ASAS Thematic Network

Report of the Third Workshop
19-21st April 2004, Toulouse

ASAS – Making it happen
(Airborne and Ground Functions for ASAS Implementation)

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1. Introduction

The Third Airborne Separation Assistance System Thematic Network (ASAS-TN) Workshop '**ASAS – Making it happen'** was held from the 19th to 21st April 2004 at the Atria Mercure Hotel, Toulouse (France).

This workshop was the third of three ASAS–TN Workshops. This workshop was focused on the 'Required airborne and ground functions for ASAS applications'.

The aim of the workshop was to capture the key issues in the realisation of ASAS from a multi-stakeholder perspective. This was approached by presentation material and chaired discussion sessions.

This report contains a summary of the key issues raised as a result of the presentations and the discussions.

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:

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;
- 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 and discussion forums provide input to this work.

The outcome of this work, as result of the entire ASAS-TN activities, will be presented at a Seminar in October 2004.

The ASAS-TN is managed by EUROCONTROL and a partnership consisting of BAESYSTEMS, 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).

3. Third ASAS-TN workshop

3.1. Format of the workshop

Day 1 consisted of an introductory session and keynote presentations in plenary from EUROCONTROL, IATA, ANSPs and airframers. A presentation on security issues was delivered in response to a request from the European Cockpit Association.

Day 2 consisted of two themed parallel sessions in the morning, and two in the afternoon. In each session, the presentations were followed by a chaired discussion session of around one-hour.

On Day 3 during the plenary session, a summary of each of the parallel sessions was presented. In addition to this Airservices Australia presented their implementation plans.

3.2. Day 1 – 19th April 2004

3.2.1. Welcome

- **Jean-Luc Sicre**, Thales Avionics

Jean-Luc Sicre (Engineering V-P Air Transport Avionics Unit, Toulouse) welcomed he audience on behalf of Thales Avionics. In his presentation he stated that as a community he believed that we were closer to implementation now as a result of he processes. He described the need for more R&D effort and to ensure global interoperability in the quest for the implementation of both A/S and G/S ASAS applications. The solutions need to be affordable.

- **Jean-Luc Marchand**, European Commission

Jean-Luc Marchand suggested that the community may not seem to be all on the same wavelength at times but through activities such as this it may begin to engage gears. He described the context of the ASAS-TN in terms of the European ATM R&D and deployment initiatives.

In terms of realising a tripling of air traffic capacity in Europe, ASAS was in the Co-operative ATM domain alongside; 4d Trajectories & Contracts; new roles / tasks distribution; CDM (Airline operations/Airport –Airside/Landside).

Jean-Luc showed many ASAS related projects and initiatives. He also described the range of stakeholder participation in the ASAS-TN events to date. The purpose of a Thematic Network is to bring all of this together and, through discussion and consensus building, develop an ASAS implementation strategy.

- **Phil Hogge**, Event Chair

Phil Hogge welcomed the delegates and explained the arrangements for the Workshop.

3.2.2. Day 1 Plenary Session

See section A.

3.3. Day 2 – 7 October 2003

Session 1 (morning – room Seria 1): Use of the system by pilots and controllers - section B.

Session 2 (morning – room Seria 2): Airborne side functional and technical issues - section C.

Session 3 (afternoon – room Seria 2): Ground side functional and technical issues - section D.

Session 4 (afternoon – room Seria 1): Strategy and implementation - section E.

After the parallel sessions, the delegates enjoyed the opportunity of seeing ASAS application demonstrations:

- List of demos

LFV: TIS-B in a TMA and A-SMGCS environment
EGOA (Enhanced General Aviation Operations using ADS B)

EEC: ADS-B Validation Testbed (AVT)
CoSpace

NASA: R&D work

NLR: ASAS avionics suite, capable of ASAS Awareness

CENA: ECLECTIC

The second day concluded with a social event sponsored by THALES Avionics.

3.4. Day 3 – 8 October 2003

Topic of the day: Workshop wrap-up session

The Chairs of each session gave reports of the presentations and the subsequent discussions. These were followed by further discussions.

See section F.

At the end of the Workshop Greg Dunstone of Airservices Australia presented their implementation plans for Australian airspace. The key issues from this presentation are reported here.

Continent-wide deployment of ADS-B

Greg Dunstone (Airservices Australia) presented the programme to implement ADS-B. The TAATS ATC system, commissioned in 1998, presents Radar and non-Radar data (including ADS-B). It manages ADS-B equipped and non-equipped aircraft together. This approach to a surveillance solution unfreezes the current paradigm that is built upon SSR.

The ADS-B Deployment Programme will initially deploy 28 ADS-B ground stations across Australia. These will be co-located with current communications sites throughout outback Australia. This programme will expand upper airspace surveillance from its current 20% coverage to 99% of the country. This is a much more cost-effective option than national radar deployment. Australia plans to replace the current Terminal Area Radars, and just to extend the life of the current en-route SSR to early 2009. In early 2009 the en-route surveillance will be by ADS-B. This follows a 5-year notice period for mandatory aircraft equipage.

The ADS-B programme will enable radar separation and enhance safety and operational flexibility for suitably equipped aircraft. This will allow more aircraft to operate at optimum levels.

The deployment provides full surveillance coverage at FL300, as a side benefit is some coverage at lower levels from the system that may be used for additional flight monitoring or local implementations.

The schedule for the operational deployment of the ground stations is the end of 2005. Currently there is one operational ADS-B ground station.

The World-wide decision to use 1090 as the initial link has helped the case for investment. Australian airlines are equipping. Australia is reaping the benefit of the EHS/ELS mandates. Qantas is committed to equipping with ADS-B out. Jetstar has 100% equipage. There are instances of non-Australian carriers not knowing that they are equipped as they enter Australian airspace. The Australian initiative may have implications for the rest of the Asia/Pacific region in terms of equipage.

The cost and system benefits of the ADS-B solution were demonstrated and included a video clip showing the relative performance of radar and ADS-B trackers. In all regards ADS-B performance was better than Radar.

The Lower Airspace Project (LAP) in Australia is currently under evaluation. GA equipage and benefits need to be established in order for the programme to be viable. Current indications, dependant on the cost of avionics equipment, are favourable. Some Government subsidy for GA equipage could square the business case.

Conclusions

- The Asia Pacific region and Australia in particular has different needs compared to Europe and the USA.
- ADS-B air to ground can provide immediate safety benefit
  - Delay is a missed safety improvement opportunity
  - And lost operating flexibility for airlines

- Air-Air is important to Regional Airlines

- Australia envisages ADS-B surveillance use
  - In low density airspace initially by the end of 2005
  - In place of existing SSR only en-route radars by 2009
    - Probably requiring a fitment mandate
    - Probably with some form of subsidy for GA to equip.

A. Plenary Session

1. Introduction

This report relates to the plenary session on Day 1 of the Workshop, which presented an overview of ASAS applications currently studied followed by two presentations presenting controllers' and pilots' views.

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

The round table experts were:

- **Bo Redeborn** (EUROCONTROL)
- **Ton van der Veldt** (IATA)
- **Matthias Poppe** (DFS)
- **Patrick Lelièvre** (Airbus)
- **John Brown** (Boeing)
- **Daniel Gaultier** (Sagem)

The session was organised so as to feed the discussion among the participants:

- Six briefings presented in the session (15/20 minutes each presentation):
    - EUROCONTROL ASAS/ADS-B activities, getting closer to implementation - Bo Redeborn;
    - Airlines' Overview – Ton van der Veldt;
    - ANSPs' Overview –Matthias Poppe;
    - Airbus Overview – Patrick Lelièvre;
    - Boeing Overview– John Brown; and
    - SAFEE Project – Daniel Gaultier.
- Chaired Discussions
- Wrap-up by Chairman.

2. Review of the briefings

2.1. Bo Redeborn (EUROCONTROL)

Bo Redeborn reported the EUROCONTROL mission and strategies. He highlighted the ASAS/ADS-B work within this framework and relevant initiatives.

- OATA - Overall Target Architecture program. The high-level definintion of a system of systems architecture for all ECAC states
- CASCADE Programme - Implementation of Cooperative ATS for Integrated Systems and Procedures for Gate to Gate benefits
- EUROCONTROL involvement in global standardisation activities
- CRISTAL Trials – Validation of Package 1 applications and surveillance techniques. This is conducted in conjunction with ANSPs.
- ADS-B/TIS-B Validation Test Bed
- CoSPace Simulations.
- Frankfurt Sequencing and Merging Simulations.

All these initiatives contribute to getting closer to ASAS/ADS-B implementation. Most of the underpinning work is on track and the focus is very much toward implementation.

Bo illustrated where the ASAS applications fitted in to the EUROCONTROL ATM 2000+ strategy. ADS-B ground surveillance, Spacing Applications and ATSA were in step 3 (2008-2011). Airborne Separation and Autonomous Separation applications were envisioned in the 2012+ timeframe.

Bo stated that our role was not to foresee the future, but to enable it.

Currently we are matching the demand in the European ATM system with the available capacity. In order to meet future demand we need to accelerate integration towards the full concept. This will be enabled to some degree through the CASCADE programme. This is based on a gate to gate concept, Package 1 applications and a common ATM architecture.

Package 2 and 3 applications are outside the scope of CASCADE, but these are addressed within EUROCONTROL in terms of support for the development of applications and standards, and support through simulation activities. It appears that the stakeholders are aligned to a subset of the applications.

EUROCONTROL supply support for the applications and ADS-B/TIS-B Validation test bed.

2.2. Ton van der Veldt (IATA)

Ton van der Veldt started by reminding delegates that airlines had recently suffered huge losses. Airlines flying in Europe daily suffer from fragmented airspace, and the potential for datalink is largely unused. There needs to be a co-operative approach with automated tools to assist both controllers and pilots.

