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1. Executive summary

The aim of the Airborne Separation Assistance System (ASAS) Thematic Network (TN) was to accelerate the application of ASAS operations in European Airspace, taking global applicability into account, in order to increase airspace capacity and safety.

In today's ATM situation in the core area of Western Europe, increased delays clearly indicate that capacity is an issue. The ASAS-TN provides short-term guidelines for a structural solution for the airspace capacity problem while maintaining or increasing safety. Exploitation of the results of ASAS-TN can start immediately, but the proposed solutions are designed for the medium and long-term time frames.

The objective of the ASAS- TN was to share current knowledge of ASAS between all European stakeholders, to develop consensus, and to produce an implementation strategy and recommendations for future activities that are required to reach the operational use of ASAS applications.

It is expected that these results will be of use to guide future European Commission (EC) actions from 6th Framework RTD projects to shorter-term TEN-T pre-operational experimentation. The expectation is also that the shared knowledge and the agreed upon recommendations will allow European industry to optimally plan and focus their new products development strategy.

There were three elements of work in the ASAS-TN project:

- Three ASAS-related workshops and a final seminar
- Development of an ASAS Implementation Strategy
- Development of Web-based forums and a document repository

The three workshops were delivered as a course of the project:

- “ASAS Operational Improvements – Dream or Reality?”, 28th-30th April 2003, Rome.
- “ASAS - What does it mean operationally?”, 6th-8th October 2003, Malmö
- “ASAS – Making it happen”, 19th-21st April 2004, Toulouse

The ASAS Implementation Strategy was developed taking into account the issues and work reported at the Workshop events.

As a communication exercise, primarily, the success of the ASAS-TN was the dissemination and sharing of ASAS related information.

There has been a good level of support from most ATM stakeholders. There has been no airport involvement to date and minimal active participation of the airlines.

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

The Workshop and Seminar Reports, ASAS-TN Strategy document and the ASAS reference material are available on:

<http://www.asas-tn.org>

2. Objectives of the project

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

The ASAS-TN was coordinated by EUROCONTROL and a partnership consisting of BAESYSTEMS, ENAV, LFV, NLR, Thales ATM and Thales Avionics. In addition to these organisations, the ASAS-TN involves a very wide range of organisations (e.g. ATM stakeholders, Universities) including Pilot and Controller professional associations (ATCEUC, IFATCA, IFALPA and VC).

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

The ASAS Thematic Network addresses the objective number 4 of key action “New Perspectives in Aeronautics” which is:

“Improvement of the operational capability of the aircraft in the air transport system and of its safety, with targets of increasing airspace capacity, reducing aircraft maintenance costs by 25% and decreasing accident rates by at least the same factor than the growth of traffic”.

Regarding today’s ATM situation in the core of Western Europe, the increased delays clearly indicate that capacity is a problem. It is a near-term problem so immediate actions are required. The ASAS-TN provides short-term guidelines for a structural solution for the airspace safety and capacity problem, with a medium and long-term perspective. Exploitation of the results of ASAS-TN can start ‘immediately’, but the proposed solutions are designed for the medium and long-term time frames.

The work of the ASAS-TN was threefold:

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

The ASAS strategy work identified and produced guidelines regarding the operational and technical standards affected by ASAS applications. It produces guidelines on further activities and ASAS-related projects that will be required for ASAS implementation.

3. Scientific and technical description of the results

3.1. Overview

The public domain deliverables of the ASAS-TN are:

- An ASAS implementation strategy
- Three workshops and the associated reports
- An ASAS-TN final seminar
- An ASAS related library and ASAS-TN project web-site

The Workshop and Seminar Reports, ASAS-TN Strategy document and the ASAS reference material are available on:

<http://www.asas-tn.org>

The ASAS-TN library is hosted on the Onesky team area of the EUROCONTROL Extranet.

3.2. The workshops

Three workshops were conducted as a course of the ASAS-TN. The workshops were designed to provide focused presentations on key issues to stimulate discussion sessions amongst all interested stakeholders. The presentation material and the discussion session were recorded in reports that are available via the project web-site.

The workshops were designed to identify the exploration of ASAS operational benefits, the ASAS applications and the technical implementation issues. Their key conclusions are reported here.

3.2.1. "ASAS Operational Improvements – Dream or Reality?", 28th-30th April 2003, Rome.

Need for agreement and commitment from the various stakeholders:

- Airlines and ATS providers have different approaches and views relating to ASAS applications
- Airlines have different visions because of the respective business (i.e. Low cost operators versus more traditional operators)
- ATS providers also have different visions because of their differing needs (i.e. Core are of Europe versus other areas)
- Obtaining GA perspectives / Military perspectives are essential
- We are missing a lot of main stakeholder specifically airports
- Few airlines and ATS providers are currently involved and participating.
- EC policy pushing for a change of paradigm. There is a disconnect with the Industry and ATS providers which are focused in short/medium term.

