ASAS Thematic Network

Report of the Second Workshop
6-8th October 2003, Malmö

ASAS what does it mean operationally?

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1. Introduction

The Second Airborne Separation Assistance System Thematic Network (ASAS-TN) Workshop '**ASAS what does it mean operationally?'** was held from the 6th to 8th October 2003 at the Savoy Hotel, Malmö (Sweden).

This workshop is the second of three ASAS–TN Workshops. This workshop was focused on operational applications supporting the users' needs identified during the first workshop. The third workshop will focus on the 'Required airborne and ground functions for ASAS applications'.

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

The aim of the workshop was to present the Ground Surveillance (GS) and Airborne Surveillance (AS) applications currently being studied around the world. This was approached by presentation material and chaired discussion sessions intended to capture key issues.

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 BAE SYSTEMS, ENAV, LFV, NLR, Thales ATM and Thales Avionics.

In addition to the above organisations, the ASAS-TN involves a very wide range of organisations (e.g. ATM stakeholders, Universities) including Pilot and Controller professional associations (ATCEUC, IFATCA, IFALPA and VC).

3. Second ASAS-TN workshop

3.1. Format of the workshop

Day 1 consisted of an introductory session describing the work of the ASAS-TN, the purpose of the Workshop and an overview of ASAS applications currently studied followed by two presentations presenting controllers' and pilots' views.

Day 2 consisted of two themed parallel sessions in the morning, and two in the afternoon. In each of these 4 parallel sessions, selected presentations addressed AS and GS applications with a view to raising the key issues. 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 the sessions was presented and the meeting elaborated workshop recommendations.

3.2. Day 1 – 6 October 2003

3.2.1. Welcome

- **Michael Standar**, LFV - Deputy ANS Support & Development

Michael Standar welcomed the event participants on behalf of LFV. In his welcome he referred to the ICAO 11th Air Navigation Conference quoting the increased recognition of ASAS within the work of ICAO. He suggested that ASAS will be one of the most sought after products in ATM. He emphasised the importance of collision avoidance systems remaining independent from separation provision, keeping its role as a safety net. He endorsed the need for a programme-driven concept, linking user expectations to gains in predictability, efficiency, safety and regularity. He also pointed out that information sharing is a cornerstone of tomorrows ATM, and to bear in mind that all the information to decide collaboratively on best outcomes is available already today, but is never distributed.

- **Bob Graham**, European Commission

Bob Graham welcomed the participants on behalf of the European Commission. He encouraged the work of the ASAS community and stated that the ASAS-TN was seen as important to consensus building. (Bob Graham's more detailed individual presentation on the EU view of the work on ASAS is described later in this document).

- **Steve Zerkowitz**, Event Chair

Steve Zerkowitz welcomed the participants on behalf of the ASAS-TN, setting the scene and describing ASAS as a watershed event that will fundamentally change the way we perform ATM.

3.2.2. Introduction session

Objectives: The purpose of the session was to set the scene for the second workshop.

Purpose and format of the workshop – Steve Zerkowitz

It was emphasised that this was a workshop event that wishes to collect information both from the presentation material and also from participants' views and comments on AS and GS application issues. The key issues the workshop was focused on were the understanding of the applications and the associated operational needs.

Analysis of the issues was addressed by discussions in the plenary sessions and the four themed sessions on the second day.

- Airborne Traffic Situational Awareness (ATSA) track;
- Airborne Separation and Self-separation track;
- Airborne Spacing track; and

- Safety and ground surveillance track

Overview of the ASAS-TN – Bill Booth (EEC)

The ASAS TN resources constitute the following:

- Information gathered at the three workshops
- Web-based discussion forums and ASAS documentation, including projects, programmes and standards
- Membership composed of all major ATM stakeholders

All contribute to the ASAS implementation strategy and roadmap that is being developed in the course of this work.

The ASAS-TN also attempts to provide information, identify issues and foster consensus in the ASAS community.

Outcome of the first workshop – Eric Hoffman (EEC)

The first ASAS TN workshop in April 2003 in Rome was entitled "ASAS Operational Improvements – Dream or Reality?" The workshop was aimed all key ATM stakeholders, focusing on an ASAS user's or operator's perspective (Pilots, ATCOs, ANSPs, Airlines etc). The individual sessions were entitled: Benefits, Costs, Impact and Safety/Interoperability. The main conclusions of the First ASAS TN workshop were:

- Need for agreement and commitment from the various stakeholders
- Package 1 definition exists but fragile
- Need for pilot and controller acceptability
- Need for agreed standards for interoperability
- Need for a clear implementation plan
- Need for improved exchange of information

The report is available on:

http://www.asas-tn.org/1stwksp/1streport.pdf

ASAS implementation strategy plan – Tony Henley (BAESYSTEMS)

Within the ASAS-TN programme, Work Package 3 (WP3) delivers an ASAS implementation strategy. This will be contributed to by all the other activities within the ASAS-TN.

This work examines implementation challenges and work in progress to suggest the way forward.

The implementation challenges were outlined as:

- Operational definition
- Technology
- ACAS/ASAS Integration
- Equipage Rates
- Certification
- Large-scale Validation
- Investment costs vs benefits

Pre-requisites for ASAS were described as:

- Pilot Support
- Controller support
- Accountant support (Airlines & ANSPs)
- Therefore:
    - Responsibilities must be clear
    - Safety must be maintained
    - Benefits must justify investment

There were many issues to be addressed in the case for ASAS equipage. These include:

- Retrofit vs Forward fit
- ATSAW vs new operations
- Core Europe vs city pairs
- Many small steps vs a few big leaps

Comments on progress to date – European Commission - Bob Graham (DG TREN)

Bob Graham presented the EU DG-TREN (directorate of transport and energy) view of ASAS activities and issues.

Package 1 is seen as being a natural progression, being just an additional toolset to enhance the safe and efficient movement of air traffic. ASAS should be seen as a building block towards Co-operative Air Traffic Management and a constituent part of the Single European Sky initiative.

Package 1 applications have been identified and we should not waiver from their development (even if at the end not all the applications have to be implemented). Package 2 and 3 are less mature, under discussion items and should not divert focus. “Industry” is “committed” but other key stakeholders (e.g. ANSPs, airports) need to be convinced. Social partners need dialogue and the ASAS-TN is part of this process.

The European Commission is fully committed to this process and provides substantial funding in this area. They consider the key ASAS issues to be:

- Safety – Responsibilities, Risk assessment
- Operational – Achievable, Usable procedures and systems
- Benefits – Capacity, Cost
- Technical – Capacity, Safety
- Sustainable – Dual link provides this.

The Requirements Focus Group (composed of EUROCONTROL, FAA, RTCA, EUROCAE) was recommended as the forum to continue dialogue to resolve issues, focus effort and provide international consolidation.

3.2.3. Plenary Session

The objective of this session was to review the GS and AS applications currently studied around the world and the views of controllers and pilots.

See section A.

3.2.4. Application demonstrations

The delegates enjoyed the opportunity of seeing ASAS application demonstrations at the Swedish ATS academy:

- Co-space (EEC)

- Basic ASAS HMI, ATCO CWP, (Aerotechtelub)
- MA-AFAS (BAESYSTEMS)
- ATSA, Air Traffic Situational Awareness (Airbus)
- EGOA, Enhanced General Aviation Operations Enhanced by ADS-B, (LFV)
- SMART (LFV and AMS)
- UAV and non-radar (LFV)
- CIRCA/ASAS-TN (EEC)

3.3. Day 2 – 7 October 2003

Topic of the day: Airborne Surveillance (AS) and Ground Surveillance (GS) applications. The purpose of the sessions was to discuss these applications from an operational perspective and to raise associated key issues.

Session 1 (morning – room A): Airborne Traffic Situational Awareness applications - section B.

Session 2 (morning – room B): Airborne Separation and self-separation applications - section C.

Session 3 (afternoon – room A): Airborne Spacing applications - section D.

Session 4 (afternoon – room B): Safety and Ground Surveillance applications - section E.

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 to elaborate workshop recommendations.

See section F.

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 **Steve Zerkowitz** with **Bill Booth** as the secretary.

The round table experts were:

- **Francis Casaux** (CARE ASAS)
- **Randy Bone** (MITRE)
- **Anthony Smoker** (IFATCA)
- **Michael Agelii** (Pilot's view)

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

- Four briefings presented in the session (15/20 minutes each presentation):
  - Description of the ASAS applications included in 'Package 1' by Francis Casaux
  - Overview of FAA/Industry ASAS Applications (Safe Flight 21) by Randy Bone
  - Users' feed-back – Controllers' view by Anthony Smoker
  - Users' feed-back – Pilot view by Michael Agelii
- Chaired Discussions
- Wrap-up by Chairman.

