight crew is envisaged as one possible option to improve air traffic management. It relies on a set of new “spacing” instructions, whereby the flight crew can be tasked by the controller to maintain a given spacing to a target aircraft. The motivation is neither to “transfer problems” nor to “give more freedom” to flight crew, but really to identify a more effective task distribution beneficial to all parties, without modifying responsibility for separation provision. Airborne surveillance (ADS-B) is required along with cockpit automation (Airborne Separation Assistance System, ASAS).

Experiment: The objective was to assess usability and usefulness of time-based spacing instructions in TMA under very high traffic. Six approach controllers from Gatwick, Orly and Roma participated during 4 weeks.

Initial results: Overall feedback was positive. The proposed working method, though implying significant changes as compared to today, seemed easy to use and assimilate. Controllers perceived benefits: reduction of workload, more anticipation in sequence building and more regular spacing on final. However, the perceived reduced monitoring for aircraft under airborne spacing, led controllers to question their ability to detect unexpected events. The number of manoeuvring instructions seems to be significantly reduced. Geographical distribution of instructions shows the impact of airborne spacing: relief from late vectoring and earlier flow integration. With airborne spacing, the inter aircraft spacing on final is more regular and trajectories are straighter.

2.1.8. Multi-function and traffic information system by Euro-Telematik

Euro-Telematik Cockpit Display of Traffic Information (CDTI) has been developed in many years of research in several projects (e.g. in FARAWAY, or in TAGA with a special focus Aviation). Several products are available:

- Multipurpose display system CDTI-2000 (certified acc. JTSO C-113, C-147)
- Flight Companion CDTI: Software for PDA handheld computers
- Display systems for ground vehicles

B. Day Two – The Work of the ASAS-TN

1. Introduction

This section reports on Day Two of the seminar, which presented the work of the ASAS-TN. A regulatory perspective by the UK CAA was also presented.

The participants were welcomed by Joe Parker (BAE SYSTEMS), Jean-Luc Marchand (European Commission) and Jan van Doorn (EUROCONTROL).

The session was chaired by Phil Hogge.

The presentations were:

- Stakeholder views and needs (Francis Casaux, DGAC/CENA)
- Ground surveillance applications (Peter Howlett, THALES ATM)
- Airport applications of ADS-B (Billy Josefsson, LFV)
- Air Traffic Situational Awareness Applications (Bill Booth, EUROCONTROL)
- Airborne Spacing Applications (Eric Hoffman, EUROCONTROL)
- Long-term Applications (Rob Ruigrok, NLR)
- How does ASAS fit into the ATM environment (Anthony Smoker, IFATCA)
- Airborne Regulatory Perspective (Kevin Hallworth, UK CAA Safety Regulation Group)
- Implementation Strategies (Tony Henley, BAE SYSTEMS)

There was an opportunity for brief questions after each presentation.

The day concluded with a panel-led discussion (1 hour and 15 minutes planned for discussion) and a wrap-up by the Chairman.

2. Chairman's introduction

Phil Hogge welcomed the delegates, reminded them of the ASAS-TN objective and explained the format and purpose of the seminar. He showed how the effective capacity of the European ATM network had increased over the last decade but that it had consistently lagged behind traffic growth, thus causing delays. Recent capacity enhancement work had been very successful but it was questionable that current methods could continue to provide sufficient capacity in the long term. ASAS applications showed early promise in a number of areas:

- Oceanic areas – Use in-trail procedures to allow aircraft to climb through other traffic to reach more economic cruising levels.
- Low density airspace – Use ADS-B out to provide a radar-like coverage in non-radar airspace.
- Airports – Use ASAS, so that pilots and controllers shared the same data to increase safety and throughput.
- High density airspace – Use ASAS, to sequence and merge traffic to improve spacing, flight efficiency and controller workload.

However, in the longer term he believed that a paradigm shift towards self separation was needed to accommodate the expected traffic growth.

There were many challenges; good progress was being made regarding global interoperability and preparing standards for inclusion into ICAO documents. But, so far, it was difficult to find clear business cases which would convince airlines to become involved in the necessary operational trials. It is essential to find local implementations with, maybe, incentives to kick start early implementation.

3. Review of the briefings

3.1. Francis Casaux (DGAC/CENA)

Stakeholder views and needs

Brief description

On the basis on the three ASAS-TN workshops, the presentation is reviewing the needs and views of the stakeholders: States, airlines, general aviation and Military, air navigation service providers and airports, pilots and controllers, aircraft and ATM industry.

Key issues in the presentation

The overall conclusions are:

- Air navigation service providers see potential benefits in Package I while Airlines are waiting for Package II&III benefits.
- Implementation timescales seem too long for airlines and too optimistic for the aircraft and ATM industry
- There are still many issues related to validation and to the demonstration of benefits
- Incentives will be needed because the airlines have to invest a lot and they may not receive initially direct benefits
- Commitment and decision are required but it seems that nobody wants to start first.

3.2. Peter Howlett (THALES ATM)

Ground Surveillance Applications

Brief description

The presentation focused on the 5 Ground Surveillance applications which are part of the first package of GS applications:

- ADS-B-ACC - ATC surveillance for en-route airspace
- ADS-B-TMA - ATC surveillance in terminal areas
- ADS-B-NRA - ATC surveillance in non-radar areas
- ADS-B-APT - Airport surface surveillance
- ADS-B-ADD - Aircraft derived data for ground tools

A review of the development status of the five applications is made, while the presentation also addresses benefits, technical solutions, costs and incentives and operational approval considerations.

Key issues in the presentation

Key points that came out of the presentation:

- ADS-B-NRA, ADS-B-TMA and ADS-B-APT stand out as the three applications which have locally reached a pre-operational or operational status. Examples were given.
- The Australian Upper Airspace project is underway, which aims at providing a continent-wide surveillance service for the Upper Airspace based on ADS-B, using a network of 28 ground stations. Development is ongoing and is expected to provide ADS-B at every Controller workstation by early 2006.

- GS applications are expected to provide initial benefits, while paving the way for AS applications by preparing part of the infrastructure and getting ATM actors accustomed to use of ADS-B.
- ADS-B out, i.e. the ability of aircraft to broadcast ADS-B messages is now available with 1090 MHz Mode S Extended Squitter technology; Airbus and Boeing have service bulletins available for ADS-B out, which is now installed on a growing number of aircraft, linked to the European mandate for Mode S Elementary/Enhanced surveillance. This is an enabler for GS applications but also for some AS applications.

3.3. Billy Josefsson (LFV)

Airport applications of ADS-B for surveillance and situational awareness

Brief description

Package I airport applications were presented as a composite application consisting of ATSA-SURF and ADS-B-APT. The reason for this is that the overlap between the two applications is significant and the fact that the applications are collectively used by airport, airline and ATC. Commonality concerning hardware could vary depending on the infrastructure and technical enabler. The general objective of Package I airport applications is to collect data from aircraft and vehicles, share the data and display it to the actors at the airport. The data presented could then be subject for processing in order to prevent incursion on runways or defined areas. As all the position data are logged, it could be used for follow up and fine-tuning of operations. Most of the major airports are today equipped with a SMGCS system with some of them using ADS-B. Adding position, identification and state vector for vehicles operating at the airport and making this common view available to the drivers, planners and ATC will have a beneficial effect on safety, efficiency and capacity.

Expected benefits from ATSA-SURF and ADS-B-APT:

- Safety, awareness between actors e.g. to prevent runway incursion, area incursion
- Efficiency, facilitate planning and best use of resources
- Capacity, increase throughput by providing awareness
- Environment, less taxi time, more efficient procedures e.g. de-icing
- Cooperative values, learn more about each other's operations but also a prerequisite for efficient cooperation

It is clear that benefits from the introduction of airport applications are collective and therefore requires collective definition, planning, implementation and consequently collective investment. Further, depending on how the ADS-B-APT system is configured the security area could be improved in terms of monitoring and supervision of ground movements. There is also a "new" category of benefits identified for airport application namely co-operative values i.e. learn more about each other operations, constraints and capabilities. Package I airport applications also fit nicely in the context of CDM (collaborative decision making) and SWIM (system wide information management). These co-operative values and experiences are believed to be part of the baseline for future air-transport operations. Costs associated with purchase, installation and training are reasonable.

