ASAS Thematic Network 2

Report of the Third Workshop
11th-13th September 2006, Glasgow

ASAS: Civil and Uncivil Practices

Document Ref: ASAS-TN2/WP1/WS3/Report/0.7

Contract No: ACA4-CT-2005-12213

Version 0.7, 26th October 2006

1 Introduction

The Third ASAS (Airborne Separation Assistance System) Thematic Network 2 (ASAS-TN2) Workshop: "**ASAS: Civil and Uncivil Practices"** was held from the 11th to 13th September 2006 at the Teacher Building, Glasgow (Scotland).

This workshop was the third of five ASAS –TN2 Workshops. It was focused on key issues with regard to ASAS implementation, lessons learnt from military and Unmanned Aerial Vehicles (UAV) experiences, human factors issues and the steps towards Package 2 applications.

The aim of the workshop was to identify and report upon the key issues with regard to global ASAS application development and delivery. This was approached by presentation material and chaired discussion sessions. The event was intended to capture key issues both via the presentations and the subsequent debate sessions.

This report contains a summary of the key issues identified at the workshop.

Part of the work of ASAS-TN2 is to report annually on the status of ASAS development and to discover what is being done and needs to be done in the implementation of ASAS as part of the global ATM (Air Traffic Management) system. Each of the workshops contributes to this process. The ASAS-TN2 project will conclude with a final seminar.

2 What is the ASAS-TN2?

ASAS-TN2 is a three-year project that is primarily a communication activity. The ASAS-TN2 is sponsored by the European Commission (DG Research).

ASAS-TN2 is a stand-alone project, following on from the work of its predecessor project ASAS-TN1. The scope has now increased to address applications beyond Package 1.

ASAS-TN1 arose 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 projects 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-TN2 is threefold:

- Five Workshops and a final seminar
- Web-based documentation; and
- Annual reporting of the status and maturity of ASAS application development.

The Workshops and discussion forums inform the application maturity reporting work.

The ASAS-TN is managed by a consortium led by EUROCONTROL that includes 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 ECA).

3 Third ASAS-TN2 workshop

3.1 Format of the workshop

Day 1 consisted of a session describing the progress and challenges with regard to ASAS implementation and standardisation. The session also addressed the place of ASAS in the (Single European Sky ATM Research) program SESAR concept of operation. The previous workshop has shown that ASAS applications are no longer handled in isolation but are well integrated within ATM.

Day 2 consisted of two sessions, the first one for the implications for ASAS drawn from the UAV, business jet and military experiences, followed by human factors and cognitive systems approaches to ASAS. In each of these sessions selected presentations addressed the subject matter with a view to raising the key issues. In each session, the presentations were followed by a chaired discussion session.

Day 3 addressed ASAS Package 2 applications and next steps in ASAS. This session was followed by concluding discussions for the whole event.

3.2 Day 1 – 11th September 2006

3.2.1 Session 0 - Introduction

- **Chris North** (European Commission DG:TREN)

Chris North welcomed the attendees on behalf of the Commission. He passed on a welcome from Jean-Luc Marchand of DG Research at the commission, the specific directorate responsible for funding the ASAS-TN2.

Chris outlined the history of ASAS development work funded by the Commission.

- The Intelligent Transport Systems (ITS) Conference in Turin in November 2000
- Automatic Dependent Surveillance-Broadcast (ADS-B) Symposium in Rome in March 2002
- Mediterranean Free Flight (MFF) Final Workshop in Rome in December 2005

All endorsed the use of ADS-B in Europe.

NUP (North European ADS-B Update Programme) and MFF were funded in order to convince conservative industry stakeholders of the benefits of ASAS through demonstrations.

There has been no change in the way that we do ATM. However there is currently no consensus and no implementation plan for ADS-B in Europe. New technology is still not coming on line in Europe (e.g. ADS-B or datalink) the FAA have their plans already published and where as Europe used to lead in ADS-B initiatives, it now lags behind. In addition there is no significant work to demonstrate benefits for Package 2 and 3 ASAS applications.

The next barrier to progress is the dynamic tension between ADS-B and 4-D initiatives in ATM. This tension could cause the same indecision and delays that we have recently experienced with datalink.

The Commission view is that ASAS and 4-D are complementary:

- 4-D for planning and avoid overload in certain areas to ensure system efficiency
- ADS-B for local tactical control to ensure safety and maximise capacity

SESAR, which is enabled by European Commission, EUROCONTROL and industry funding, needs to take sufficiently ambitious steps to include ASAS.

UAVs will appear in a human-centered ATM system. ASAS will be part of the solution to automating ATM.

SESAR needs to embrace new concepts of which ADS-B is one. EC and EUROCONTROL projects have shown ADS-B to work and bring benefits. It is up to the ASAS/ADS-B community to make it happen.

- **Nick Sibley**, (BAE SYSTEMS)

Nick Sibley welcomed the attendees on behalf of BAE SYSTEMS.

He said that it was gratifying to see European Commission support for technology programmes which will reduce greenhouse gas emissions through more efficient routings and reduced flight time spent in the hold. One of the pressures on the airline industry today is to improve its green credentials, and more flexible air traffic management as will be discussed over the next few day is one of the few ways we can improve the fuel performance of the existing fleet of aircraft.

Civil aircraft have a very long service life, often flying 1000s of hours a year for 30 or more years and their fuel efficiency is designed into them many years before they are built. An affordable ASAS is almost unique in offering such a retrospective fuel saving and consequent greenhouse emissions.

He made a plea that make the systems be affordable to an operator with 30 to 100 fare paying seats in more congested skies as well as to the long haul operators with 300 or more seats.

A perennial problem for an aircraft designer is deciding which system is going to be the one which becomes the industry standard, so in the case of ground proximity warning systems, there were several systems in the market and those who chose the wrong systems ended up paying to have a second system fit. There is an initiative to integrate ASAS into SESAR, which as an aircraft manufacturer BAE SYSTEMS support.

Global interoperability is also seen as vital.

Military and civil aircraft approvals have historically been rather different in nature, but are converging. This convergence can only continue, particularly with UAVs, so similar standards for military and civil UAV control laws and processes must be a requirement for the future.

- **Phil Hogge**, (ASAS-TN2)

Phil Hogge welcomed the delegates on behalf of the ASAS-TN2 and reminded them that the workshop objective included the need “to accelerate the implementation of ASAS applications in European Airspace”. Bearing in mind that the SESAR Project was now in the middle of its Definition Phase, and that time was very short, it would be particularly important to position airborne separation concepts and the ASAS applications correctly within the SESAR Project. All delegates having any contact with the participants in the SESAR Project must ensure that the potential of these applications is fully understood.

Two new issues that the workshop would address would be (1) to find out what could be learnt from the military experience with data-link systems and ASAS-like applications for spacing and formation flying; and (2) to discuss the increasing use of UAVs and the growing pressure to accommodate them in all the airspace since this could lead to greater use of ADS-B and sense & avoid systems.

Other key issues were the recent developments around the world such as the Australian and US plans for ADS-B implementation, and the US NGATS (Next Generation Air Transport System) work on new concepts of operation that were very similar to those being discussed in Europe. There would also be separate session devoted to human factors issues and work needed on Package 2 applications and beyond.

- **Jim Stenson**, (EURAMID) - **A Military Perspective on ASAS Developments**

Jim is a former RAF air traffic controller (ATCO) and is employed by the Air Traffic Alliance (ATA) as the EURAMID representative on the SESAR executive committee. EURAMID is the European ATM Military Directors Conference.

He stated that military pilots see ATM as a necessary evil. They want free access to airspace, the use of extensive airspace for new weapon systems and as little interference in this as possible by ATM.

In military aircraft ATM equipment competes with military equipment in terms of space and cost. In the military fleets tactical aircraft are different from transport aircraft. As an example, in the UK transport aircraft will be equipped (e.g. C-130 and C-17) and get benefits from ATM. The next generation of Hawk aircraft are TCAS (Traffic Alert and Collision Avoidance System) equipped. However fast jets pose a problem although plans to equip the Tornado GR4 are in place. There is public pressure for a military TCAS-like system following conflicts in the North East of England.

UAVs are coming on-line but currently can only operate in segregated or operational airspace. There needs to be a multi-layered solution to UAV integration and ASAS is a key enabler to this.

There used to be a reluctant engagement with civil ATM by military users, but now the situation has improved. However some states have better relationships between civil and military than others. EUROCONTROL provide a civil military interoperability support structure, however the EC provides a challenge to the military as some states are unwilling to cede security and defence policy to the EU, hence EURAMID is important as an informal conference of nations.

The military fear SESAR will affect their freedom of access to airspace. Consequently the military have to be active in SESAR.

Military airframes, fast jets in particular, exhibit taut equipage constraints; only essential equipment can be considered. However, in reality, anything is possible if money is thrown at the problem. Thus the real stumbling block is budgetary in nature. If the need (expressed in tactical or political terms) is great enough, increasingly scarce budgets will be flexed to accommodate equipage. However, the threshold for all air forces (at least in Europe) is very high. Therefore the perceived need will be very high

A. Session 1 Progress and Status of Implementation and Standardisation

4 Introduction

This session was chaired by **Christos Rekkas** (EUROCONTROL HQ) and **Pierre Gayraud** (Thales Avionics) with **Chris Shaw** (EUROCONTROL EEC) as the secretary.

- Seven briefings were presented in the session:
  - CASCADE Status, ADS-B Implementation in Europe by Alex Wandels
  - Standards by Jörg Steinleitner
  - ADS-B in Australia by Greg Dunstone
  - FAA ADS-B Program by Rick Castaldo
  - Aircraft Operator Plans by Bob Hilb
  - Aircraft Manufacturers Plans by Stéphane Marché
  - Link with SESAR by Phil Hogge
- Chaired discussions including a formal debate at the end chaired by Phil Hogge

5 Review of the briefings

5.1 Alex Wandels (EUROCONTROL HQ)

Brief description

The EUROCONTROL CASCADE (Co-operative Air Traffic Services through Surveillance and Communication Applications Deployed in European Civil Aviation Conference area) presentation consisted of two main parts:

The first tried to answer the question "What do we need to conduct ASAS operations?" The level of aircraft equipage has been mentioned, as well as the growing confidence in ADS-B with EUROCONTROL/FAA/EUROCAE/RTCA work (in the context of the Requirements Focus Group - RFG), the CRISTAL (Cooperative validation of surveillance techniques and applications of package I) validation projects (in 12 European countries) and the ADS-B operations CASCADE, AsA (Air Services Australia) and FAA (US Federal Aviation Authority) have a business case for "ADS-B-out". Concerning "ADS-B-in", the most promising application from this point of view seems to be ATSA-ITP (Airborne traffic situation awareness – in trail procedure).

The second part gave a brief status report on the CASCADE programme, with focus on ADS-B. The CASCADE Programme coordinates the work towards implementation of ADS-B in Europe in the short-term, i.e. 2008-2012 and can report significant progress. The initial validation phase will end in 2006, followed by the pre-operational validation phase (2006-2008) and the implementation phase, starting in 2008 on the basis of the European Implementation plan for ADS-B (to be delivered by end 2007). Currently Sweden has decided to implement ADS-B in Kiruna in 2007, whereas 7 other European countries (Mediterranean) will achieve readiness for operational approval for ADS-B NRA (Surveillance in non radar airspace) and RAD (ADS-B surveillance in radar airspace) in a number of sites by 2008. On the airborne side, the ADS-B Pioneer Airline Project of CASCADE (to be kicked-off in 2006) will catalyse "ADS-B-out" certification by pioneer airlines (currently around 15 airlines have expressed interest in participation). Moreover, a European ADS-B policy is currently being prepared in co-operation with the European Commission.

Key issues in the presentation

- There are a number of building blocks in terms of hardware, software, standards, procedures, confidence, trials, certification and operational approval. Putting these in place requires time, money and dedication.
- Trying to jump immediately from today's operations to ASAS operations is not possible and attempting to do so may be counter-productive therefore CASCADE has established a step-by-step programme.