2. Review of the briefings

<u>Brief description</u>

Francis Casaux presented the Airborne Surveillance Applications in Package 1. He provided a description of the applications, the individual issues associated with them, and the current work in progress. They were related, where relevant, to presentations that were to be made as part of this workshop.

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

The objectives of Package 1

- Focus on operational applications suited for core European high-density traffic areas without excluding other areas
- Operational airborne and ground user needs for ADS-B are considered
- Develop the Operational and Technical Standards required for early implementation of ADS-B applications.

2.1. Randy Bone (MITRE)

<u>Brief description</u>

The Safe Flight 21 Program is a Government and industry cooperation to expedite the implementation of emerging technology (i.e. GPS, ADS-B, FIS-B, TIS-B). Nine operational enhancements have been demonstrated in test beds: e.g. Alaska, Louisville, Memphis.

Ground-to-Ground:

- Improved Surface Navigation for the Pilot

- Enhanced Controller Management of Surface Traffic

Air-to-Ground & Self-Contained:

- Affordable Reduction of Controlled Flight into Terrain (CFIT)
- Surveillance Coverage in Non-Radar Airspace

Air-to-Air

- Improved Separation Standards
- Improved Low-Visibility Approaches
- Enhanced See and Avoid
- Enhanced Operations for En Route Air-to-Air

Ground-to-Air

- Weather and Other Data to the Cockpit

Key issues in the presentation

➔ Common ASAS applications have been identified between Europe and the US

➔ Surface maps have been developed (78 to date; 160 by 2005)

➔ UPS is equipping with AT2000 CDTI and conducting enhanced situational awareness with B757/B767 fleet (total of 107 aircraft). This includes conflict detection, situational awareness in flight, see and avoid, enhanced visual approach.

2.2. Anthony Smoker (IFATCA)

Brief description

Tony Smoker described the official ATCO view of ASAS issues. He discussed the issues of trust, education and training that need to be addressed with the controller community with regards to ASAS.

Key issues in the presentation

IFATCA PROVISIONAL POLICY is that: "Where ASAS is implemented, a clear and unambiguous statement of the separation responsibilities of pilots and controllers is required.

IFATCA has no fundamental objection to the use of CDTI in areas where it is demonstrated to maintain or improve system safety. Before ASAS applications are put in place, it should be proven that they maintain or improve system safety while providing net cost benefits.

IFATCA considers the following to be the minimum attributes of any CDTI system used in Airborne Separation Assurance / Assistance applications:

- Positive, unambiguous identification of all relevant aircraft to the standards currently required of ATC systems and controllers.
- Sufficient information as to the intent of relevant aircraft to avoid any action taken in maintaining separation from generating additional conflicts."

The position needs to be revisited to reflect current understanding of ASAS, especially Package 1.

IFATCA has a need to develop policy on the development and use of these applications in order to provide guidance to our representatives on the various standard-setting forums. That policy should be based on a clear set of minimum requirements necessary for the transfer of specific separation responsibility from the ground to the cockpit.

Comprehensive policy needs to be developed (by SC IV & SC VII) on the transfer of separation responsibility from ATC to the cockpit. This policy should take account of developing technology that will theoretically extend the feasibility of such transfer beyond the current visual limits.

2.3. Michael Agelii (Pilot's view)

Brief description

Michael Agelii gave a presentation on a high-level perspective of ASAS by a pilot with ASAS expertise and knowledge. It should be noted that these are his individual views and experience and do not necessarily reflect the views of any organisations or professional bodies to which he belongs.

Key issues in the presentation

In the presentation, the "typical" pilot was described as being somewhere on the following scale:

- Skeptical to changes from a flight safety perspective
- Accepts and handles, but dislikes high workload
- Eager to receive traffic information
- Accepts and likes responsibility
- Keen to optimize and perfect his flight
- Loves new technical gadgets and "toys"

The more experience that they had of ASAS, the more they moved from the top to the bottom of the scale. Thus pilots were seen as "perfectly cut out for ASAS"

The range and implications of Package 1 applications were identified as having a bringing together for flow or moving apart for safety effect on aircraft. Pilots need to be made aware of the fundamental objective of an application.

The advantages of a centralised (current) or distributed (future) ATM system were explored in terms of being orderly, simple and robust.

3. Issues from chaired discussions

We need to harmonise the terminology of applications globally.

USA has more of an implementation approach to ASAS. The demonstrations in Alaska and Louisville were effective and the resulting interest often takes the leadership by surprise.

IFALPA expressed concerns that unlawful interference should be addressed. A new presentation was proposed for Session 4 of this workshop to address this.

We should look at all the data link options (including those not on the table at present).

Pilots are managing an already complex system. It is therefore essential to involve pilots with engineers in the development process.

IFATCA has no fundamental objection to ASAS, although the average controller is fearful. CDTI is welcome where it can be proven to maintain or enhance safety. There are fundamental issues to be addressed with issues of responsibility. The issue of Intent information needs to be addressed.

The USA definition of early applications is not the same as Package 1. Could the same regional development approach in the USA be applied to Package 1?

However, the airlines in Europe wanted the focus to be on the core area. One suggestion was that we could address the suggestion by focusing on certain city pairs in core-area Europe.

Evidence shows that delays in Europe have decreased; so is there still such a great incentive for airline investment in ASAS?

Airlines will gain other benefits in terms of flight efficiency form the introduction of ASAS. We are waiting for the results of CBA studies. This is where we should focus our attention.

Visual Approach is a controversial issue. In fact there are many issues with regard to CDTI. CDTI with no associated procedures is "bad news". One possibility is to only show the target aircraft that is relevant to the ASAS application. There is a risk of giving information that pilots will misuse in ways they should not, or use when they should not. CDTI needs to come with training and procedures. It should not be seen as just a benign gadget that can enhance awareness without changing anything else.

It is what you don't automate, or proceduralise, that may produce unpredictable outcomes. e.g. misuse of the TCAS display.

It was clearly stated (in fact re-iterated) at ICAO ANC that ACAS should be invisible, except as the last safety step. ASAS will need to take into account the existence of ACAS. Education and procedures need to be developed to ensure interoperability.

ASAS is one new tool among many (AMAN, EMAN, MTCD, etc). It is of little use to analyse the benefits of one advance in isolation benefits in isolation, there needs to be one CBA encompassing them all.

Most pilots know "zip" about ASAS. We need to spread the word.

Technical and Operational Procedures need to be developed and the issue of contingencies in the ASAS applications understood. We need to be sure of the resilience of the system with an ASAS component in it.

IFATCA commented that there are many issues that remain to be resolved. Weather, e.g. high winds change the traffic system in ways that need to be fully understood. Human errors, such as what happens when a pilot turns the wrong way, need to be addressed.

There are many human factors issues that need to be addressed – workload factor, heads down time. This issue is compounded if we consider going from dual crew to single pilot cockpits.

The way forward is by obtaining evidence regarding benefits, workload, safety, etc. In terms of change management, we need to take a radical systems approach in order to drive through the change. The technology is easy to address in this context; however the soft issues – institutional, human factors – are the more complex.

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 – Airborne Traffic Situational Awareness Applications

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 **Francis Casaux** from CENA as the secretary.

The round table experts were:

- **Simona Canu-Chiesa** (Airbus)
- **Oliver Reitenbach** (DFS)
- **Bernhard Czerlitzki** (DLR)

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

- Four briefings presented in the session (15 minutes each presentation):
  - On the way to ASAS … ATSA, the first step by Simona Canu-Chiesa.
  - Traffic Identification – Some tendencies from the NUP EVA Simulation by Oliver Reitenbach.
  - TAGA Traffic Awareness for General Aviation in Germany by Oliver Reitenbach.
  - MA-AFAS – Taxi Management and Alert Tests by Bernhard Czerlitzki.
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

6. Review of the briefings

6.1. Simona Canu-Chiesa (Airbus)

Brief description

Airborne Separation Assistance System concept is based on delegation of manoeuvres to the crew but there are several steps which must be accomplished before we can achieve 'Full' separation delegation. The first of these is Airborne Traffic Situation Awareness

Today, aircrews make use of both visual separation procedures and the Traffic Alert and Collision Avoidance System display to provide some information on surrounding traffic, even thought it is not designed for that purpose. The situation with regard to supply of situational awareness needs to be formalised.

In order to provide full Airborne Traffic Situation Awareness, it is essential to develop the functionality in a systematic manner that ensures that issues of operational procedures and safety are properly addressed. This will be done using the agreed ED78A/DO264 methodology which involves the development of Operational Service and Environment Definition (OSED) from which the Safety & Performance Requirements (SPR) and Interoperability Requirements (Interop) documents are developed.