Airlines need safe and efficient services from gate-to-gate. These could be delivered be means of a 4D-trajectory contract, however, C-ATM also provides the opportunity for growth by enhancing both capacity and safety. ASAS could improve situational awareness, reduce controller workload and provide a distributed surveillance system. The use of data rather than voice comms will allow automation to support both the pilots and the controllers. It may also be possible to use larger sectors with the controller workload focused more on the strategic flow management.

Outside Europe, ASAS will be independent of the ground infrastructure, and the use of global ADS-B infrastructure standards will support the use of common data.

Flight deck displays need to be simple, functional and provide operational benefits. CDTI displays need to be in the pilot’s immediate field of view, integrated into the existing displays.

It is time for a paradigm change away from the existing radar based environment. Airlines would like to see greater clarity between the many different ADS-B/ASAS activities that are currently working towards this.

2.3. Matthias Poppe (DFS)

Matthias Poppe presented a joint paper on behalf of three European ANSPs (i.e. AENA, LFV and DFS). He referred to the need for a strategy for ADS-B Package. There is a requirement to lower the cost-base through the use of technologies relative to the traffic growth. There needs to be a business case not only for the airlines, but also for the ANSPs. These business cases should address near-term benefits and could include incentives.

Interoperability is an important issue as ANSPs must work together in order to deliver systems benefits. ANSPs must look beyond national boundaries. This requires work within the Single European Sky and EUROCONTROL programmes. Specifically he stressed the need for the alignment between 4-D trajectory planning and ASAS applications. This should be supported by relevant R&D activities.

We need to address the transition issues and procedural issues relating to systems failures and non-nominal behaviours.

2.4 Patrick Lelièvre (Airbus)

Airbus has launched a Mode S Transponder enhancement programme to enable operators to comply with Elementary Surveillance (ELS) and Enhanced Surveillance (EHS) rules applicable to the airspaces of a number of States in Europe. We used this opportunity to deliver ADS-B out in the same step. Significant safety, efficiency and operational benefits have been identified with the use of ADS-B out. 1090 ES has been certified and is being used for surveillance purposes.

With regard to ASAS applications the recommendation was to start with simple early achievable benefits. Two suggested example applications are:

- Non-radar area ➔ Safety and operational benefits with ATSAW
  - ADS-B out for ground radar like surveillance
  - ATSAW onboard
  - Safer, more profitable airline operations

- Radar area ➔ Optimise gate arrival time
  - Approach management
  - Sequencing and merging with new ASAS procedures
  - Ground taxi management also crucial

There are still many unresolved issues regarding ASAS. These include mixed equipage, non-equipped aircraft, workload and transfer of responsibilities. Without resolution of these issues clear benefits cannot be guaranteed. Without clearly defined benefits, Airlines and ANSPs will not invest.

In addition to addressing the above issues, there is an urgent need for harmonised standards to guarantee world-wide interoperability.

With regard to ASAS spacing applications, lessons learnt from R&D activities show us that the crew cannot comply with those additional tasks without efficient airborne functions and a degree of automation.

Conclusions

- ASAS is a tool integrated into Single European Sky global concept
- Start with pre-requisite
  - Define an Operational concept and Real Needs
  - Mandate ADS-B Out
- Take into account industry capacity
- Ensure harmonisation of applications, and define the needs
- Start with simple applications with minimum system impact
  - No problem for Enhanced Airborne Situational Awareness,
  - Impact of simple spacing should be readily managed
  - Automated ASAS applications required for more complex functions
- Full ASAS Package 1 before 10 years could be a DREAM
  - Airline financial situation, maturation time, Standardisation process, certification, deployment (retrofit), etc
- Carry on R&D to get confidence! ➔ validate with large scale trials

Airbus envisage that ASAS/ADS-B applications will begin with the simplest applications first in some specific parts of the world. Even if progress is at a regional level there needs to be global co-ordination through standardisation activities.

With regard to the datalink Airbus strategy sees ADS-B out using 1090 extended squitter as the first step. In addition, research should be pursued on a potential additional link.

2.5 John Brown (Boeing)

John Brown stated at the beginning that, unsurprisingly, Boeing's position was very similar to that of Airbus.

Boeing has already included the wiring and hardware for ADS-B out as part of the EHS update. They have no firm plans for ADS-B-IN and CDTI.

The first hurdle to overcome will be the business case. The operators' business cases remain shaky at the best of times. In addition other airlines business cases compete for resources (e.g Cabin systems).

We need to understand a whole range of issues; costs and benefits; where ASAS fits in the future ATM system; liabilities with regard to equipment, procedures and responsibilities; certification; fleet mix; and the human element.

Conclusions

John referred to the need to ensure global interoperability at several levels; Strategic, Operational, Functional and Systems level.

Political/Strategic

- Rules of the air
- ICAO standards
- Mandates
- Safety case
- Similar procedures in similar airspace

Operational

- Harmonization of procedure development
    - Involve regulators and service providers
- Definition of minimum requirements
    - The lowest common denominator
- Consistency in data output
    - Stable standards
- Consistent range of applications
    - Service provider capabilities

Functional

- Common frequencies
    - Mode S….but then what?
- Common protocols and data
    - Standards
- Common algorithms

  - Predictable responses

System

- Consistent performance
  - Early definition of requirements
- Pilot interface requirements
  - Reduce variability from crew performance
- Controller requirements
  - Conformance monitoring etc

In conclusion Boeing saw global interoperability as essential, the business case was imperative and there was still a large amount of work to be done with regard to standards

2.6 Daniel Gaultier (Sagem)

This presentation on the SAFEE project was delivered in response to a specific request from European Cockpit Association, which was expressed during the second ASAS-TN workshop, for Security issues to be addressed at an early stage.

The programme that Daniel described is in its early phases, having started on 1st February 2004. The project covers;

1 Intelligence & International cooperation

2 Airport periphery

3 Terminals

4 Aircraft parking lots

5 Aircraft in flight

The areas of specific interest in the ATM environment are radar tracking and voice and data-link security issues.

Daniel described prospective ATM applications that could come into play in times of terrorist attack, such as a “Fly-me home system”.

The work of the SAFEE project is to be achieved via an End-Users Club of stakeholders.

3. Issues from chaired discussions

Bo Redeborn (EUROCONTROL) commented that the airframers presentations seemed to focus on problems rather than solutions.

John Brown (Boeing) responded that to some degree this was the brief for their presentations in this session. He added that unless there is a problem to solve, then they don’t change the aircraft.

Patrick Lelièvre (Airbus) replied that in his presentation the following day he would address ASAS implementation.

Bo Redeborn suggested the use of incentives to mitigate some of the institutional issues associated with ASAS. The technical issues may be less of a problem.

Greg Dunstone (Airservices Australia) commented that fitting ADS-B out on the aircraft is a major step forward from Airbus and Boeing. In his experience some of the airlines do not know that they have this capability on board.

Phil Hogge asked Airservices if they required a mandate.

Greg Dunstone replied that they would mandate in 2009 when they decommission the radars on the East Coast. They have a clear business case that they have put to their customers. This will be addressed in their presentation on the final day.

Rocky Stone (UPS) asked what it would take to get the business case bolstered. It is telling when airlines do not know of the equipage.

John Brown said that he had not seen an individual case for ASAS applications. Cash flow for equipping with ASAS could be negative for the first 6 years, with benefits in 20 years time. Thus this is not a cheap product from an airline's perspective. Package 1 is a good start, well at least the more complex applications i.e. not Situational Awareness. But Package 1 does not offer immediate benefit and you have to spend a lot of money up front.

Tony Henley (BAESYSTEMS) stated the need for a business case targeted at an individual airline/operator with specific application(s). With incentivisation this should aim at business gains within 2 years.

Bo Redeborn stated that all stakeholders will need to meet the capacity demands in a growing business. There is a requirement to double the traffic in Europe. This will not be possible with the current ATM system and will require a paradigm change. ASAS is a promising enabler.

Phil Hogge agreed but said that airlines will not put money in until it hurts in terms of delays.

Eric Hoffman (EUROCONTROL) asked if the strategies of all the ANSPs present were aligned. A lot of development money is coming from ANSPs.

Matthias Poppe (DFS) said that they are asked about ASAS by their strategy people. They see some promising Package 1 applications.

The Radar infrastructure in core area Europe is seen to be the same for a 5 to 10 year horizon. This affects the business case. How do you develop an ADS-B/TIS-B infrastructure in Europe given this?

Peter Potocki (Airbus) said that there was no ANSP mention of how to improve the lives of the operators. ASAS alone will not help, ASAS with automation will.

Billy Josefsson (LFV) commented that ASAS applications could help ANSPs be more cost-effective for their customers, this is why they are in their current strategy.

Jean-Marc Loscos (DGAC) stated that the French position is somewhere between that of DFS and LFV. They see a few Package 1 applications in core area Europe with G/S NRA applications in French overseas territories. ASAS is not seen in isolation, indeed ASAS/AMAN integration is being worked upon with regard to smoothing traffic flow. ASAS as part of C-ATM work is being addressed, we still need to work on ASAS with 4-D trajectories. For core-area Europe we may be stuck for the moment with regard to ASAS, as there has been a large investment in Mode-S radars (11 in Western France). However there may be the opportunity for local implementations, e.g. surface movement. He also stated that the CRISTAL and CASCADE programmes are very new, something more than this is needed from an ANSP perspective.

Bob Arnesen (ECA) asked the SAFEE project about data security issues in relation to the 1090 ES, the transmissions can be picked up by anyone with the right equipment. Is there a need for encryption?

Daniel Gaultier (SAFEE/Sagem) replied that Sub Project 4 will look at these issues and will look at ATM data issues in general. He welcomed the input of stakeholder experts in delivering this work.

Patrick Lelièvre stated that security should not just to be addressed at the data link level. Full system security should be addressed.

Stéphane Marché (Airbus) asked about the current status of TIS-B activities within the ANSPs.

Billy Josefsson said that there would be a TIS-B demo at Arlanda the following day.

Matthias Poppe said that DFS were currently evaluating TIS-B and a report is due soon.

Andy Zeitlin (MITRE) said that the FAA Operational Implementation was just about to happen in Florida. More East Coast sites would follow. There will be a decision in 2004 regarding national implementation.