Package I definition:

- Consensus still fragile
- The step approach is recognised.
- But the size of step I is still questioned:
 - Either the step is not ambitious enough
 - Or a subset of package I applications should be aimed for.

Need for pilot and controller acceptability:

- Pilot and Controllers Organisation to be more involved in the operational definition

Need for agreed standards for interoperability including:

- EUROPE and US should work together
- Operational definitions
- Pilot/controllers roles
- Business Case
- Safety Case
- The ADS-B technology choice is making the issue more complex

Need for a clear implementation plan:

- A roadmap is needed
- A CBA is needed
- To mandate or not mandate?
- Is there a requirement for an incentive policy?

There is a need for improved exchange of information.

3.2.2. "ASAS - What does it mean operationally?", 6th-8th October 2003, Malmö

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

Institutional recommendations:

- Strong coordination between US and Europe (including terminology) is essential
- Continue to use the Requirement Focus Group (RFG) as the method for cooperation
- ASAS applications should be considered as a set of components and integrated into the ATM system
- Share and learn from experience of local studies and implementations
- Security requirements must be addressed during ASAS application development and validation
- Political awareness of the potential benefits of ASAS applications should be enhanced in order to ensure appropriate financial resources

'Package I' recommendations:

- In order to ensure safe operations of ATSA applications (use of CDTI), clear procedures must be defined
- ATSA-SURF plus taxi map brings significant safety benefit – should be considered for early implementation
- Proceed to a large-scale pre-operational trials of ASAS Package I as soon as possible, involving equipage of one or more airline fleets.
- Characterise currently available ADS-B data link technology system performances against Package I requirements.
- Encourage the development of regional implementation plans of globally agreed applications.

- Incentivisation schemes need to be identified to encourage all stakeholders (e.g. Airports, Airlines, GA, ATSPs) to equip. Specifically, methods to ensure that those investing in ASAS receive benefits must be established.
- Investigate minimum equipage levels necessary to achieve benefits per application.

‘Future packages’ recommendations:

- Work to continue on Package II and III and beyond.
- Extended safety analysis and address contingency procedures for Separation and Self-Separation
- Continue work on ADS-B data link technology beyond what is currently foreseen for Package I

3.2.3. “ASAS – Making it happen”, 19th-21st April 2004, Toulouse

3.2.3.1. *General*

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

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

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

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

3.2.3.2. *Operational applications*

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

- GS applications is a natural starting point;

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

Package I applications provide opportunities for benefits through local implementations:

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

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

3.2.3.3. Benefits and costs

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

Some key conclusions can be drawn at this stage:

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

3.3. The ASAS Implementation Strategy

The key conclusions and recommendations from The ASAS Implementation Strategy are reported in section 7 of this report.

The Implementation Strategy reviews the status of the Package I applications, both the Ground Surveillance and Air Surveillance applications. The document also reports on the ADS-B data-link.

The Standardisation and Certification activities and issues associated with ASAS are also reported.

From this start point, underpinned by information received at the Project Workshops, the early ASAS implementation strategy was developed.

3.4. The ASAS-TN Seminar

All of the work of the ASAS-TN was presented in a Seminar. “ASAS: Time for Decisions. The Way Forward”. This was held in Brighton on October 11th to 13th 2004.

The ASAS-TN presentations at the seminar were supported by ASAS tutorial sessions and supplemented by presentations describing the wider institutional ATM context.

The Seminar Report summarises the work of the Project and the issues raised at the event. The main findings are reported here.

3.4.1. General

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

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

- Significant progress in the global harmonisation definition and the validation of ASAS and ADS-B applications and particularly on the applications included in ‘Package I’ have been made. As for any new concept elements of the future ATM, work is still needed. The European Commission, EUROCONTROL and all ATM stakeholders are currently developing a European ATM Master Plan.

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

3.4.2. ASAS-TN Recommendations

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

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

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

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

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

4. Results and conclusions

4.1. ASAS-TN Conclusions

In order to speed up the introduction of ASAS and ADS-B, a package of applications that could be implemented within a 5 to 10 year time frame has been defined. This timeframe is a challenge but experts consider it feasible. It is possible to go faster with a local implementation of specific applications but 'Package I' defines a set of operational applications offering benefits for a large majority of airspace users.

The packaging approach is pragmatic and aims at the early implementation of these applications on a world-wide basis. 'Package I' is going to help to focus the energies required for the development of the appropriate operational/technical standards and equipment. The approach is flexible. States, ANSPs and airspace users may select, from the set of applications, those that are the best suited to their operations and their needs and then opt for actual implementation. However, 'Package I' applications were meant to be taken as a whole in terms of standards and equipment.