The presentation continued with the Airbus strategy for realising the process, which is closely linked to ongoing and planned European Union FP5 and FP6 programmes.

Three main categories of applications were described using examples of the expected Cockpit Display of traffic information (CDTI). These included:

Visual Separation Procedures aided by ATSAW

- Enhanced Visual Acquisition for See and Avoid,
- Enhanced Successive Visual Approaches,
- Enhanced Visual Acquisition for Successive Take-Offs,
- Runway Occupancy Awareness,
- Surface Traffic Awareness

Anticipation of Operations &Trajectories

- Flight Operations Improvement

Blind Broadcast Operations

- Enhanced Traffic Information Broadcast by Aircraft

Key issues in the presentation

➔ ATSA is a first step of ASAS

➔ ATSA, when available, will support a range of applications

➔ ED78A/DO264 methodology should be used to define and validate the applications

6.2. Traffic identification - Oliver Reitenbach (DFS)

Brief description

The Enhanced Visual Acquisition (EVA) application developed within the NUP programme corresponds to the GS/AS Package 1 application Enhanced Successive Visual Approaches (ESVA).

The presentation reports on the simulation work done on the EVA application in the NUP project. For aircraft performing EVA using ASAS (i.e. a CDTI in this case), the objective was to study how to identify the target aircraft using voice communication. Mixed-equipage fleet was considered and several traffic identification options were studied.

The best results were obtained using the 'reversed airline designator/flight number' for identification of the target aircraft (e.g. 'Lufthansa 123, Maintain own visual separation 234 Delta Lima Hotel' or 'Lufthansa 123, Maintain own visual separation 234 Lufthansa'). No major operational problem was identified during the simulation runs to cope with a heterogeneous fleet of aircraft (with or without ASAS equipage).

Key issues in the presentation

➔ The issue of the identification of the target aircraft in voice communication messages is a major issue common to several ASAS applications. The standard call sign cannot be used because this could divert the attention of the wrong flight crew, cause confusion and impact adversely safety.

➔ The proposed solution need to be further evaluated in the framework of the definition/validation of GS/AS Package 1 applications and MITRE experts will consider it for the Safeflight 21 trials in Louisville (USA).

➔ To make the application more effective, a simplified phraseology avoiding read-back was studied and is being proposed for harmonisation.

6.3. TAGA - Oliver Reitenbach (DFS)

Brief description

The TAGA (Traffic Awareness for General Aviation) project evaluated the potential benefits enabled by the use of a traffic presentation onboard General Aviation (GA) aircraft. The application considered corresponds to the 'Package 1' application Enhanced visual acquisition for see & avoid

(ATSA-S&A). It is an aid for the flight crews to perform their collision avoidance task during VFR flights, mainly operating in class E and G airspace.

The objective of the project was to answer the following question: 'Does a traffic presentation onboard a General Aviation aircraft support the pilot in the detection and identification of traffic?'.

Key issues in the presentation

- ➔ TIS-B (Traffic Information Service – Broadcast) provided the surveillance information to the aircraft. Six-second update period seems adequate for the detection of aircraft of the same airspeed category but higher rate (less than three-seconds update period) is required to detect fast traffic (e.g. military fighters) and during approach and departure phases.
- ➔ An acoustic traffic alert is useful to help identifying slow traffic and is required for fast aircraft.
- ➔ By the use of a traffic presentation the overall traffic detection probability was increased from 68% (without ASAS) to 80% (with ASAS) during the flight trials. The enhanced traffic detection rate took place in the forward quadrant at distances greater than 2.5 NM and of course in the backward quadrant.
- ➔ Pilots' feedback was that traffic presentation provides significant assistance in the detection and identification of traffic.

6.4. Bernhard Czerlitzki (DLR)

Brief description

The presentation focused on the Taxiway Management aspects of the "More Autonomous Aircraft in the Future ATM System" MA-AFAS European Union Framework 5 part funded programme. MA-AFAS involved a number of themes and included equipping two aircraft with a Cockpit Display of Traffic Information supported by ADS-B and ASAS functionality.

The Taxi Management functions evaluated included:

- Increased Situation Awareness using Airport Map Display and Ground CDTI
- Use of Digital Data link instead of Voice using 'Controller pilot data link communication' (CPDLC) for Ground Operations
- Display of Taxi Route and Taxi Clearances on an Airport Map (using databases to ED-99)
- Surveillance and Warning indications including Runway Alert and Runway Incursion

The moving taxi Map Display provides a range of features including Traffic Objects, Intersections & Stop-bars and the uplinked Taxi route. The display also supported a text line for CPDLC messages. The traffic information is driven from ADS-B and/or TIS-B and provides three different symbol types: aircraft with heading, aircraft without heading, and ground vehicles with a number of manual and automatic decluttering options. The taxi route is generated using a specially developed 'Taxi tool' touch screen route editor by the ground movement controller and uplinked to the aircraft via data link. The aircraft display shows both the cleared and uncleared sections of the route including stop-bars where appropriate. The programme included the definition of a specific set of Taxi-related CPDLC messages to support ground management.

The generation of 'Runway Alerts' –generated when ownship continues beyond the limit of its clearance - and 'Runway Incursion' – indicating that another vehicle is on the cleared runway – was demonstrated using only information derived internally to the aircraft i.e. no specific ground support for warnings is required.

Pilot comments on the system were generally favourable, 'It was easy to use the system'. Although a number of HMI improvements were identified including the need for a history function to allow old CPDLC messages to be retrieved. It was also noted that the detailed operational requirements for taxiing with the new display facilities CDTI and taxi route had still to be finalised

Key issues in the presentation

- ➔ Traffic and Taxi route displayed on moving taxi map display in the cockpit
- ➔ Air-ground data link used to transfer taxi route, taxi clearances and TIS-B traffic to the aircraft

- ➔ Taxi warnings and alerts generated by the onboard system based on Traffic information and cleared route although the precise requirements for this need to be refine (This is an ASAS package 2 function)
- ➔ Operational procedures (particularly optimum safe use of two crew during taxi operations) still to be finalised

7. Issues from chaired discussions

7.1. Discussion on ATSA applications in flight

Surveillance and navigation:

- Integration of performance specifications for navigation and surveillance data must be consistent
- RNP vs ASA MASPS – Set of requirements are defined in the ASA MASPS recently endorsed by RTCA/SC186. Is this compatible with the current RNP (PRNAV) requirements?
- Additional comments
    - The Automatic Dependent Surveillance (ADS) concept has introduced a strong relationship between Navigation performance and surveillance requirements. Indeed, quality of surveillance is dependent on the achievable Navigation performance
    - Very strong requirements on navigation performance for air transport aircraft exist today and actual performance information is continuously available. This is not the case for the majority of GA aircraft. What special conditions/requirements should be identified for GA aircraft using ADS-B?

Role of TIS-B is not clear?

- TIS-B as a gap-filler?
- TIS-B for redundancy?
- NIC/NAC/SIL for radar surveillance must be established before it can be use?
- Costs for TIS-B – Who is supporting the costs?

Can TIS-B be used for spacing applications - probably not!

- Integrity, availability etc requirements for surveillance data are defined (ASA MASPS) –But can they be met using TIS-B?
- US work to-date suggests that the performance requirements for spacing cannot be achieved but work is ongoing.
- TIS-B is good for ATSA applications (subject to the ATSA procedures that are to be defined)
- Local implementations of TIS-B, (e.g. TMA and for ground vehicles, at specific airport) will be established and look useful; however wide area implementations are not envisaged!

Operational use of ATSA – Benefits/risks of pilot-initiated procedures

- Need procedures and pilot training for using CDTI to ensure consistent behaviour – possible to establish for professional pilots but more difficult for non-professional pilots
- The learning curve – it will take time to establish a consistent pilot response to CDTI-displayed situations. In Radar controlled airspace, ‘no action’ is likely to be the correct response
- CDTI is not a quality assurance tool to measure quality of control i.e. it should not be used by the pilot as a way of monitoring the actions of the controller – there must be trust and an unambiguous acceptance that the controller has responsibility (ACAS alerts excepted)

Different needs/use of GA vs Commercial Air Transport

- Use of ATSA applications should be distinguished by airspace type and flying rules (VFR /IFR)

Separation responsibility

- No Change!
- Use today's rules (airspace categories, IFR/VFR flights and the associated ATC services) for ATSA applications in 'Package 1'.