Greg Dunstone said that there was no TIS-B implementation foreseen in the Australian plans.

Jean-Marc Loscos suggested that TEN-T could support TIS-B in Europe via incentivisation.

Bo Redeborn said that there is a requirement for TIS-B as the military do not have room for any more avionics boxes, therefore TIS-B will be required for non-segregated airspace.

The discussion, prompted by Ton van der Veldt (IATA) turned again to priorities for airlines. These he suggested include S&M and C&P applications.

Eric Hoffman reported on the work for CDG airport involving a tool to expedite traffic and the potential to separate traffic.

CBAs are iterative in nature. We need to learn from the datalink experience where there was no initial CBA. We need to build confidence in the systems, don't put the CBA first.

4. Concluding remarks

The day's events were bought to a conclusion by outlining the issues from the discussion and how some of then would be addressed by the subsequent day's presentations.

B. Session 1 – Use of the system by pilots and controllers

5. Introduction

This report relates to Session 1 on Day 2 of the Workshop, which addressed Airborne Traffic Situational Awareness applications. The session was chaired by **Tony Henley** from BAE Systems with **Eric Hoffman** from EUROCONTROL as the secretary.

The round table experts were:

- **Liz Jordan** (NATS)
- **Karim Zeghal** (EUROCONTROL EEC)
- **Rob Ruigrok** (NLR)
- **Rocky Stone** (United Airlines)
- **Richard Barhydt** (NASA Langley)

The session was organised so as to feed the discussion among the participants:

- Five briefings presented in the session (15 minutes each presentation):
    - Controller feedback from Cospace/NUPII TMA experiments – Liz Jordan
    - Findings and trends from the CoSpace/EVP series of flight deck experiments on ASAS spacing – Karim Zeghal.
    - Lessons learnt from pilot involvement in ASAS Separation/Self Separation experiments – Rob Ruigrok.
    - ITC experience in the pacific and an airline's view of ASAS opportunities – Rocky Stone.
    - Development and evaluation of prototype flight-deck systems for distributed air-ground traffic management – Richard Barhydt
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

6. Review of the briefings

6.1. Liz Jordan (NATS)

Controller feedback from the CoSpace / NUP II TMA experiment

<u>Brief description</u>

The presentation provided an overview of a series of simulated trials of ASAS Sequencing and Merging in the Paris derived TMA. Traffic was derived from real traffic samples and an ASAS equipped A320 cockpit simulator together with a number of simulated aircraft under control. A total of 34 aircraft were included in the scenario to represent 'normal' traffic with a peak load of 38 to test stability in overload conditions.

In the trial the role of each of the two executive controllers was to integrate two flows of aircraft from IAF onto final approach for one runways for each of the two airports using different flight path geometries.

<u>Key issues in the presentation</u>

Using ASAS S&M the Controller was able to plan ahead more effectively and better anticipated the situation. This was enabled by the early issue of spacing instructions and setting up required sequence in advance of today's norm

The number of 'late' instructions for heading/speed adjustment was dramatically reduces enabling better management of traffic and significantly smoother flows. This provides greater operational efficiency and potentially increased capacity.

Typical responses from the controller included;

'Stayed totally in control',

'Talking and listening out of the way early',

'Able to keep the metal picture'

Outstanding issues that must be addressed include:

The applicability of the technique to other airspace environments,

Detection and handling of unexpected events including the requirement for briefing on fallback options

Risk of de-skilling the controller- the task is simpler with ASAS S&M but important to retain skills to manage non nominal situations

A general point was made about the implications of changes in working methods associated with a possible general resistance to change to which all human operators are prone.

It was also note that ASAS was useful in the appropriate scenario but that it should not be expected to solve all problems.

6.2. Karim Zeghal (EUROCONTROL)

CoSpace / EVP series of flight deck experiments

Brief description

Identify a more effective allocation of spacing tasks between controller and flight crew

The presentation described a progressive sequence of ASAS experiments carried out by EEC which focused on Sequencing and Merging (spacing) from a cockpit perspective. The experiments supported a stepwise validation process, which increased in sophistication both in terms of the tasks to be performed and the realism of the simulation environment. The current system supports S&M down to the final approach fix and includes full recorded RT traffic background and a variety of occasional 'exceptional' events.

The development of the flightdeck simulator has included a progressive extension of the tools to provide guidance to the crew in order to ensure satisfactory manual control while maintaining acceptable workload.

Twelve Airbus rated airline pilots were involved in the latest experiment which achieved 24 runs with time spacing, 6 with distance spacing, 12 conventional approaches. Flight crew tasks comprised a range of activities including; automatic flight, checklist, operational flight plan, ATIS, briefing, and manual speed adjustments

Key issues in the presentation

The operational acceptability of the concept was derived from feedback of the pilots involved.

They were positive about being "in the loop", believed that they understanding of the situation and were better able to anticipate Maintaining the Spacing was considered feasible at the. ±5s level with limited assistance, at acceptable workload under nominal conditions down to final approach fix.

Is spacing still feasible under degraded situations (aircraft systems failures, adverse meteorological conditions etc, …) and is the acceptable to add new tasks with potential risk of workload increase . Both of which can be addressed with the appropriate level of assistance to pilot.

Still to be completed is a full analysis of the impact of the behavior of the preceding pilot with its possible risk of oscillatory effects.

6.3. Rob Ruigrok (NLR)

Lessons learned from pilot involvement in ASAS experiments

Brief description

The presentation reported on the results of 3 separate sets of experiments conducted by the NLR into pilot responses to ASAS functionality. The experiments covered Self-separation (including transitions from free flight to managed airspace) and Spacing from the MFF programme and Spacing from MA-AFAS. A range of different conditions and levels of functionality were evaluated by a total of 25 pilots and their performance and opinions were evaluated. Issues of workload (routine and peak), operational acceptability, levels of automation/guidance provided by the systems, acceptability of procedures and clarity of responsibility were assessed

Key issues in the presentation

In some scenarios there was a risk of uncertainty between the controller and the pilot as to whom was responsible for separation assurance. This is an important issue and must be carefully assessed in future activities to ensure that there is no possibility of confusion.

To avoid the possibility of operational confusion communication terminology used in ASAS procedures must be clear and unambiguous. Specifically the same words should not be used for different functions unless the meaning is identical.

Pilots commented that they will often be at the end of a long flight when they are asked to carry out ASAS operations. The instructions and procedures need to be simple and the set of different cases/instructions should be as small as possible

In all evaluations of ASAS (as with any other new function/operation) it is essential to test pilot responses under non-nominal scenarios as well under routine conditions.

The involvement of Pilots in the design and evaluation of new functionality should begin as early as practical both to ensure their priorities are understood and

It was also concluded that it is inappropriate to rely on opinion of one pilot as there are many different views. It was also concluded that systems should be designed for all pilots – i.e. are not only be usable to those with high levels of computer literacy.

Overall pilots were found to be very positive about the ASAS functionality they evaluated with most finding the workload fully acceptable.

6.4. Rocky Stone (United Airlines)

In-Trail Climb experience

Brief description

The presentation described the development and use of TCAS based in-trail climb procedures which successfully implemented in 1994 in the Pacific. The work only involved two airlines and was limited both by the availability of aircraft and the characteristics of TCAS. TCAS had neither the range nor reliability at longer range to allow robust operation. However the procedure was approved and was used operationally to a limited extent, eventually being removed from the Aircraft Flight Manual in 2000. Although it only had limited operational use a number of valuable lesson were learnt from the work- specifically Phraseology for coordination between the cooperating aircraft and the ground and the importance of the understanding the Aircraft climb performance limitations.

We now have ADS-B technology which removes the limitations of TCAS and allows a range of Oceanic ASAS applications can be considered today. In trail following, climb and descent appear possible with simple pilot interfaces and minimum levels of certification.

The same technology can be the extended to the terminal area to improve arrival rates at capacity constrained runways using Cockpit display of traffic information Extended Flight Rules (CEFR).

Key issues in the presentation

TCAS is not good for achieving positive identification of aircraft in cooperative maneuvers and has significant range limitations but In-Trail procedures provide benefits. ADS-B technology removes the problems and enables the benefits. Specific requirements for the applications include specification of minimum distance from the lead aircraft and minimum speed to ensure spacing from a potential following aircraft. The pilot display can be simple and may not need to be in the primary field of view (such as a side mounted Electronic Flight Bag). It is also anticipated that the certification task is will be relatively straightforward although a requirement for automated traffic monitoring with aural alerts is expected.

6.5. Richard Barhydt (NASA Langley)

Brief description

The presentation covered two linked activities carried out by NASA Langley.

The first, en-route component, comprised the development and test of functionality to increase ATM system capacity while increasing safety. It has a long-term focus and involves allowing aircraft capable of operating under Autonomous Flight Rules to be mixed with non-AFR equipped aircraft. A basic prerequisite is that information on all aircraft, including 'Intent', (AFR capable or not) is available via ADS-B or TIS-B. It included not only conflict detection and resolution (with respect to aircraft and hazardous regions of airspace) but also a flow management element by the use of a single required time of arrival constraint. A key feature of the project is the way 'Intent' data is generated. In order to avoid problems of transmitting what the aircraft is planned to do (e.g. the FMA trajectory) which may not be what happens, a 'command trajectory' is used which links information from FMS, Mode control, CDU and FMC, to provide what will happen if the pilot does not intervene.

The second element relates to the use of Airborne Merging and Spacing tool for Terminal Arrivals (AMSTAR) which is designed to reduce delay time by improving threshold crossing accuracy and precision. This provides speed the commands needed to achieve desired threshold crossing time behind a preceding aircraft and includes wake vortex minima requirements well as compensating for wind changes encountered during approach. In order to ensure low pilot workload and system stability, speed changes were given in 5 knot increments and Speed commands kept within 10% of nominal speed profile. This provided a smooth transition to desired final approach speed.