At Stockholm-Arlanda airport (Sweden), the set of ADS-B APT applications will be fully certified at the end of 2004. Stockholm Arlanda airport was used as an example. The existing A-SMGCS system has an ADS-B interface in order to be able to present aircraft, vehicles equipped with transponders. The A-SMGCS system also includes Ground-based Regional Augmentation System and TIS-B services. The technical enabler at Arlanda is VDL mode 4. There is also another system called airport organiser which is used mainly for monitoring, communication and co-ordination with buses and vehicles. The Arlanda applications also comprise INFO-B services, which are used for communication. At present 22 buses and 17 other vehicles are equipped with transponders. There are still few commercial aircraft equipped but general aviation has recently equipped 10 aircraft some of them with transponder and CDTI and another 30 aircraft installations are foreseen in the near future. The focus on the vehicles has its origin in the user requirements for efficient turnaround process and also safety and security aspects. There is also relatively low cost associated with the equipage of buses and vehicles. However, the benefits to have vehicles included in the common view cannot be underestimated from a planning, efficiency and safety perspective.

At Arlanda, there are currently two actors investigating potential equipage. Fire squad vehicles should benefit from being part of and have access to the common view. Frankfurt airport has successfully implemented this application. The other use is the SAS (Scandinavian Airlines System) who operate about 70 mini-trucks at the airport. The maximum operating mini-trucks at the same time are never exceeding 40, however there could be benefits (need for fewer mini-trucks) if there was a monitoring of these trucks.

The introduction of Package I airport applications will have impact for all the actors but the indications are that they are perceived as an improvement. One general consequence is that procedures, rules and letters of agreement, have to be revisited. The other general improvement is that the ability to predict and plan ahead increases for all the actors. Impact on the ATC operations could be small or big depending on the existing equipage. Aircraft operators should perceive improvements in turn-around process in terms of common awareness and just in time delivery of resources. The guidance, monitoring and follow up on buses and vehicles will be a source of major improvement.

In general, when a common view or situational awareness is provided to the users, they will start to use it and include it in their planning and decision-making. The roles for ATC, airline and airport actors are believed to be the same but more “in the loop”. This means that they are able to work more proactively planning ahead thus avoiding late changes and surprises. It is also anticipated that a more efficient “cut” between airport and airline operations as well as between ATC and pilot could be enabled by a proper introduction of Package I airport applications.

Key issues in the presentation

- Activities in the CDM and SWIM area are believed to put further requirements on high performance Package I airport applications.
- The costs for introducing ADS-B-APT and ATSA-SURF are low compared to the airborne case, however most of the values are collective and therefore requires collective investments accompanied with a clear business case.
- Package I airport applications are promising and enable safe and cost efficient operations with focus on supporting the turnaround process and at the same time improving safety for the actors at the airport.
- ADS-B-APT could be an easy Package I application to implement and also an application that could serve as a buy-in to airline and airport.

3.4. Søren Dissing/Bill Booth (EUROCONTROL)

Air Traffic Situation Awareness (ATSA) applications

Brief description

These applications are aimed at enhancing the flight crew’s knowledge of the surrounding traffic situation, both in the air and on the airport surface, thus improving the flight crew’s decision process for the safe and efficient management of their flight. No changes in separation tasks or responsibility are required for these applications.

The main benefit expected from the ATSA applications is safety via enhanced situational awareness. This benefit should arise from presenting the flight crew with flight information concerning surrounding traffic, possibly in conjunction with a navigation display or a surface map. Situational awareness can be provided in all airspace, in all phases of flight, and on the airport surface. It can operate in any weather condition. Some specific benefits could be:

- Assist flight crews with see-and-avoid duties;
- Assist flight crews in avoiding blunders or errors;
- Provide information to facilitate correct decision-making; and

- Provide flight crews with information consistent with that available to the controller.

There may also be some efficiency benefits via CDTI assisting enhanced visual approaches and airport surface movements.

The ATSA applications in Package I are:

- ATSA-SURF - Enhanced traffic situational awareness on the airport surface
- ATSA-AIRB - Enhanced traffic situational awareness during flight operations
- ATSA-S&A - Enhanced visual acquisition for see & avoid
- ATSA-SVA - Enhanced successive visual approaches

These have been evaluated as a course of the NUP, MA-AFAS and MFF projects.

Implementation issues: there should be:

- No change in the current procedures; and
- No changes in responsibilities.

For the ground ATC systems no changes are needed, unless TIS-B is used. The ATC may need to be aware of equipage.

For the air, there will be ATSA related tools on board the aircraft that are used only to enhance the current procedures. Therefore the aircraft systems are low level of criticality. There will need to be a generic CDTI with the following functions:

- surrounding traffic presentation
- state vector for the surrounding traffic
- filtering functions
- potentially intent display

ADS-B deployment is necessary. There will either have to be mandatory ADS B equipage or segregated airspace for equipped aircraft (or the use of TIS-B as a gap filler).

It is possible that with the implementation of other more “demanding” Package I applications (i.e. airborne spacing applications) the ATSA tools will be available on board the aircraft (i.e. CDTI). It may be that ATSA becomes available to some airlines as a side benefit of equipping for other applications. UPS have already equipped in the US solely for ATSA benefit.

In remote areas, there are potential benefits for ATSA as evidenced by the current use of Traffic Information Broadcast by Aircraft (TIBA) procedure. Airbus has been studying ADS-B, as well as the related applications and Enhanced TIBA in particular for several years.

It is possible that Enhanced-TIBA requires changes to the ADS message as currently defined, as well as substantial changes to the FMS. This latter issue is costly. Aircraft identification using TIBA voice and Enhanced-TIBA must be identical (or at least close enough to avoid any confusion). In any case, in the Airbus Enhanced-TIBA work, on-board medium term conflict detection generated warnings are not to be seen as conflict alerts but rather as advisories only. Furthermore, Enhanced-TIBA will be a manually activated function.

FALBALA (First Assessment of the operational Limitations, Benefits & Applicability for a List of Package I AS applications). The project supported the validation of three selected Airborne Surveillance (AS) applications from Package I, from which two were:

- Enhanced Traffic Situational Awareness during flight operations (ATSA-AIRB),
- Enhanced Visual Separation on Approach (ATSA-VSA)

The project aimed at providing a better understanding of the current situation from both an airspace and an aircraft perspective through the analysis of European radar data recordings, and assessing the possible operational benefits brought by the AS applications under investigation.

FALBALA study has demonstrated that:

- the airspace and airport characteristics and the traffic demand should be considered when assessing operational applicability and benefits of AS applications envisaged for implementation.
- the radar data analysis is of particular interest to better understand the current situation and assess possible benefits within specific airspace and at various airports.
- operational benefits depend on the AS application and the operational environment.

With regard to the ATSA-VSA application, it is considered that an investigation of the differences in operations between United States and Europe, will support the assessment of the possible benefits

Estimates show that investments alone for ATSA applications will not be made, as the benefits are just in the area of safety.

Investments are expected to be on the airlines side. However investments can be foreseen on the ground if TIS-B is necessary for ATSA.

It was strongly recommended that the introduction of ATSA applications be properly managed, including instructions, training and if necessary procedures for pilots to do nothing new based on ATSA alone. Controllers currently experience pilots questioning clearances or hesitating based on traffic situational awareness provided by the TCAS display.

The following conclusions were drawn:

- ATSA is ATM business as usual – just better informed business with a common picture
- There may be no business case for ATSA alone outside remote areas
- It is difficult to quantify ATSA safety benefits
- Changes in Situational Awareness via CDTI may not produce predictable outcomes and should be researched and managed (c.f. Radar induced collisions in maritime domain).

3.5. Eric Hoffman (EUROCONTROL)

Airborne Spacing applications

Brief description

As described in the PO-ASAS, these applications require the flight crews to achieve and maintain a given spacing with designated aircraft, as specified in a new ATC instruction where this can be done more effectively from the flight deck. Although the flight crews are given new tasks, separation provision is still the controller's responsibility and applicable separation minima are unchanged.

Transferring spacing tasks to the flight deck is expected to increase of controller availability, leading to improve safety, in turn: better traffic management and, depending on airspace constraints, more capacity. Additional benefits include a more strategic role for the controller, resulting in better flow management. From a flight deck perspective, it is expected to provide the flight crew with a gain in awareness and anticipation.

The three Package I applications were reviewed in turn.

The “Airborne Spacing - Enhanced Sequencing and Merging” application (ASPA-S&M) is designed for en-route airspace and the Terminal Control Area (TMA) in a radar/radar-like environment. The applicable flight phases include cruise and descent from top of descent to the runway, although spacing for departures may also be considered. It relies on a set of new spacing instructions related to the sequencing (e.g. in-trail following) and merging of traffic.

