CARE/ASAS Action

CARE/ASAS Activity 5 Description of a first package of GS/AS applications

Version 2.2 - September 30, 2002

Executive summary

The main objective of this document is to describe a first package of operational applications suitable for an early implementation. The terms 'GS/AS (Ground Surveillance/Airborne Surveillance) applications' are used to name the operational applications that are considered. GS/AS applications encompass all operational applications often identified as ADS-B (Automatic Dependent Surveillance – Broadcast) applications, TIS-B (Traffic Information Service – Broadcast) applications or ASAS (Airborne Separation Assistance System) applications. GS/AS applications will be defined at a higher and more abstract level than these other applications.

ADS-B is recognised as a key enabler for GS/AS applications and the proposal is focused on the operational use of ADS-B data to improve the ATM system. The main considerations taken into account for this work are:

- It is focused on operational applications suited for core European high-density traffic areas without excluding other areas, in line with the ATM2000+ strategy and the expected Operational Improvements. Global applicability is also a key consideration;
- The operational needs of airborne and ground users are considered; and
- It seeks to facilitate the elaboration of operational and technical standards required for the implementation of these operational applications.

It should be stressed that the document does not address the actual implementation of any GS/AS applications.

The description of Package I includes twelve operational applications:

- five GS applications:
  - ATC surveillance for en-route airspace (ADS-B-ACC);
  - ATC surveillance in terminal areas (ADS-B-TMA);
  - ATC surveillance in non-radar areas (ADS-B-NRA);
  - Airport surface surveillance (ADS-B-APT); and
  - Aircraft derived data for ground tools (ADS-B-ADD).
- and seven AS applications:
  - Enhanced traffic situational awareness on the airport surface (ATSA-SURF);
  - Enhanced traffic situational awareness during flight operations (ATSA-AIRB);
  - Enhanced visual acquisition for see & avoid (ATSA-S&A);
  - Enhanced successive visual approaches (ATSA-SVA);

- Enhanced sequencing and merging operations (ASPA-S&M);
- In-trail procedure in oceanic airspace (ASPA-ITP); and
- Enhanced crossing and passing operations (ASPA-C&P).

During the next phases of development (i.e. harmonisation, validation, safety and costs), it could be necessary to reassess the GS/AS applications currently included in Package I:

- Some applications may be ready for earlier implementation than envisaged at present;
- Some applications may need to be made more specific to better match the users' needs;
- Some applications may be discarded because they do not have real customers; and
- Some applications may be postponed to future packages because they are not mature enough and they could delay the implementation of Package I.

The GS/AS applications included in Package I are foreseen to be implemented within a 5-to-10 year timeframe. This objective is a challenge but experts consider it feasible. It is possible to go faster for the local implementation of specific applications but Package I concerns 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, ANS providers 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 are clearly meant to be taken as a whole in terms of standards and equipment.

In parallel to the development of Package I, it is necessary to work on the definition of future packages. Several important issues have already been identified and R&D work has to be carried out.

The document is a contribution to enhance the ATM system. It is offered to the European Commission, EUROCONTROL and ANSPs, IATA and aircraft operators, and the industry. It is hoped that the document will support their strategic decisions and recommendations. It was also developed with the objective of facilitating the development of common standards between EUROCAE and RTCA for global interoperability.