Key issues in the presentation

A High fidelity simulator study was employed in which Pilots achieved the desired spacing interval (mean values within 5 sec when following speed guidance with Mode Control Panel or manual throttles and better than 1 sec when coupled to autothrottle.

A flight test at Chicago O'Hare with was also undertaken using the Langley B-757 research aircraft: The trial took place at night with widely varying winds (35+ knot tailwind to headwind changes on final) but a mean spacing performance of within 1 sec of desired interval was achieved although the standard deviation increased to ~ 8 sec from less than 2 secs achieved in the simulator

7. Issues from chaired discussions

7.1. General discussion

➔ Requirement for common terminology

As in the previous workshops, the paramount importance for all stakeholders involved in ASAS to agree on terminology was highlighted. In particular, we need to ensure that various actors are not using the same application name to describe different operational objectives. It was acknowledged that the Common Requirement Determination (CRG) process performed in the context of the RFG is a near term pragmatic step to reach this goal.

➔ Clear definition of separation vs. spacing and legal issues shall be provided

Confusion at worse - or fuzziness at least - remains on whether some proposed applications are foreseen in the spacing or in the separation PO ASAS application category. Clarity on this aspect as early as possible in the application development process is essential. In addition, and somehow independently to the core separation responsibility issue which is tackled by the spacing/separation distinction, there are likely to be other legal implications for avionics manufacturers and airlines linked to the use of ASAS equipment.

➔ Extensive briefing and training of subjects is essential

Before performing real time, human in the loop experiments, it is essential that the key assumptions (in particular in terms of separation responsibility) used for the application definition and the supporting rationale are properly articulated to the experiment subjects. They should take into account lessons learnt from the past! As controllers are typically quite averse to change because they are very safety minded, failure to provide such visibility has been reported to generate strong negative defensive reactions.

➔ Importance of realistic environment: fatigued pilots, abnormal conditions

ASAS applications must be validated not only in nominal, academic, “sanitized” conditions, but also take into account the real daily operational environment. Therefore, this should also include a representative set of abnormal/non-nominal conditions, typically weather, wind, technical failures, as well as airline operational type passenger related constraints (or disruptions), impact of typical crew scheduling patterns – potential for fatigues pilots…

➔ Impact of equipage rate on benefits

While data is now becoming available on potential of ADS-B/ASAS benefits when all aircraft are equipped, there are still significant uncertainties on the scalability of the benefits when only part of the fleet is equipped. ASAS Spacing applications targeted at the approach phases for hub airports may help achieve locally significant equipage rate. In addition, by design, spacing instructions are to be used in parallel with “classical” instructions/clearances – hence full equipage is not a pre-requisite to start using them and getting initial benefits (yet to be quantified!).

➔ ADS-B In is key for unlocking benefits

The availability of surveillance information on board aircraft leads to a leap in the magnitude of benefits anticipated as compared to ADS-B Out only.

7.2. Sequencing & Merging

➔ Time vs. distance spacing

A consensus exists that time based rather than distance based spacing is the way forward. However, separation minima in area targeted for initial use for S&M are based on distance (rather than time). The existing analysis showing compatibility between time-based spacing and distance based separation should be refined and publicized.

➔ Fallback definition for abnormal conditions

As for any other ATM operations and procedures, S&M abnormal conditions should be anticipated and pilots & controllers should be provided with fallback procedures

➔ Where can S&M go down to? 4NM as today!

In today's operations, for all practical purposes, the approach controllers stop issuing speed instruction to aircraft past the Final Approach Fix (FAF) about 4NM from runway threshold. The reason is that past this point, the flight crew has very little leeway but to decelerate to reach its final approach speed. So the spacing between the aircraft at the FAF has to be set up such that the desired spacing at the runway threshold is obtained after deceleration to the final approach speeds. The use of S&M is expected to have little or no influence on this: flight crew should not be expected to continue adjusting their aircraft speed by actively monitoring the positioning of the previous within 4NM of the runway threshold.

➔ Integration with other tools/AMAN: work in progress

Ground automation in the form of arrival management tools (AMAN) is either already in operations or in development in some airspaces where S&M instructions are envisaged. Studies have started to investigate the potential interaction/integration between AMAN and S&M. A strong pre-requisite is good shared understanding of how AMAN are actually being used in the field (in complement to how AMAN are designed to be used – as it may differ).

➔ Stability & efficiency rather than raw capacity from S&M

At airports already at or near maximum theoretical capacity, the foreseen benefits of the use of S&M are in terms of more reliable and repeatable delivery of the aircraft to the runway and in terms of more efficient/less stacking trajectories.

➔ Sequencing: procedural separation of arrival and departure flows

The procedural separation of arrival and departure flows is already a common practice in a number of airspaces as it significantly streamlines the sequencing task. S&M is only expected to be really helpful in airspaces where such enhancement of the airspace has been performed.

➔ Various cockpit display options for S&M

Research so far has looked at various possible ways of providing information to the flight crew to support the performance of S&M applications. The diversity is expected to remain.

➔ Pilot workload: a change but not necessarily an increase, possible assistance

S&M clearly induces a change to the tasks that have to be performed by the flight crew. But, this may not lead to an overall increase of the workload, in particular, depending on the level assistance provided to them.

➔ Controller tasks: shift, different challenge, overall more planning, more control, tools to aid monitoring

S&M may lead to a significant shift in the nature of the tasks performed by the controllers. This will impact his source of motivation/sense of challenge. Overall with S&M, the planning component within the tasks is increased, actually leading the controller to feel more in control of the overall situation. Some level of ground automation, in particular simple tools to assist in monitoring, is likely to be benficial.

➔ Minimum level of automation/guidance still TBD

Research has shown so far that very little system assistance is required both on the ground and in the air to support controllers and pilots in the performance of S&M in nominal conditions. There is not enough data whether such levels are also acceptable to handle abnormals.

➔ Applicability of S&M in departure

In the context of the RFG Fast Track process, the SPR work on S&M is focused on the approach phase. However, in the S&M OSED, operational requirements for the use of S&M from the cruise phase to the final approach are included. There is no specific reason to exclude S&M from the departure phase other than the fact that so far no clear operational need has been documented yet.

➔ S&M has value only in airspace with sequencing constraint

There should no expectation of benefits from the use of S&M in an airspace where there is no sequencing constraint.

➔ ACAS/ASAS: not an issue for S&M. C&P more challenging.

From the results available so far from the IAPA study, the ACAS logic is not expected to generate spurious TAs or RAs during S&M, nor does S&M expect to have an impact on ACAS. The geometry and kinematics of Crossing and Passing are more challenging from the perspective of ACAS logic.

7.3. In Trail Climb

➔ Global applicability of ITC

ITC/ITD is expected to be useful in all oceanic airspaces.

➔ CPDLC for ITC: useful but not essential

CPDLC/data-link is very likely to ease/expedite the initiation of ITC/ITD procedures as it would reduce communication time. However, it should clearly not be made a pre-requisite.

➔ ACAS/ASAS: not an issue for S&M. C&P more challenging.

8. Concluding Remarks and Recommendations

From the discussions during the session, it appears quite clearly that as a significant level of maturity has now been achieved on spacing applications and S&M in particular in nominal conditions, the next challenge in the near term is to “expand the envelope” and consider non-nominal conditions, partial equipage as well as a wider variety of airspaces.

C. Session 2 – Functional and technical issues and solutions

1. Introduction

This report relates to Session 2 on Day 2 of the Workshop, which addressed Airborne Separation and Self-Separation applications.

The session was chaired by **Jean-Claude Richard** from Thales Avionics with **Giorgio Matrella** from ENAV as the secretary.

The presenters and round table experts were:

- **Patrick Lelièvre** (Airbus)
- **Jim Walton** (UPS)
- **Pierre Gayraud** (Thales Avionics)
- **Okko Bleeker** (Rockwell Collins)

The session was organised so as to feed the discussion among the participants:

- Four briefings were presented in the session (15 minutes each presentation):
    - Airbus ASAS design and implementation by Patrick Lelièvre
    - UPS ASAS fleet equipage issues by Jim Walton
    - ASAS – implementation in avionics by Pierre Gayraud
    - BAESYSTEMS and Rockwell Collins ASAS avionics perspectives by Okko Bleeker
- Discussion (1 hour and 30 minutes planned for discussion)
- Wrap-up by Chairman.

2. Review of the briefings

2.1. Patrick Lelièvre (Airbus)

Brief description

The basic strategy is to capitalize on ADS-B OUT first in order to set up the way for the ADS-B IN. The main purpose is to get a phased approach integrated within the existing A/C System architecture with the ultimate goal of no increase Pilot workload and thus a certain level of automation. The phased approach should allow to begin with Package1 and to proceed without major architecture changes, with Package 2/3 reducing the cost for airlines.

Key issues in the presentation

· No additional workload for the crew and thus a certain level of ASAS automation is needed.

· Operational requirement should lead the System requirements.

· Make it simple first but allow for growth.

· Display useful information and just that.

· ASAS and ACAS correlation is a prerequisite.

· Integration with existing Aircraft systems is a necessity.

· Aircraft implementation shall have to take into account initial fit AND retrofit considerations.

· One possible baseline for ASAS smooth implementation can rely on TCAS computer evolving into a “Traffic Computer”.

· Package 1 implementation roadmap should last until 2015 taking into consideration certification, training, ASAS technical consistency and implementation time issues.

2.2. Jim Walton (UPS)

Brief description

UPS presented their ASAS implementation strategy on their entire A/C fleet. It is based on operational usage of Enhanced Situation Awareness, See and Avoid, and Successive Visual Approaches applications. The simplicity of the implementation led to great pilot acceptance and was mainly driven by pragmatic considerations (retrofit installation capability, complexity/certification feasibility etc..). One of the key constraints was the ASAS/ACAS independency which has to be carefully respected.

Key issues in the presentation

· UPS fleet is mostly equipped for:

  o Enhanced Situation Awareness.

  o See and avoid.

  o Successive visual approaches.

· No change in ATC rules.

· UPS selected a standalone solution rather than an integrated one for cost and complexity/certification rationale.