There is a large body of work in Europe and in the US, including real time simulations and flight trials supporting that ASPA-S&M could lead to significantly more regularly flow and inter aircraft spacing.

Requirement Focus Group is fast tracking the development of Safety & Performance Requirements. Pre-operational trials are considered in SEAP / LAVA / C-ATM and initial activities linked to avionics “scoping/sizing” have started. In addition, a number of ANSPs have expressed of the interest and need for further investigations of the applicability of ASPA-S&M in their specific airspace (e.g. Spain, Italy, France).

The In-Trail Procedure in non-radar oceanic airspace is a procedure allowing in-trail ADS-B equipped aircraft, which may not be longitudinally separated from each other, to climb or descend through each other's flight levels.

Vast amount of experience can be derived from US experience on TCAS in trail climb. On-going prototyping and validation activities have been initiated in the context of NUPII. Concerning the Safety and Performance Requirements determination, development within RFG will be starting imminently.

The objective of the Crossing & Passing Procedure (ASPA-C&P) is to provide the controller with a new set of procedures to solve conflicts directing, for example, the flight crews to cross or pass a designated traffic while maintaining a given spacing value. A significant number of variants exist. R&D work is on-going (e.g. MFF, ASSTAR) including even some isolated flight trials (MA-AFAS). While being within the RFG Scope, ASPA-C&P is expected to be among the last applications to go through the Safety and Performance Requirement determination process.

From a technical perspective, it is expected that not much may be needed on the ground: knowledge of Spacing equipage and possibly monitoring tools. In the aircraft, ADS-B in & out is required. In addition, cockpit assistance and automation tools are anticipated to be needed to support the flight crew – a CDTI and at least flight director. Spacing is a complement rather than competitor to ground Decision Support Tools.

Spacing applications are very much at the core of Package I and as such within the remit of RFG activities. The ATM Master Plan is making explicit reference to Spacing applications for the 2012 timeframe. Large scale pre-operational validations are currently in the planning stage

3.6. Rob Ruigrok (NLR)

ASAS Long-term applications

Brief description

The "Long(er) Term ASAS Applications" presentation focussed on Airborne Separation and Airborne Self-Separation applications. Airborne Separation (Package II) applications consist of Sequencing & Merging, Crossing & Passing and CDTI Enhanced Flight Rules type of applications, with the flight crew responsible for separation with one (target) aircraft. Aiborne Self-Separation (Package II and III) is regarded as the ultimate ASAS application, in which the flight crew is responsible for separation with all traffic in the Free Flight area. In this application, the crew has advanced conflict detection, conflict resolution and conflict prevention tools available for this task, whereas in Airborne Separation specific ASAS cockpit tools are required. Several options for mixing Airborne Self-Separation equipped aircraft and non-Airborne Self-Separation equipped aircraft in the same or segregated airspace are listed.

The presentation explained the Airborne Separation and Airborne Self-Separation applications, together with an identification of the roles of the actors and expected benefits in terms of capacity, safety, efficiency and emissions. Airborne Separation expected benefits build upon Airborne Spacing expected benefits, as listed in the Airborne Spacing presentation. Increased capacity due to lower air traffic controller workload is foreseen, together with safety, efficiency and environmental benefits. Airborne Self-Separation expected benefits indicate the ability of this application to handle several times today's Western-European traffic density, in en-route airspace, together with safety, economical and environmental benefits. Explanations and material from research was presented, explaining the reasons for these benefits, while at the same time addressing general concerns on pilot workload, safety and traffic complexity, when applying Airborne Self-Separation.

The expected technical solutions for both applications are presented, on both ground and air, showing major changes in the air. Full double-redundant ASAS systems are foreseen, giving that the flight crew is responsible for separation in both applications. An alternative is presented, showing the full re-sectorisation of European airspace from the ONESKY project. Indications from this project show however a maximum capacity increase of 35% compared to today's traffic densities, by which this appears no real alternative for ASAS Self-Separation to meet the Vision 2020 challenges.

The operational approval process and standards of Airborne Separation and Airborne Self-Separation applications are discussed. Giving the standardisation and certification lead time of about ten years, it is suggested to start the standardisation process for these applications soon (if we want to use them by 2015), and to start the implementation of Airborne (Self-)Separation applications in sparse density regions, in parallel to Package I implementation(s) in core Europe.

Finally, an initial assessment of a potential business case is presented for these applications. The business case depends on the quantified benefits and the costs of equipage, the later one being currently highly unknown. However, given the major changes on board of the aircraft, it is likely that incentive strategies will be needed to solve the long-term investment issue. Suggestions are reduced charges for equipped airlines, better service to equipped airlines or priority for the equipped airlines.

After the presentation, a comment was raised that the presentation generalised results and benefits too much, since different Airborne Separation and Airborne Self-Separation applications have different results and benefits. The ASAS-TN team recognised this comment and explained that it was decided to present these two ASAS applications in one, (too) short presentation. Further, the Airborne Self-Separation application was somewhat more detailed, given the more mature R&D status of this application.

A second question was raised on how to combine 4D and ASAS type of applications, in gate-to-gate operations. The ASAS-TN team member presenting this presentation gave his personal view on this, expressing that gate-to-gate 4D applications seem not very realistic on long flights crossing several airspace regimes (and states). Instead, 4D departure managers at the departure airport, 4D arrival managers at the arrival airport (with Airborne Spacing), and ASAS (Airborne Self-Separation) in the en-route phase of flight, in between the two TMAs, seems a more realistic combination of 4D and ASAS applications.

The last question referred to the view on pilot workload, as included in the presentation. It was explained that the results presented did not express a view, but scientific results and data from representative and realistic pilot-in-the-loop simulation experiments, in advanced flight simulators.

3.7. Anthony Smoker (IFATCA)

How does ASAS fit into the ATM environment?

<u>Brief description</u>

The presentation reviewed the results of the experiments and trials thus far, and infer what this means for the integration into ATM *per se.*

The results from a range of experiments show:

- ADS-B - Ground Surveillance applications show the potential for positive benefits now, across a range of ATM domains.
- ASPA applications, particularly sequencing and merging and in trail climb and descent, show considerable promise.
- ATSA applications have the potential for positive safety benefits in a number of different domains. However, their use in some operational environments needs careful implementation. Full benefits in non-radar airspace can only come with complete equipage

Operational benefits will depend on the particular applications and the operational environment. In some cases the airspace design may need to change to support ASAS applications. Other ATM developments may offer greater operational benefits, so ANSPs may choose not to implement ASAS applications. Metrics to understand and analyse this need to be developed. In other cases, ASAS applications will be complementary to other ATM developments, thus hybrid solutions may be used. In all cases it is essential that ASAS is compatible and integrated into the ATM system wholly. Implementation of ASAS applications, should attempt to support controller and pilot operational problems

Initial indications are that controller and pilot acceptance of ASAS applications is good, but there are a number of issues that surround integration into the control process that must be satisfied. Training and preventing adverse changes to workload (although redistribution of workload tasks will occur) are the most significant. The training effort can be expected to be a resource intensive activity.

ASAS applications integrate air-and ground, and thus is a new dimension in ATM processes. Certification will reflect this and needs to take total system approach. Transition to ASAS operations will need to embrace controllers and pilots as willing actors in the change, and also have a systemic focus. There are a number of safety issues that will need to be addressed as a result.

Key issues in the presentation

- ASAS applications can integrate into ATC operations successfully and there is the potential for wide-ranging positive benefits
- Some ASAS applications will need structural changes in the operational environment to optimise benefits and ASAS must integrate and be compatible with other ATM systems
- Controller and pilot training combined, with the preparation for the changes that the implementation of ASAS applications will bring, are pivotal for successful implementation.

3.8. Kevin Hallworth (UK CAA Safety Regulation Group)

Airborne Regulatory Perspective

Brief description

First it was recalled that a total system approach is required considering together ATM, aircraft airworthiness, flight operations and airport operations.

Within the JAA, the CNS/ATM Steering Group has already started to analyse the certification issues concerning ASAS in order to anticipate the regulation activities. It will make three recommendations to Central JAA/EASA within position paper pp009. It is a mature draft that provides an overview of ASAS developments and their implications.

Guidance for the equipage standard for each ASAS application is being considered.