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Acronyms

3FMS	Free Flight, Flight Management System
ACAS	Airborne Collision Avoidance System
ADD	Aircraft Derived Data
ADS	Automatic Dependent Surveillance
ADS-B	ADS - Broadcast
ADS-B-ACC	GS application - ATC surveillance for en-route airspace
ADS-B-ADD	GS application - Aircraft derived data for ground tools
ADS-B-APT	GS application - Airport surface surveillance
ADS-B-NRA	GS application - ATC surveillance in non-radar areas
ADS-B-TMA	GS application - ATC surveillance in terminal areas
ADS-C	ADS - Contract
ADSP	Automatic Dependent Surveillance Panel (now OPLINKP)
AEA	Association of European Airlines
AGC	Air/ Ground Cooperative ATS (EATMP)
AMAN	Arrival Manager
AMCP	Aeronautical Mobile Communications Panel
ANSP	Air Navigation Service Provider
AP1	Action Plan 1 (FAA/EUROCONTROL R&D Committee)
AS application	Airborne Surveillance application
ASA	Airborne Surveillance Application for EUROCAE
ASA	Airborne Separation Assurance for RTCA
ASA	Automated Support to ATC (EATMP)
ASAS	Airborne Separation Assistance System
ASPA-C&P	AS application - Enhanced crossing and passing operations
ASPA-ITP	AS application - In-trail procedure in oceanic airspace
ASPA-S&M	AS application - Enhanced sequencing and merging operations
ASSAP	Airborne Surveillance and Separation Assurance Processing
ATC	Air Traffic Control
ATD	Air Traffic Control & Data Processing
ATM	Air Traffic Management
ATMCP	Air Traffic Management Operational Concept Panel
ATS	Air Traffic Services
ATSA-AIRB	AS application - Enhanced traffic situational awareness during flight operations

ATSA-S&A	AS application - Enhanced visual acquisition for see & avoid
ATSA-SURF	AS application - Enhanced traffic situational awareness on the airport surface
ATSA-SVA	AS application - Enhanced successive visual approaches
ATSAW	Air Traffic Situational Awareness
CAP	Controller Access Parameters
CARE	Co-operative Actions of R&D in EUROCONTROL
CBA	Cost Benefit Analysis
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CENA	Centre d'Etudes de la Navigation Aérienne
CNS	Communication, Navigation and Surveillance
CONOPS	Concepts of Operations
COOPATS	Cooperative ATS
CO-Space	Cooperative Spacing
CPDLC	Controller-Pilot Data Link Communications
DMAN	Departure Manager
DME	Distance Measuring Equipment
EACAC	Evolutionary Air ground Co-operative ATM Concepts
EATMP	European Air Traffic Management Programme
EC	European Commission
ECAC	European Civil Aviation Conference
ECIP	European Convergence and Implementation Plan
EEC	EUROCONTROL Experimental Centre
EMERALD	EMErging RTD Activities of reLevance for ATM concept Definition
EMERTA	EMErging Technologies Opportunities, Issues and Impact on ATM
EUROCAE	European Organisation for Civil Aviation Electronics
F2WGO	Free Flight Working Group-Operational
FAA	Federal Aviation Administration
FARAWAY	Fusion of ADS and RAdar data through two-WAY data link
FFAS	Free Flight Airspace
FLIPINT	Flight Path Intent
FMS	Flight Management System
FREER	Free-Route Experimental Encounter Resolution
GNSS	Global Navigation Satellite System
GS application	Ground Surveillance application
GS/AS	Ground Surveillance / Airborne Surveillance

GSA	Ground Surveillance Applications
HMI	Human Machine Interface
IAF	Initial Approach Fix
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ID	Identification
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
JAA	Joint Airworthiness Authority
JAFTI	JURG ADS Fast Track Initiative
JCB	Joint Coordination Board
JURG	AEA/IATA ATM-CNS Joint User Requirements Group
LCIP	Local Convergence and Implementation Plan
MA-AFAS	More Autonomous Aircraft in the Future ATM System
MAICA	Modelling and Analysis of the Impact of the Changes in ATM
MAS	Managed Airspace
MASPS	Minimum Aviation System Performance Standards
MEDUP	Mediterranean Update Project
MFF	Mediterranean Free Flight
MHz	Mega Hertz
Mode S	Mode of SSR which provides selective addressing of aircraft
MOPS	Minimum Operational Performance Standards
MTCD	Medium Term Conflict Detection
NAT	Atlantic Region
NEAN	Northern Europe ADS-B Network
NEAP	North European CNS/ATM Application Project
NLR	Nationaal Lucht en Ruimtevaartlaboratorium
NM	Nautical Mile
NUP	NEAN Update Program
OCD	Operational Concept Document
ODIAC	Operational Development of Integrated surveillance and Air/ground Data Communication
OIs	Operational Improvements
OPLINKP	Operational Data Link Panel (former ADSP)
ORD	Operational Requirement Document
PO-ASAS	Principle of Operation for the Use of Airborne Separation Assurance Systems
R&D	Research and Development