· ASAS implementation has not to alter in any way the ACAS function.

· Correlation algorithms can exist between ASAS and ACAS but without altering ACAS.

· Great pilot acceptance.

2.3. Pierre Gayraud (Thales Avionics)

Brief description

For THALES Avionics, ADS-B OUT is a prerequisite for ADS-B IN, makes sense as it prepares the users to ADS-B information utilisation. But it is not the final goal as the Package 1 spacing (and future Package 2 and 3) applications are really the ones where the business cases are potentially good. More over a retrofit capability makes for a good business case and the recommendation is to propose A/C architecture encompassing both retrofit and initial fits. A/C installation shall respect ACAS independency and shall also be integrated with the existing A/C architecture in order to allow further growth. A slowing factor for the process is the relative instability of standards. As a conclusion, the avionics of modern Air transport aircraft can accommodate Package 1 ASAS applications without any additional boxes or antennas but consideration should be given to A/C systems full integration.

Key issues in the presentation

· ADS B Out is satisfying ASAS ground Applications and is a prerequisite for ADS B IN.

· ADS B In is satisfying:

  o Situation awareness and Visual acquisition but with no Applications

  o Spacing with more or less sophisticated applications needing automation

· ASAS/ACAS independency but compatibility is essential

· Retrofit considerations are essential to the business case

  o Box count is a must

  o TCAS Computer => Traffic Computer (with partitioning techniques) is an ideal candidate for hosting the majority of ASAS implementation/integration

  o Integration with Cockpit Displays, FMS, Warning system, …

· Definition of standards is not stable yet

· The avionics of modern Air transport aircraft can accommodate Package 1 ASAS applications without any additional boxes or antennas.

2.4. Okko Bleeker (Rockwell Collins)

Brief description

Airlines goals are in capacity and punctuality improvement. Applications benefits should be direct to the "investing" airline, to let them have the chances of returning any investments made. To support change all applications require "co-operative" A/C. The existing fleet will dominate until 2015, for this reasons Retrofit requirements are largely needed. From a technical and future architecture view point ADS-B IN/OUT are simultaneously required. We should focus on limited procedural change in order to get a degree of achievable improvement.

Key issues in the presentation

· Airborne Surveillance applications Package 1 segmented into:

  o Awareness

  o Enhanced vision

  o Trajectory oriented

· Retrofit is more essential to the business case than new programs (B737/MD80/A319/320/321) and is by far the largest ATM improvement factor

· Practically, ADS B In and Out are simultaneously required as an A/C is simultaneously a client and a server

· Considerations to be given to MMI and End Systems (FMS) integration

· Direct and unconditional benefit to the investing operators is mandatory

· The degree of achievable improvement depend on limited to relatively small procedural changes

  o Limited responsibility transfer to the crew

  o Airlines Liability still an issue

3. Issues from chaired discussions

From the general discussions following the above presentations, there was a Consensus that: ASAS retrofit issues are essential to the Business case and the ASAS implementation roadmap. It was mentioned several times that operationally ASAS application efficiency will rely mainly on the number of equipped aircraft (the larger number, the better). The number of new A/C put on the market yearly (5% of the total number of A/C flying) is insufficient to make the business case a good one. One way or the other, and probably through the products and A/C architecture design, a common definition encompassing the initial fit, forward fit and retrofit will be useful if not necessary.

It was also mentioned that Package 1 should be the backbone of the ASAS strategy and initial implementation should cover everything from Gliders to "Big Boys" through Military A/C and regional ones, however P1 definition is not contradictory with specific regional needs (airborne and ground perspectives).

Specifically, air to air ADS-B applications are important to regional airline operating outside controlled airspace. Consequently it is important for ASAS community to get regional A/C manufacturers and regional operators involved into ASAS discussion.

Although the above consensus was shared by a majority of the participants it appeared also that in a somewhat contradictory fashion, 2 different strategies were presented:

· Pragmatically, do what you can as soon as possible: Standalone equipment approach for Situational Awareness type of applications

· More strategically oriented: Act simply at first but Think big.

This mean adapting the A/C architecture in such a way it will satisfy not only the immediate needs but also the more long term ones. It is not an easy task to modify the architecture and to integrate the new ASAS functions into Cockpit Displays, FMS, Warning Systems etc and Airlines will never accept to doing this several times in an Aircraft's life.

There was also a strong need for stabilizing the standards (DO260X, Intents, Applications MASPS, MOPS) . It appears that at present the most suitable body for this activity is the RFG (Requirement Focus Group) jointly established between Europe and USA for needed Interoperability purposes.

4. Concluding remarks & recommendations

The following conclusions and recommendations were drawn:

- Retrofit considerations are the keys for establishing business cases and applications efficiency.
- Package 1 applications should be the backbone of ASAS implementation Strategy, flexible enough to address airborne and ground perspectives. Modern A/C avionics are fully ready for accepting Package 1 Applications implementation with minimum impact by transforming TCAS computer into a Traffic Computer.
- ASAS integration needs to stay as simple as possible at first, but having in mind the most complex (and promising) application as retrofit will be done probably just ones in one A/C life.
- Regional Airlines and regional A/C manufacturers have to jump on board of ASAS Fora and be part of the out coming consensus.

Standards in terms of ADS B messages and Application definition absolutely need to be stable. Interoperability between U.S. European and Australian activities is a necessity and Requirement Focus Group “RFG” appears to be the right body to initiate correctly these standardisation tasks.

D. Session 3 – Functional and technical issues and solutions

1. Introduction

This report relates to Session 3 on Day 2 of the Workshop, which addressed Airborne Spacing applications. The session was chaired by **Francis Casaux** from EUROCONTROL with **Dominique Egron** from Thales ATM as the secretary.

The round table experts were:

- **Christos Rekkas** (EUROCONTROL HQ)
- **Peter Howlett** (Thales ATM)
- **Andy Zeitlin** (Mitre)
- **Niclas Gustavsson** (LFV)

The session was organised so as to feed the discussion among the participants:

- Four briefings presented in the session (15 minutes each presentation):
  - o Surveillance data processing networks and validation tools by Christos Rekkas
  - o Ground systems for ADS-B based surveillance by Peter Howlett
  - o Capabilities of TIS-B for supporting ASAS – Andy Zeitlin
  - o NUP results by Niclas Gustavsson
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

2. Review of the briefings

2.1. Christos Rekkas – (EUROCONTROL)

Brief description

The ADS Programme of EUROCONTROL was presented, highlighting the two main streams addressing ASAS Package 1 applications:

- GS (Stream 1): from 2004 to 2008 as initial date for operation in European area
- AS (Stream 2): from 2004 to 2010 as initial date for operation in European area

The key deliverables of the ADS Programme, which are developed in co-operation with the stakeholders (ANPS, Airspace Users, industry etc.), are mainly composed of:

- Harmonised requirements on applications
- Safety case (including separation minima)
- Business case
- Infrastructure specification and ground prototype development
  - o V7.1 ARTAS development Radar, Mode-S and ADS-B data (May 2005)
  - o Surveillance network
- TIS-B Server development (completed September 2004)
- Surveillance Analysis Tools (SASS-C)
- ADS-B Validation Testbed AVT platform
  - o in Brétigny and Arlanda
  - o Phased implementation: full set of P1 applications achieved on 2005
- Validation activities are gathered through the CRISTAL project (Co-operative Validation of Surveillance Techniques and ASAS Applications of Package 1)
  - o In partnership with local stakeholders including ANSPs and industry (“Crystallisation effect”)

- Currently in Sweden, Italy, UK, Ireland, Austria, Spain, Portugal, Greece; on-going discussion with other European countries

Key issues in the presentation

- The necessary tools to perform the Package I validation are needed, and ADS programme is playing an important role
- The AVT Platform could be provided by EUROCONTROL to ANSPs or customised for local use, linked with local existing capabilities
- The situation having multiple platforms for validation should be optimised in order to avoid duplication and to concentrate on more in depth experiments
- The CRISTAL project involving local ANSPs and industry should also involve Aircraft Operators
- The Airport data base from the Airport Programme should be associated
- The relationship with Navigation requirements needs to be established in order to benefit on consistency

2.2. Peter Howlett – (Thales ATM)

Brief description

The Australian Upper Airspace Project : AirServices Australia launched a project which consists in deploying a network of ADS-B ground stations to provide nationwide surveillance coverage above FL300 (ADS-B NRA). The project was presented in much more detail by G.Dunstone on day 3. A contract was awarded to THALES ATM for the provision of 56 AS 680 ADS-B Ground Stations for this project.

The main Features of the AS 680 Ground Station were outlined:

- Receives ADS-B report based on Mode S 1090ES
- Effective range of approximately 250 NM at and above FL300
- ADS-B Reports are formatted into Asterix format Cat 21
- Designed for remote controlled unmanned operations

Some typical Issues were detailed:

Redundancy is needed to ensure availability. Redundancy implemented through the ground system was described, e.g. dual Ground stations, redundant communication links, down to redundant processing elements and networks in the TAAATS ATC system

Processing of ADS-B data is necessary in the system for a variety of functions e.g. handling of overlapping coverage of ground stations

Ground Station Monitoring principles were described

In conclusion it was observed that operational trials and early implementation are essential to learn to use ADS-B and to build experience. It should bring in particular benefits on standard refinement.

Key issues in the presentation

There will be transition issues, especially when considering de-commissioning of radars.

For Upper Airspace, the update rate of ADS-B tracks presented to the controller will be 5s to remain as comparable as possible to radar, thus not taking advantage of the higher update rate available with ADS-B. Pros and cons were discussed.

A discussion took place on the navigation source used for ADS-B: GPS versus FMS data

Throughput performance requirements at ground station level were discussed. It was meant depending on local environment and density.

More issues will come as the project progresses and further applications are addressed.

2.3. Andy Zeitlin – (MITRE)

Brief description

The development of TIS-B has been based on specifications defined in RTCA MASPS DO-286 (April 2003). Currently an update is underway with DO-286A (expected approval October 2004).