The first recommendation is that JAA should establish a specialist sub-committee to consider the implications of ASAS developments with the objective of developing operational regulatory and guidance material with attention to Package I.

The second recommends that the development of the CDTI should be carefully followed with consideration of human factors, display symbology, flight deck integration, crew procedures, training and the likely impact on certification standards.

Eventually, the third is that JAA flight crew licensing specialists should consider the impact on flight crew licensing standards that may arise from the implementation of ASAS applications.

Within the presentation, a number of possible certification issues have been listed:

- integration of ASAS with existing ACAS;
- integration of warnings and cautions;
- human factors and crew work load;
- accident data recording of ASAS data;
- system architecture (processing within a Traffic Advisory Computer or within the FMS);
- system safety assessment; and
- compliance with EASA Certification Specifications (CS 25).

There is an on-going process within the RFG to perform a global air-ground safety assessment. The Operational Safety and Performance Assessment for both ground and airborne system have to be completed in order to develop the SPR and INTEROP standards that will be called by the certification regulations.

It has been recommended also that the regulation activity be coordinated with FAA.

3.9. Tony Henley (BAE SYSTEMS)

Implementation Strategies

Brief description

Package I addresses ground and airborne spacing applications; it is not a single ‘System’ but a collection of applications enabled by new technology. Package I provides surveillance and new operational capabilities.

‘Airborne Separation’ applications, involving transfer of separation responsibility to the aircraft, are in Package II & III.

Standards and the ICAO position:

There is a need to generate new standards for ASAS to cover the Overall Air/Ground applications including the concept of operations, Ground ATM systems, communication, navigation and surveillance elements. This is progressing through the normal standards bodies in co-ordination with ICAO order to ensure global interoperability.

It was noted that ICAO has recommended that States support the cost-effective early implementation of packages of ground and airborne ADS-B applications, noting the early achievable benefits from new ATM applications; and ensure that implementation of ADS-B is harmonised.

This work is being driven by the very successful international Requirements Focus Group RFG comprising EUROCONTROL, FAA, EUROCAE, RTCA with Australian and Japanese support which is making considerable progress in the development of the necessary OSED, SPR and INTEROP standards for Package I.

Standards requirements are very dependent on the specific application to be deployed and therefore effort should be focused on those giving near term gains

New European Regulations may complicate progress on ground system standards, co-operation e.g. between EUROCAE, EASA, EUROCONTROL Safety Regulation Commission.

Certification:

New ATM certification requirements will be derived in the light of the ESARR 4 and it was noted that ASAS applications will be among the first to comply with these new regulations. The methodology for certification of ASAS air ground interaction will be based on the EUROCAE ED78A methodology supplemented as necessary to address specific safety requirements.

Applications:

Near term Opportunities

It was suggested that ASAS applications could be operational in Europe within 3 or 4 years if the necessary level of commitment was in place (some applications will be operational in this time frame in other parts of the world). Specifically Europe has three major programmes that include ASAS validation as key objectives. The programmes are

- C-ATM – which needs to identify Airline and ANSP pairs to undertake airborne validation of aspects the new ATM elements; CDM, 4D and ASAS
- SEAP – which has started detailed work on the preparation for validation of selected ASAS applications including air ground systems modification and certification but is having difficulty accessing the necessary funding to continue the work
- CASCADE – Which is a very significant ASAS and data-link implementation co-ordination programme but may possibly not be addressing the high value Spacing applications quickly enough.

Finally, the ASAS-TN Deliverable ‘Towards an implementation Strategy’ was commended to all as the basis for further decision making and development action. The report recommendations for an Early Implementation Strategy are presented below:

ASAS and ADS-B are not purely European issues but global ones. It is important for global activities to be co-ordinated so that GS/AS applications and terminology become standardised. The Requirements Focus Group (RFG) has been created to co-ordinate ASAS activities between Europe and the US.

Recommendation 1: It is essential that the RFG continues to bring together the experience and knowledge from global ASAS and ADS-B activities in order to define a common set of GS/AS applications along with the associated safety and interoperability requirements.

In order to support the work of the RFG, the results from European research projects such as MFF, NUP and MA-AFAS need to be validated with respect to safety, human factors and controller/pilot acceptance.

Recommendation 2: The ASAS and ADS-B validation work should be accelerated and co-ordinated within Europe across the NUP, SEAP, C-ATM, LAVA and other programmes.

There have been many studies on the ADS-B data-link technology and the evidence from the studies has been less than conclusive. The main conclusion from the studies is that most early implementations are likely to be based on Mode S extended squitter although some regions may adopt alternative approaches. It is also expected that additional alternative link technologies will be required in the future in order to meet requirements for integrity and capacity.

Recommendation 3: In line with ANConf/11 recommendations 7/1 and 7/2, the initial deployment of ADS-B in Europe should be based on Mode S extended squitter with VDL Mode 4 providing regional implementations.

In order to provide incentives for aircraft operators to equip aircraft, it is important to demonstrate the operational performance and cost benefits to the aircraft operators early. This can probably best be achieved by initially targeting local areas where it is feasible to equip sufficient numbers of aircraft to enable the benefits of ASAS and ADS-B to be demonstrated.

Recommendation 4: Demonstrate ASAS and ADS-B benefits at local level first.

The initial implementation should be capable of handling many of the ‘Package I’ applications and also of being extended to handle some ‘Package 2’ applications. The implementation could be largely independent of other aircraft systems and as a consequence would probably include its own display and control units. In such an implementation, the pilot will control the aircraft during spacing manoeuvres using the autopilot.

Recommendation 5: Develop a retrofit solution for equipping existing aircraft.

This approach to a retrofit solution should enable earlier introduction of ASAS and ADS-B because it reduces the extent of aircraft modification and hence certification required. The main limitation with this approach is that it is a short term solution. It may not provide the operational flexibility or automated operation required for the long-term.

Recommendation 6: The preferred implementation in the long-term of ASAS and ADS-B applications is expected to be within a fully integrated, dual redundant avionics system.

The integration of ACAS display information with the ADS-B display information needs to be considered for the initial implementation and particularly for the final implementation where a common display surface is likely to be used.

Recommendation 7: It is essential that the ADS-B-based traffic display and ACAS display do not present conflicting pictures and that the presence of ADS-B information does not in any way compromise the safety net provided by ACAS.

Among the various applications identified for inclusion in ‘Package I’, there are three applications that are expected to bring early benefits in Europe: In areas with no existing radar cover or restricted radar coverage, the introduction of ADS-B-out equipped aircraft will enable ANSPs to provide a radar-like service to equipped aircraft.

Recommendation 8: Consider the ADS-B-NRA application for early implementation.

The second GS application that would be suitable for early implementation is ADS-B-APT. This is expected to provide benefits at airports with restricted ground surveillance cover or where there is no existing surveillance system and restricted visibility as a result of poor weather or at night is a frequent occurrence.

Recommendation 9: Consider the ADS-B-APT application for early implementation.

The ASPA-S&M application provides a means for controllers to create more regular flows of aircraft. The new instructions decrease the controller workload, without significantly changing the pilot workload, by reducing the need for tactical control of aircraft within a sector. One anticipated benefit is increased capacity through better adherence to optimum approach spacing.

Recommendation 10: It is recommended that the ASPA-S&M application be considered for implementation as early as practical at specific airports where benefits have been shown to exist.

This should provide significant benefits to stakeholders and also creates a sound basis on which to build more advanced capabilities.

3.10. Panel led discussion

The panel chaired by Phil Hogge were:

- Alain Printemps DGAC/CENA
- Jean-Claude Richard Air Traffic Alliance
- Christian Denke IFALPA
- Anthony Smoker IFATCA
- Jan van Doorn EUROCONTROL
- Jean-Luc Marchand European Commission

Initially each of the panel members were invited to summarise the key ASAS issues as they perceived them:

Christian Denke

Christian Denke identified five key issues:

1. The strong need for total system assessment together with addressing end to end certification. The ground systems certification process will need a review in the light of ASAS.
2. System redundancy. There could be failure mode issues with ADS-B implementations compared to the current CNS implementations. Current CNS offers dissimilar redundancy implementations. Caution should be exercised when designing ADS-B implementations to ensure that they are not symmetrical in design if used as the sole means. However ADS-B may improve matters where we have nothing at present.