7.2. Discussion on ATSA application on the airport surface

Alerts-Runway incursion etc

- False alarms - major concern
- Complex issues which will be addressed in Package 2 (no separation minima yet defined for surface operation, increased precision and integrity of position data expected to be required – we don't know the requirements)

ATSA-SURF procedures (and avionics)

- should support pilot in all airport environments (e.g. with or without SMGCS)

7.3. Discussion on international cooperation

'Reverse Call Sign' for target aircraft identification from NUP: ie 'Lufthansa 123, Maintain own visual separation (from) *234 Lufthansa*'

- Further evaluation is needed in the framework of the definition/validation of GS/AS Package 1 applications and by MITRE.

Harmonisation of standards for ATSA applications

- Teams on either side of the Atlantic must (continue to) work effectively together – Support RFG and international working groups.

8. Concluding Remarks and Recommendations

ATSA applications must come with procedures

➔ not just a CDTI

ATSA-SURF plus taxi map can provide significant safety benefit – NOW

ATSA as a 'first step' to ASAS Package 1?

➔ some applications may require full ATSA/ASAS equipage or the use of TIS-B

➔ the use of ATSA may not result in optimum benefits from the beginning, but it is a necessary step towards ASAS

C. Session 2 - Airborne separation and self-separation applications

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 **Giorgio Matrella** from ENAV with **Rob Ruigrok** from NLR as the secretary.

The presenters and round table experts were:

- **Bernard Hasquenoph** (CENA)
- **Randy Bone** (MITRE)
- **Andy Barff** (EUROCONTROL)
- **Jacco Hoekstra** (NLR)
- **Mark Ballin** (NASA)

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

- Four briefings were presented in the session (15 minutes each presentation):
    - CENA - ASAS crossing work in ECLECTIC project, by Bernard Hasquenoph
    - Safe Flight 21- CDTI Enhanced Flight Rules (CEFR), by Randy Bone
    - MFF – ASAS Separation and Spacing, by Andy Barff
    - NLR – Overview of NLR ASAS work, by Jacco Hoekstra
    - NASA – Airborne Separation and Self-Separation within DAG –TM, by Mark Ballin
- Discussion (1 hour and 30 minutes planned for discussion)
- Wrap-up by Chairman.

2. Review of the briefings

2.1. Bernard Hasquenoph (CENA)

Brief description

The ECLECTIC (Electronic separation Clearance for Enabling the Crossing of Traffic under Instrument meteorological Conditions) project consists of evaluation of the acceptability and feasibility of an ASAS application in Package 2 (airborne separation application, ASEP): the ASAS Crossing procedure, or ACP.

The ACP is a new procedure to enable the flight crew of the “cleared aircraft” to provide or maintain an “airborne separation” from one other aircraft (the “crossed aircraft”) designated by ATC, in a limited time and space, using ASAS. During the procedure, ATC does not have to monitor the separation. The benefits expected from the implementation of this procedure are a reduction or a streamlining of the controller’s workload, and a possible reduction in the separation value resulting in a better flight efficiency.

The ECLECTIC project includes the development of a demonstrator in a first stage, running on a PC unit. The demonstrator consists of a simplified aircraft simulator, a radar display, a flight deck interface (ND with CDTI and ASAS functions) and algorithms for maintaining airborne separation.

Key issues in the presentation

- ➔ Assessment of operational feasibility and acceptability of ASAS Crossing Procedures (ACP), as studied in several European projects (NUP II, MFF, MA-AFAS), as input for Package 2.
- ➔ Approach is to use the demonstrator and examine crossing scenarios, including:
    - Controller radar display
    - Flight deck HMI example (CDTI + control unit, not proposed for implementation)
    - Automatic or manual initiation of ACP
- ➔ ACP is considered a procedure embedded in current operations, which is as safe as today's procedures. ATC should be able to recover in case of ASAS unavailability.
- ➔ Airborne separation minima depend on air and ground equipment.
- ➔ The phraseology must remain simple and robust.
- ➔ The target aircraft designation is still an open issue. It must be unambiguous and should not generate confusion with traffic not involved.
- ➔ Locking target aircraft navigation and informing target about ACP is still to be discussed.

2.2. Randy Bone (MITRE)

Brief description

The Cockpit Display of Traffic Information (CDTI) Enhanced Flight Rules (CEFR) concept is an extension of the current visual separation procedure. In this concept, the flight crew is authorised to use the CDTI in lieu of visual out-the-window contact with an aircraft during visual approaches. The concept was presented, its purpose, results from four simulations, and the current status.

Key issues in the presentation

- ➔ CEFR operations are based on existing visual approach procedures, without operational changes.
- ➔ CEFR objective is to increase capacity under deteriorated weather conditions. As in the current visual separation procedures, the controller is relieved of separation responsibility for that particular aircraft and allows for more flexible operations. Main difference is that in CEFR operations, the procedure can be used in lower visual conditions with lower cloudbase, compared to the current visual separation procedure.
- ➔ CEFR concept / separation based on a CDTI is viable from a pilot perspective, in various conditions (day/night, instrument/visual approaches, CDTI size and location in cockpit).
- ➔ ATC continues to play key role, with increased flexibility for the controller in sequencing aircraft for final approach.
- ➔ Benefits exist, but must consider other operational enhancements to make a business case.

2.3. Andy Barff (EUROCONTROL)

Brief description

The ASAS Separation Concept in the MFF programme was presented, including details and explanation of forthcoming real-time simulation of Athens and Malta airspace. Furthermore, the ASAS Spacing Concept has been outlined as an integrated component within current operations, taking into account ASAS Spacing operations from an en-route sector towards the Rome TMA.

Key issues in the presentation

- ➔ MFF Separation and Spacing applications are in line with PO-ASAS.

- ➔ Forthcoming ASAS Separation real-time simulations (controller viewpoint) in Greek / Maltese airspace will cover issues on Radar / ADS-B fusion and gaps in coverage of both Radar and ADS-B surveillance.
- ➔ ASAS Spacing cannot be considered in isolation. Benefits are expected to be greatest when it is a component of an integrated concept.
- ➔ Sequences of arriving aircraft in ASAS Spacing will be set up before top-of-descent, in en-route sectors, while benefits are expected in the TMA. New tasks for en-route sectors establishing the sequence are foreseen.
- ➔ Feasibility of merging of ASAS-spaced flows at medium level will be investigated.

2.4. Jacco Hoekstra (NLR)

Brief description

A selection of results of a number of ASAS Self-Separation-related projects in which NLR was involved was presented, including NLR/NASA/FAA Free Flight, INTENT and MFF projects. These studies are often quoted as a reference for the feasibility of Free Flight / Self-Separation, but this presentation also contained guidelines for the “how” of ASAS Self-Separation operations, based on 8 years of research.

Key issues in the presentation

- ➔ ASAS Self-Separation yields significant capacity, safety and efficiency benefits. Pilot workload appears to be no major issue.
- ➔ Pilots and controllers appear to prefer different solutions to mix Self-Separation equipped and non-equipped aircraft in the same airspace.
- ➔ State-based Conflict Detection, Resolution & Prevention (CD&R) is sufficient for introduction and benefits; intent-based system preferred for future.
- ➔ Aircraft intent information has a positive effect on flight efficiency compared to state-based references.
- ➔ A co-operative resolution phase should always be included in CDR&R, also when priority rules are used, for fail-safety reasons and bottleneck solutions.
- ➔ Highest pilot workload is experienced in vertical transitions between Free Flight Airspace (FFAS) and Managed Airspace (MAS).
- ➔ Next steps: ADS-B bandwidth tests and standardisation of CDR&P.
- ➔ It is time for a leap forward: retrofit state-based system during field trials in non-radar airspace: North Atlantic?

2.5. Mark Ballin (NASA)

Brief description

Distributed Air/Ground Traffic Management (DAG-TM) is a concept of future mature-state air traffic operations that proposes to distribute information, decision-making authority, and responsibility among flight crews, the air traffic service provider, and aeronautical operational control organisations. This presentation provided an overview of the airborne component of the DAG-TM concept, which is founded on the operational paradigm of free flight. The two DAG-TM concept elements that rely on airborne separation and self-separation were discussed: en route free manoeuvring and constrained terminal arrival spacing operations. The presentation provided an introduction to DAG-TM and identified benefit mechanisms that may lead to the accommodation of significant traffic growth. It then provided details of the operations and procedures as currently defined, primarily from the flight crew’s perspective.

Key issues in the presentation

- ➔ DAG-TM concept is based on sharing information related to flight intent, traffic, and the airspace environment, with collaborative decision making among all involved system participants. Decision authority is distributed to the most appropriate decision-maker.