5.2 Jörg Steinleitner (EUROCONTROL HQ)

Brief description

The presentation reported on the status of the global ADS-B Package I standardization work, largely in relation to the work performed by the ADS-B Requirements Focus Group (RFG). The RFG is a primarily EUROCONTROL/FAA/EUROCAE/RTCA group of experts with additional participation from Australia and Japan.

Firstly, the presentation produced a quick reminder of the RFG scope, approach, process and products. Then, a high-level status report of the requirements definition work on each of the Airborne Surveillance Applications addressed by the RFG was given. This was complemented by the revised RFG planning and put into the overall ADS-B standardisation context. The first deliverable (ADS-B NRA) should be ready this month and six more applications are scheduled from now to 2008. ASPA-S&M (Airborne spacing sequencing and merging) is awaiting maturity of UPS/ACSS M&S (Airborne spacing merging and spacing) concept.

Finally, lessons learned of global ADS-B standardization were captured, also in relation to their bearing on further ASAS requirements determination work within the RFG and beyond.

Key issues in the presentation

- The overall aim of the RFG work is to determine the requirements for each of the Package I applications at the level of operational, safety, performance and interoperability requirements. This is performed through an operationally led top-down approach starting with the precise definition of each application.
- This requirements material is published in EUROCAE/RTCA standards, hence setting the baseline for Package I implementation, incl. at the level of certification regulation.
- Links are well established with the various ICAO Panels concerned and the EUROCAE/RTCA (sub-) system standardisation activities. There is, however, currently a lack of an operational ICAO panel that takes on-board its work programme the procedural and phraseology aspects established for the airborne surveillance applications, i.e. for inclusion in PANS-ATM (procedures for air navigation services – ATM) and PANS-OPS (operations), as appropriate.
- Overall, the RFG progresses well on all its fronts, mainly thanks to its excellent team and the intensive co-ordination applied. A significant milestone is the delivery of the ADS-B-NRA standard material which is due to be published in the fourth quarter of 2006. Given the ambitious work programme, however, additional resources are required in order to meet the target dates of 2007 and 2008, respectively, for the remaining airborne and ground surveillance applications.
- All in all, it is highlighted that RFG establishes the foundation for the implementation of all short-term and future ASAS applications.

5.3 Greg Dunstone (Airservices Australia)

Brief description

The preliminary ADS-B program for ATC surveillance in Australia has concluded. Now the first 5 stations of the Upper Airspace project have been operationally commissioned and are used by ATC operationally. Pilots no longer provide voice position reports. All the appropriate ATC and pilot training is complete. The commissioning of the full 28 ground stations has been delayed by progress on the satellite datalinks to the ATC centres. 5 nautical mile separation standards have been formally approved. A NPRM is under preparation regarding ADS-B avionics standards that will be required if aircraft broadcast ADS-B data in Australia

The ATLAS (Australian Transition to Satellite Technology) project remains under active consideration despite the cancellation of the avionics RFP (Request For Proposal). The cancellation was NOT the result of concerns regarding security, nor due to the purchase of new Terminal area radars, nor due to uncertainty regarding technology choice. Additional consultation regarding a mandate of ADS-B equipage is required.

Airservices has placed contracts for a wide area multilateration system for Tasmania – and for ASMGCS (Advanced surface movement guidance and control system) in 3 major cities. Airservices Australia has also defined changes to the ATC system tracker to include multilateration, ADS-B and radar taking advantage of the strengths of each including linkage to flight plans using the Flight ID field.

Key issues in the presentation

Based on their experience Airservices has raised some concerns based on their experience, namely that:

- ADS-B NRA is operational today. It is believed it is dangerous to keep adding “one more thing” to ADS-B specifications and standards because this behaviour will delay benefits for years.
- ADS-B is a total system where some components are out of control of the ANSP (Air navigation service provider). This is completely normal and not an area of concern because it is the same as radar in this respect.
- Avionics are required to transmit “correct data”. Effort is required to identify and correct the bugs that exist and prohibit aircraft that transmit inappropriate data. The root cause is to be identified rather than complaints about ADS-B data.
- If you don’t trust the transmitted data, not only will ADS-B-NRA fail but air-air applications will never work. Ground based validation systems aren’t available in the air-air environment.
- We continue to be concerned that GPS (Global positioning system) experts are seldom engaged in the ADS-B forums and the role of GPS integrity measurement is not well understood in the surveillance community. The GPS expert role is difficult (they speak another language) but essential
- Presenters in many forums are pointing to so called “bad” positional data with NUC=0 (Navigation Uncertainty Category). In most cases these are aircraft without ADS-B capability but in any case this is of no concern since the data is not misleading. Please stop counting NUC=0 aircraft as ADS-B capable.

5.4 Rick Castaldo (FAA)

Brief description

Rick described the FAA dual track ADS-B program for ground infrastructure and avionics equipage. In addition to ADS-B out for ATS surveillance it includes TIS-B (Traffic Information Service – Broadcast) to provide traffic data from SSR (Secondary Surveillance Radar) to non-ADS-

B aircraft and FIS-B (Flight Information Service – Broadcast) to transmit weather. It will allow starting from 2018 removal of legacy surveillance means. An initial list of 7 ADS-B services and applications has been defined in 4 segments. Segment 1 is scheduled from 2006 to 2010 with segments 2 to 4 from 2010 to 2025. 40% of aircraft are planned to be equipped by 2014 and 100% by 2020. For now the business case estimates that it will be 2031 before reaching break even point on investment. FAA is in process to improve it. Baseline costs of 80 million dollars in 2007 and 85 million dollars in 2008 have been approved. Segment 1 locations are along the east and west coasts, and the great lakes.

Key issues in the presentation

- Program has transitioned from Research and Development (R&D) to implementation
- Segment 1 baseline established
- Dual track service acquisition and rulemaking activities underway
- Risk Mitigation plans in effect
    - Governance process
    - Backup analysis underway
    - Separation standards workgroup established
    - Specification coordination with industry and international community

5.5 Bob Hilb (UPS – United Parcel Service)

Brief description

UPS in conjunction with the FAA, NASA, DOT, MITRE, ACSS (Aviation Communication and Surveillance Systems), and Boeing plans on implementing Sequencing, Merging, and Spacing next year at the Louisville International Airport. Initial implementation will occur in low to medium density traffic involving only UPS aircraft arriving from the west. The airborne Merging and Spacing (M&S) tool will be an implementation of the EUROCONTROL CoSpace algorithm. The ground based Sequencing tool is being developed by NASA and MITRE and is called Airline Based Enroute Sequencing and Spacing or ABESS. ABESS will be operated from the UPS Global Operations Center until it is mature enough be implemented by the FAA.

Constant Descent Arrivals (RNAV arrivals connected to the approach for each runway) have been built from the west. These can be flown with very low power settings by the various aircraft types involved. ABESS builds a sequence of aircraft and assigns airspeeds to the aircraft to obtain approximately the required spacing until the aircraft are within ADS-B range. ABESS then assigns each participant the aircraft to follow and the appropriate spacing to be set in their M&S system. The aircraft use M&S to follow that aircraft to the runway within a much more constant manner. Using time-based wake turbulence separation standards and moving the responsibility of wake turbulence separation to the aircraft enables further capacity gains in almost all weather conditions.

This system will increase capacity and efficiency while reducing noise and emissions. Future phases of the implementation will include high-density operations from all directions during the main UPS hub operation. The M&S system will be upgraded with a combination of the CoSpace algorithm and a NASA developed algorithm which will allow multiple merges on the arrivals and more flexibility in allowing aircraft to pick their own top of descent for the arrival.

Key issues in the presentation

- Standardization of M&S algorithms to ensure worldwide interoperability
- Sequencing of all of aircraft into an airport in a collaborative manner amongst service providers and operators
- CDAs that can be flown by a wide variety of aircraft types with various generations of flight management systems

- Moving to time based wake turbulence separation standards and changing the responsibility for wake turbulence separation to the aircraft
- Universal equipage.

5.6 Stéphane Marché (Airbus)

Brief description

Airbus presented its current plan. It represents an update of the plan presented at the Malmö ASAS-TN2 one year ago.

The first step in the Airbus ASAS plan is ADS-B-Out. Airbus has set up a strategy to support the ADS-B Out certification of the aircraft in operations and already ADS-B capable at minimum cost. Behind that Airbus prepares the future of ADS-B Out, anticipating required additional messages resulting from the RFG work, compliance with new standards (e.g. DO-260A for USA) and transponder continuous improvement.

The second step is the implementation of ADS-B-in applications: ATSA applications. ATSA-ITP (In Trail Procedure) is the most promising in the short term: it will allow significant fuel saving. Even without ATSA-ITP, ATSA will provide benefits: TIBA (Enhanced Traffic Information Broadcast Application) or enhanced traffic awareness. The target date for ATSAW certification is end 2008. Meanwhile maturity on ATSA-ITP procedures will be gained and technical as well operational assessment will be performed within the EUROCONTROL CRISTAL ITP project and the equivalent projects in Australia and USA.

The future step for ATSA will be on airport surface (ATSA-SURF).

Key issues in the presentation

- ADS-B Out certification for ATS surveillance.
- ATSA-ITP is the most promising short-term ATSA application.
- Need to validate the ATSA-ITP procedures in the CRISTAL ITP program.

5.7 Phil Hogge (ASAS-TN2)

Brief description

The SESAR Project was currently in the middle of its Definition Phase during which it would (1) define the Future ATM Target Concept, (2) define the architecture of the ATM System Network, and (3) identify a set of Enabling Technologies. The deadline for input to these discussions was March/April 2007, time was very short.

The Future Concept of Operations ought to include (1) the use of 4D trajectories to assist flow management and to strategically de-conflict traffic (to the extent possible); and (2) airborne surveillance to assist pilots to share tasks such as spacing and separation.

NGATS was looking at similar concepts in a similar time scale in the US. Thus there is a rare opportunity to drive standardization and commonality with regard to systems, procedures and phraseology on both sides of the Atlantic. Full use should therefore be made of the MoUs (Memorandums of understanding) signed between the EC and FAA and between Eurocontrol and FAA on coordinating implementation and R&D. Furthermore, the SESAR JU (Joint Undertaking) and the JPDO (Joint Planning and Development Office)//FAA should be required to coordinate effectively.

Australia was implementing ADS-B Out in non-radar airspace (ADS-B NRA), and the US was planning to do the same in radar airspace (ADS-B RAD). However in Europe, while there is work being done at programme level, there is no high level plan committing all European countries to an ADS-B implementation plan together with a corresponding rationalization of the SSR infrastructure. SESAR will need to plan this, and it will also be necessary to agree the common worldwide standard for ADS-B Out.

In oceanic areas the addition of ADS-B In and a CDTI (Cockpit Display of Traffic Information) would permit aircraft to carry out in trail climb procedures which could bring substantial benefits in the form of fuel savings and, on the long Pacific payload/range limited sectors, the ability to increase payload (i.e. additional revenue). There is therefore considerable potential on all oceanic routes for the use of these ASAS applications, and it is to be hoped that the North Atlantic could be used as a proving ground for the first application of self-separation techniques.

In dense continental airspace, ASAS applications are already being used for spacing and enhanced visual separation on the approach (ATSA-VSA) in the USA at Louisville, and in Europe simulation studies have been carried out on sequencing and merging (ATSA-S&M) in the TMA(Terminal Manoeuvring Area). In both these situations benefits can be shown in terms of capacity, reduced fuel burn and reduced emissions. In addition ATSA-SURF has the potential to substantially improve safety on the airport surface. It would only take another runway incursion accident to trigger public and political pressure for its quick introduction, as was the case with TCAS in the US some 20 years ago.

ASAS applications should be considered as part of the controller's "tool kit" and be an integral part of the ATM system. 4D trajectories and ASAS applications should be used together in a balanced way, the exact balance depending on future developments. A rigid 4D trajectory system might not be able to cope with all the usual perturbations of the system (weather, aircraft unserviceabilities, lost passengers, etc.) and could prove to be very expensive in terms of computer requirements on the ground. Equally, full self-separation in dense airspace might prove to be too expensive to certificate. The balance is probably to use 4D trajectories to achieve a measure of "strategic de-confliction" with ASAS being used for some spacing and separation functions.