3. The IFALPA policy on data-link includes the requirement that security aspects need to be addressed. This includes the monitoring of broadcast data by unauthorised persons as well as more malicious use.
4. CDTI/Human Factors – These are important issues especially with regard to certification, he referred to the CAA Safety Regulation Group presentation by Kevin Hallworth.
5. At a 1996 Conference on preventing collisions at Sea in China. Rules regarding preventative actions versus controller passing manoeuvres using "safe" distances were compared. Frequency of collisions became an issue. Self-separation needs to be based on clear rules for passing. The IFALPA policy regarding delegation is that without validated ICAO procedures and technologies responsibility should remain with the ground.

Anthony Smoker

Since the commencement of the ASAS-TN activities it is noticeable that there is distinct progress being made in ASAS activities, particularly the focus now being given to operational issues.

Package II & III give controllers real cause for concern vis-a-vis the roles responsibilities of the actors in the ATM control process.

Package I however gives controllers more confidence as they are developed and maturing. Despite this there needs to be greater visibility of the experiments and trials – it is difficult to find results for trials experiments etc, and for the operational community these will inform and provide the basis for understanding and acceptance. Please publish results so that organisations like IFATCA, and IFALPA, can gain access to detailed results.

There is and will be considerable change for Controllers to deal with in the operational environment, not solely because of the introduction ASAS, but with the many other changes that are promised within the ATM environment. These changes bring new levels of complexity in the context of growing traffic levels, and new procedures, tools and techniques – and attendant workload.

ATSA applications are a cause for concern. This year pilots have questioned him on two occasions regarding instructions based on their TCAS display. This is an unacceptable practice and led to increased workload in busy situations.

There are concerns that IFATCA have about ASAS applications generating new conflicts or mis-matches between air and ground. For example identification of other targets in establishing spacing procedures, the potential for air and ground systems to use systems that have different accuracies and the resultant effects upon surveillance and detection tasks. Thus there is much work to be fulfilled to take the ASAS applications into the real operational world.

Finally, we presume that ASAS (i.e. the system) will need to be certified in terms of human performance and human factors. This is a relatively new rigour in certification for ground systems, and will undoubtedly add considerably to the challenges ahead, and thus should not be underestimated.

Jan van Doorn

ASAS will bring a paradigm shift. We also see issues such as the advent of UAVs. Changes will be always with us.

Until now all ATM costs, whether related to the aircraft equipment or to the ATM service provision, are absorbed by the users. But as there are overall benefits to society that may be realised, a paradigm shift in costs to the users is appropriate and taxpayers money should be used, via the Commission, to support such initiatives.

Global elements – ADS is just an enabler. ADS has its own lobby and this is dangerous – work from operational needs, not from a "Box" perspective

Business cases – for Package I we could have a too limited view. What can Package I do for airline operations and flow management –Widen the scope of the thinking and the studies? For example, although data-link was seen as very important for the future, the limited scope of first applications made a lousy business case. But it made it by surfing on the ACARS needs for VDL/2. ASAS situation could be analogous to what we experienced with data-link and we should learn from this.

If Package III can deliver three times the traffic, great – Pilots like it and this is when flying with three times the benefit – so look to the longer term when working now. And can the longer term enhance the business case? Need for advanced validation!

Certification is another issue. It could be a showstopper – training for low-cost airlines – they want low cost pilots and consequently simple cockpits and aircraft.

Where are the decision-makers? The work of PHARE (Programme for Harmonised Air traffic management Research in Europe) for 4D contracts failed to reach them and therefore the 4D applications failed to be implemented.

Jan discussed (as an interested researcher, not as EUROCONTROL) some provocative research topics. Jamming is one – radars can be jammed or blown up today, never done!. Similarly GPS can be jammed and yet it is still used by the military, so clever terrorists have most probably done a negative business case on it and won't target it? Security therefore is not necessarily such a showstopper. Given this using the three GNSS plus ADS-B we could replace all other Navaids and radar and have truly marvellous global coverage and unification. We could also get rid of cockpit windows. If we have effective CDTI, we could get rid of much more, UAV's are pointing to the first use of pilot-less aircraft for cargo shuttles by 2020!.

Jean-Claude Richard

My main concern is related to the necessary logistics, which will be attached to the actual usage of an ASAS application.

Let's imagine for a moment that we are in a situation where we would like to make use of an already fully certified ASAS application, let's say the "Sequencing & Merging" one (which means that the certification work is behind us and that the appropriate on board and ground equipment are certified and are available from the suppliers)). I firmly believe that we are not far from this.

But it's not enough as several additional artefacts are still needed, at least the following three:

1. The on board equipment needs to be successfully installed and tested on board the fleet of a concerned airline. Assuming that is just possible to do so during the B or C checks, for a concerned fleet of several tens of aircraft, this may mean several years (4/6?) before getting an homogenous fleet.
2. The crews must be properly trained; lets count for 4/5 crews per aircraft and the facts that Pilots and first officers are not paired. That counts again for years before having all the cockpits crew population trained and formally qualified.
3. Same story for the Air traffic Controller population that will need the same level of training and homogeneity.

At least initially, there is little chance to get one or two aircraft approaching together, fitted with appropriate equipment, controlled by authorized and trained crews and monitored by knowledgeable ATC controllers.

Conversely there is strong probability for getting only part of the chain and thus leading to an immense sense of frustration during at least the initial phase of introduction.

Careful introduction planning is certainly one of the biggest challenges we will have to face to. The earlier we think about it, the better.

Jean-Luc Marchand

DG RTD has a longer-term perspective and is particularly concerned by the Research and Development. ASAS is included in the 2020 vision and ACARE. Some applications are already funded – e.g. ASAS-TN2 and ASSTAR for the longer term

DG TREN work is more for the shorter and medium term and is particularly concerned with the implementation. ADS-B will be part of the integrated air/ground system with some of the separation function being performed by the pilot.

Convincing the airlines in the current economic climate is difficult. We need business cases, if these fail to convince we may need incentives to encourage voluntary installation. Then we may need to push for equipage based on a mandate if these fail.

NUP, SEAP etc projects have demonstrated viable ASAS applications providing local benefits. These are fundamental to progress. From these local cases the flag is raised high for the rest of EUROPE. SESAME will pave the way. Some people say that SESAME is diverting the resources? But the message regarding ASAS applications benefits will be passed through projects such as this.

Alain Printemps

Alain Printemps presented an ANSP point of view

The overall ASAS activities are very complex and confusing – e.g. we have SEAP, RFG, SESAME. ADS-B out is not mandatory at this moment. Users want a paradigm change.

ANSP cannot implement all changes at once (Operational Changes, Technology Changes). There is a high workload implementing other things up to 2008 (including training, data-link and CPDLC, Flight Data Processing System, multi-sector planning, 4D FMS and now ASAS). After 2008, ANSPs implement data-link, then Flight Data Processing System, then multi-sector planning, then ASAS.

The place of ASAS needs to be decided on the priority list.

ASAS has a good case and is relatively easy to implement on the ground. ADS-B out mandate is easy to put in place.

We need to put emphasis on how to implement Package I. Perform CBAs, quantify ASPA-S&M benefits with few aircraft equipped, and quantify the benefits of CPDLC and ASAS. Local benefits will not necessarily be of interest and may be incompatible elsewhere, especially if not derived from global requirements – therefore they could be ineffective elsewhere.

We need to convince the controllers that ASAS is the best option for now and the future – (Controllers last 20-30 years). They need to be convinced they will not be put out of a job.

ASAS people need to convince others that ASAS is the best technology solution (above data-link, etc.). Show long-term is the best solution in the evolution of the ATM system.

Discussions

Tony Henley - We need to narrow the focus driven by business/operational need. There is competition with other solutions, it is difficult to include ASAS in a total systems approach with other solutions before doing large-scale validations on ASAS only.

So we need large scale validation activities. A set of applications for immediate implementation needs to be defined. They need to be compatible with the future – but unless we get things going right away ASAS may die as an option. Do it and do it quickly.

Hans Nyhoj - Urged the community to rapidly take a decision concerning ASAS functionalities and implement it on a global basis. Otherwise local needs could lead to decide local implementations, which is not the best solution in aviation. There is a big risk if we do not become organised with a common plan in Europe. Delays will soon go up again to 1999 levels and pressure on the decision makers from citizens of Europe will follow. From this point of view he thought that SESAME is one of the better initiatives he has ever seen in order to organize and coordinate the deployment of new ATM functions with the consensus of all stakeholders, but airspace users should be more involved as they are the end users and pay for the services.

Phil Hogge – If you want politicians to make a decision you need to present the information and the full picture.