The basic strategy is to begin implementation of ASAS and ADS-B concepts at a local level so that the proof of concept and associated benefits can be demonstrated operationally at low cost to the airlines and ANSPs. Once the benefits have been demonstrated operationally, the aircraft operators can be encouraged to equip all of their aircraft and enable the application of ASAS and ADS-B concepts to become more widespread. The first part of this strategy requires that sufficient aircraft operating within a single airspace are equipped so that they become ASAS/ADS-B capable. This will require the introduction of ASAS functions into the cockpit. These functions will improve situation awareness in the cockpit by providing a CDTI capability and will enable ASAS manoeuvres to be implemented by providing appropriate guidance information to the pilot.

The introduction of ASAS and ADS-B presents a number of challenges including the generation of a clear operational definition, technology issues and certification of new equipment. It is clear that for ASAS to progress there has to be support from aircraft operators, pilots, ANSPs, controllers and equipment manufacturers. In order to achieve this, the roles and responsibilities of both the pilot and controller for each application must be clearly defined so that safety is not compromised.

There is a cost associated with the introduction of ASAS and ADS-B, much of which will be paid by airlines and ANSPs. Therefore, the benefits to the airlines and ANSPs of implementing ASAS and ADS-B must be sufficient to justify the investment costs. The use of incentives or, where appropriate mandates, as a way to accelerate deployment should be considered as a means of transferring costs to the party that benefits.

ASAS and ADS-B are not purely European issues but global ones. It is important for global activities to be co-ordinated so that GS/AS applications and terminology become standardised.

Across Europe and the US, GS/AS applications have been developed and demonstrated within many research programmes. The Requirements Focus Group (RFG) provides a framework for cooperative work between the USA, Europe and now, Australia and Japan. It will ensure that the experience gained from the various research programmes is reflected in ASAS/ADS-B standards.

For the long-term, work needs to continue on applications for Package II and Package III. This requires more analysis of the safety implications of delegating responsibility for separation applications, including self-separation, to the cockpit.

The selection of the ADS-B data-link technology has proved to be a stumbling block and implementation of ADS-B has been slowed down by the lack of agreement. This position has been changing. At ANConf/11 [14], it was noted that one of the key factors in selecting a data-link technology appeared to have been a requirement to ensure global interoperability while enabling the near-term introduction of ADS-B services. The main consequence of this is that most early implementations are likely to be based on SSR Mode S extended squitter although some regions may adopt alternative approaches. It is also expected that additional alternative link technologies will be required in the future in order to meet requirements for integrity and capacity. In Europe, the initial deployment of ADS-B will be based on SSR Mode S extended squitter with VDL Mode 4 providing regional implementations and a dual link capability where necessary.

Among the various applications identified for inclusion in Package I, there is a subset that is expected to bring early benefits. The benefits arise because many aircraft are being equipped with SSR Mode S extended squitter and as result, are visible to any suitably equipped receiver.

In areas with no existing radar cover or restricted radar coverage, the introduction of ADS-B-out equipped aircraft will enable ANSPs to provide a radar-like service. The Upper Airspace Project in Australia is leading the way here by installing a large number of ADS-B ground stations. This is expected to provide a significant improvement to the service supplied to the aircraft operators while reducing the long-term cost to the ANSP.

Another GS application that would be suitable for early implementation is ADS-B-APT. This is of immediate benefit to airports that are not equipped with SMGCS and where restricted visibility as a result of poor weather is a frequent occurrence. At airports equipped with SMGCS but with restricted ground surveillance cover or blind spots, the application is expected to provide benefits by providing an additional source of position information. A related application is ATSA-SURF. This could enhance situation awareness in the cockpit while the aircraft is on the airport surface. The full benefits of this application though, will only be achieved when all aircraft and relevant ground vehicles are ADS-B-out equipped. During the transition period, the benefits would only

be achieved if the positions of non-equipped aircraft and ground vehicles were made available to equipped aircraft.

The AS application expected to generate the greatest benefit in the short term is the ASPA-S&M application. This provides a means for controllers to create more regular flows of aircraft. The new instructions should decrease the controller workload, without significantly changing the pilot workload, by reducing the need for tactical control of aircraft within a sector. The main expected benefits are reduced controller workload and potentially, increased capacity through better adherence to the optimum approach spacing.

Progress towards the implementation of ASAS in Europe has been slow but steps are being taken to speed this up. The North European Update Programme (NUP) and the Mediterranean Free Flight (MFF) project are progressing. The first stages of planning for large-scale evaluation trials began in January 2004 with the start of the European Union part Trans European Network (TEN) project called SEAP.

ASAS-TN has provided the means to share the current knowledge on ASAS/ADS-B between all European stakeholders and provides recommendations for future activities required to reach the operational use of GS/AS applications. It is expected that these results will be of use to guide European actions. The expectation is also that the shared knowledge and the agreed recommendations will allow European industry to optimally plan and focus their new product development strategy.

4.2. ASAS-TN Recommendations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Recommendation 10: It is recommended that the ASPA-S&M application be considered for implementation as early as practical at specific airports where benefits have been shown to exist. This should provide significant benefits to stakeholders and also creates a sound basis on which to build more advanced capabilities.

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