Autonomous operations are very attractive to aircraft operators since several simulations show that only a distributed self-separation process appears to be able to cope with three times the current traffic levels. The INTENT Project has shown that controllers using ground-based systems became overloaded at around 1.5 times the 2000 traffic levels, whereas pilots were still not overloaded at 3 times the traffic. The author of this presentation has flown the NLR GRACE (Generic Research Aircraft Cockpit Environment) simulation and was very impressed by the flight deck displays and the ease with which, after only minimal training, it was possible to carry out self separation in the above traffic levels in Maastricht airspace. He was also convinced that a CDTI alone was not adequate and might even be dangerous. Predictive ASAS with the requisite Conflict Detection &Resolution algorithms, symbology and alerting logic was necessary in order to display predicted conflicts and the necessary track changes or vertical manoeuvres to resolve them. Predicting conflicts was not intuitive but with Predictive ASAS the task became surprisingly simple.

Most aircraft and avionics manufacturers are working on ADS-B and ASAS systems, and it would be very helpful if they could reach a consensus as to what was necessary, together with a road map of possible implementation. But the most important steps are:-

Key issues in the presentation

- SESAR must look outside Europe and build on the developments that are taking place elsewhere in the world.
- SESAR should adopt ASAS applications as controller tools, integrated into the ATM system.
- The SESAR concept of operations and associated roadmap must be developed in such a way that it keeps in step with NGATS
- SESAR must keep the door open for the use of autonomous operations in the long term.
- The ASAS community must educate proactively all those who are working to develop the SESAR concept of operations so that ASAS applications are understood and their potential fully appreciated.
- The requisite input to the definition of the future concept of operations must be made by March/April 2007.

6 Issues from chaired discussions

Bernhard Wolfmayr, Austrocontrol: Expressed concern about dependent surveillance like ADS-B replacing SSR?

Greg Dunstone, Airservices Australia: answered SSR is dependent in the vertical sense.

Rick Castaldo, FAA: added with appropriate analysis ADS-B can be as safe as SSR.

Abbas Rizvi, FAA: confirmed that ICAO define surveillance as independent if the object does not participate and consequently they are both dependent.

Bill Booth, QinetiQ: asked whether the airlines are involved?

Rick Castaldo, FAA: answered we meet president of ATA (Air Transport Association) monthly. The FAA are following closely UPS.

Greg Dunstone, Airservices Australia: suggested looking at ATSA (Air Traffic Services Australia) website. Airline representatives (IATA International Air Transport Association) are requesting a mandate.

Alex Wandels, Eurocontrol HQ: replied airline commitment in Europe is not as big as US, JAFTI (Joint User Requirements Fast Track Initiative) airlines are on-board.

Greg Dunstone: replied that all customers are saying they want ADS-B in Australia

Chris Adams, Eurocontrol Maastricht: asked if there are any plans for ADS-C (ADS- Contract).

Greg Dunstone: answered already ADS-C nationwide in Australia with FANS-1 (Future Air Navigation System). There may be a transition to ATN (Aeronautical Telecommunications Network) if the customer requires.

Kevin Morgan, NATS UK: asked how to approve safety in Europe?

Alex Wandels: answered that EASA (European Aviation Safety Agency) handles airworthiness in Europe whereas ATM is handled at a national level.

Chris North, European Commission: replied there is a proposal to extend the competence of EASA to ATM. Legislative proposals may be in 2007 and take another 4 to 5 years to become effective.

Mike Wood, Flybe: Cargo airlines are exceptional. Majority of airlines are making losses (total in billions of dollars) and not in a position to invest.

Rick Castaldo: Cargo airlines fly at times when passengers do not. It is not simple to build new runways. There is financial pressure to change. There is not much choice but to implement ADS-B.

Alex Wandels: Europe and Australia try to see what can be done with existing transponder D0260.

Greg Dunstone: commented that the drivers are different in different parts of the world.

Rick Castaldo: ADS-B allows use of airspace that couldn't be used before. Much of the US military can't fly in RVSM (Reduced Vertical Separation Minimum) airspace because they are not equipped. If we do not make a decision today, tomorrow will be more expensive.

John Ackland, Boeing Seattle: suspected there was a lack of understanding of how avionics get onboard aircraft. Manufacturers need to look at typically 1,200 customers and how can operation benefit them?

Tony Henley, BAE Systems UK: asked when will Europe have an area with ADS-B and will SESAR have an impact on the timescales?

Alex Wandels: replied Sweden should have ADS-B next year and SESAR should not push back the timescales. ADS-B policy is coordinated with European Commission. Chris North recommends being ambitious for feeding into SESAR. Some use SESAR to slow down ADS-B implementation progress. In the longer term SESAR should include ADS-B out and accelerate ADS-B progress.

Rick Castaldo: commented that 4D and ADS-B are not in competition. ADS-B is an enabler for 4D. He advised caution when analysing the cost of ADS-B. He asked the question where is the ratio 1:10 derived from?

Christos Rekkas: Replied that the 1:10 ration is based mainly on comparing the costs of SSR ground stations with ADS-B ground stations.

Rick Castaldo: There will be substantial costs on the airborne side of ADS-B

Bob Arnesen, IFALPA/ECA: questioned the use of the term visual approach in Phil Hogge's summary?

Phil Hogge: replied that he should have said visual separation.

Bob Arnesen: asked NLR if the targets in their self-separation simulation were also flying autonomously?

Rob Ruigrok, NLR: answered yes but all aircraft have flight plans direct to destination and manoeuvre according to rules.

Phil Hogge: added that the self-separating aircraft were not free to do as they like and reminded the audience of how the term free flight had become so misleading.

Bob Arnesen: commented that without rules there was concern that pilots might be encouraged to 'play chicken' with each other.

Rob Ruigrok: described the self-separation pilot tool predictive ASAS with the amber and yellow bands of heading etc to avoid creating conflicts.

Mark Watson, NATS: asked if the UPS merging and spacing application for Louisville could work in dense complex airspace like at London Heathrow?

Bob Hilb: The application should be able to work in high density with close to 100% equippage

Mark Watson: asked how crossing traffic could be handled?

Bob Hilb, UPS: replied there would still be a need for a tube like structure airspace to channel the crossing traffic

Hugo de Jonge, NLR: asked if during the merging and spacing application if a critical distance spacing had been seen below which oscillation occured?

Bob Hilb: mentioned that they had not seen any oscillation so far.

Hugo de Jonge: wondered if controllers are keen on capacity then what happens if they delegate separation?

Bob Hilb: replied that reducing spacing tolerance should increase throughput

Goran Lindquist, LFV: commented that UAVs have no pilot on board and asked if there are plans to reduce the number of pilots on board at UPS

Bob Hilb: replied not that he was aware of.

Tony Henley: there is a reduced crew research project within the EC framework programme 7

Stephane: emphasised that there is a need to show benefits

Bob Hilb: commented that an RTCA group had prepared 12 benefit categories.

Rick Castaldo: commented that speed accuracy enroute of ADS-B is better than classical radar.

B. Session 2 – UAV, Military and Business Aircraft Operations: ASAS Implications

7 Introduction

This session was chaired by **Tony Henley** (BAESYSTEMS) with **Peter Howlett** (Thales ATM) as the secretary.

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

- Six briefings presented in the session:
  - Civil/Military Challenges by Francois Cervo
  - Airborne Data Links by Jonas Jakobsson
  - Business Jet Cockpit Challenges by Serge Lebourg
  - UAV Systems in Civil Airspace by Martin Darkins
  - UAVs in ATM – a Cooperative Approach by Göran Lindquist
  - Sense and Avoid – UAV Conflict Avoidance by Jean-Louis Roch

8 Review of the briefings

8.1 François Cervo (EUROCONTROL HQ)

Brief description

François Cervo first presented an overview of the current status and use of military data links. He then addressed the challenges of ensuring datalink interoperability between civil and military aircraft, based on the findings of a feasibility study conducted in 2003 on civil aviation use of the MIDS/Link 16 technology. He also addressed some concerns related to safety and security.

Key issues in the presentation

- Military operations rely on a multi-link environment employing state of the art Data Link technologies.
- Civil-military data link interoperability needs to be addressed.
- Feasibility of civil aviation use of MIDS/Link 16 was investigated in a study made in 2003. The main conclusions of this study were:

  Civil aviation use of MIDS/Link 16 is considered feasible but a majority of opinions was against the proposal because of:

  - Frequency and spectrum constraints in the L band
  - Institutional, security issues
  - Some technical constraints (latency, Doppler, etc.)
- Way Ahead is yet unclear:
  - Ensure interoperability through a Ground Interface solution?
  - A Future interoperable civil-military Communications System based on software data radio technology?

8.2 Jonas Jakobsson (Swedish Airforce/SAAB)

Brief description

Jonas Jakobsson is a test pilot with SAAB AB. His presentation reflected on his own experience and lessons learnt from flying military aircraft equipped with digital datalinks, multiple surveillance sensors and advanced displays and how these could apply to ASAS operations in the cockpit.

Key issues in the presentation

- Cockpit displays should be designed in accordance with a "Need to know" philosophy. It takes considerable time and maybe even a few mishaps for a pilot (or air traffic controller) to accept the fact that it might be a good idea not to be presented with all the information at all time.
- It has been regularly observed that Modern Situation displays tend to get too much attention from the part of pilots who spend too much time head-down. A similar effect was noticed when VFR pilots started to use GPS navigators.
- Military operations routinely fly IMC with as little separation as 1,5 nm within the group. While this is currently achieved with a combination of datalink and aircraft radar, it has been established that datalink alone would be sufficient.
- While older cockpits had dedicated controls and displays associated with the various sensors, Modern military cockpits are now designed to merge information collected from multiple sensors. This principle is very effective and facilitates handling of
- Beware of degraded modes and possible artifacts/misbehaviours introduced by these modes.
- Airborne data links are great and one of the major improvements that have been done to military aircrafts. This could easily translate to civil aircraft. However, in order to be successful, care should be taken when introducing airborne data-links and displays e.g.:
    - Display information when and if needed. Avoid information fatigue
    - Develop procedures and train pilots to use the information properly, in particular:
        - Train pilots to know when to fly head down and when to fly head up.
        - Train pilots to cope with degraded modes

8.3 Serge Lebourg (Dassault Aviation)

Brief description

Serge Lebourg presented views on future crew configurations being investigated in the context of future business jets taking advantage of increased automation and addressed some of the issues associated with these crew configurations.

He touched upon predicted improvements in the Communication Navigation and Surveillance areas that could benefit these types of aircraft. He emphasized how ADS-B and ASAS applications could improve operations but also some of the issues that need to be addressed.

Key issues in the presentation

- In the last ten years, aviation safety has improved in such a manner that last year there were no catastrophic accidents in commercial air transport in Europe. One of the main contributors to this improvement is progress in the domains of avionics with the generalization of collision avoidance systems in the air (TCAS) and with the ground (GCAS) and the use of large displays able to provide the pilot with a clear status of the aircraft trajectory and situation awareness. Aviation safety must continue to improve despite the ever-growing traffic

- This challenge will request a new approach of the aircraft systems and of their use by the crew.
- Automation has always been a way to improved safety, but automation is only efficient if pilots can be "kept in the loop". Crew roles will have to be redefined and dangerous situations due to poor crew coordination eliminated.
- New crew configurations will have to be developed such as:
    - "1 pilot + 1 pilot resting" for long haul flights
    - "1 pilot + 1 Qualified Crew Member (QCM)"
    - "1 QCM " crew configuration to allow safe operation of automatic aircraft (last step before introducing UAV in air transport)
- ATM will play an important role and will be also a challenge in the way to improve the safety.
- Communication: communications based on obsolete VHF or HF technologies and using English language voice communication represent today probably the highest risk in term of safety.
    - New systems based on "message data link" allowing automation of answers have to be developed.
    - Introduction of such system will drastically reduce pilot workload and so will improve safety.
- Navigation: GPS has shown the way, tomorrow navigation systems allowing automatic landing on any runway will have to be developed.
- Surveillance: ADS-B is coming, ASAS too, this will allow for a better optimization of the flight, nevertheless ASAS will have to be evaluated in the light of crew reduction. To avoid that collision be the result of a single error, ASAS might require automation of collision avoidance system (TCAS).