Jan van Doorn – Highlighted that aviation has generally some difficulties to build implementation plans and specifically EUROCONTROL was accused in the past to produce plans that are not detailed enough (ATM 2000+). This difficulty will be overcome with SESAME. It will offer to the Air Transport Industry a framework providing high-level requirements as well as a proposed implementation plan which will provide benefits to society. The airlines may then step forward to define the requirements, industry to deliver the solutions, and ANSPs to serve them.

Tony Henley – SESAME is important and will produce valuable output. However the concern was raised that SESAME, while looking at the important consideration for the medium and long term, may divert attention from short term needs.

Jean-Claude Richard - In response it was stated that SESAME sets out to cover both the short terms actions and the long term planning.

Alain Printemps - All three steps are covered in SESAME – short, medium and long. There are other alternatives to ASAS to deliver the improvements. The ASAS community should clearly deliver the maximum knowledge and expertise to SESAME

Chris Ulvetter – Made the point that by getting rid of procedural separation in Australia flight times will decrease. But this may not be relevant in core Europe.

Jean-Luc Marchand - There was a question about the diversity of the on-going actions in preparation of ASAS. The European Commission recognizes that R&D activities, by nature, can give the impression of dispersion but SESAME is a way to coordinate all the activities. We must face reality. We have an inheritance based on national ANSPs and several other sponsoring organisations. The Single European Sky may change this. We need a plan and SESAME is supposed to be a key element of this. Please give them some time and your inputs. If SESAME doesn’t reach any consensus then the Political will may be necessary to mandate some of the things.

Will SESAME take the entire budget? The percentage of the budget for basic research will double in the 7th Framework Programme. The Aeronautics technological platform already exists and its budget will grow. In addition, DG:TREN is pushing to make ATM a technological platform within the 7th Framework Programme.

Jan van Doorn - SESAME budget is a combination of TEN-T and EUROCONTROL. The current budget for SESAME is re-routed budget and the subsequent budget foreseen in the 2nd and 3rd phase of SESAME, which is Galileo-like, is new budget which would not have existed otherwise. Short-term elements will not be effected in fact they even be spurred on. Within SESAME there is the wider scope for CBAs with many elements linked together and not analysed in isolation (like the situation for RVSM and 8.33 were done separately and would have been better done together).

Eric Hoffman - Some CBAs are valid at a societal level rather than for individual stakeholders

Vincent de Vroey - The Association of European Airlines mentioned that the airspaces users should lead an activity like SESAME. Due to worldwide interoperability aspects SESAME should not be focused on Europe but should have a global view. In line with its objectives SESAME should also provide orientations for the R&D activities. There is a need for global interoperability – therefore not just a European master plan. It should drive the research needs and streamline and integrate the research

Kim O’Neil - Opposed SESAME because it was industry led. He stated that we need quantified benefits. He also could not understand the decision of airlines to use Mode S because he saw Mode S as a single thread system which would become chronically overused specifically in the TMA.

Vincent de Vroey - Replied that the airlines fully supported the Mode S decision.

Tony Henley - Mode S gives us a target rich environment now and we need to use it. We can make other required link decisions further down the line. Regarding Cost benefits Analysis, if you need to convince an airline you do not necessarily achieve this by also helping their competitors. Airlines need to make a profit. Current airlines may not be there in 10 years – but we will still be flying. Will they act collectively? Different airlines have different needs.

Chairman's concluding remarks

The technology for Package I applications is available it is working now. Although there were many difficult certification issues still to be overcome, the RFG (involving EUROCONTROL, the FAA, RTCA and EUROCAE) was successfully fast tracking the material required for inclusion into the relevant ICAO documents.

The Package applications timescales, 2005-2011, were too slow for the airlines but too fast for industry. Airlines could not see benefits coming fast enough and hence it was difficult to get them involved.

It was important to note that pilot and controller responsibilities remained unchanged, only the details of tasks and procedures would need to be altered. The need for adequate training to accommodate these changes should not be under-estimated.

Single European Sky (SES) Regulations will create the necessary common European standards for ground systems. This is good, but it will be necessary to allow for the fact that these processes are new and will need to bed down.

Unfortunately there was no overwhelmingly convincing big business case. Instead it would be necessary to develop individual business cases for local implementations, and many of these would be difficult to prove. Two things were necessary:

1. A long term vision of the final goal - the need to accommodate double the traffic, that conventional methods were most unlikely to cope, but that recent research on ASAS self separation indicated the ability to handle three times the current traffic within very acceptable pilot workloads. Therefore it was reasonable to expect the self separation approach to cope with twice the current traffic levels.
2. To ensure that all local implementations were consistent with this long term goal, and to seek political commitment to support these business cases, with funding if necessary, so that society's need for an efficient European air transport infrastructure could be met.

C. Day Three – Implications and actions

1. Introduction

This section reports on Day Three of the seminar, which addressed the context for ASAS in terms of strategic plans, EUROCONTROL programmes and legal liabilities issues.

The session was chaired by Phil Hogge

The presenters and round table experts were:

- European context Single Sky and ACARE (Jean-Luc Marchand, European Commission)
- ATM Master Plan and SESAME (Bob Graham, EUROCONTROL)
- Implementation Activities (Jose Roca, EUROCONTROL)
- ASAS Liability considerations (Francis Schubert, Skyguide)

2. Review of the briefings

2.1. Jean-Luc Marchand (European Commission)

Brief description

Jean-Luc presented some of the key activities in the European Context. This includes the Single European Sky (SES) and ACARE initiatives. He also summarised the relevant issues in the 6th and 7th Framework Programmes. This was described in terms of the context of the European ATM Master Plan and the European industrial activities.

The fragmented state of European Airspace was described as inadequate to meet the future needs of ATM traffic growth. At least seven good reasons call for a single sky. Among which the fact that there are currently more than 60 ACCs in Europe, with the sectors and routes designed according to national borders and not to traffic flows.

The SES legislation entered into force in April 2004. Initially European airspace will be reorganised into Functional Airspace Blocks (several possible models under definition), in order to reduce fragmentation and provide the necessary harmonisation for the required efficiency gains through the flexible use of airspace.

Jean-Luc described the inter-relationship between the consultation bodies (the SES Committee and the Industrial Consultation Body advising the EC).

On research side, the ACARE project (DG RTD Initiative) was described as a unique initiative where all research partners team together. The ACARE initiative is hoped to be a key driver for ATM research. It is a Technological Platform.

Jean-Luc showed the wide range of ASAS-related projects that have been funded by the Commission and the major European Sponsors. In addition he quickly reported on the status on three new projects to be launch in the near future: ASAS-TN2, ASSTAR and C-ATM.

It will be the role of ASAS-TN2 to increase the synergy between the numerous existing European (and to a certain extent American) ASAS projects in particular on Package II and III aspects.

Finally, when reporting on the 6th and 7th Framework Programme preparation status, Jean-Luc Marchand underlined the key role that the strategy document will play in the coming months to help in the definition of the 3rd call and the work programme definition. The strategic recommendations will pave the way for ASAS functions implementation especially in the frame of the Master Plan definition.

2.2. Bob Graham (EUROCONTROL)

Brief description

Taking into account the Vision 2020, the ACARE Strategic Research Agenda and the Single European Sky regulations, the European Commission and EUROCONTROL are working together for the elaboration of a European ATM Master Plan. This plan is going to address the full life cycle identifying clear paths from research through to deployment. It will be owned by and developed with all stakeholders. The plan identifies three phases:

- 2007 – Foundation
- 2012 – SES Deployment
- 2017 – Collaborative – High performance

An ambitious programme is required to support further development of the European ATM Master Plan. It is called "SESAME", a major initiative from the industry, called by the EC, for the implementation of the Single European Sky supported jointly through EC TEN-T and EUROCONTROL funding. This definition phase includes the development of the European ATM Master Plan and the work programme for the 2007-2012 period. The project is expected to start in May-June 2005.

As many other concepts, ASAS is still under validation and ASAS applications should be studied as an integrated part of ATM. These validation results are essential for the elaboration of the European ATM Master Plan.

2.3. Jose Roca (EUROCONTROL)

Brief description

Jose Roca presented the EUROCONTROL CASCADE Programme. CASCADE was created from the merger of two other EUROCONTROL Programmes: ADS and AGC.

The focus of CASCADE is to implement:

- Initial ADS-B applications (First Package of GS/AS applications)
- Additional CPDLC applications
- D-FIS applications

And to make use of existing infrastructures where possible, as a follow-up of Mode S and Link 2000+ Programmes.