In the US, implementation has begun with these sites planned:

- East Coast implementation (40 stations), Embry-Riddle (2), Alaska (1)
- Based on UAT including TIS-B and FIS-B for mainly General Aviation
- FAA decision on national implementation should come end 2004

The TIS-B concept is based on:

- Fundamental service “gap filler” for non ADS-B targets
- ADS-B rebroadcast “multilink gateway” allowing exchange through different links
- Additional roles (e.g. Full traffic picture, validation with comparison to ground surveillance data, etc.)

The three main TIS-B functions are distributed along:

Ground surveillance processing (to create and maintain tracks, assessing quality)

Distribution processing (to filter and distribute target reports)

Ground link-specific processing (to format messages and use data link), in liaison with the airborne link-specific processing (extracting target reports and providing to ASAS processing)

Key issues in the presentation

- TIS-B has been initially developed for visual acquisition of traffic in the air and on the surface, with sizeable business case addressing GA
- For more demanding applications, it should be questioned
- The NIC/NAC/SIL for ground surveillance tracks were discussed, opening further discussion
- Dual Link: currently it is based on UAT with second link on 1090 ES planned for the future
- All Airspace is authorised for GA purpose (except around limited specific areas for security reason)
- Other topics of interest should be investigated: e.g. Service volume, Traffic information volume and Surveillance quality parameters

2.4. Niclas Gustavsson – (LFV)

Brief description

The NUP history is based on 8 years experience:

- From 1996 with proof of concept (NEAN-NEAP)
- Through definition (NUPI)
- To validation (NUPII)

The current NUPII programme is addressing a full picture of activities:

- Applications (GS/AS)
- Technology
- Safety
- Validation

The work is organised according to Tiger teams and Cluster of applications (Non radar, Off-shore, Air to Air and ATS). It brings operational definition of AS and GS applications (RFG contribution). Other activities are covering:

- Business and Cost analysis
- Technical installation
- Validation (RT and FT simulations, Flight trials)
- Safety (ED78A)

Finally it was presented the ADS-B planning overview applicable in Sweden addressing significant improvement as well on air and ground.

Key issues in the presentation

- No major showstoppers were encountered
- Ensure growth of traffic and applications
- Incentive for airlines
    - New ASAS Routes applicable in Nordic area
- Several NUP workshops are planned in order to disseminate results and getting feed back
- NUPII++ is under preparation focussing on pre-operational use for 2005

3. Concluding remarks and recommendations

Some concluding remarks came out from session 3:

- Support from early implementation on standardisation progress.
- Implementation plans are in place in Australia, US East Coast and Sweden addressing AS/GS applications.
- Through the CRISTAL trials, EUROCONTROL is promoting the validation of Package 1 applications to fulfil the needs of European stakeholders and progress towards implementation.

E. Session 4 – Strategy and implementation

4. Introduction

This report relates to Session 4 on Day 2 of the Workshop, which addressed Safety and Ground Surveillance applications. The session was chaired by **Billy Josefsson** from LFV with **Rob Ruigrok** from NLR as the secretary.

The round table experts were:

- **Martine Blaize** (EUROCONTROL HQ)
- **Jonathan Hammer** (MITRE)
- **Jorg Steinleitner** (EUROCONTROL HQ)
- **Tony Henley** (BAESYSTEMS)

The session was organised so as to feed the discussion among the participants:

- Four briefings presented in the session (15 minutes each presentation):
    - ESARR4 regulation by Martine Blaize
    - ASA MASPS by Jonathan Hammer
    - RFG rapid global harmonisation by Jorg Steinleitner
    - ASAS-TN proposed implementation strategy by Tony Henley
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

5. Review of the briefings

5.1. Martine Blaize (EUROCONTROL)

<u>Brief description</u>

M. Blaize, Deputy head of the Eurocontrol Safety Regulation Unit, introduced the key roles of an ATM safety regulator as defined today by the Safety Regulation Commission (SRC).

Martine explained that in view of the more commercial approach in ATM service provision, Air Navigation Service Provision and Safety Regulation tasks and responsibilities are being separated in Europe in different, independent organisations, as decided in 1998.

European harmonisation of ATM safety regulation is led by the SRC, which developed the Eurocontrol <u>Safety Regulatory Requirements</u> (ESARRs) as regulatory decisions by Eurocontrol, binding on its member states.

In addition, the <u>Single European Sky Regulations</u>, recently approved, also establish a regulatory Framework for ATM in Europe, going beyond safety.

Finally, <u>EASA airworthiness regulations</u>, mainly applicable to aircraft equipment, is a third set of binding regulations to which any new system in an aircraft shall comply.

ASAS will have to comply with all three of them.

A complicating factor is that besides ICAO, European an Eurocontrol regulations, also national and local regulations might need to be taken into account.

Martine zoomed in on the different ESARRs, with special attention to ESARR4 “Risk Assessment and Mitigation”. The ESARR4 process was described:

1. System under subject should be defined, including proposed changes.
2. “What can go wrong” should be assessed and described, including occurrences and severity.
3. Risk mitigation should be defined.
4. Verify that all safety requirements have been met.

The ESARRs define what is required to be done for safety approval. To meet the ESARRs, there might be different “Means of Compliance”.

For a system like ASAS, both qualitative and quantitative “proof” is required for safety approval. Martine explained that mathematical “proof” is certainly not enough for this. Further, a “total system approach” seems required for ASAS, taking into account ATM, Airport, Flight Operations and Airworthiness regulations.

Key issues in the presentation

- National safety regulatory functions in ATM are expected to comply with ICAO and rules, agreed and enforced, at European level (some goal based, others more prescriptive).
- ATM rules and related conformity assessment principles apply to the related airborne element of the ATM system, in addition to applicable airworthiness and flight operations regulations.
- Augmented safety target(s) established by a state for its airspace represents an input to the safety assessment to changes in ATM.
- One difficulty for ASAS implementations will be to reconcile in one set of requirements/in one implementation, all applicable safety regulations (airworthiness, operations, ATM) and for all actors involved to be accordingly “approved” by their respective authorities.

5.2. Jorg Steinleitner (EUROCONTROL)

Brief description

The Requirements Focus Group (RFG) was established in April 2003 to perform the co-ordinated determination of Package I requirements. The creation of this group is an important step towards worldwide operational and technical interoperability of Package I.

The RFG is a joint European/US activity with the principal membership of experts from EUROCONTROL, FAA, EUROCAE and RTCA but others are welcomed as members (e.g. Australia and Japan).

The notion of “co-ordinated” requirements determination relates to the involvement of all relevant stakeholder categories in the development, validation and implementation of such highly integrated air-ground systems as Package I. The RFG membership therefore includes representation from air navigation service providers, airspace users, airborne and ground equipment manufacturers, airframe manufacturers and regulatory authorities.

The deliverables of the group will be the harmonised Operational Services and Environment Descriptions of Package I (OSED), as well as the related Safety and Performance Requirements standard (SPR), and INTEROPerability requirements standard (INTEROP). The RFG work thereby follows an interactive process with several document updates aiming at final requirement standards by end 2005.

The RFG deliverables form the basis for the qualification activities throughout the life cycles towards the implementation of Package I. As such, the deliverables will be proposed to the relevant ICAO panels, regional co-ordinating groups and standards organisations as appropriate, in order to meet the objective of supporting world-wide interoperability.

Key issues in the presentation

RFG needs involvement from all relevant stakeholder categories, and associated experts.

Ownership of the RFG deliverables is defined at regional level (e.g. EUROCAE for SPR and INTEROP, EUROCONTROL for OSED) and will be used by states, industry and regulatory bodies.

OSED version 1.1 will be available at the end of April 2004. Next RFG meeting is in June 2004, in Toulouse.

5.3. Jonathan Hammer (MITRE)

Brief description

Jonathan Hammer, as co-chair of RTCA SC-289, presented the Aircraft Surveillance Applications (ASA) Minimum Aviation System Performance Standards (MASPS).

ASA MASPS provide system and sub-system performance requirements to support ASA applications:

- Enhanced Visual Acquisition (EVAcq)
- Enhanced Visual Approach (EVApp)
- Airport Surface Situational Awareness (ASSA)
- Final Approach and Runway Occupancy Awareness (FARAO)
- Conflict Detection (CD)

Apart from these “basic” applications, some “stressing” applications are also described in the ASA MASPS, so equipment manufacturers will have lead information on what applications will be envisioned in future versions of the MASPS.

These “stressing” applications include:

- Approach Spacing for Instrument Approaches (ASIA)
- Independent Closely Parallel Approaches (ICSPA)
- Airborne Conflict Management (ACM)

Background for the ASA MASPS (functions, not boxes) was the notion that the ADS-B MASPS did not include the “full picture”. For this reason, the ASA MASPS are drafted at a higher, ASAS application level, intended to provide framework for current and future applications.

ASA MASPS have defined ASA Capability Level (ACL) and Transmit Quality Level (TQL). The ACL are divided into 4 categories:

1. transmit–only
2. basic
3. intermediate
4. advanced (1 and 2)

It allows for additional applications and will assure backward compatibility.

Key issues in the presentation

ASA MASPS (RTCA DO-289) is a cornerstone standards document from RTCA for the development of future Aircraft Surveillance Applications. It provides detailed system and sub-system requirements for initial 5 applications (EVAcq, EVApp, ASSA, FAROA, CD) and examines potential future ‘stressing’ requirements by probing analyses for ASIA, ICSPA and ACM.

Requirements are flown down to ADS-B & TIS-B MASPS, Link MOPS (UAT, 1090 MHz, VDL/4), and Airborne Separation Assistance System (ASAS) MOPS (currently under development).

FAA/EUROCONTROL Requirements Focus Group (RFG) is now addressing harmonisation of future applications and associated standards / methodologies. Input from RFG is expected to update ASA MASPS and MOPS.