- ➔ Distributing decision authority is a key enabler in multiplying system capacity.
- ➔ DAG-TM has a mature-state focus. No other proposed paradigm for ATM has the potential to accommodate the expected growth (threefold) efficiently and safely.
- ➔ Autonomous Flight Rules (AFR) are introduced as a new option for aircraft flight operations, and produce the distributed (Self-Separation) network in which aircraft exercise autonomous flight management capabilities to meet TFM constraints, maintain separation from all other aircraft, and to achieve user optimisation objectives.
- ➔ IFR operations are centrally managed by ground systems and controllers, and mature independently from AFR operations through evolutionary enhancements to ground automation.
- ➔ AFR and IFR operations coexist in the same en-route and terminal-transition airspace in which AFR flights give way to IFR operations, in order not to change existing controller procedures for the IFR / non-ASAS-equipped aircraft. AFR and IFR traffic are merged for terminal arrival using ground-based local TFM. Terminal operations at capacity-limited airports are fully IFR.
- ➔ Expected benefits are scalability of growth for airspace capacity, increased safety and reliability and economic scalability. AFR operations permit growth scalability of the airspace system by accommodating significant traffic growth without exponential growth in ground infrastructure. Enhanced IFR operations provide access to all users with minimal impact from AFR operations.
- ➔ Users have incentive to equip for AFR through relief from flow management and planning acceptance restrictions.
- ➔ Advanced Terminal Area Approach Spacing (“ATAAS”) procedures based on an extension of existing charted procedures to maximise throughput, through integrated enhancements in ground and airborne capabilities.

3. Issues from chaired discussions

3.1. Discussions on Airborne Separation applications

The pass-in-front manoeuvre was questioned, since this type of manoeuvre is not common in current ATC practices. However, the equipage levels of the aircraft involved in the ASAS Separation application might be a reason to use it because for example only the aircraft that should pass-in-front can be acted upon by the controller for ASAS Separation. Also restricted areas might be reasons why the aircraft which should ideally pass-behind cannot be acted upon.

3.2. Discussions on Airborne Self-Separation applications

Compatibility between Self-Separation operations and controller tools was questioned. In this respect, NASA approach was different from NLR approach. NASA allowed ASAS Self-Separation equipped aircraft to coexist in the same airspace as non-equipped aircraft. NASA explained that work has started on the integration of airborne and ground tools.

NLR has tested various approaches in one of the their Self-Separation experiments to mix Self-Separation equipped and non-equipped aircraft. However, NLR generally assumed that access to FFAS is limited to equipped aircraft. For this reason, the compatibility between controller tools and Self-Separation equipment/operations is not a main issue.

Self-Separation (distributed system) is required to cope with future traffic demand (threefold).

3.3. Discussions on Airborne Separation & Self-Separation applications

Concern was expressed about the Air Traffic Controller side in Separation and Self-Separation. Roles between planner and tactical controllers might (need to) change and distribution of workload between controllers and pilots will certainly change. More complex applications are expected with the introduction of ASAS, so a clear, intuitive and standardised HMI is required on both ground and airborne side.

In the case of FMS solutions for ASAS manoeuvres, these solutions should continuously be checked to account for unexpected trajectory (including speed) changes of the aircraft involved in manoeuvre. In case a new conflict arises, a new solution should be offered to the pilots.

An extended safety analysis is required for Separation and Self-Separation, as well as more attention for contingency procedures.

The question of how much information to show to the pilots in Separation and Self-Separation applications was debated. Some people argued not to show all information or show the information depending on the ASAS application, because pilots might interfere with air traffic control, based on information. After discussion, it was agreed that all available information needs to be shown to the pilots, selectable by pilots, but with clear procedures (potentially different per ASAS application) and training on how to use and not use the information.

3.4. General Discussions

ADS-B assumed ranges as used in the applications presented were questioned. It was argued that ranges in reality might be smaller and therefore further investigation on this is required.

Equipage levels were discussed. It was identified that a minimum percentage of ASAS equipped aircraft is required to obtain the expected benefits. The required equipment will vary per ASAS application, but needs to be defined explicitly so that controllers and pilots realise what ASAS applications can be accepted. Clear presentation of equipage level on especially controller HMI is required for this reason.

While developing (potentially long term) ASAS applications, expected or foreseen changes outside the ASAS domain should be taken into account.

Consistency between Ground and Airborne system was debated. Some people argued consistency between Ground and Airborne systems was not required, since there will always be only one person in change for separation assurance. The argument to require consistency was that Ground and Air should have a consistent “picture” in order to avoid possible confusion and discussion. No agreement was reached, but some said that at least conflict detection should be consistent between Ground and Air. Downlink of Aircraft derived Parameters (DAP) was identified to be a potential enabler to improve consistency between Ground and Air.

It was unclear to the workshop what separation minima exactly mean in different applications. For example when a 5 nm behind is instructed, is 4.9 nm okay? Are margins included or not, and if so, what are they? Furthermore, accuracies of ground and airborne systems are different, so it is unclear “who to believe”, air or ground?

Iterations in the validation process are required and the OSEDs are continuously updated as a result of these iteration processes.

4. Concluding remarks & recommendations

ASAS Separation and Self-Separation have the potential to yield significant capacity, safety and efficiency benefits.

Issues have been identified at the workshop, including compatibility and consistency of ground and airborne tools, role changes of controllers and pilots, the effect of developments outside the ASAS domain and the requirement for extended safety analysis, including contingency procedures.

Mixed ASAS equipage needs further attention in research, as well as the performance of ADS-B installations in aircraft in real-life.

Iterations in the validation process are required and the OSEDs are continuously updated as a result of these iteration processes.

Session recommendations:

- Mixed ASAS equipage needs further attention in research.
- Investigate real ADS-B airborne system performance. This means: UAT, VDL-4 and 1090.
- Investigate minimum equipage levels per application in order to get benefits.

- Extended safety analysis and attention for contingency procedures for Separation and Self-Separation required.
- Air / Ground consistency requirement needs further investigation. DAP might contribute to increased Air/Ground consistency
- Procedures and training need to be developed per ASAS application on how to use and not use the information on the CDTI.
- The definition of separation minima needs clarification.

D. Session 3 – Airborne Spacing Applications

1. Introduction

This report relates to Session 3 on Day 2 of the Workshop, which addressed Airborne Spacing applications. The session was chaired by **Billy Josefsson** from LFV with **Eric Hoffman** from EEC as the secretary.

The round table experts were:

- **Karim Zeghal** (EUROCONTROL Research Centre)
- **Michael Agelii** (Pilots' view)
- **Tony Henley** (BAE Systems)
- **Thierry Arino** (Sofréavia)

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

- Four briefings presented in the session (15 minutes each presentation):
  - Co-Space - Experimental results on Sequencing & Merging by Karim Zeghal
  - In-Trail Spacing and Definition of Spacing Distance by Michael Agelii
  - Crossing & passing – MA-AFAS by Tony Henley
  - ASAS/ACAS interactions – IAPA project by Thierry Arino
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

2. Review of the briefings

2.1. Karim Zeghal (EUROCONTROL Experimental Centre)

Brief description

The presentation gave an overview of a series of experiments performed at the EEC on Sequencing and Merging in the framework of the CoSpace project. The overriding motivation of CoSpace is to increase controller availability to improve safety first, then efficiency and capacity. Both air and ground perspectives are investigated in parallel. The project relies on a small step iterative approach to gather results on the Package 1 Sequencing & Merging application. It explicitly takes into account the roles and responsibilities of the ATM actors in addition to limiting the technological assumptions to a minimum. The focus is on the sequencing of arrival flows in en-route as well as in TMA airspace. Distance- and time-based sequencing have been considered. From the data collected by CoSpace, the usability of S&M to support the sequencing of arrival flows can be asserted in specific contexts. It can also be shown that S&M results in more stable arrival sequences at the Initial Approach Fix. Repeatedly, workload and point of gaze measurements indicate that S&M allows controllers to maintain strategic handling of traffic under very high traffic conditions (as opposed to switching to a reactive mode) in the Enroute sectors investigated. S&M appears to require some anticipation by the Air Traffic Controller to be used effectively but at the same time, when this is achieved, S&M (by providing a more stable overall traffic situation) further increases the look ahead time at which he may start planning actions effectively.

While the work on S&M in TMA is less mature, the initial feedback from controllers is positive. There appears to be also potential to increase controller availability. The feedback from flight crews is similarly positive. Pilots appreciate the chance to take a more active role and get a better understanding of the situation. It provides them with more anticipation and therefore opportunities for better flight management. However, the new tasks bring a potential risk for workload increase on the flight deck.

In summary, the CoSpace presentation put forward a large body of experimental work over years providing consistent hints of the feasibility and benefits of S&M for the sequencing of arrival flows.