The presentation explained the scope, approach and stakeholder involvement in CASCADE.

Working arrangements of the programme were presented and the link with the Requirements Focus Group (RFG) explained.

CASCADE intends to act towards implementation of ATM 2000+ Strategy step 3 applications

- Including Package I ground and airborne applications
- Maximising the use of existing infrastructures and investments made so far

In the coming years, it will include trials, simulations, business case and implementation planning activities.

2.4. Francis Schubert (Skyguide)

Brief description

Contrary to many fears, expressed mainly by air traffic controllers, the Self Separation concept does not alter the basic rules of distribution of legal liabilities between pilots and controllers, but merely introduces new areas of application of existing principles. The liability rules of air navigation are basically centred on the pilot, who retains the ultimate responsibility regarding safety considerations, including traffic separation tasks. To perform such tasks, the pilot will rely on whatever means are available to prevent a collision with other aircraft. Depending on these circumstances, these means may be the pilot's own eyes, ATC assistance, or, as planned in the future, onboard equipment. Thus, Free Flight will not become a substitute for ATC, but merely broaden the range of means to support the pilot in the safe conduct of his flight. The research into both Common law and Roman law, and the available case history, would conclude that traditional liability principles, which are currently ruling the distribution of legal liabilities remain appropriate in the future Free Flight environment. Consequently, whether Free Flight can be safely implemented does not depend on the definition of clear liability rules, but on whether the technological tools are of sufficient reliability and accuracy to support an air navigation context where the pilot can be entrusted with additional traffic separation tasks.

2.5. Chairman's Concluding Comments

Two years of ASAS-TN work had brought together the many strands of ASAS developments, had defined the Package I applications, and had resulted in an ASAS implementation strategy document. The material required for inclusion in ICAO documents was nearly ready, with the RFG's final deliverables scheduled for completion in the last quarter of 2005.

Above all, the technology for Package I applications is available and works. Clearly ASAS must be integrated into the overall ATM systems and into the Master Plan. The big issue for the ASAS community was to find suitable local implementations, representative of the wider infrastructure, which could be done quickly. Only by doing this could benefits be demonstrated and the regulatory process for an integrated air/ground system be validated.

It was essential to find an airline willing to take part. The Chairman had one message for delegates; "Find that airline!".

D. ASAS-TN conclusions

1. Introduction

Over the last years, ASAS and ADS-B applications have gained international recognition. Positive progress towards acceptance has been achieved. Even if it is recognised that there are still many issues to be addressed which are challenges, “ASAS is believed to be worth having”.

2. ASAS-TN recommendations

The ASAS-TN consortium invites the global ATM community to accept the following commitments:

Commitment 1: ASAS and ADS-B applications shall be an integral part of the European ATM Master Plan. They have the potential to enhance the ATM system in the areas of safety, capacity, flexibility, efficiency and environment.

Commitment 2: It is now necessary to conduct operational trials in Europe involving revenue flight. This will include in-situ certification and operational approval of the applications.

Commitment 3: ASAS application must be studied as an integral part of the ATM system. Synergies with other new concept elements should be identified in order to maximise benefits.

Commitment 4: Stakeholders must participate in ASAS-TN2 activities to ensure a common understanding. In addition to workshops and seminars, these should include contributing to the ASAS-TN2 library and providing inputs to the Internet forums of discussion.

3. ASAS-TN conclusions

After two years of activities, providing a network for the exchange of information, organising workshops, and developing recommendations for implementation, the ASAS-TN consortium came to the following conclusions:

- Significant progress in the global harmonisation definition and the validation of ASAS and ADS-B applications and particularly on the applications included in ‘Package I’ has been made. As for any new concept elements of the future ATM, work is still needed.
- Airspace users are convinced that ASAS and ADS-B applications will be an integral part of the future ATM system. The benefits of these applications are promising but it is necessary to confirm these claims through work on validation, safety, certification, benefits versus costs, etc. The commitment of the airspace users is essential and needs to materialise.
- ASAS and ADS-B provide a set of applications which are designed to work as an integral part of the ATM system and activity to ensure this integration must be undertaken. ASAS applications do not necessarily compete with new concept elements such as ‘4D concepts’. For example, work is currently being performed on the integration of arrival manager (AMAN) and the airborne spacing application called ‘sequencing and merging’.
- The ASAS-TN has proved to be a valuable enabler to progress ASAS and ADS-B. As an open forum for discussion it has acted as a catalyst in the understanding and acceptance of these new ideas. Global stakeholder participation has been excellent. However, an increased participation of aircraft operators, particularly the airlines, and airport operators would be very beneficial.

4. Dissemination

All the presentations made during this workshop are available through the ASAS-TN website at the following address: http://www.asas-tn.org . They are also accessible through the ASAS-TN One Sky Team Internet facility.

The key messages and conclusions of the seminar will be:

(1) Delivered to the European Commission;

(2) Given wider dissemination via the activities of the ASAS-TN; and

(3) Provided through Internet to all ASAS-TN event attendees.

5. Future events

An ASAS-TN2 Co-ordination Action proposal was submitted under Call 2A of the 6th Framework Programme on 31 March 2004. The project was selected by the European Commission in June 2004 and ASAS-TN2 is planned to start early 2005.

The ASAS-TN2 consortium is composed of EUROCONTROL as the Co-ordinator of the project, six Participants (THALES Avionics, BAE SYSTEMS, ENAV SpA, LFV, NLR, and THALES ATM). A body of Members is also identified. The Co-ordinator, the Participants and the Members (called ASAS-TN2 Partners) are entitled the same benefits with regards to the use of the ASAS-TN2.

The ASAS-TN2 project is divided into four work-packages:

- WP0 - ASAS-TN2 Management: WP0 is the management of the Co-ordination Action;
- WP1 - ASAS-TN2 workshops and seminar: WP1 will organised two-day events on ASAS/ADS-B topics for the R&D community but also for the ATM stakeholders;
- WP2 - ASAS-TN2 Internet and Document Repository: WP2 implements forums of discussions and ASAS/ADS-B related documents will be made publicly available. In addition to its own objectives, WP2 can support other work-packages through the creation of dedicated WP forums; and
- WP3 – ASAS-TN2 'Tableau de Bord' and Reports: WP3 will focus on delivering a yearly status of the progress towards the implementation of ASAS/ADS-B applications ('Tableau de Bord') and the production of reports.

The main ASAS-TN2 outputs concern the sharing of current knowledge on ASAS/ADS-B between all European stakeholders and in recommendations for future activities required to reach the operational use of ASAS/ADS-B applications. It is expected that these results will be of use to guide European actions. The expectation is also that the shared knowledge and the agreed upon recommendations will allow European industry to optimally plan and focus their new products development strategy.

List of attendees

Name	Organisation	Country
Kim O'Neil	Advanced Aviation Technology Ltd	UK
Vincent De Vroey	AEA	Belgium
Brad Chuck	Air Traffic Management	UK
Patrick Lelievre	Airbus France	France
Richard Beck	Airbus France	France
Giuliano D'Auria	Alenia Marconi Systems	Italy
Massimiliano De Angelis	Alenia Marconi Systems	Italy
Takashi Hatta	ATC SYSTEMS SERVICES	Japan
Antonio Paradell	ATOS ORIGIN	Spain
Josep Martrat	ATOS ORIGIN	Spain
Marcus Kern	Austrian Cockpit Association	Austria
Alastair Hyndman	BAE SYSTEMS	UK
Chris Rossiter	BAE SYSTEMS	UK
Fraser McGibbon	BAE SYSTEMS	UK
Joe Parker	BAE SYSTEMS	UK
Keith Greenfield	BAE SYSTEMS	UK
Kevin Steel	BAE SYSTEMS	UK
Laurence Homer	BAE SYSTEMS	UK
Mary Hicks	BAE SYSTEMS	UK
Mick Pyewell	BAE SYSTEMS	UK
Nigel Sheeran	BAE SYSTEMS	UK
Paul Albrow	BAE SYSTEMS	UK
Richard Watters	BAE SYSTEMS	UK
Suk Rathore	BAE SYSTEMS	UK
Ted Lewis	BAE SYSTEMS	UK
Tony Henley	BAE SYSTEMS	UK
Manuel De Klerck	Belgocontrol	Belgium
Fabio Gamba	Boeing	Belgium
Francisco Navarro	Boeing	Spain
John Allin Brown	Boeing	USA
Miguel Vilaplana	Boeing	Spain
Taji Shafaat	Boeing	USA
Christer Ullvetter	CAA Sweden	Sweden
Derek Brown	CAA UK	UK
Kevin Hallworth	CAA UK	UK
Mark Bonnick	CAA UK	UK
Steve Wright	Cathay Pacific Airways	Hong Kong