8.4 Martin Darkins (BAE SYSTEMS)

Brief description

Martin Darkins presented an overview of the BAE Systems activity in UAVs which has resulted in the first CAA approved fully autonomous mission of an unmanned aircraft in UK airspace. Much of the information presented has only recently been approved for public release.

The presentation covered the scope of Military UAVs, the main challenges to UAV operation in civil airspace, what is being done within the UK and concluded with a comment on the likely impact of ADS-B. There is a wide range of UAVs flying today. They range in size from the relatively small vehicles like the BAE Systems Phoenix to the Global Hawk, which is the same size as a Boeing 737, with widely varying missions. Broadly UAVs fall into two groups: low cost short range continuously monitored vehicles and expensive, large, long endurance vehicles with ever increasing level of autonomy. An “Autonomous” Vehicle was defined as one which flies a mission based on a task and has the ability to react to threats and its situation awareness without human intervention

The challenge is to provide unmanned autonomous vehicles which can seamlessly integrate into the operational environment. To this end, a dedicated team has been set up to explore the boundaries of fully autonomous flight.

In Civil controlled airspace the ATC who are responsible for safe separation between aircraft should be unaware of whether they are dealing with a manned or unmanned aircraft. The key Issues are:

- Will UAV be able to comply with ATC requests as a manned a/c - there could be a delay communicating the instruction to a UAV operator in a ground station
- Who has control over UAV? Who takes responsibility? And what happens if the UAV automatically responds to ATC, which contradicts an onboard conflict detection and resolution system.
- What happens if communication is lost?

However ASAS advocates that pilots will be able to take on more responsibility for their safe spacing with other a/c including UAVs. Aircraft with ADS-B-in will be able to see a/c in their vicinity and take appropriate action to maintain safe spacing. The £32M UK funded ASTRAEA programme aims to challenge regulatory requirements and develop and test new operational rules. ASTRAEA will investigate use of ADS-B technology to enable ATC spacing and separation tasks to be delegated to the UAV pilot when flying in controlled airspace and new operating procedures for UAVs with a level of mission autonomy.

A key enabling technology is Sense and Avoid and BAE Systems are planning a flight trial of Sense and Avoid algorithms together with virtual ADS-B inputs to recreate the equivalent of a pilot's See and Avoid capability. The trial will use a modified Jetstream (with a pilot) operating in automatic mode.

The Sense & Avoid algorithm known as the Collision Detection and Resolution algorithm formulates a series of nested cylindrical zones around the target aircraft. The first is the Protection Zone, which represents the region of space with an unacceptably high risk of collision. The second zone is the action zone in which warnings of collision are issued and avoidance action commanded.

For the ADS-B test, virtual ADS-B tracks will be separately generated on a co-altitude but opposite heading to the Jetstream

For UAVs operating under mission autonomy new flight rules and procedures will have to be defined. This will be very much easier if ALL air vehicles including balloons gliders etc are ADS-B-out capable. This will be a challenge but would provide a very large market which should reduce the cost.

Conclusion

UAVs are here now, they are being used in war zones such as the recent Lebanon conflict but very close to civil air space. They will also be used for crisis management in populous areas. We need to be able to operate UAVs in unsegregated airspace and widespread ADS-B equipage will make this much easier

Key issues in the presentation

- UAVs are happening now
- There will be lots of them with very different capabilities
- Operation in civil airspace is a key requirement
- ASAS/ADS-B will significantly contribute to achieving this

8.5 Göran Lindquist (LFV)

Brief description

Göran Lindquist presented an ATS' providers and an ATCO' views and involvement in future UAV operations. Focus is on the UAV integration with other traffic into non-segregated airspace. LFV and SAAB are conducting joint simulation studies & workshops during 2006/07 in preparation for a live Demonstration "Castor UAV Demo" in less than two years from now.

Several national actors, incl. certification procedure with Swedish CAA are jointly contributing in development of this UAV concept to operate in non-segregated airspace focusing on newest ATM technology.

The business opportunities for this segment of civil UAVs are based on them being very "cost effective" and "easy to operate", having "long endurance", certified for "all types of airspace" and available for a completely "new civil market". Mission objectives can typically be foreseen in surveillance and search missions connected to forests, agricultures, high sea, search & rescue, paparazzi, power cables, roads, etc, .

It is anticipated that by the time they come into full operational service UAV autonomy will be very well developed. We should all be aware that the UAV customer's will require their "picture-products" continuously on-line. The need for ATM flexibility is therefore much more important for UAVs than other airspace users. UAV will most likely request to operate "anywhere" at "anytime".

An OSED for the Castor UAV Demo has now been produced jointly by LFV and SAAB.

A number of joint Simulations, Workshops and Validation studies are in progress at Malmö-Sturup. Several objectives have been defined for these, including, analysis of impact on the ATM community and on the UAV airworthiness process. Potential solutions will be evaluated, and together with necessary further developments of the ATM infrastructure and UAV technology to improve UAV operability.

Introduction of UAV today will create unfamiliar situations for ATM:

- UAVs demand new solutions to meet new operational needs
- The level of automation in UAVs makes it necessary for ATM to treat UAV differently
- Large numbers of simultaneous UAV operating in same area; together with their long endurance will create challenges
- Data link failures, engine and avionic failures will require special attention

"UAVs can be seen like flying virgins – Innocent, Curious, Very well equipped!"

Key issues in the presentation

- UAV - enablers for new ATM concept.
- UAVs will form a bridge into a new era of civil and military ATM based on many of the ASAS foundations.
- UAV can be a catalyst for a rapid move towards ASAS-based ATM
- ATM providers can down stream take an active role in UAV operations
- Be sure, civil operated UAV will soon share the non-segregated Sky.

8.6 Jean-Louis Roch (Thales Aerospace)

Brief description

Jean Louis began his presentation by introducing the principle elements of a general UAV system i.e. the air vehicle with its propulsion, avionics and 'mission' payload, the ground segment comprising control station with operators and the launch and recovery systems, with some form of data link connecting the two. He also indicated that UAVs have to work in complex environments potentially interacting with a range of air ground and satellite systems.

A critical features of UAVs, stemming from the lack of an on board pilot, is situation awareness which depends on sensors collecting and transmitting data to the ground with associated problems of latency. UAVs also introduce new failure modes including 'loss of data link' which leads to the need for at least some vehicle autonomy. It is therefore essential that some form of 'sense (or detect) and avoid' system be provided. The exact requirements of the function are still to be defined but some key principles can be identified; in order to operate in unsegregated airspace the UAV must be able to identify, and be identified by, the surrounding traffic as well as the ground traffic control. Systems which provide this capability must meet the requirements of airworthiness and operational authorities. Specifically the resulting system must demonstrate an equivalent level of safety to that achieved by current manned vehicles and operate in a manner transparent to ATC and other users.

The sense and avoid function needs to provide awareness of all other traffic (both co-operative and uncooperative) as well as a manoeuvre capability to avoid collisions. It is also anticipated that terrain and weather awareness will be required to ensure equivalent 'manned' vehicle operation.

Considering the traffic sense and avoid requirement, this could be met –at least in respect of cooperative threats - by the current TCAS II system extended to provide an automatic manoeuvre capability. For non-cooperative threats a mix of sensors possibly including lightweight radars and /or electro-optic and infra-red will be required. Significant work to test the effectiveness and method

of use (automatic response or via the ground operator) still need to be done. Regulator acceptance of the safety case is a significant issue.

ASAS/ADS-B may provide significant operational benefits for UAVs both in terms of situational awareness and enhanced manoeuvre capability e.g. sequencing and merging.

A three layer 'awareness' approach is envisaged comprising strategic – covering terrain weather and long range traffic, Tactical which would provide alerts on threats and Reactive which should provide short term manoeuvre capability in response to imminent hazards.

In conclusion the technologies for sense and avoid exist – although their conformance to the regulatory requirements remains to be confirmed, UAVs are likely to be significant users of ADS-B and ASAS to support interaction with traffic and ATC, and new 'UAV technology' e.g. sense an avoid, is expected to have significant benefits for manned civil air transport.

Key issues in the presentation

- To operate in unsegregated airspace UAVs will need 'Sense and Avoid'
- 'Sense and avoid' must work with cooperative and non cooperative threats
- UAVs are expected to make use of ADS-B /ASAS both for situation awareness (cooperative threats) and for operational reasons
- 'Sense and avoid' once approved by the regulators is likely to be used to enhance the safety of manned civil operations

9 Issues from chaired discussions

B. Wolfmayr (Austrocontrol): How do you envisage UAV/aircraft separation in uncontrolled airspace?

M. Darkins: This would be done with some of the sense & avoid technologies presented earlier, but it is then a matter of cost versus performance and whether or not the other aircraft are equipped with cooperative transponders.

K. Morgan (NATS): What is the business case for trying to accommodate UAVs in non-segregated airspace? In the end, the ATM system is paid for by airlines so what would be the motivation for airlines to invest to allow UAVs to fly in their airspace?

T. Henley: It's a valid question that needs to be addressed globally.

Alternatively, why wouldn't the UAV community have to pay for the improvements and for the service?

Q: In what timeframe do you see UAVs coming into non-segregated airspace?

M. Darkins: Rate of progress is huge. There will be some products around in 5-years' time. The ASTRAEA was initiated precisely for this reason: look at what needs to be done to allow UAVs in non-segregated airspace, so expect this to happen in the short term.

J.L. Roch: Yes, 2012 appears to be a reasonable estimate. There are already around 2000 UAVs in operation in Japan, so it's for real.

S. Lebourg: See & avoid procedures are fundamentally unsafe and UAVs may be a way to accelerate the development of safer procedures and principles that could then be adopted for manned aircraft.

J. Brown (Boeing) So much effort goes into see & avoid but I'm surprised to see that so little is done about ensuring separation. Is separation solely done by ATC or does the UAV operator have a role to play here?

C. Adams (Maastricht UAC): Maastricht operational centre has already been approached by a Civilian Company who want to operate civil UAVs. They are there and they are flying, so why are we still at this stage?

C. Session 3 – Human Performance, Human Factors and a Cognitive Systems Approach to ASAS Operations

10 Introduction

This session was chaired by **Billy Josefsson** from LFV with **Anthony Smoker** from IFATCA and **Giorgio Matrella** from ENAV as the secretary.

Seven briefings were presented in the session:

- Overview of Human Factors and Human Performance Issues and Activities by Anthony Smoker (IFATCA)
- Situational Awareness Issues of both Pilots and Controllers by Claudia Fusai (Deep Blue)
- Controller and Human Performance Issues of both Pilots and Controllers by Sven Ternov (LFV)
- Pilot Human Factors by Rob Ruigrok (NLR)
- Pilot and Human Performance Issues by Bob Arnesen (IFALPA)
- Cognitive Engineering Perspectives of ASAS by Amy Pritchett (Georgia Tech)
- A Model of Cognitive Systems and ASAS that supports an ASAS Human Performance Research Agenda by Fredrik Barcheus (KTH Sweden), Lena Martenson (KTH Sweden) and Anthony Smoker (IFATCA)

11 Review of the briefings

11.1 Anthony Smoker (IFATCA)

Brief description

Anthony Smoker presented an overview of the issues. ATM Human Factors work from analysis of HMI issues, workload experiments and analysis of situational awareness.

The focuses of the presentations in this session are:

- Cognitive engineering and joint cognitive systems
- Human performance
- Resilient systems and resilience engineering

In the real world context ATM Human Factors should recognize that human beings rarely, if ever, plan to be unsafe in what they do. Human beings seek to optimize processes, this includes both taking the line of least resistance as well as using systems in ways that were never envisaged by the designers.

At present it appears that every system is stretched to operate at its maximum capacity. Given this it is likely that whatever ASAS is designed to bring in terms of benefits, it is likely that it would soon be used in other ways to stretch capacity.