Key issues in the presentation

- ➔ There is a significant risk of misuse of S&M spacing instructions by controllers if not properly trained. Such misuses could lead to degradation in safety compared to today's situation.
- ➔ Little work has been performed on abnormal situations with S&M. While no showstopper is anticipated, this will require a lot of work.
- ➔ While early data on S&M in TMA appears promising, it is less mature than its en-route/E-TMA counter-part, requires possibly more drastic changes in controller working methods, impacts a more critical phase of flight from the flight deck perspective and hence is overall more challenging.

2.2. Michael Agelii (Pilot's view)

Brief description

Capt Michael Agelii highlighted work based on identified shortcomings in the algorithm used in NUP spacing trials. A generic definition of spacing was proposed taking into account all phases of flight and addressing the use of both time and distance to define the spacing. The rationale for this is to create the prerequisites to benefit from spacing applications in as many situations as possible. Further a spacing reference point (SRP) was defined. The idea is to measure the spacing distance between a fixed point, SRP, (WPT, RWY threshold or initial approach fix, IAF) and a moving target. The measurement could also be between a dynamic point, SRP, (leader) and a follower or a typical spacing situation between two aircraft. An algorithm that should work with the SRP concept has been developed in collaboration between SAS and Luleå University as a thesis in mathematics. The full thesis can be downloaded from http://www.nup.nu/asp/fncShowDoc.asp?Key=external@232

The algorithm is called T2 because it addresses all situations by the following logic: The shortest way to fly from follower position to leader position and end up in the same direction is at most via two turns and a straight line. The function of the algorithm was demonstrated using leader and follower in different relative positions. In order to support the SRP algorithm, potential additions to the ADS-B message were identified namely position, track, velocity, SRP and distance to SRP. The T2 algorithm and the SRP concept is a starting point and will be subject for further evaluation but also used in validation activities.

Key issues in the presentation

- ➔ The definition of SRP and use of the T2 algorithm suggest that a generic approach can be applied for ASAS spacing to all phases of flight using either time or distance.
- ➔ The earlier algorithm deficits concerning turns should be improved with the implementation of the T2 algorithm.
- ➔ Potentially the use of the SRP and T2 algorithm could serve spacing applications in all phases of flight.

2.3. Tony Henley (BAE Systems)

Brief description

Tony Henley provided an overview of the flight trials of the Package 1 Crossing & Passing application performed in Roma in March '03 in the context of the MA-AFAS programme, which finished in July '03. He was assisted in his presentation by 2 ENAV controllers that had taken an active role in the trials. Three variants of C&P were successively introduced – lateral passing, vertical crossing and lateral crossing – before focussing next on the latter one. The different phases of the lateral crossing were presented, highlighting the precisely-defined successive steps of pilot/controller interactions as well as the supporting phraseology. The importance of the adherence to "applicability conditions" e.g. in terms of crossing angles was reiterated. A video of the flight trials was shown, including two crossing (pass behind) manoeuvres, one as seen from a controller perspective, the second one as seen from the flight deck. From both perspectives, it appears to be totally uneventful and well integrated in the current working practice. No modification of the ground system had to be performed to allow for the C&P to be used. For each single pass-behind manoeuvre performed in the trials (10NM), an accuracy of 0.5NM was observed with respect to the given spacing values. The controllers expressed their appreciation of the new procedures and they expressed their wish to further evaluate the procedure with more aircraft, to build trust and confidence.

Key issues in the presentation

➔ C&P is only to be used under the proper applicability conditions/constraints.

➔ There is a need to have a better understanding of the monitoring task of the controller.

➔ Controllers need to build trust and confidence in what can be achieved with C&P. A “simple” application like pass behind leads into a quite detailed and intricate description of phases and steps describing the interactions between air and ground.

2.4. Thierry Arino (Sofréavia)

Brief description

The presentation addressed the relationship known so far between the ACAS logic and potential ASAS applications. The ACAS programme in Eurocontrol funds the IAPA (**I**mplications on **A**CAS **P**erformances due to **A**SAS implementation) project. Motivation for these efforts is that ACAS II is part of the ATM system where the ASAS applications and procedures are being developed. It is obvious that efforts must be undertaken to ensure compatibility between ACAS and ASAS.

Phase I of the IAPA project comprises the initial scope of ACAS and ASAS interaction issues. Phases II and III will comprise a full set of simulations and more in depth analysis. The main objective of the IAPA project is to provide guidelines on any identified ACAS and ASAS interaction issue for the development of future ASAS applications in Europe.

The applications selected for the studies in Phase I were the sequencing and merging (S&M) application including merging and in-trail phases and crossing and passing (C&P) application including lateral overtaking, lateral crossing and vertical crossing.

For Phase I, the approach was to construct situations involving two aircraft with various performances and identifying encounter parameters influencing the ACAS alert triggering. The major assumption was a perfect CNS environment.

Parameters that were identified as highly salient for the S&M application: Altitude at waypoint (WPT), required spacing at WPT, angle of convergence at WPT, length of the base turn, relative initial speed, altitude and spacing between leader and follower.

In the S&M condition there was an increased risk of potential Traffic Advisories (TAs) only when the spacing value was close to 3NM. Further, in the S&M in-trail phase no ACAS alerts could be triggered when aircraft was on same leg with spacing > 3NM, neither when travelling on opposite legs with base length > 3NM.

Parameters highly salient for the C&P application covering lateral overtaking, vertical and lateral crossings were altitude, track spacing, required vertical spacing, relative vertical and horizontal speed between both aircraft, required spacing at the track crossing point and angle of convergence between aircrafts.

In the lateral overtaking condition no ACAS alerts when track spacing > 3NM. For the vertical crossing condition TAs and Resolution Advisories (RAs) were triggered using 1000-ft-level-off geometries. Finally for the lateral crossing condition TAs were very likely to occur with required spacing < 5 NM. Further the Miss Distance Filtering (MDF) performance was found to be critical to prevent undesirable RAs.

In view of the major assumptions and limitations of the preliminary ACAS / ASAS interaction study performed within IAPA, it was noted that definitive conclusions shall not be drawn for any of the Package I applications. It was finally emphasised that it is necessary to investigate further the set of ACAS / ASAS interaction issues identified. The work methodology and framework developed during Phase I will facilitate this task.

Key issues in the presentation

- ➔ The major influencing factors of ACAS / ASAS interactions were to be found in the airborne spacing values and the quality of the aircraft trajectory.
- ➔ The ACAS impact on and interaction with ASAS operations still needs a lot of attention and investigations. In particular, it is of interest to investigate impact of ASAS operations on the safety benefit provided by ACAS.

3. Issues from chaired discussions

There has been quite a lot of work done up to now in the field of Arrival Management (AMAN) from a ground perspective aiming at defining sequences and providing advisories to controllers to implement these sequences. This should not be seen as competing with ASAS.

- ➔ AMAN / ASAS interactions: AMAN provides a strategic sequence; applying ASAS is one way to implement the sequence.
- ➔ The use ASAS applications may allow for a more accurate and reliable implementation of the sequences defined by the AMAN in terms of ability and effort on the whole to navigate with higher accuracy

There is considerable discussion on whether C&P should be in the spacing or separation category.

- ➔ No consensus on C&P as spacing or separation

When questioned, controllers having been involved in trials expressed that they were impressed with ability of aircraft to acquire 6NM. However, on the first few occasions, they acknowledged that it did lead to a few extra “heartbeats”.

- ➔ Controllers need to be able to build trust and confidence in the ability of aircraft to accurately and reliably follow ASAS instructions.

While they are still responsible for providing separation, controllers may have very little time to react and very few options available if an aircraft does not properly follow an ASAS instruction.

- ➔ Monitoring tools must be designed so they effectively assist controllers to better and earlier detect non-conformance to ASAS (and non ASAS!) instructions.

Controllers are currently applying buffers on top of the separation minima when providing separation. It should be foreseen that when using spacing instructions such minima the notion of buffer should remain

- ➔ Will the buffer on top of separation minima be smaller or larger when using C&P spacing instructions?

Today practices with (simultaneous) vertical level-off currently provide similar situations where controllers have very little option to intervene should one aircraft not comply with an instruction (typically level bust) – parallels could be drawn between today’s level off and C&P spacing in terms of resilience to errors or of responsibility.

- ➔ Responsibility issue may be a red herring if proper parallels with current situations can be drawn.

Concerns were voiced that global technology standards supporting all ASAS applications are required. It was noted that individual links might be pushed forward for varying reasons while real needs are marginalised.

Retrofitting, and the associated costs (new displays and software), is a potential barrier to implementation. Forward fitting alone of new airframes is not a feasible option to bring overall fleet ASAS equipage to usable levels in a reasonable timeframe.

- ➔ More research on the retrofit solutions is required.

All possible paths and variants should be explored in particular by looking at short-term, less advanced by still functional alternatives (i.e. without waiting for the perfect high-end solution).