RGCSP	Review of the General Concept of Separation Panel (now SASP)
RNAV	Area Navigation
ROT	Runway Occupancy Time
RTCA	Radio Technical Commission for Aeronautics
RTD	Research and Technical Development
SAP	System Access Parameters
SARPs	Standards and Recommended Practices
SASP	Separation and Airspace Safety Panel (former RGSCP)
SC	Special Committee
SCRSP	Surveillance and Conflict Resolution System Panel (former SICASP)
SCS	Strategy, Concept & System
SEAP	Large Scale South European ADS pre-implementation Programme
SICASP	SSR Improvements and Collision Avoidance System Panel (now SCRSP)
SMGCS	Surface Movement Guidance and Control System
SPF	Strategic Performance Framework
SSR	Secondary Surveillance Radar
STAR	Standard Arrival Route
SUPRA	Support for the Use of PResently unserved Airspace
SUR	Surveillance
TCAS	Traffic alert and Collision Avoidance System
TCPs	Trajectory Change Points
TGL	Temporary Guidance Leaflet
TIBA	Traffic Information Broadcast by Aircraft
TIS	Traffic Information Service
TIS-B	Traffic Information Service - Broadcast
TLS	Target Level of Safety
TMA	Terminal Manoeuvring Area
T-MAT	University of Glasgow study
TORCH	Technical, EcOnomical and OpeRational Assessment of an ATM Concept AcHievable from the year 2005
TT	Tiger Team
UAT	Universal Access Tranceiver
UMAS	Unmanaged Airspace
URD	User Requirement document
VDL	VHF Digital Link
VF	Validation Framework
VFR	Visual Flight Rules

VHF	Very High Frequency
VMC	Visual Meteorological Conditions
WG	Working Group

CARE/ASAS Action

CARE/ASAS Activity 5 Description of a first package of GS/AS applications

Version 2.2 - September 30, 2002

1. Introduction

1.1. Objectives of the document

The main objective of this document is to describe a first package of operational applications suitable for an early implementation. The terms 'GS/AS (Ground Surveillance/Airborne Surveillance) applications' are used in this document to name the operational applications that are considered. GS/AS applications encompass all operational applications often identified as ADS-B (Automatic Dependent Surveillance – Broadcast) applications, TIS-B (Traffic Information Service – Broadcast) applications or ASAS (Airborne Separation Assistance System) applications. GS/AS applications will be defined at a higher and more abstract level than these other applications.

ADS-B is recognised as a key enabler for GS/AS applications and the proposal is focused on the operational use of ADS-B data to improve the ATM system. The document does not address the operational requirements for CNS technologies supporting GS/AS applications.

In addition to airborne surveillance, AS applications are going to require new aircraft functionalities. For example, applications implementing 'airborne spacing' could require a suitable human-machine interface to navigate relative to another traffic and/or new navigation functions.

The main considerations taken into account for this work are:

- It is focused on operational applications suited for core European high-density traffic areas without excluding other areas, in line with the ATM2000+ strategy and the expected Operational Improvements. Global applicability is also a key consideration;
- The operational needs of airborne and ground users are considered; and
- It seeks to facilitate the elaboration of operational and technical standards required for the implementation of these operational applications.

It should be stressed that the document does not address the actual implementation of any GS/AS applications.