Name	Organisation	Country
Alain Printemps	DGAC/CENA	France
Eric Vallauri	DGAC/CENA	France
Francis Casaux	DGAC/CENA	France
Jean-Marc Loscos	DGAC/CENA	France
Philippe Louyot	DGAC/CENA	France
Frédéric Chupeau	DGAC/DNA	France
Patrick Souchu	DGAC/STNA	France
Christian Denke	ECA / IFALPA	Germany
Stephan Romahn	Euro Telematik AG	Germany
Andy Barff	EUROCONTROL	France
Bill Booth	EUROCONTROL	France
Bob Graham	EUROCONTROL	France
Catherine Lachiver	EUROCONTROL	France
Chris Shaw	EUROCONTROL	France
Colin Meckiff	EUROCONTROL	France
Eric Hoffman	EUROCONTROL	France
François Cervo	EUROCONTROL	Belgium
Jan Berends	EUROCONTROL	Belgium
Jan Van Doorn	EUROCONTROL	Belgium
Jean-Paul Vriamont	EUROCONTROL	Netherlands
José Roca	EUROCONTROL	Belgium
Mick Van Gool	EUROCONTROL	Belgium
Patrice Behier	EUROCONTROL	Belguim
Seppo Kauppinen	EUROCONTROL	Belgium
Wim Post	EUROCONTROL	Belguim
Jean-Luc Marchand	European Commission	Belgium
Binny Prabhaker	Frost & Sullivan	UK
Johan Orshinger	Frost & Sullivan	UK
Giovanni Tesi	Galileo Avionica	Italy
Colin Goodchild	Glasgow University	UK
Ben Stanley	Helios Technology	UK
Anthony Smoker	IFATCA	UK
Marcial Valmorisco Fernandez	ISDEFE	Spain
Fredrik Barcheus	KTH	Sweden
Lena Martensson	KTH	Sweden
Anders Jernberg	LFV	Sweden
Billy Josefsson	LFV	Sweden
Per Höegberg	LFV	Sweden
Sören Wikerud	LFV	Sweden

Name	Organisation	Country
Staffan Torner	LFV	Sweden
Jan Bursik	LPS (Bratislava)	Slovak Republic
Domenico Cardamone	Marconi Selenia Communications	Italy
Gianluca Gabatel	Marconi Selenia Communications	Italy
Andrew Zeitlin	MITRE / CAASD	USA
John Koelling	NASA	USA
Ken Jones	NASA	USA
Michael Durham	NASA	USA
Rose Ashford	NASA	USA
Thomas Prevot	NASA	USA
Tom Graff	NASA	USA
Craig Foster	National Air Traffic Services Ltd	UK
Dennis Bolt	National Air Traffic Services Ltd	UK
Mark Watson	National Air Traffic Services Ltd	UK
Richard Pugh	National Air Traffic Services Ltd	UK
Shahrear Quayyum	National Air Traffic Services Ltd	UK
Jacco Hoekstra	NLR	Netherlands
Rob Ruigrok	NLR	Netherlands
Claude Le Tallec	ONERA	France
Phil Hogge	Philip Hogge Consulting	UK
John Bennett	QinetiQ	UK
Ken Carpenter	QinetiQ	UK
Dennis Merryweather	Raytheon Systems Ltd	UK
Claudio Eckert	RegTP Germany	Germany
Bo Saebb	SAS	Sweden
Hans Nyhoj	SAS	Denmark
Francis Schubert	Skyguide	Switzerland
Chris Ovenden	Smiths Aerospace	UK
Alaxandra Pfeil	Technical University of Darmstadt	Germany
Michel Caquet	THALES ATM	France
Mike Watson	THALES ATM	France
Peter Edsall	THALES ATM	France
Peter Howlett	THALES ATM	France
Jean-Claude Richard	THALES Avionics	France
Pierre Gayraud	THALES Avionics	France
Manfred Forster	Tyrolean Airways	Austria
Andreas Lecchini	University of Cambridge	UK
William Glover	University of Cambridge	UK

List of acronyms

4D	4 Dimensions (i.e. Longitude, Latitude, Altitude and Time)
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-B-APT	GS application - Airport surface surveillance
ADS-B-NRA	GS application - ATC surveillance in non-radar areas
AENA	Aeropuertos Espanoles y Navigacion Aerea (Spain)
AGC	Air/Ground Cooperative ATS Programme
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AS	Airborne Surveillance
ASAS	Airborne Separation Assistance Systems
ASAS-TN	Airborne Separation Assistance Systems Thematic network
ASPA-C&P	AS application - Enhanced crossing and passing operations
ASPA-ITP	AS application - In-trail procedure in oceanic airspace
ASPA-S&M	AS application - Enhanced sequencing and merging operations
ATC	Air Traffic Control
ATCEUC	Air Traffic Controllers European Unions Coordination
ATM	Air Traffic Management
ATSA	Airborne Traffic Situation Awareness
ATSA-AIRB	AS application – Enhanced traffic situational awareness during flight operations
ATSA-S&A	AS application – Enhanced visual acquisition for see & avoid
ATSA-SURF	AS application – Enhanced traffic situational awareness on the airport surface
ATSA-SVA	AS application – Enhanced successive visual approaches
C-ATM	Co-operative ATM
C&P	Crossing and Passing
CAA	Civil Aviation Authority
CARE	Co-operative Actions of R&D in EUROCONTROL
CBA	Cost Benefit Analysis
CD&R	Conflict Detection and Resolution
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CDU	Cockpit Display Unit
CENA	Centre d'Etudes de la Navigation Aérienne (France)
CNS	Communication, Navigation and Surveillance
CPDLC	Controller-Pilot Data Link Communications

DGAC	Direction Générale de l'Aviation Civile (France)
EC	European Commission
EC DG TREN	European Commission, Directorate General for Energy & Transport
ESARR	EUROCONTROL Safety Regulatory Requirements
EUROCAE	European Organisation for Civil Aviation Electronics
FAA	Federal Aviation Administration
FALBALA	First Assessment of the operational Limitations, Benefits & Applicability for a List of Package I AS applications
FIS-B	Flight Information Service – Broadcast
FMS	Flight Management System
GA	General Aviation
GPS	Global Positioning System
GS	Ground Surveillance
HYBRIDGE	Distributed control and stochastic analysis of hybrid systems supporting safety critical real-time systems design
IAOPA	International Council of Aircraft Owner and Pilot Associations
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFALPA	International Federation of AirLine Pilot Association
IFATCA	International Federation of Air Traffic Controller Association
IFR	Instrument Flight Rules
LFV	Luftfartsverket (Swedish Civil Aviation Administration)
MA-AFAS	More Autonomous Aircraft in the Future ATM System
MFF	Mediterranean Free Flight
Mode S	Mode of SSR which provides selective addressing of aircraft
NLR	Nationaal Lucht en Ruimtevaartlaboratorium (the Netherlands)
NUP	NEAN (Northern Europe ADS-B Network) Update Program
NRA	Non-Radar Areas
OSED	Operational Service and Environment Description
PO-ASAS	Principles of Operation for the Use of ASAS
R&D	Research and Development
RFG	Requirements Focus Group
RTCA	Radio Technical Commission for Aeronautics
SAS	Scandinavian Airlines
SEAP	South European ADS pre-implementation Programme
SES	Single European Sky
S&M	Sequencing and Merging
SMGCS	Surface Movement Guidance and Control System
SPR	Safety and Performance Requirements

SSR	Secondary Surveillance Radar
STNA	Service Technique de la Navigation Aérienne (France)
SVA	Successive Visual Approaches
SWIM	System Wide Information Management
TAGA	Traffic Awareness for General Aviation
TCAS	Traffic alert and Collision Avoidance System
TEN-T	Trans European Network – Transport
TIBA	Traffic Information Broadcast by Aircraft
TIS-B	Traffic Information Service – Broadcast
TMA	Terminal Manoeuvring Area
UAV	Unmanned Aerial Vehicle
UPS	United Parcel Service
VC	Vereinigung Cockpit
VDL	Very High Frequency Digital Link
VFR	Visual Flight Rules
WP	Work Package