Cognitive aspects of systems and collaborative and cooperative systems need to be studied. How will safety be measured in the context of these interacting systems, indeed do we really understand safety today?

Systems may have competing goals and in some instances there are competing systems. We need to understand and define where the boundaries lie.

Key issues in the presentation

- Have all the ASAS HF issues been captured? Will the ASAS system be tolerant of failures?
- Do we really understand safety today?
- Do we understand where the boundaries lie between joint systems?

11.2 Claudia Fusai (Deep Blue)

Brief description

Starting from the experience gained during the Mediterranean Free Flight (MFF) project, the presentation focuses on controllers' situational awareness during ASAS applications (sequencing and merging).

The controllers ASAS tools described in the presentation refer to the ones used in the last MFF real time simulation (RTS3), as they proved to be the most mature and effective developed within the project. The presentation shows on one side the items that controllers found effective to build an appropriate picture of the situation and on the other side it describes controllers' suggestions to improve the HMI. For each improvement requested by controllers, the relative problem evidenced during the simulation is also presented, in order to appreciate the understanding of the criticality.

Key issues in the presentation

- Human Factors analysis of the controller's activity identified the need of tools and procedures to support the management of the traffic during ASAS applications. In particular some of the difficulties evidenced by controllers were related to:
    - The representation of potential ASAS chains between different sectors, to ensure the building of a common picture and therefore to ease and speed-up inter-sectors co-ordinations.
    - The monitoring of ASAS chains in order to reduce controllers' uncertainty regarding the ability of an a/c to achieve the spacing, to be aware of eventual problems in maintaining the spacing and to support the use of cognitive clusters.
- ATCOs were not comfortable in being responsible for the safe separation in the spacing task whilst delegating this task to the flight crew. Controllers demanded clarity to the roles and responsibility of controllers and pilots in the spacing manoeuvre. Where the responsibility is with the controller, then a monitoring tool shall be provided.
- Even if some general ASAS procedures are currently defined, the simulation proved the need of procedures refinement, procedures detailing and of a further investigation on how ASAS impacts on current procedures.

11.3 Sven Ternov (LFV)

Brief description

The presentation discussed, in a generic manner, the benefits and eventual hazards from the different new applications, such as departure management, in trail spacing, free flight in uncontrolled airspace, integrated runway management, ADS-B, 4 D trajectory and similar tools. The data was based upon several real time simulations and live trials.

Each of these tools was considered from human factors and safety perspective, the premise being that capacity and safety were in essence seeking to be balanced. In particular controllers maintain an active monitoring task, as a dimension of their workload, which is an essential component of safety in operations. Thus the human factors results were analyzed with consideration of the effect upon safety.

The following were recommended for further research:

HF & SAFETY need to integrate

Roles ATCO – PILOT – SYSTEM

Who is the monkey? Who is the organ grinder? Who is responsible for safety (when??)?

How to keep the ATCO alert when in monitoring mode

Key issues in the presentation

- Is the role-play between controller/pilot poorly defined with negative impact on collaborative decision making?
- Does the new application interfere with the controller's safety monitoring process?
- May the input from the application trap the controller into making erroneous decisions?

11.4 Rob Ruigrok (NLR)

Brief description

Sound human factors research means that you test a new system or procedure in a balanced way on a representative mix of enough end-users and determine statistical significance on different systems procedures. The techniques employed include model-based simulation, low and high fidelity real-time simulation, and live trials.

Summaries of the results of 4 projects on the human factors of ASAS as performed by NLR, were presented:

- NLR/NASA Free Flight
- INTENT,
- MA-AFAS
- MFF

These showed that:

- Vertical navigation display not required for traffic reasons
- State based CD&R required, but intent based CD&R is preferred.
- Conflict prevention function required
- Human-machine interface used is "favourable' to "perfect"

Key issues in the presentation

- Pilot workload was generally acceptable and not an issue in the experiments
- Use of procedural based rules to support ASAS self-separation operations where multiple aircraft conflicts: CD&R priority rules and a flight level orientation scheme to contain the number of conflicts
- ASAS/ACAS integration is partially addressed, but not yet solved completely. Are the two compatible?

11.5 Bob Arnesen (IFALPA)

Brief description

The greatest challenge in the development of ASAS will be to integrate the necessary software and hardware into the aircraft and thereafter establish and implement ASAS procedures for the different

applications that ensure that the cockpit workload does not significantly increase. Pilots work in an environment where they are legally responsible to manage their flights so as to avoid collisions through the use of many long established tools such as right-of-way rules, see-and-avoid, selection of flight levels, etc. The pilot community sees a number of ASAS applications as being tools the can be used to effectively and safely manage the flight from start to finish in the future ATM. Proximity avoidance based on a CDTI is fundamentally different from separation provisions. The implementation of advanced airborne procedures, together with any associated deviation from traditional separation provisions, needs to be done on a "total system" basis, evaluating both the airborne and ground based components against the latest advances in human performance. Given the complexity and density of the airspace today and in the future, IFALPA believes that separation responsibility should remain with ATC on the ground. The question that needs to be asked is, in a highly regulated environment that demands the utmost of discipline and compliance with clearances and instructions. Do we want pilots exercising autonomous responsibility at will? Or are we willing to accept the fact that someone has to have responsibility for the big picture and that pilots, given the right tools, are capable of performing approved and tested procedures?"

Key issues in the presentation

- The ASAS hardware and software needed to manage the flight must be developed and integrated so that the pilot avoids heads down and away down to perform them.
- The use of ASAS applications must not lead to any significant increase in workload for the cockpit crew.
- Do not underestimate the amount of initial and recurrent training that ASAS operations will require.
- ASAS is just one of many tasks that that a pilot can perform and is a tool that they will have to optimize the management of the flight.
- Proximity avoidance based on a CDTI is fundamentally different form separation provisions.
- ASAS applications that go beyond "separation assistance" should be renamed.
- IFALPA is of the opinion that separation responsibility should remain with ATC on the ground based operation.

11.6 Amy Pritchett (Georgia Tech)

Brief description

In addition to the concerns noted by the other speakers, a number of additional concerns are raised by ASAS systems when examined in the broader context of roles, responsibilities, and operating procedures.

The first of interest are the broader implications of situation awareness for the design of ASAS -- the human pilot will likely require not only knowledge of the other traffic, but also an understanding of how, when and why the ASAS issues alerts and commands, and how they relate to operating procedures and goals. This advances concerns with situation awareness from being primarily a 'cockpit display' issue to also ensuring that the algorithms and functioning underlying ASAS are communicated to the pilot (and perhaps controller) -- and thus that they are communicable, a constraint on algorithm design.

The second of interest to this talk recognizes that the role of the ASAS will not be ultimately determined by the system designers, but by the pilot interacting with it in a dynamic operating context. Early studies have found, for example, that systems such as GPWS and TCAS may be given the role in one context as an attention director, but in others may become command devices or initiators of procedures, and yet others serve as sources of nuisance and overload. The factors influencing the assignment of role can include not only the system's functioning, but the pilot's understanding of the situation without any decision aiding, supporting and conflicting operating procedures, managerial pressures (just follow the alert!), and cultural standards for interaction with technology.

Key issues in the presentation

- HF must be in earlier in the design / decision phases for anything that relates to ASAS operations.
- Concepts must be empirically tested and evaluated.
- Humans should not be perceived as a black box in the system model: the environmental and contextual factors must be understood and considered. Human behaviour makes sense only in context.
- Cognitive Engineering basic principles are applicable to ASAS definition, design and development
- Attention director metaphor useful in ASAS design of warning monitoring system in particular.
- ASAS deserve a broad system viewpoint
- Procedures should be designed as rigorously as technological components of the system. Procedures provide the baseline for behaviour by the human actors in the system. They drive expectation for example.

11.7 Fredrik Barcheus , Lena Martenson (KTH Sweden) and Anthony Smoker (IFATCA)

Brief description

ATC is a typical example of a complex socio-technical system, and as such is not easily analysed. A common way of handling this complexity is to simply bind the scope of analysis. However, if the boundaries are not drawn with the appropriate degree of aggregation, conclusions drawn from the analysis that are proper within the narrow scope that is analysed may be dysfunctional within the larger scope of the final system.

In the system there are sources of information and actors that may take the form of humans or automation. This may be described as a Joint Cognitive System (JCS). The basic assumption of a JCS is that the whole is larger than the sum of the parts

A Joint Cognitive Systems perspective prescribes that:

The human should not be considered from a linear “information processing” view, but as a part of an integrated whole

Rather than regarding humans and machines from the view that one or the other is more fit for some tasks (according to Fitts’ list) the machine may be regarded a cognitive agent

The problem driven approach implies that current working procedures must be thoroughly investigated, and human operators should be part of the development along the way, not only as test drivers of complete components

Key issues in the presentation

- JCS model can accommodate both air and ground components and behavior
- JCS are flexible and can house future developments within ASAS and air-ground integration
- Cognitive engineering analysis of ASAS applications demand that the total air and ground system is represented.

12 Issues from chaired discussions

John Brown (Boeing) raised the issue of the validity of the results via a vis volunteer pilots versus pilots who have little interest in getting involved with experiments into future operations as well as the number of line pilots who have been exposed to ASAS experiments.

Amy Pritchett (Georgia Tech) commented that cultural differences between different companies as well as countries all contributed to diversity and differences in pilot attitudes in experiments.

John Brown (Boeing) challenged the motivation of those volunteering and asked whether this manifested itself an as a bias in the results.

Sven Ternov (LFV) in response advised the forum of a live runway incursion experiment in Sweden, where some one hundred and fifty pilots will be participating. The advantage of this is that there will be an educational benefit of the trial to line pilots per se.

Bob Hilb (UPS) noted that UPS used both volunteer pilots and those assigned to experiments from the UPS reserve list of pilots.

Rick Castaldo (FAA) asked whether or not pilots used TCAS as an ASAS type tool, and if ADS-B/ASAS was available whether or not pilots should receive incentives to optimise the management of flights by using the tools provided. **Bob Arnesen (IFALPA/ECA)** Pilots use TCAS in this way unofficially, particularly on final approach. However pilots know that TCAS must always be used with great caution, cognizant of its limitations. If the pilot has a new system or tool available then he will invariably use it to the extent possible.

It was noted by **David Wing (NASA)** that not all volunteer pilots act positively towards the experimental concept. **Amy Pritchett (Georgia Tech)** commented that operational participants – both pilots and controllers – find it difficult to change their ways of working away form the current methods and adapt to new ways and to integrate new ways of working into their modus operandi.

Sven Ternov (LFV), made a plea for integrated operations between air and ground. A particular concern was that controllers were being turned into “managers” the comment from the floor, was that the FMS turned pilots into managers twenty-five years ago.

The forum was specifically asked for opinions ion the suitability of cognitive engineering to ASAS. **Tony Henley** (**BAE Systems**) responded by asking if there were any aviation systems or projects where the techniques have been applied? The response was that to date, they have been applied retrospectively, and principally to military aircraft systems. TCAS in the early days of implementation caused significant disturbance within the system because pilots were not operating in accordance to the procedures. Cognitive engineering would have identified this earlier. **Tony Henley (BAE Systems)** responded by asking whether or not the costs were prohibitive, particularly in terms of the potential delay to implementing new systems. Any delay may defer any benefits; if TCAS had been delayed, there may have been accidents caused that it could have prevented.

13 Concluding remarks

- In order for ASAS to develop further there is a need for a theoretical model that covers air and ground aspects.
- Cognitive Engineering principles, and practices, seem applicable for ASAS developments, and take an integrated view of the ASAS system.
- Joint Cognitive Systems look at ASAS as cooperative rather than delegation.
- The multi-disciplinary nature of human factors approaches (use of ATCOs, Pilots, Engineer, HF experts) should be increased for all phases of ASAS (renaming, definition, design, procedures, HMI design, HCI, validation, follow up of operations etc..) and the systems boundaries need to be set such that an integrated air and ground is the unit of measurement.