1.2. Development of the document

In January 2002, taking into account the latest work conducted within the EUROCONTROL Organisation and EUROCAE/WG51, it was decided to set up an expert group to elaborate a proposal for a first package of operational applications suitable for early implementation. The work was conducted within the framework of CARE/ASAS. Because GS/AS applications include also operational applications that are not ASAS related, the expert group included individuals with the required knowledge.

Under the title 'Proposal for a coherent package of applications, equipment & standards', the initial work was presented during the ADS-B Symposium in Rome (12-14 March 2002). The proposal was well received and was supported by the participants. During the same symposium, the European Commission decided to create a body called the 'Joint Coordination Board' (JCB) to co-ordinate research, development and validation work performed by the various European Commission ADS-B projects and to expedite implementation.

Several versions on the document were developed and were circulated for comments. The main meetings where the document was presented and discussed are:

- 27 March 2002 - EUROCAE WG51 meeting in Paris
- 4 April 2002 - Lufthansa and ADS programme meeting in Haren
- 10-11 April 2002 - NUP II meeting in Toulouse
- 23 April 2002 - EUROCAE WG51 meeting in Toulouse
- 17 May 2002 – First JCB meeting in Brussels
- 29-30 May 2002 - EUROCAE WG51 meeting in Malmö
- 20 June 2002 – ODIAC meeting in Haren
- 4 July 2002 – Version 2.0 of the document was delivered during the second JCB meeting.

JCB/2 decided to initiate a formalised commenting process on version 2.0 of the document with a deadline 15 September 2002. The expert group met on 19 September 2002 to review the comments and amend the document.

The final version of the document (version 2.1) is proposed for endorsement at the third JCB meeting on 30 September 2002 in Brussels.

1.3. Structure of the document

The document is organised into seven chapters, starting with chapter 1 on the objective of the document.

Chapter 2 reviews briefly the work performed so far as well as the on-going work by the relevant bodies (e.g. ICAO panels, EUROCONTROL Organisation, EC funded projects, JAA, EUROCAE and RTCA) on GS/AS applications.

Chapter 3 describes how GS/AS applications are related to the EATMP ATM2000+ strategy and the Operation Concept Document and how they can contribute to the achievement of the related Operational Improvements.

Chapter 4 gives the rationale for grouping GS/AS applications into packages and the criteria considered for the selection of GS/AS applications included in Package I.

Chapter 5 is the core part of the document: the description of Package I.

Chapter 6 discusses future packages.

The document concludes with chapter 7 and five annexes are appended:

- Annex 1: Standard document organisation and relationships
- Annex 2: Operational Improvements related to GS/AS Applications
- Annex 3: Operational Improvements, GS/AS applications included in Package I and the ATM2000+ roadmap
- Annex 4: Description of GS applications included in Package I
- Annex 5: Description of AS applications included in Package I

1.4. References

The following references were considered when developing this document:

[1] CARE/ASAS/CENA/02-037 – CARE/ASAS Activity 4 – Review of ASAS applications studied in Europe – Version 1.0 – February 8, 2002

[2] Principle of Operation for the Use of Airborne Separation Assurance Systems (PO-ASAS) – Edition 7.1 – June 19, 2001

[3] CARE/ASAS/NLR/00-012 - CARE/ASAS Activity 1- European ASAS literature and study review (Problem Dimensions / Evaluation of Past Studies) – Version 2.0 – December 23, 2000

[4] CARE/ASAS/EEC/01-020 - CARE/ASAS Activity 2 - Towards a validation framework for ASAS applications - Version 1.0 - June 12, 2001

[5] CARE/ASAS/Glasgow University/01-019 - CARE/ASAS Activity 3: Investigation of Experience in Modelling and Determining Separation Minima - version 1.8 - February 22, 2001

[6] CARE/ASAS/Sofreavia/01-018 - CARE/ASAS Activity 3: Airborne Separation Minima – Final Report – Version 2.1 - April 3, 2002