5.4. Tony Henley (BAESYSTEMS)

Brief description

The ASAS TN implementation strategy is a deliverable within the ASAS TN that reflects issues like datalink, applications and implementation issued as recommendations to be followed in order to be compatible with current development. The objective is also to pave the way for the next packages. This deliverable will be distributed within the ASAS-TN network (600 people) for comments.

In Europe, the initial deployment of ADS-B will be based on 1090 Extended Squitter with VDL4 providing regional implementations and a dual link capability where necessary.

The ASAS validation work should be co-ordinated within Europe across the SEAP, C-ATM, LAVA and other programmes using where appropriate the MAEVA methodology.

Among the various applications identified for inclusion in Package 1, there is a subset that is expected to bring early benefits namely: ADS-B-NRA, ADS-B-APT, ATSA-SURF and the ASPA-S&M.

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. The applications selected are believed to contribute to a good business case for a (local) set up even consisting of a small number of aircraft as long as there is high local equipage density. In order for the airline to equip, the avionics must be affordable and the majority of aircraft is believed to be subject for retrofit. Taking global interoperability into account is a prerequisite.

The experience gained from the early implementations will support further extensions of the concepts within Package 2 and 3 applications.

Key issues in the presentation

In Europe, the initial deployment of ADS-B will be based on 1090 Extended Squitter with VDL4 providing regional implementations and a dual link capability where necessary.

Prerequisite for early implementation is to find applications which have minimal changes to the ground infrastructure, which are successful without 100% equipage, for which retrofit avionics are affordable and which do not have a change in separation responsibility. ADS-B IN and OUT are required for benefits in Europe.

Package 1 subset applications that are expected to bring early benefits are, ADS-B-NRA, ADS-B-APT, ATSA-SURF and the ASPA-S&M. The ASPA–ITP application is promoted by airlines for early implementation.

6. Issues from chaired discussions

Regarding safety regulations and safety approval process, it was questioned whether current ATM improvements would pass the safety approval process as described in the presentation. The answer was “no”. The new safety approval process brings quite a “high mountain to climb” before safety approval of an ATM improvement. The good news is that several projects, like RVSM, have adopted the ESARR4 process successfully.

During the discussion on acceptable Means of Compliance for ESARR4, it was stated that ED78A/Do264 is only partially covering the requirements. Eurocae WG53 is working on a “method” which will provide full Means of Compliance. In this respect, the SAF-ASAS document produced by FAA/Eurocontrol AP1 could also provide valuable input, as judged by Martine. Safety approval “by comparison” is possible, if applied with good rationale.

In order to allow the RFG SPR work begin before the delivery of the Initial OSED mid 2004, the RFG has selected two “fast-track” applications: ADS-B-NRA and ASPA-S&M

The need for educational effort towards stakeholders about ADS-B out and potential synergies with ongoing and mandatory Mode S update activities was identified. One possible addressee was IATA.

Acceptance and ownership of RFG deliverables is critical to ASAS community and depends on how well RFG communicates and iterates the deliverables. It also depends on the stakeholders' involvement.

The former European OSED Harmonisation Group activities are now embedded in RFG and subsumed under the work of the RFG Application Definition Sub-group.

RFG does not replace existing standardisation bodies, but instead takes benefit of what is already there. RFG provides on its turn input to the to existing standardisation bodies, e.g. with requirements flowing down to updates of technical standards, as well as regulatory authorities.

Discussions on the ASA MASPS identified where ASAS Spacing is "located" in the ASA MASPS. It was argued that ASAS Spacing is part of ASIA, but ASIA in fact appeared to be ASAS Separation context. This revealed the need to further clarify this issue and compare the list of applications in the ASA MASPS with ASAS applications as envisioned in PO-ASAS and the various ASAS Packages.

Questions on the "European" involvement in drafting the ASA MASPS revealed that the ASA MASPS are mainly drafted by "the US". Jonathan would welcome more European involvement in this ASA MASPS, as well as in the ASAS MOPS.

Electronic Flight Bag (EFB) was identified as potential early enabler for e.g. ASAS ground surveillance applications, which needs further investigation. However the certification level needs to be assessed in this analysis, taking into account navigation accuracy, taxi map accuracy, what pilots are expected to do with the information, and when (low/good visibility, etc.).

ADS-B OUT will not bring benefits in terms of e.g. capacity increase in Europe. ADS-B IN and OUT are needed for early benefits in Europe.

7. Concluding remarks and recommendations

ASAS Safety approval in Europe shows to be a complex process since three Regulations need to be taken into account:

1. Eurocontrol Safety Regulatory Requirements (ESARRs),
2. Single European Sky Regulations, and
3. EASA Airworthiness Regulations.

The "Means of Compliance" to meet the ESARRs will require both qualitative and quantitative "proof". There is currently no method, which is fully ESARR4 compliant, although both ED78A/Do264 and SAF-ASAS are good starting points. Further, safety approval "by comparison" is possible, if applied with good rationale.

The Requirements Focus Group (RFG) is an important step towards worldwide operational and technical interoperability of Package I.

RFG does not replace existing standardisation bodies, but instead takes benefit of what is already there. RFG provides on its turn input to existing standardisation bodies, as well as regulatory authorities

RFG has involvement from all relevant stakeholder categories, and associated experts.

Aircraft Surveillance Applications (ASA) Minimum Aviation System Performance Standards (MASPS) are close to final and describe system and sub-system performance requirements for some basic ASAS applications and insight in future requirements for some more "stressing" applications.

Input from RFG is expected to update ASA MASPS and MOPS.

Mapping of ASAS applications as envisioned in PO-ASAS and the various ASAS Packages onto the ASA MASPS applications is recommended for harmonisation purposes.

Further, more European involvement is recommended in RTCA ASA MASPS work and ongoing ASAS MOPS work.

Prerequisite for early implementation is to find applications which have minimal changes to the ground infrastructure, which are successful without 100% equipage, for which retrofit avionics are affordable and which do not have a change in separation responsibility. ADS-B IN and OUT are required for benefits in Europe.

Package 1 subset applications that are expected to bring early benefits are, ADS-B-NRA, ADS-B-APT, ATSA-SURF and the ASPA-S&M. The ASPA–ITP application is promoted by airlines for early implementation.

In Europe, the initial deployment of ADS-B will be based on 1090 Extended Squitter with VDL4 providing regional implementations and a dual link capability where necessary.

Local ASAS applications with small number of aircraft equipped, but with high local equipage density will be key to early implementations.

Avionics must be affordable and the majority of aircraft is believed to be subject for retrofit. Stand-alone, low certification level implementations (e.g. EFB) in aircraft should be further looked at.

Global interoperability is a prerequisite.

F. Workshop conclusions

1. Introduction

Phil Hogge introduced the plenary session by saying that had detected a significant change in the presentations and discussions. Very recently in Europe, ADS-B and ASAS were just the dreams of a few believers. Now it has become a respectable goal and was included in the EUROCONTROL ATM Strategy. Furthermore, there was a growing alignment not only amongst the delegates to these workshops but also between the different regions of the world – the USA, Europe and Australia.

The next stage is to build the implementation steps towards this goal and, crucially, to work on convincing business cases.

In low density airspace where there is limited radar coverage, as in Australia, it was clearly beneficial to implement ADS-B Out. Airservices Australia plan to have comprehensive ADS-B surveillance coverage to improve safety and obviate the need for more radars.

In Europe, the situation is different. It is probable that the best opportunity for making a good business case will be at airports. ADS-B ground surveillance applications could be used to provide pilots with traffic information on their map displays to improve safety during ground manoeuvring and to increase throughput during low visibility operations. Elsewhere, in high-density airspace, it is likely to be more difficult to show convincing evidence of benefits. Nevertheless, ASAS applications such as spacing, merging and sequencing all show considerable promise by transferring certain tasks to the pilot, thereby reducing controller workload, increasing capacity and smoothing the traffic flow during the descent and arrival phases.

It will be essential to find a few airports at which this could be done. These need to have a dominant carrier, willing to participate, so that by equipping only a relatively small number of aircraft there would be a high proportion of “equipped flights” to demonstrate the benefits.

The Chairs of each session gave reports of the presentations and the subsequent discussions. These were followed by further discussions regarding recommendations proposed by the chairperson. A general discussion took place giving the possibility for the participants to comments the proposed conclusions and recommendations.

Note: Following conclusions and recommendations were elaborated by the ASAS-TN consortium following the discussions during the final session of the workshop. They were reviewed by the participants through a review process by E-mail.

2. Workshop conclusions

2.1. General

Two years ago ADS-B and ASAS seemed to be the dream of a few believers. Now it is a respectable goal:

- ANC/11 recommendation 1/7 encourages ICAO and States to support the cost-effective early implementation of packages of ground and airborne ADS-B applications, noting the early achievable benefits from new ATM applications;
- Decision for large scale implementation of ADS-B has been made in Australia;
- In-service aircraft from UPS fitted with ASAS and performing approved ATSAW applications in the US; and
- EUROCONTROL Agency has set up a new CASCADE programme to move towards implementation in Europe.

Feasibility of ADS-B/ASAS applications is now demonstrated and no major showstopper has been encountered. The industry is ready to fulfil the requirements for Package I applications.

Good international collaboration is taking place (Europe, USA, Australia) through for example the RFG initiative and ASAS-TN.

2.2. Operational applications

Package I should be the backbone of the ADS-B/ASAS strategy but the focus may be placed on a subset of Package I applications:

- GS applications is a natural starting point;
- ADS-B out capability of the aircraft is a prerequisite to implement AS applications that have the potential to bring significant benefits.
- For core area of Europe, AS applications (i.e. ADS-B IN capability of the aircraft) is required to get benefits.
- Package I is the first step preparing for longer-term improvements (i.e. Package II and III) which should ensure growth of Air transport.

Package I applications provide opportunities for benefits through local implementations:

- Low density airspace - e.g. GS application in Australia for better services for the airspace users;
- Airports - GS applications and AS applications have the potential to improve the safety of current operations;
- High-density airspace – Spacing, sequencing and merging applications are key for more regular, safer and efficient flows of traffic.
- Oceanic airspace – In this environment where procedural separation is provided, AS applications should help to provide more efficient flights.