The term of **'incentivisation'** was introduced. It appears to be a key issue to closely tie benefits to the users having made the investment decisions. ASAS benefits are expected to materialise for the benefits of ANSP and airports in terms of capacity gains that could be shared between all users equipped or not. This could lead to provide growth opportunities for "competitors" having not invested. Lessons should be drawn from LINK2000+/CPDLC experiences on incentive schemes.

➔ Mechanism for ensuring a direct tie-up between investment/equipage and benefits must be devised

In order to convince airlines or ANSPs to invest and deploy ASAS, the worth of a generic European-wide CBA was questioned. This is of no use at all for individual actors to know that, overall, Europe with be better off with ASAS. Individual actors must be in a position to assess their own specific CBAs and get positive feedback.

➔ There is another potential discrepancy in the sense that benefits are "long term" while the "short term" outlook for the airlines are very bleak. Therefore, even clearly positive CBAs (as in the case of datalink/CPDLC) do not automatically lead to airline equipage as they may not have the short term cash to make the investments.

➔ It will make more sense if actors (ANSP, Airport, Airlines) regionally work out CBAs and could agree on a common direction of investment. There is a need for common strategic lines.

It is essential to define transition strategy taking into account the difference in time to invest and to accrue benefits.

The example of UPS in Louisville provides for a good case study. It shows the need to get airline equipage to have at the same time a "real" operational need, a reasonably low cost avionic solution and finally an incentive scheme, covering on one hand the non-recurring engineering costs and, on the other hand, through loans, the equipage costs.

The selection of the location for such pioneering work is paramount as there must be a real need. From the data available, it appears quite clearly that there is a link between sequencing (and thus ASAS) and airspace sector design– benefits may be maximised as anticipation is increased. Hence, modifications of the airspace structure – even locally – may provide even higher benefits.

Nevertheless, this shouldn't be understood as a call for local ASAS variants. On the contrary, there is a strong need to consolidate regional variants of ASAS so as to be more focussed.

➔ ASAS has started in many "pockets". Consolidation is happening. There is a need to be still more focussed.

There is at this point very little airline participation to ASAS activities even less commitment to implementation.

➔ Mandate is not the silver bullet to get airline participation.

There is a mismatch between the airlines' struggle to survive within the next 6 months and the 10 year benefits promised.

➔ Beyond 100% funding of airline to ASAS activities (as a valuable first step), the key issue is that all engineering non-recurring costs should be paid for now and not by airlines.

The recent ANC endorsements of the new ATM Ops concept will lead to a more mainstream role for ASAS. It will help spread the word that ADS-B/ASAS is the way ATM will be in 10 years, therefore ADS-B/ASAS should become standard forward fit.

However, the ADS-B data-link situation is far from perfect, if not outright messy. Therefore it does not encourage stakeholders to make commitments. It is recognised that a longer term solution for ADS-B data link is required – however, there is currently no dedicated broadband research programme.

➔ No tidy solution for communication is in sight.

4. Concluding remarks and recommendations

A limit has been reached concerning simulations for Package 1 applications – progress depends now on awareness being generated through real-life experiences in parallel to the continuation of simulations. Lessons learnt from Capstone's experience – rather than or in addition to countless simulation run in labs – have had a direct positive influence in ADS-B investment decisions in the Gulf of Mexico.

➔ The group unanimously recommended proceeding to large-scale pre-operational trials of ASAS Package 1 as soon as possible involving equipage of one or more airline fleets.

This also clearly implies upgrading in parallel the supporting infrastructure of a selected set of ANSPs and airports.

E. Session 4 - Safety and Ground Surveillance applications

5. 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 **Pierre Gayraud** from THALES Avionics with **Peter Howlett** from THALES ATM as the secretary.

The round table experts were:

- **Göran Hasslar** (LFV)
- **Bob Peake** (Airservices Australia)
- **Bob Darby** (EUROCONTROL)
- **Ken Carpenter** (QinetiQ)
- **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):
    - GS application in Kiruna - A Swedish ADS-B validation site by Goran Hasslar
    - ADS-B implementation in Australia by Bob Peake
    - Safety analysis EUROCONTROL ADS programme by Bob Darby
    - AP1 – Safety and ASAS applications by Ken Carpenter
    - ADS-B Safety & Security aspects by Niclas Gustavsson
- Discussion (1 hour and 30 minutes planned for discussion), and
- Wrap-up by Chairman.

6. Review of the briefings

6.1. Göran Hasslar (LFV)

<u>Brief description</u>

Göran Hasslar presented work being accomplished in Kiruna, an airport located in the Northern part of Sweden, to implement and validate two Ground Surveillance applications enabled by ADS-B:

- ATC surveillance in non-radar areas (ADS-B-NRA)
- Airport surface surveillance (ADS-B-APT)

He highlighted the specificities linked to the location of this airport, nature of traffic and ATC services available in the region. He described current and near term activities to begin operational trials of the two applications and gave an overview of the approach taken for the approval of these operational trials by the Swedish Aviation Safety Authority for operations to start in Q2-2004.

These trials use VDL Mode 4 as the link technology.

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

➔ ATC surveillance in non-radar areas (ADS-B-NRA)

- Mix of equipped and non-equipped aircraft (except in the final approach phase, separate areas are defined and dedicated to equipped and non-equipped aircraft)
- Radar and ADS-B mix in the southern part of Kiruna TMA.

- ➔ Airport surface surveillance (ADS-B-APT)
  - Mix of equipped and non-equipped aircraft
  - Low flying helicopters
- ➔ Status
  - 1 aircraft + 1 helicopter equipped
  - Validation ongoing
  - Will continue with live tests during next year
- ➔ Procedures
  - Basic radar-like procedures
  - No change in separation minima
  - Minor changes in phraseology, e.g. “ADS-B contact” instead of “radar contact”
  - Considering preferential routing of ADS-B equipped A/C
- ➔ Safety case prepared for Swedish Aviation Safety Authority for operations as of Q2-2004
  - System parts
  - Surveillance application – in progress
  - Improvement of Safety Levels is a key motivation

6.2. Bob Peake (Airservices Australia)

Brief description

Bob Peake gave a quick overview of the ATC environment available in Australia and highlighted that most of the continental area was actually non-radar airspace, with operations supported by Pilot reports / VHF voice and FANS 1/A. There is therefore a particular motivation in Australia to investigate potential operational use of ADS-B to support operations in these areas.

He described ongoing operational trials of ADS-B-based Ground Surveillance in Non-Radar Airspace (ADS-B-NRA) in the Burnett basin, on the Northeastern coast of Australia. These trials are seen as an opportunity to improve ATC services in the area, but the primary objective is to use trial results and findings as a stepping stone towards a large scale deployment of approximately 20 ADS-B ground stations to provide radar-like ground surveillance in the continental area. Airservices Australia selected 1090 ES as the link technology and indicated that a major benefit of this choice was that ADS-B-out on 1090 ES will be readily available from several avionics and airframe manufacturers.

He described the comparison approach taken for the safety case and stressed the importance of extending the analogy when possible to the way failure modes and outages are managed.

Key issues in the presentation

- ➔ Australian radar coverage only on East Coast and South East + Perth and Darwin
  - Rest of country is FANS 1/A + VHF voice/Pilot reports
  - Deployment of 20 ADS-B Ground Stations considered for continental area to improve surveillance services
- ➔ First step: Operational trial in Queensland Burnett Basin
  - No radar coverage below FL 120
  - 20 aircraft account for most of the traffic
  - Dash 8 + Beech 200 + GA + helicopters
- ➔ Objectives
  - Operational trial system: Avionics, ground station, TAAATS software changes

- Develop operational procedures and accumulate experience
- Report on possible large-scale deployment

➔ Safety Case

- ADS-B being validated as equal to or better than radar
- Radar procedures and separation standards (5 NM) then used with minimal changes for ADS-B
- No data fusion – radar source used preferentially, otherwise ADS-B
- GPS RAIM prediction – inadequate satellite coverage managed like scheduled radar outage

6.3. Bob Darby (EUROCONTROL)

Brief description

Bob Darby presented current activities performed within Stage 2A of the Safety Analysis activity conducted by the EUROCONTROL ADS programme.

This activity follows the ED-78A methodology and addresses four Package 1 GS applications and three AS applications. The starting point and prerequisite of this top-down approach is a mature Operational Services and Environment Description (OSED) for each of the applications. From this OSED, an Operational Hazard Assessment (OHA) is derived, which then leads to an Allocation of Safety Objectives and Requirements (ASOR) to the ground and airborne components of the system.

Bob's presentation highlighted the lesson learned in using the methodology and the importance of having mature OSEDs at the start of the process.