  At each stage of system design and development, studies and analysis using the JCS approach demand that there is a need for realistic actors, operational ATCOs, and pilots etc. There are practical issues which limit what is possible, but at each stage the operational actors need to be involved at with practical levels of engagement.

Outcome for future HF / ASAS related research

- Roles ATCO – PILOT – SYSTEM
- Integration Air Ground
- HMI – ASAS
- HCI – ASAS
- How to keep the ATCO alert when in monitoring mode
- Conflict prevention function and concerns
- ASAS / ACAS interaction – integration
- ASAS applications that go beyond “separation assistance” should be renamed
- A retrospective JCS analysis of ASAS NRA, ITP and ADD applications (???)

D. Session 4. Towards ASAS Package 2

14 Introduction

This session was chaired by **Nico de Gelder** from NLR with **Soren Wikerud** from LFV as the secretary.

Six briefings were presented in the session:

- NASA Research results in 4D-ASAS by David Wing & Bryan Barmore
- ASSTAR: Airborne Separation Operations in Oceanic Airspace by Bob McPike
- ASPASIA: Benefits of new SatCom Technologies to ASAS by Toni Paradell
- Safety Risk Assessment of Airborne Self-separation by Henk Blom
- NGATS Airspace Research by Harry Swenson
- ASAS in the ATC Domain Strategy by Dragos Tonea

15 Review of the briefings

15.1 David Wing and Bryan Barmore (NASA)

Brief description

NASA has been conducting research on Air Traffic Management (ATM) concepts that allocate 4D trajectory management functions between ground-based service providers and aircraft equipped with Airborne Separation Assistance Systems (ASAS). The presentation reported the status of research on the concepts of Autonomous Flight Management (AFM) for the en-route domain and Airborne Precision Spacing (APS) for the terminal arrival domain. AFM is a mixed-equipage environment in which 4D-ASAS-equipped aircraft manage their local trajectories in conformance with Traffic Flow Management (TFM) constraints established by the service provider, while in shared airspace with ground-controlled aircraft. APS aims to increase arrival precision between aircraft at the runway threshold, thereby enabling increased runway throughput, through airborne technology for achieving a desired spacing between aircraft that are merging or in-trail on either step-down or continuous-descent approaches.

Over several years, NASA has developed these distributed air/ground concepts and studied their technical feasibility and performance potential through technology prototyping, human-in-the-loop simulations, and detailed concept analyses. The applicable ASAS technologies and procedures were described, and the research activities conducted were discussed, along with sample research results for both the AFM and APS concepts.

Key issues in the presentation

The presentation addressed several key issues with respect to implementing ASAS applications in 4D trajectory-based ATM operations.

- An effective air/ground allocation of trajectory management functions is posed, with the service provider performing strategic functions and the aircraft performing local functions.
- The concepts extend performance-based aircraft operations (e.g. RNP) beyond traditional CNS capabilities to include arrival time conformance, separation management, and merging/spacing.
- Prototyping the technologies and procedures for the research has forced NASA to address some key challenges associated with integrating ASAS technologies into the

flight deck environment, such as data availability and fallibility, flight-mode flexibility, displays and procedures integration, and workload mitigation.
- Some of the scenarios studied in simulation were extreme by design to test the boundaries of feasibility.
- Results show that both concepts have merit and that technical challenges should be surmountable.

15.2 Bob McPike (NATS)

Brief description

The NAT Oceanic region suffers from the constraint of having only very limited VHF voice cover and radar surveillance due the fact that the bulk of the area is outside the range of VHF/UHF transmitters. As a result, the bulk of communication is conducted using short wave radio which is subject to various limitations including poor audibility due to weather and sunspot effects which can sometimes render communication impossible. As a result of this constraint, ATC is required to issue strategic clearances to flights. The separation standards used for these clearances are very large due to various uncertainties over and above the communications difficulties, particularly navigational inaccuracies and the limited accuracy of weather forecasts.

The use of strategic clearances, while very safe, does limit the flexibility of aircraft in achieving optimum flight profiles, with consequent fuel and other penalties. The use of ASAS creates opportunities to overcome some of these limitations by employing capability on the flight deck to assume responsibility for monitoring separations between ATC-designated flights. At present, three applications are being considered, an In-Trail Procedure (ITP) which would allow a flight to transit through a level occupied by another flight at separations much lower than those normally applied; an In-Trail Follow (ITF) procedure which would allow an aircraft to maintain a position behind another, ATC-designated aircraft – this procedure would allow flights to climb to flight levels that would be deemed to be 'blocked' under existing separation standards; and a Free-Flight Track (FFT) procedure which would allow flights to freely change speed and flight level on a designated oceanic track, while assuming responsibility for separation from all other aircraft on that track.

The high levels of congestion on ocean tracks, particularly in the case of the interactions between eastbound oceanic flights and European domestic traffic, also create the possibility of using some ASAS procedures, such as ITF, to ensure better presentation of traffic to European domestic sectors, at the oceanic-domestic boundary.

The ASSTAR has produced procedures for ITP, ITF and FFT procedures, and will be conducting simulations, during winter 2006/7 to test the feasibility of these procedures and to identify where improvements are required.

Key issues in the presentation

- Limitations within the current oceanic concept of operation.
- Impact of these limitations on aircraft fuel burn.
- Opportunities presented by the ITP, ITF and FFT applications to overcome some of these difficulties.
- Problems presented by increasing traffic congestion at the oceanic-domestic boundary and the opportunity presented by ASAS in managing some of these problems.

15.3 Toni Paradell (Atos Origin)

Brief description

ASPASIA is a research project sponsored by the European Commission, Directorate-General for Energy and Transport (DG-TREN), within the 6th Framework Programme. The main objective of ASPASIA, in the framework of innovative surveillance and tactical applications, is the combination of new advanced SatCom technology as complementary ADS-Broadcast data link in the provision of Airborne Separation Assistance Systems (ASAS) and Approach Management systems (AMAN).

New operational concepts designed by Air Traffic Management (ATM) actors, will enable Aircraft to fly with more autonomy, thanks to traffic information sharing between airborne and ground systems. In this context, satellite solutions can play a key contributory role, by their capability to enable universal access to a common traffic information situation.

ASPASIA will study SatCom applicability to ASAS applications, including an economic Cost-Benefit analysis. The benefits of satellite for ASAS will be benchmarked through a limited set of mature applications. The benefits of satellite are not only considered when satellite is the only communication means, i.e., in oceanic airspace, but also whenever it can be an appropriate means of communication, even in core Europe.

These objectives will be achieved by the execution of two main streams of activities:

1. Exploration, selection and further development of Package I applications in the specific environment of satellite communications.
2. Refinement and development of a satellite communication system architecture that supports new surveillance scenarios, stressing the performance capability which new satellite generations provide. This system will allow validating SatCom requirements for surveillance applications.

The outcome of this project will be a fully integrated ASAS / Satellite platform allowing the assessment of satellite as a powerful enabler of ASAS services adoption in many European areas.

Key issues in the presentation

- The main objective of the project is the investigation of new advanced Satellite Communications technology as complementary ADS-B and TIS-B data link in the provision of surveillance applications.
- The added value of the satellite is related to its global coverage, and can be seen as a complementary system and as a backup system.
- Testbeds based on ASPA-S&M, ADS-B-NRA and AMAN tools will be developed to assess SatCom applicability for surveillance applications.
- Validation will be performed through the use of both a SatCom simulator and a real satellite system based on DVB-RCS standard.
- The main expected achievements of the project are a SatCom platform for surveillance applications, and an assessment of the benefits of SatCom systems for surveillance applications, including a Cost-Benefit Analysis.

15.4 Henk Blom (NLR)

Brief description

The title of the presentation was “Safety risk modelling and simulation of airborne self-separation”. First the motivation for this research was explained. More than a decade ago, the concept of “free flight” (now also referred to as airborne self separation) has been “invented” as a high potential concept in accommodating future high traffic demands over busy en-route areas in Europe and US. Initially this triggered a wide variety of believers and disbelievers. Since then a lot of safety research has been performed (e.g. human factors studies using pilot-in-the-loop simulations,

functional hazard analysis and system safety requirements and integration studies), as a result of which the general belief is that airborne self-separation can be made sufficiently safe as long as traffic demand is low. In spite of all this research, safety beliefs still differ a lot when it comes to high traffic demand. This simply means that research has not yet sorted out the application where free flight has been "invented" for. This motivated NLR to start a novel, safety risk directed approach toward the study of airborne self separation.

A European research project HYBRIDGE has been conducted to develop the necessary innovative mathematical methods. The key quality of these methods is that they are able to model, analyse, influence and simulate the behaviour of large-scale multi (human or technical) agent distributed systems up to the level of rare emergent behaviour. Emergent behaviour is the result of dynamic interactions between multiple agents, and cannot be observed from individual agent behaviour. Subsequently the Monte Carlo simulation model for AMFF was applied to some demanding air traffic scenarios. For a scenario of two aircraft starting at the same flight level and on a head-on course, the estimated risk is caused by failures of technical systems. For multi-aircraft scenarios under high traffic demands, the estimated risk steeply increases with traffic demand. Further evaluation showed this to be caused by rare occurrence that multiple conflicts start clogging. Though these occurrences caused the risk steeply to go up, they appeared to happen so rarely that it will be impossible to observe them in real-time simulations. This exactly is a good example of rare emergent behaviour that becomes visible through large scale MC simulations and speed up approach.Within HYBRIDGE the working of this novel speed up approach has been tested on one particular airborne self-separation concept of operation, i.e. the Autonomous Mediterranean Free Flight. This concept has explicitly been developed to accommodate low traffic demand over the Mediterranean. Upon request of the pilots, the ASAS supports the pilot in solving one conflict at the time only. For this AMFF concept an initial Monte Carlo simulation model has been developed (not incorporating ACAS and some other functionality). Subsequently this Monte Carlo simulation model was applied to some air traffic scenarios. For a scenario of two aircraft starting at the same flight level and on a head-on course, the assessed risk appeared to be caused by failures of technical systems. Subsequently more demanding scenarios have been evaluated. Under high traffic demands, the estimated collision probability steeply increases with traffic demand. This appeared to be due to rare occurrences that multiple conflicts start clogging. Though these occurrences caused the risk steeply to go up, they appeared to happen so rarely that it will be impossible to observe them in real time simulations. This exactly is a good example of a rare emergent behaviour.

Key issues in the presentation

- Ten years after the "invention" of free flight, its potential of accommodating high traffic demands for which it has been "invented" still exists, but the research to show that this is indeed possible still is incomplete;
- Three complementary safety criteria need be addressed: - safety perception, dependability and accident risk;
- So far, accident risk assessment has been studied using methods from safety critical industries that involve decision making at a far lower distribution level. Hence these methods fall short in identifying and assessing rare emergent behaviour;
- Once rare emergent behaviour has been identified and assessed, then designers of advanced air traffic will be able to improve their design. The implication is that the primary purpose of accident risk assessment is to provide effective safety feedback to the advanced concept designers, and to the managers of a concept development programme;
- Monte Carlo simulations have been strongly improved over the last few years in areas of human performance modelling and simulation speed-up methods, and further developments are strongly ongoing.
- Initial application of the most advanced safety risk assessment method to the Autonomous Mediterranean Free Flight (AMFF) concept confirms that advanced accident risk assessment is able to provide useful safety feedback to the designers.
- In order to find out what the potential of free flight under heavy traffic demand is, the aim of the HYBRIDGE partners is to focus our follow-up research there.
- The initial accident risk assessment performed can and should be improved in many directions: i) extension of the model with ACAS and other functionalities, ii) further improving the Monte Carlo simulation approach itself, iii) performing a proper validation of

the simulation model and the accident risk level assessed, iv) application of the approach toward other airborne self separation designs (also to other ASAS based designs).

15.5 Harry Swenson (NASA)

Brief description

In October 2005, NASA's Aeronautics programs were refocused toward the mastery, intellectual stewardship, and technical excellence in the field of aeronautics. NASA Aeronautics' research philosophy promotes making significant contributions to the foundational sciences. As a result, the Airspace Systems Program was restructured to directly address the air traffic management (ATM) research and development (R&D) needs of the Next Generation Air Transportation System (NGATS) in collaboration with the member agencies of the Joint Planning and Development Office (JPDO). The refocused Airspace Systems Program, through development and demonstration of revolutionary concepts, capabilities, and technologies, will enable significant increases in capacity, efficiency, and flexibility of the National Airspace System.