[7] EUROCONTROL EATMP – FCO.ET1.ST07.DEL02 - ATM2000+ Strategy Update – Version 1.0c – Draft Proposal – 23 April 2002

[8] EUROCONTROL EATMP – FCO.ET1.ST07.DEL01 - Operational Concept Document – Edition 1.1 – January 4, 1999

[9] EUROCONTROL EATMP - AGC Programme - Towards Cooperative ATS – The COOPATS Concept – Edition 1.0 – June 18, 2001

[10] EUROCONTROL EATMP – ADS Programme – ADS Concept – Edition 1.7 – September 28, 2001

[11] EMERALD/WP5/SOF/015/1.0 – Assessment of emerging technologies: the specific case of ADS-B/ASAS – Version 1.0 – March 12, 1998

[12] EUROCONTROL EATMP – FCO.ET1.ST04.DEL01 – ATM User Requirements Document (URD) – version 2.0 – 5 January 1999

[13] EUROCONTROL Experimental Centre – EACAC 2000 Real-Time Experiments – Initial evaluation of Limited Delegation of Separation Tasks to the Flight Deck – Version 5.1 – 14 September 2001

[14] AEA/IATA ATM-CNS Joint User Requirements Group (JURG) - ADS Fast Track Initiative (JAFTI) - Version 1.3 - June 14, 2002

2. Background

2.1. Introduction

The following sections are reviewing briefly the work performed so far by the relevant bodies as well as the on-going work.

2.2. ICAO standardisation

2.2.1. Air Traffic Management Operational Concept Panel - ATMCP

The Air Traffic Management Operational Panel had its first meeting (ATMCP/1) on 18-28 March 2002. The ATM Operational Concept Document (OCD) constitutes Appendix A to the ATMCP/1 report on Agenda Item 2. This operational concept is a description of the manner in which the ATM system will deliver services and benefits to airspace users by the year 2025.

Seven ATM operational concept components are identified and described. Amongst these components, GS/AS applications can contribute to improve the future ATM system in terms of safety, capacity and flexibility:

- Aerodrome operations: e.g. the ability to safely manoeuvre in all weather conditions while maintaining capacity.
- Traffic synchronisation: e.g. delegation of maintenance of spacing to the flight deck to increase traffic throughput while reducing ground system workload.
- Airspace user operations: e.g. Aircraft capabilities consistent with the applicable airspace management requirements will allow users to fly user-preferred trajectories.
- Conflict management: e.g. The ATM system will be designed to minimise restrictions to user operations and, in particular will be designed to avoid, where possible, tactical changes to trajectories; therefore, the pre-determined separator will be the airspace user, unless safety or ATM system design requires a separation provision service.

2.2.2. Operational Data Link Panel - OPLINKP

ADSP (Automatic Dependent Surveillance Panel) was the previous acronym of OPLINKP.

In October 1999, ADSP/5 produced two appendixes to the Report on Agenda Item 4 – Development of an operational concept and operational requirements for the use of a system to a) increase situational awareness and b) provide airborne separation assurance:

- Appendix A – Information relevant to the use of ADS-Broadcast. Operational applications are divided in two categories: 1) use of ADS-B by aircraft and 2) use of ADS-B by ATS.
- Appendix B - Information relevant to the use of a system to increase traffic situational awareness and provide airborne separation assurance. This document identifies two classes of ASAS applications: 1) Traffic situational awareness applications and 2) Co-operative separation applications.

The OPLINKP work programme includes:

- Develop operational requirements for the use of a system to increase airborne traffic situational awareness;
- Develop a concept of use and operational requirements for the application of ADS-Broadcast; and
- Monitor the development of the use of systems providing airborne separation assurance in order to develop a concept of use.

Working Group A of OPLINK is currently working on these programme items and OPLINKP/1 could be scheduled in 2003.