Key issues in the presentation

➔ Initial Safety work started in 1999 (Stage 0), then carried on to Stage 1 based on case studies

- Definition of applications was not detailed enough

➔ Current work: Stage 2A contract

- Based on GS/AS Package 1
- Coordinated with CBA and Architecture work
- Assessment of 7 ADS-enabled ASA and GSA applications defined in the Package I OSED
- For each Package I application, apply ED-78A process: from each application OSED, establish Operational Hazard Analysis (OHA), then allocate Safety Requirements to ground and airborne elements (ASOR)

➔ OHA – Operational Hazard Analysis

- Time and effort consuming
- Very dependent on maturity of OSEDs.
- Change in OSEDs requires complete re-work

➔ ASOR – Allocation of Safety Objectives and Requirements

- New process – learning as we proceed
- More complex for surveillance than for communication

6.4. Ken Carpenter (QinetiQ)

Brief description

Ken presented the content and objectives of the SAF-ASAS document prepared by the Action Plan 1 team, which is to be presented to the FAA/EUROCONTROL Cooperative R&D Committee in February 2004. The document was in its review period and will be completed in November 2003.

This document provides guidance on how to develop safe applications and on how to demonstrate that they are safe. It references various analysis and simulation methods and makes recommendations as to what methods should be applied at various stages of the specification/development cycle.

The document recommends iterative development.

Key issues in the presentation

- ➔ SAF-ASAS is a document produced by the Action Plan 1 team reporting to FAA/EUROCONTROL R&D Committee
  - In draft status, to be completed in Nov. 2003
- ➔ Its purpose is to provide guidance on
  - how to develop safe applications
  - how to demonstrate that applications are safe
- ➔ Discusses the problems for each category
  - does not discuss specific applications
  - does not try to show that ASAS is safe
- ➔ Provides a review of the available methods
  - Discusses the use of the methods for ASAS applications
  - Discusses what it means for an ASAS application to be safe
- ➔ Recommends iterative development

6.5. Niclas Gustavsson (LFV)

Brief description

In addition to the initial Workshop program, Niclas gave a short presentation on how ADS-B is expected to enhance safety as a whole, but may also raise security issues due to the relative ease with which ADS-B information can be accessed and potentially used in undesirable ways. He said that the point was raised during the ANC 11 meeting in Montreal and his presentation weighed the pros and cons of making aircraft data available in relatively open fashion. He also cited different solutions to mitigate this risk and expressed concern that the issue was not being addressed.

The subject was not addressed in the chaired discussions of session 4, but was raised by one person during the discussions of the last day's plenary session.

Key issues in the presentation

- ➔ Short presentation on pros and cons of easy access to ADS-B from a safety and security point of view
  - Benefits
  - Potential misuse
- ➔ Addressed potential mitigation measures
  - Authentication
  - Independent verification of position
  - Encryption

7. Issues from chaired discussions

Addressing Safety and Ground Surveillance in the same session actually proved to be very appropriate and induced a discussion on the approval process of the different applications since the two ground surveillance applications both led to a safety assessment in order to obtain approval from their respective regulatory authorities to authorise operational trials. The approach –

a comparison with radar performance - taken for the approval of the two ground surveillance applications was found to be very different from the top-down approach being contemplated for airborne surveillance applications.

Extensive discussion followed regarding the differences between these two approaches and the limits of the comparison approach:

Ground Surveillance applications seem easier to approve because it is generally only a technology change supporting an existing concept of operation. Safety can be demonstrated “by comparison” with conventional operations, provided that appropriate measures are taken to mitigate failure modes, etc.

Bob Peake and others in the assistance concurred that mitigation means and procedures defined over the years for radar surveillance should be reproduced for ADS-B as closely as possible so that the close analogy facilitate the approval process. As an example, Airservices Australia have defined a procedure for managing predicted GPS satellite coverage holes that is identical to the procedure adopted for scheduled radar maintenance. Procedures to manage aircraft address conflicts was another example given. Several attendees insisted on the importance of constantly monitoring system operation and recording operational data to collect statistics and analyse system errors.

The discussion showed that a number of other short-term GS applications are planned or can be expected worldwide. While some large scale deployments are planned, e.g. in Russia and Sweden, there was a feeling that, in many cases, this would come as «pockets» of local implementation, where fleet equipage was less of an issue than in a widespread deployment.

Training controllers to the new procedures as well as the new technologies and related behaviour / failure modes was considered essential. Regarding potential new error modes, it was strongly recommended that the system be designed to eliminate or mitigate the errors, rather than relying on controllers to detect and correct errors.

It was contended that the comparison approach taken for these initial ground surveillance applications – while much faster and easier than the top-down approach contemplated for the airborne surveillance applications – would reach its limits as soon as the analogy is no longer close enough.

A point was made that the airborne navigation function is involved in the elaboration of ADS-B reports and should also be considered in the safety assessment. It is unclear whether this has been adequately taken into account.

A discussion also took place regarding the target separation values to be attained through ADS-B. It was argued that the community tends to focus too much on achieving radar-like separation minima, whereas larger separation values would be perfectly acceptable in most cases. Changing subject to airborne separation, it was questioned whether moving to airborne separation would effectively reduce separation or whether the pilots might tend to include their own safety buffer, which would, in effect, result in wider separation.

There was a consensus that the approval process of Airborne Surveillance applications would be more complex than the approval process of Ground Surveillance applications because there is nothing to compare to. The approach will require a full safety assessment to demonstrate that the Target Levels of Safety are met. As pointed out, a full safety assessment is now required by ICAO regulation for all new ATM applications. Since airborne applications will involve both a new operational concept and new supporting technology, it cannot be avoided.

The methodologies are exhaustive and address all the aspects: operational, technical, procedural, human. But it is recognised that they are very effort- and time-consuming

A suggestion was made that it might ease the process if we started with Ground Surveillance applications to accumulate experience and build confidence/trust in the technology. It might be easier then to develop and approve new concepts of operation and applications based on same technology.

8. Concluding remarks and recommendations

- ➔ Ground Surveillance applications, relying on existing operational concepts, should benefit from a straightforward approval process.

- ➔ Ground surveillance applications are planned or expected worldwide, but it is more « pockets » or local implementations than widespread deployments. Then fleet equipage should not a significant issue.

- ➔ Training controllers to the new applications is considered essential and it is strongly recommended not to rely on controllers to mitigate issues due to the new technologies.

- ➔ The safety analysis of Airborne Surveillance applications will require a more effort- and time-consuming process that cannot be avoided.

- ➔ It is suggested to start with Ground Surveillance applications and then to develop and approve applications using new concepts but based on the same technology.

F. Workshop conclusions

1. Introduction

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.

2. Workshop recommendations

The following recommendations are considered to be the main headlines from the workshop:

Institutional recommendations:

➔ Strong coordination between US and Europe (including terminology) is essential

➔ Continue to use the Requirement Focus Group (RFG) as the method for cooperation

➔ ASAS applications should be considered as a set of components and integrated into the ATM system

➔ Share and learn from experience of local studies and implementations

➔ Security requirements must be addressed during ASAS application development and validation

➔ Political awareness of the potential benefits of ASAS applications should be enhanced in order to ensure appropriate financial resources

'Package 1' recommendations:

➔ In order to ensure safe operations of ATSA applications (use of CDTI), clear procedures must be defined

➔ ATSA-SURF plus taxi map brings significant safety benefit – should be considered for early implementation

➔ Proceed to large-scale pre-operational trials of ASAS Package 1 as soon as possible, involving equipage of one or more airline fleets.

➔ Characterise currently-available ADS-B data link technology system performances against Package 1 requirements.

➔ Encourage the development of regional implementation plans of globally-agreed applications.

➔ Incentivisation schemes need to be identified to encourage all stakeholders (e.g. Airports, Airlines, GA, ATSPs) to equip. Specifically, methods to ensure that those investing in ASAS receive benefits must be established.

➔ Investigate minimum equipage levels necessary to achieve benefits per application.

'Future packages' recommendations:

➔ Work to continue on Package 2 and 3 and beyond.

➔ Extended safety analysis and address contingency procedures for Separation and Self-Separation

➔ Continue work on ADS-B data link technology beyond what is currently foreseen for Package 1

3. Actions by the ASAS-TN consortium

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

- 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
- 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

4. Dissemination

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

http://www.asas-tn.org/2ndwksp/index.html

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.

5. Future ASAS-TN events

A third workshop is to be held in Toulouse on 19th to 21st April 2004. This will focus on the airborne and ground functions required in order to make ASAS happen.

An ASAS-TN seminar will be held on 11th to 13th October 2004.

Further information will follow in due course.

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7. 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
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