The ATM community should take advantage of these local implementations. It is a real opportunity for cross-fertilization.

2.3. Benefits and costs

If Package I applications are well identified, more work is needed for quantifying the benefits and the associated costs. It is crucial to get some convincing business cases for aircraft operators and ANSPs.

Some key conclusions can be drawn at this stage:

- All aircraft types should be considered including regional aircraft;
- Forward fit of aircraft is not enough to get benefits in an acceptable timeframe;
- Retrofit is essential and there is a need produce cost effective retrofit avionics;
- Mandate of equipment will be just applicable to beneficial applications;
- Incentives for aircraft operators need to be found through better or preferential services, reduced charges, financial support to pioneering operators.

3. Workshop recommendations

Note: Some recommendations are reiterating recommendations expressed during the previous ASAS-TN workshops. This shows their importance and the need to take the necessary actions.

The first ASAS-TN workshop developed the following recommendations:

- The existing European ATM2000+ strategy and Strategic Performance Framework on ADS-B/ASAS needs to be converted into a detailed implementation plan as soon as possible. This is the task of the newly formed CASCADE programme.
- All stakeholders have to invest in RFG - RFG is key for the development of co-ordinated requirements and global interoperability (both technical and operational). Steps need to be taken to accelerate this process through prioritisation and best allocation of resources and funding.
- As recommended by ANC/11, States should take actions to accelerate the ICAO standardisation process to facilitate and allow early implementation of Package I applications.
- It is essential in Europe that all actors involved in safety regulations contribute to make the process of approving operationally Package I applications be faster, less complex and less expensive.
- As already expressed, operational trials and early implementation are essential. They should build upon existing knowledge and practices with the involvement of aircraft operators and particularly airlines. Airports could be the places where the business case is right to provide stakeholder benefits.

All the participants have recognised the huge contribution of the ASAS-TN workshops to the progress of ADS-B/ASAS. There is a strong need to continue ASAS-TN activities for the next following years. The ASAS-TN is a unique forum in the world and its main features are:

- It facilitate transatlantic co-operation for global interoperability;
- It is a forum for all players: Industry, aircraft operators, ANSPs, regulatory authorities, pilot and controller associations, R&D centres, universities, etc.
- It contributes to a better understanding of the needs of the various players all over the globe.
- It is facilitating operational and technical standardisation. Better understanding allows the elaboration of consensus and the development of suitable solutions.

It provides through the workshop report good metrics to monitor and to evaluate the progress which are made.

4. Actions by the ASAS-TN consortium

Recommendations are effective when they are transformed into actions. The ASAS-TN project, which is mainly an inter-organization communication activity, within its scope and objective will act in the following areas:

- Develop guidelines to help the European Commission and EUROCONTROL to accelerate the implementation of ASAS application in Europe (as part of WP3).
    - Incentives
    - Transition plan
- Disseminate the available information on ASAS applications;
    - Workshop report dissemination to the decision makers
    - Promotion of the final seminar to airspace users, ANSPs, Airports, …
- Foster the exchange of information among the various players and to enlarge the ASAS community; and
    - Use of CIRCA
    - Education - Acronyms – Tutorials for pilots, for controllers, for engineers and researchers

5. Dissemination

All the presentations made during this workshop are available through the ASAS-TN website at the following address:

http://asas-tn.eurocontrol.fr

They will be also accessible through the ASAS-TN CIRCA Internet facility.

The key messages and conclusions of the workshop will be:

(1) Delivered to the European Commission;

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

(3) Provide an input to the ASAS-TN Workshop 3 to feed the development of an ASAS implementation strategy.

6. Future ASAS-TN events

A concluding seminar is planned from 11-13 October 2004 and stakeholders (i.e. airspace users, ANSPs, airports, industry, policy makers) are going to be invited.

Further information will follow in due course.

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8. List of acronyms

4D	4 Dimensions (i.e. Longitude, Latitude, Altitude and Time)
ACAS	Airborne Collision Avoidance System
ACP	ASAS Crossing Procedures
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
ADS-C	Automatic Dependent Surveillance – Contract
AENA	Aeropuertos Espanoles y Navigacion Aerea (Spain)
AFAS	Aircraft in the Future ATM System
AFR	Autonomous Flight Rules
AGC	Air/Ground Cooperative ATS Programme
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AOC	Airline Operational Control
AP1	Action Plan 1 (FAA/EUROCONTROL R&D Committee)
ARTAS	ATM Surveillance Tracker and Server
AS	Airborne Surveillance
ASA	Airborne Surveillance Application
ASAS	Airborne Separation Assistance Systems
ASAS TN	Airborne Separation Assistance Systems Thematic network
ASDE-X	Airport Surface Detection Equipment Model X
ASEP	Airborne Separation Application
ASFA	Airborne Surveillance Functional Architecture
ASOR	Allocation of Safety Objectives and Requirements
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
ASSA	Airport surface situational awareness
ATAAS	Advanced Terminal Area Approach Spacing
ATC	Air Traffic Control
ATCEU	Air Traffic Controllers European Unions
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATSA	Airborne Traffic Situation Awareness
ATSAW	Air Traffic Situational Awareness

ATSP	Air Traffic Services Provider
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
ATSAW	Air Traffic Situational Awareness
C-ATM	Co-operative ATM
C&P	Crossing and Passing
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
CEFR	CDTI Enhanced Flight Rules
CENA	Centre d'Etudes de la Navigation Aérienne (France)
CFIT	Controlled Flight into Terrain
CNS	Communication, Navigation and Surveillance
CPA	Closest Point of Approach
CPDLC	Controller-Pilot Data Link Communications
CWP	Controller Working Position
DAG-TM	Distributed Air/Ground Traffic Management
DGAC	Direction Générale de l'Aviation Civile (France)
DGNSS	Differential Global Navigation Satellite System
EADI	Electronic Attitude Director-Indicator
EC	European Commission
EC DG TREN	European Commission, Directorate General for Energy & Transport
ECLECTIC	Electronic separation Clearance Enabling the Crossing of Traffic under Instrument meteorological Conditions
EEC	Eurocontrol Experimental Centre
ERC	Eurocontrol Research Centre
ES	Extended Squitter
ESARR	EUROCONTROL Safety Regulatory Requirements
ETMA	Extended TMA
ETMS	Enhanced Traffic Management System
ESVA	Enhanced Successive Visual Approach
EUROCAE	European Organisation for Civil Aviation Electronics

EVA	Enhanced Visual Acquisition
EVA-SA	Enhanced Visual Acquisition for See and Avoid
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FANS	Future Air Navigation System
FAROA	Final Approach and Runway Occupancy Awareness
FFAS	Free Flight Airspace
FIR	Flight Information Region
FIS-B	Flight Information Service – Broadcast
FMA	Final Monitor Aid
FMC	Flight Management Computer
FMS	Flight Management System
FMU	Flight Management Unit
FP	Framework Programme
GA	General Aviation
GPS	Global Positioning System
GS	Ground Surveillance
GSA	Ground Surveillance applications
HITL	Human in the loop
HMD	Horizontal Miss Distance
IA	Interoperability Assessment
IAF	Initial Approach Fix
IAOPA	International Council of Aircraft Owner and Pilot Associations
IAPA	Implications on ACAS performances due to ASAS implementation
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
IMC	Instrument Meteorological Conditions
ISA	Instantaneous Self Assessment
LFV	Luftfartsverket (Swedish Civil Aviation Administration)
LNAV	Lateral Navigation
MA-AFAS	More Autonomous Aircraft in the Future ATM System
MAS	Managed Airspace
MDF	Miss Distance Filtering
MFF	Mediterranean Free Flight
MMI	Man Machine Interface

Mode S	Mode of SSR which provides selective addressing of aircraft
MSAW	Minimum Safe Altitude Warning
MVA	Minimum Vectoring Altitude
NAT	Atlantic Region
NLR	Nationaal Lucht en Ruimtevaartlaboratorium (the Netherlands)
NM	Nautical Miles
NUP	NEAN (Northern Europe ADS-B Network) Update Program
NRA	Non-Radar Areas
OHA	Operational Hazard Analysis
OPA	Operational Performance Assessment
OSA	Operational Safety Analysis
OSED	Operational Service and Environment Description
PO-ASAS	Principles of Operation for the Use of ASAS
PSR	Primary Surveillance Radar
R&D	Research and Development
RAIM	Receiver Autonomous Integrity Monitoring
RFG	Requirements Focus Group
RTA	Required Time of Arrival
RTCA	Radio Technical Commission for Aeronautics
SA	Situational Awareness
SAM	Safety Assessment Methods
SAS	Scandinavian Airlines
SASP	Separation and Airspace Safety Panel
SCAA	Swedish Civil Aviation Authority
SCRSP	Surveillance and Conflict Resolution System Panel
SDPS	Surveillance Data Processing System
SEAP	South European ADS pre-implementation Programme
S&M	Sequencing and Merging
SMGCS	Surface Movement Guidance and Control System
SPR	Safety and Performance Requirements
SRP	Spacing Reference Point
SSR	Secondary Surveillance Radar
STCA	Short Term Conflict Alert
STM	Surface Traffic Management
STNA	Service Technique de la Navigation Aérienne (France)
SVA	Successive Visual Approaches
TAGA	Traffic Awareness for General Aviation
TCAS	Traffic alert and Collision Avoidance System

TEN-T	Trans European Network – Transport
TFM	Traffic Flow Management
TIS-B	Traffic Information Service – Broadcast
TLS	Target Level of Safety
TMA	Terminal Manoeuvring Area
T-MAT	University of Glasgow study
TOD	Top of Descent
UAV	Uninhabited Airborne Vehicle
UPS	United Parcel Service
VC	Vereinigung Cockpit
VDL	Very High Frequency Digital Link
VFR	Visual Flight Rules
VHF	Very High Frequency
VNAV	Vertical Navigation
VMC	Visual Meteorological Conditions
WP	Work Package