The restructured Airspace Systems Program is comprised of two new projects: NGATS ATM Airspace and NGATS ATM Airportal. The major focus of the two projects is the development of en-route capabilities and terminal/surface capabilities, respectively. Both projects contribute to the foundational sciences: computer science, automation design, applied mathematics for system optimization, and human factors.

The goal of the NGATS ATM Airspace Project is to explore and develop concepts and integrated solutions that provide research data in order to define and assess the allocation of ground and air automation concepts and technologies necessary for NGATS.

Research to support this project is being conducted and performed at NASA Ames, Langley, and Glenn Centers. Groundbreaking research being conducted in the NGATS ATM Airspace Project, which is enabling emerging airborne technologies to be utilized in the airspace, will ultimately accelerate the JPDO vision of the future air transportation system.

Key issues in the presentation

- Modify static airspace resources (controllers/structure) by temporally increasing capacity based on the movement of resources.
- Modify airspace/airports capacity by using multiple optimization techniques to adjust demand through departure times, route modification, adaptive speed control, etc., in the presence of uncertainty.
- Address airspace capacity barriers due to human workload/responsibility for separation assurance by utilizing sequential processing of sequence and merging with separation for transition and cruise airspace
- Address airspace capacity barriers due to human workload/responsibility for separation assurance by utilizing simultaneous sequencing, spacing, merging, and de-confliction for terminal airspace with nearby runway thresholds.
- Provide accurate trajectory predictions that are interoperable with aircraft FMS trajectory generations using prediction uncertainty growth and propagation
- Understand the performance-enhancing effect of emerging airborne technologies on solutions to the fundamental capacity vs. demand ATM problem.
- Develop system design and analysis tools to sort out the functional/temporal distribution of authority and responsibility among/between automation and humans

15.6 Dragos Tonea (EUROCONTROL HQ)

Brief description

Eurocontrol has launched the ADAS initiative (Advanced Data-link and Airborne Surveillance applications) to ensure separation and self-separation applications are developed in a co-coordinated manner with other ATM elements currently foreseen in European and US operational concepts. ADAS

will work to develop, integrate and validate key elements concerning the use of airborne surveillance in the future ATM system, including support data-link applications.

Airborne separation in the ATC domain is all about integration in an overall operational context. All concepts are being examined, for all phases of flight, and Airborne Separation will be progressed only if it meets operational and economic needs.

ADAS will go beyond the initial set of airborne surveillance applications that CASCADE has in its portfolio and will cater for an intelligent transition to more advanced applications. The European stakeholders have repeatedly asked for the future to be built, starting with the present. There is therefore a requirement to ensure continuity, good visibility, and co-ordination with the initial developments of airborne surveillance applications.

ADAS is responsible for ensuring co-ordination with the FAA (ADS-B Programme) for airborne surveillance applications within the framework of common actions plans established between FAA and Eurocontrol. As such, ADAS has been tasked to ensure European co-ordination through Eurocontrol mechanisms that allow for consultation with the stakeholders and through direct contact with other projects investigating separation and self-separation applications.

ADAS develops data-link applications in support of ATC, FIS and alerting services by means of new CPDLC messages or other applications that support seamless distribution of information between air and ground. In support of airborne surveillance applications, ADAS develops the operational requirement for data-link applications that may be needed (e.g. traffic identification message).

In response to the findings of EUROCONTROL'S yearly PRR (Performance Review Report), ADAS is accelerating the development and integration of airborne surveillance applications in terminal areas in a practical way that will allow to maximize the benefits of airspace structure (e.g. P-RNAV), support tools (e.g. AMAN) so that predictability and efficiency are improved.

ADAS operates within the bounds set by SESAR concept with key elements development already underway. Once SESAR will finalize its concept, ADAS will prioritize and align activities accordingly.

Key to future developments, ADAS is tasked with the production of:

- An integrated concept of use for airborne surveillance applications that will constitute the backbone of ASAS integration in the future 4D environment envisioned by current operational concepts. All domains (airport, terminal area, en-route, oceanic) are to be covered with the terminal area being tackled first
- Separation and self-separation applications development and validation (ASAS Package2/3)
    - Terminal area applications (e.g. ASEP S&M)- with the aim of harmonizing US-Europe operations;
    - En-route applications (e.g. ASEP C&P)
    - Oceanic
    - Airport

The work on the airborne separation white paper will identify key issues (operational need, responsibility for separation provision, intervention, airborne separation minima, human factor, systems and performance, legal liability, and others) and recommend activities to attempt to solve them.

The work on the application description will follow the philosophy to keep it simple, to keep it practical. An application and its associated procedure is not going to be developed because a piece of technology is available but because an operational problem needs a better solution in the future than what we have today. Airborne separation applications must be developed as part of the tools the ATM system can use in an integrated manner. It is believed that the future system should allow for enough flexibility so that whilst the airspace users fly their preferred trajectories, they are also provided with the necessary tools in order to respond in real-time to tactical situations.

Within its co-ordination tasks, ADAS aims to ensure ICAO co-ordination with respect to airborne surveillance applications development through the relevant panels that are involved or need to be involved in this process.

ASEP-S&M was then presented as an example how ADAS would proceed in developing airborne separation applications. More details on the ASEP-S&M application will become available in a draft OSED in November.

Key issues in the presentation

- ADAS is taking pragmatic steps to ensure package 2 and 3 development. ADAS is about practical steps, about detailing the operational concepts, and about integration with other ATM developments
- Key Eurocontrol activity for developing separation and self-separation applications
- Work is done within the framework of SESAR concept; further alignment to be done when official concept emerges from SESAR;
- ADAS builds on work previously done for Package1
- Airborne Separation white paper will detail the issues and environment
- Initial set of deliverables available for review by ADAS partners and stakeholders
- European co-ordinator on airborne surveillance applications (separation &self separation) through Eurocontrol stakeholder consultation mechanisms and direct contact with other projects
- Global co-ordination through FAA-Eurocontrol common action plans and ICAO;
- The key message was that Package 2 is happening, and it is happening in a globally co-ordinated, pragmatic and structured way.

16 Issues from chaired discussions

Q: Mark Ballin (NASA) first stated that he fully supported the importance of the risk assessment approach as presented by Henk Blom, he then asked “Are the safety numbers realistic enough to use them as absolute values, isn’t it more appropriate to use them in a comparative way, to compare one concept against another”

A: Henk Blom (NLR) answered that in this research the aim is to identify safety issues of the concepts under review, and to feed this back to the concept designers. The current simulations and figures serve this aim. When absolute safety figures are desired, then missing agents should be added and validation should be performed.Q: Jean-Claude Richard (Air Traffic Alliance) asked Dragos Tonea how the Advanced Datalink and Airborne Surveillance (ADAS) initiative is connected to SESAR, it seemed not to be linked at all to the SESAR activities.

A: Dragos Tonea (EUROCONTROL HQ) said that the ADAS project aimed to link to SESAR, one must develop a plan to cover package 2/3 and one cannot stop at package 1, the real benefits come from the subsequent packages. ADAS will detail the operational concept emerging from SESAR with respect to airborne surveillance applications and integrate the applications in the future ATM environment. ADAS does not aim to come with a concept of its own but will work within the framework SESAR agrees to; until such framework is finalised, ADAS will work on the main ASAS ideas expressed in operational concepts from Europe and the US (NGATS).

Q: Maria del Mar Tabernero Serrano (ANEA) asked Bob McPike if it’s acceptable for oceanic controllers not to be able to monitor Oceanic In-Trail Follow (ITF) operations, in the proposed operation only the pilot can do that. Is ADS-C considered to give the controller the possibility to monitor the involved aircraft?

A: Bob McPike (NATS) the current opinion is that it is not necessary to monitor the aircraft which are involved in an ITF procedure. In the ICAO documents there are already situations in which the controllers have to trust the aircraft to maintain separation, e.g. DME-based climb through procedure. Furthermore, Bob said that it is also an education process, a process that will start when performing the simulations within the ASSTAR project. In theory separation could be monitored by the use of ADS-C, however there is a cost associated to it because of the use of satellites, approximately one euro for each ADS-C report.

Q: Bob Arnesen (IFALPA/ECA) expressed that Free Flight is not free and is not the appropriate name for these operations. He thought that the Americans using the word “autonomous flight” was better and suggested to the ASAS-TN committee to come with a recommendation to change the name.

A: Phil Hogge (ASAS TN2) fully agreed with Bob Arnesen. The crew has to comply with the company plan and cannot perform manoeuvres at will.

A: Henk Blom (NLR) on the other hand said “be careful to change the name”. It is not only the name, concepts may vary and are difficult to put under a single name.

A: David Wing (NASA) said that they used the term “Autonomous Flight Management” to address this issue and to indicate that it is also about complying with other constraints such as, special use airspace, weather and flow management. He also stated that “Self-Separation” is not the appropriate name because it implies that an aircraft operates in a vacuum.

Q: Sergey Laletin (GosNIIAS) asked how ADAS will ensure interoperability of the applications it develops.

A: Dragos Tonea (EUROCONTROL HQ): Intention is to reuse the methodology and processes developed within the RFG for Package1 applications. Nevertheless the development process for OSED/SPR/INTEROP documents will make use of lessons learnt and aim to improve the methodology.

Q: Sergey Laletin (GosNIIAS) then asked why VDL2 had been cut away

A: Dragos Tonea (EUROCONTROL HQ): ADAS focuses in the initial development phase on operational requirements. Technology assessment will be done once a stable OSED per application is produced. The implementation started with Package1 (CASCADE) will impact the environment description when such analysis is performed but no commitment to any technology has been made by ADAS.

17 Concluding remarks

- The work of NASA shows that the way forward is a combined ASAS-4D approach. They are currently working with many partners on a first step to implementing airborne spacing in large, complex terminal environments.
- HYBRIDGE has demonstrated a novel Monte Carlo simulation speed approach which is able to identify rare emergent behaviour that cannot be seen by any other method.
- The quantitative nature of Monte Carlo simulations makes the method a promising one in quantifying the risk of rare emergent behaviour. In order to reach this milestone, it remains to be shown that the Monte Carlo simulation model and accident risk assessment results can be validated to a desired level.
- Oceanic regions are providing big opportunities for introducing ASAS airborne separation, with advantages to both airlines and air traffic control.
- ASAS needs to be positioned as one of the tools available to the ground and airborne system (pilots and ATCO included); ASAS interactions with the rest of the tools (e.g. AMAN, data-link applications, controller and pilot support tools) need to be detailed and documented in a consistent manner.
- ADAS initiative has been launched to foster global co-operation and develop in a pragmatic way, within SESAR operational concept, separation and self-separation applications. ADAS goal is to gradually move the development of separation applications from the R&D approach to an implementation approach. ADAS will build on work done by the RFG and CASCADE and follow, to the largest extent possible, the methodology and processes agreed globally.
- The name free flight should be reconsidered, it is confusing and it puts people in the wrong mind setting. Autonomous flight or autonomous aircraft operations are suggested.

18 Demonstrations

In addition to the formal presentations made during the sessions, DSNA and the University of Glasgow presented current work on ASSTAR algorithms for ASAS Crossing procedures in radar environment. On the basis of a crossing scenario over South-East of France extracted from radar recordings, ASSTAR crossing procedure is simulated through a cockpit simulator. The proposed manoeuvre for the clearance aircraft as well as the guidance by the airborne surveillance system are illustrated, including wind. The cockpit was connected to a PC where the calculations for a rather simple geometric algorithm were made. Others algorithms will be investigated in the near future. This was illustrating the potential of an ASAS on-board relying on simple algorithms to support airborne separation application such as lateral crossing & passing.

19 Conclusions from the Workshop

Status

Under the CASCADE programme (co-ordinating the work towards implementation of ADS-B in Europe in the short-term, i.e. 2008-2102) there is significant progress.

The CASCADE deliverables (including the European Implementation Plan for the initial ADS-B applications) should be used as inputs and baseline by SESAR.

Strategic outlook

The ASAS-TN2 should provide information to SESAR to ensure that ASAS/ADS-B is properly considered in the Concept of Operations.

ASAS is proposed as a key concept element in NGATS.

UAVs and military considerations

Military requirements for the use of airspace are now evolving (e.g. UAVs) and these must be taken into account when introducing new ASAS/ADS-B applications.

Increasing numbers of commercial and military and military UAVs of varying size and capability require access to controlled airspace. ASAS/ADS-B will contribute to achieving this

Sense and avoid, once approved by the regulator for UAVs, is likely to be used to enhance the safety of manned civil operations.

System design

Human Factors experts warned of the risk of the unintended use of ASAS/ADS-B capability

When you think about new information added, think about if there is a procedure associated with it.

Post-implementation monitoring is seen as an important way of capturing adaptive use of systems.

With respect to the CDTI and other ASAS displays, only provide information necessary for the user not what they say that they want.

Another promising application area

Operations in oceanic airspace and the transition regions are expected to be significantly improved by new ASAS/ADS-B applications. These benefits accrue to both airlines and ANSPs.

20 ASAS-TN2 Recommendations/Actions

- Engage more with SESAR
- Write to SESAR ExCom
- Produce a summary matrix of ASAS key issues

21 Dissemination

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

http://www.asas-tn.org

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-TN2; and

(3) Provide an input to the ASAS-TN2 Work Package 3 ASAS application maturity work

22 List of attendees

Name	Org/Company	e mail
Chuck Manberg	ACSS	Chuck.Manberg@l-3com.com
Maria del Mar Tabernero Serrano	AENA	mmtabernero@aena.es
Vasily Avilkin	Aeroflot	vavilkin@aeroflot.ru
Jean-Claude Richard	Air Traffic Alliance	jean-claude.richard@thalesatm.com
Sabine Vieyres	Airbus	sabine.vieyres@airbus.com
Stéphane Marché	Airbus	stephane.marche@airbus.com
Greg Dunstone	Airservices Australia	Greg.Dunstone@AirservicesAustralia.com
Mauro Secondino	Alenia Aeronautica	msecondino@aeronautica.alenia.it
Phil Hogge	ASAS-TN2	phogge@compuserve.com
Rodrigo Diaz	Atos Origin	rodrigo.diaz@atosorigin.com
Toni Paradell	Atos Origin	antonio.paradell@atosorigin.com
Bernhard Wolfmayr	Austro Control	Bernhard.Wolfmayr@austrocontrol.at
Adam Ward	BAE Systems	adam.ward@baesystems.com
Di Francis	BAE Systems	di.francis@baesystems.com
Fraser McGibbon	BAE Systems	fraser.mcgibbon@baesystems.com
Martin Darkins	BAE Systems	martin.darkins@baesystems.com
Nick Sibley	BAE Systems	nick.sibley@baesystems.com
Nick Valente	BAE Systems	nick.valente@baesystems.com
Rosemary Bray	BAE Systems	rosemary.bray@baesystems.com
Tony Henley	BAE Systems	tony.henley@baesystems.com
Mike West	BAE Systems	mike.west@baesystems.com
Paul Farrant	BALPA	paul.2farrant@btinternet.com
John Ackland	Boeing	john.r.ackland@boeing.com
John Brown	Boeing	john.a.brown@boeing.com
Taji Shafaat	Boeing	taji.shafaat@boeing.com
Francisco Navarro	Boeing R&T Europe	francisco.a.navarro2@boeing.com
Miguel Vilaplana	Boeing R&T Europe	miguel.vilaplana@boeing.com
Stefano Elefante	Boeing R&T Europe	Stefano.Elefante@boeing.com
Carlo Mamone Capria	CIRA	capria@cira.it
Serge Lebourg	Dassault	Serge.Lebourg@dassault-aviation.com
Claudia Fusai	Deep Blue	claudia.fusai@dblue.it
Marinella Leone	Deep Blue	marinella.leone@dblue.it
Andreas Krebber	DFS	Andreas.krebber@dfs.de
Hartmut Villwock	DFS	Hartmut.Villwock@dfs.de
Oliver Haßa	DFS	oliver.hassa@dfs.de
Ralf Kohrs	DLR	Ralf.Kohrs@dlr.de
Jean-Marc Loscos	DSNA	Jean-marc.loscos@aviation-civile.gouv.fr
Philippe Louyot	DSNA	Philippe.louyot@aviation-civile.gouv.fr
Thierry Miquel	DSNA	Thierry.miquel@aviation-civile.gouv.fr
Kenichi Lee	Embraer	kenichi.lee@embraer.com.br
Fabrizio Maracich	ENAV	FMaracich@enav.it
Giorgio Matrella	ENAV	gmatrella@enav.it
Jim Stenson	EURAMID	jim.stenson@blueyonder.co.uk
Gabor Petnehazy	EUROCONTROL CRDS	Gabor.Petnehazy@eurocontrol.int
Angelo Scorciarino	EUROCONTROL EEC	angelo.scorciarino@eurocontrol.int
Bob Graham	EUROCONTROL EEC	robert.graham@eurocontrol.int

Catherine Lachiver	EUROCONTROL EEC	catherine.lachiver@eurocontrol.int
Chris Shaw	EUROCONTROL EEC	chris.shaw@eurocontrol.int
Eric Hoffman	EUROCONTROL EEC	eric.hoffman@eurocontrol.int
Alex Wandels	EUROCONTROL HQ	alex.wandels@eurocontrol.int
Bob Darby	EUROCONTROL HQ	bob.darby@eurocontrol.int
Christos Rekkas	EUROCONTROL HQ	christos.rekkas@eurocontrol.int
Daniel Avram	EUROCONTROL HQ	daniel.avram@eurocontrol.int
Dragos Tonea	EUROCONTROL HQ	dragos.tonea@eurocontrol.int
Jan Berends	EUROCONTROL HQ	jan.berends@eurocontrol.int
Jorg Steinleitner	EUROCONTROL HQ	jorg.steinleitner@eurocontrol.int
Jose Roca	EUROCONTROL HQ	Jose.roca@eurocontrol.int
Robert Stewart	EUROCONTROL HQ	Robert.stewart@eurocontrol.int
Stephen O'Flynn	EUROCONTROL HQ	stephen.oflynn@eurocontrol.int
François Cervo	EUROCONTROL MIL	francois.CERVO@eurocontrol.int
Christopher Adams	EUROCONTROL MUAC	christopher.adams@eurocontrol.int
Chris North	European Commission	Christopher.north@ec.europa.eu
Abbas Rizvi	FAA	Abbas.Rizvi@faa.gov
Bill Petruzel	FAA	william.petruzel@faa.gov
Rick Castaldo	FAA	rick.castaldo@faa.gov
Rick Perez	FAA	rick.perez@faa.gov
Mike Wood	FlyBe	Mike.Wood@flybe.com
Amy Pritchett	Georgia Tech	amy.pritchett@ae.gatech.edu
Sergey Laletin	GosNIIAS	laletin@gosniias.ru
Ben Stanley	Helios Technology	ben.stanley@helios-tech.co.uk
James Hanson	Helios Technology	james.hanson@helios-tech.co.uk
Colin Trundle	HVR Consulting Services	Colin.trundle@hvr-csl.co.uk
Jon Arden	HVR Consulting Services	Jonathan.Arden@hvr-csl.co.uk
Sigurleifur Kristjánsson	Icelandic CAA	silli@caa.is
Bob Arnesen	IFALPA/ECA	bob.arnesen@telia.com
Anthony Smoker	IFATCA	anthony.smoker@virgin.net
Marie-Do Dupuy	Imperial College	md.dupuy@imperial.ac.uk
Daniel Cobo	ISDEFE	dcobo@isdefe.es
Fredrik Barchéus	KTH Sweden	Barcheus@kth.se
Lena Martenson	KTH Sweden	lenamartensson@indek.kth.se
Anne-Lovise Linge	LFV	anne-lovise.linge@lfv.se
Billy Josefsson	LFV	billy.josefsson@lfv.se
Göran Lindquist	LFV	goran.lindqvist@lfv.se
Sören Wikerud	LFV	soren.wikerud@lfv.se
Sven Ternov	LFV	sven.ternov@mailbox.swipnet.se
James Latta	Lockheed Martin Stasys	james.latta@lmco.com
John Bates	Lockheed Martin Stasys	john.w.bates@lmco.com
Matthias Groth	Lufthansa	matthias.groth@dlh.de
Joseph Comeaux	MITRE	joe.comeaux@ramstein.af.mil
Mitsuhiro Matsusaka	Mitsubishi Research Institute	m-matsu@mri.co.jp
Ken Jones	NASA	K.M.Jones@larc.nasa.gov
Mark Ballin	NASA	mark.g.ballin@nasa.gov
Rick Shay	NASA	r.f.shay@larc.nasa.gov
Harry Swenson	NASA Ames	Harry.N.Swenson@nasa.gov
Bryan Barmore	NASA Langley	bryan.barmore@nasa.gov
David Wing	NASA Langley	David.Wing@nasa.gov
Bob McPike	NATS	Bob.McPike@nats.co.uk

Craig Foster	NATS	Craig.foster@nats.co.uk
Dan Roberts	NATS	Dan.ROBERTS@nats.co.uk
Eamonn Riley	NATS	Eamonn.RILEY@nats.co.uk
Kevin Morgan	NATS	kevin.morgan@nats.co.uk
Mark Watson	NATS	Mark.watson@nats.co.uk
Tom Graff	NIA/NASA	tomjgraff@gmail.com
Henk Blom	NLR	blom@nlr.nl
Hugo De Jonge	NLR	jongehw@nlr.nl
Nico de Gelder	NLR	degelder@nlr.nl
Rob Ruigrok	NLR	ruigrok@nlr.nl
Ken Carpenter	QinetiQ	Ken.Carpenter@atc.qinetiq.com
Bill Booth	QinetiQ (EUROCONTROL EEC)	bill.booth.qinetiq@eurocontrol.int
Dennis Merryweather	Raytheon Systems Ltd	Dennis.Merryweather@raytheon.co.uk
Eric Thomas	Rockwell Collins France	ethomas@rockwellcollins.com
Adrian Ionescu	ROMATSA	adrian.ionescu@romatsa.ro
Mariana Spânu	ROMATSA	mariana.spanu@romatsa.ro
Jonas Jakobsson	SAAB	Jonas.Jakobsson@saab.se
Florent Béron	Skyguide	florent.beron@skyguide.ch
Philippe Waecker	Skyguide	philippe.waecker@skyguide.ch
Sue Brash	Skyguide	sue.brash@skyguide.ch
Jean-Louis Roch	Thales Aerospace	jean-louis.roch@fr.thalesgroup.com
Michel Procoudine	Thales ATM	michel.procoudine@thalesatm.com
Patrick Brandière	Thales ATM	patrickm.brandiere@thalesatm.com
Peter Howlett	Thales ATM	peter.howlett@thalesatm.com
Cedric D'Silva	Thales Avionics	cedric.d-silva@fr.thalesgroup.com
Pierre Gayraud	Thales Avionics	pierre.gayraud@fr.thalesgroup.com
Alexandra von Eckartsberg	TU-Darmstadt	eckartb@fsr.tu-darmstadt.de
Colin Goodchild	University of Glasgow	c.goodchild@aero.gla.ac.uk
David Moore	University of Glasgow	d.moore@eng.gla.ac.uk
John Anderson	University of Glasgow	j.anderson@aero.gla.ac.uk
Javier Lopez	University of Glasgow/Boeing R&TE	javixlow@yahoo.com
Mark Hurston	United Airlines	mark.hurston@united.com
Bob Hilb	UPS	bhilb@ups.com
Cal Fleming	US Air Force	Cal.Fleming@langley.af.mil
David Kassander	US Air Force	David.Kassander@scott.af.mil
Jack Oehme	US Air Force	Jack.Oehme@pentagon.af.mil