2.2.3. Surveillance and Conflict Resolution Panel - SCRSP

SICASP (SSR Improvements and Collision Avoidance System Panel) was the previous acronym of SCRSP.

In November 1993, SICASP/5 decided to include in its work programme a task on 'Review proposals for other uses of ACAS to determine whether any further technical specifications are required and ensure that the collision avoidance function is not affected'. It was recognised that non-collision avoidance uses of ACAS were already being exercised or investigated.

In February 1997, SICASP/6 produced 'The ASAS concept' as appendix A to the Report on Agenda Item 6 on 'Future work' (SICASP/6-WP/44).

In September 2000, SICASP/7 produced the 'ICAO Airborne Separation Assurance Circular - version 1.0' as appendix A to the Report on Agenda Item 5 on 'Development of guidance material for airborne separation assurance system (ASAS)' (SICASP/7-WP/55). This circular has been circulated for comments to the relevant ICAO panels. Currently, Working Group A of SCRSP is updating this circular which is planned for delivery in December 2002.

Working Group B of SCRSP is in charge of the ICAO standards for the ADS-B technology known as 1090 MHz Mode S extended squitters.

The SCRSP work programme includes the following task: 'Develop, as necessary, ICAO provisions to meet the operational and technical requirements for an airborne separation assurance system (ASAS)'. SCRSP/1 is planned in Spring 2004

2.2.4. Aeronautical Mobile Communications Panel - AMCP

AMCP is in charge of the ICAO standards for the ADS-B technologies known as VDL Mode 4 and possibly UAT.

2.2.5. Separation and Airspace Safety Panel - SASP

RGCSP (Review of the General Concept of Separation Panel) was the previous acronym of SASP.

During RGCSP/10 in May 2000, the meeting decided to include in its future work programme a task entitled: 'Consider developing airborne separation minima for application using airborne separation assurance system (ASAS)'.

The progress of this task is highly dependent on the contribution from States. So far SASP was presented with the ASAS circular from SCRSP, the PO-ASAS document from the FAA/EUROCONTROL R&D Committee and work conducted within CARE/ASAS Activity 3.

SASP/1 is tentatively planned in 2003.

2.2.6. Air Navigation Conference

The Eleventh Air Navigation Conference is planned in Montreal from 29 September to 10 October 2003. The ATM Operational Concept Document prepared by ATMCP is going to be presented under Agenda Item 1 – Introduction and acceptance of a global air traffic management operational concept. Relevant work being carried out by both SCRSP and OPLINKP will be brought forward to form the basis for part of the work under this item.

2.3. EUROCONTROL Organisation

2.3.1. FAA/EUROCONTROL R&D Committee

Within the context of the FAA/EUROCONTROL R&D Committee, Action Plan 1 developed the PO-ASAS document [2] which categorised ASAS applications. It is now used as a reference in ASAS related projects.

Currently, Action Plan 1 is working on the development of a document addressing 'ASAS applications and Safety'. The delivery date is January 2003.

2.3.2. CARE/ASAS

CARE/ASAS was created in September 1999 as an initiative from the EUROCONTROL R&D Committee. CARE/ASAS is dedicated to improve coordination and to help/support on ASAS studies/projects in Europe. Several activities are progressed with the objective to deliver products useful for the ASAS community:

- Activity 1 - Problem dimension and evaluation of past studies: This activity performed a review of past ASAS studies in Europe. The deliverable was a report CARE/ASAS/NLR/00-012 - European ASAS literature and study review (Problem Dimensions / Evaluation of Past Studies) [3]. This A1 report was disseminated in April 2001.
- Activity 2 - ASAS Validation Framework: This activity has delivered a first report CARE/ASAS/EEC/01-020 - CARE/ASAS Activity 2 - Towards a validation framework for ASAS applications - Version 1.0 - June 12, 2001 [4]. This A2 report was disseminated in September 2001. Currently, a consortium of five organisations led by NATS is running a project called CARE/ASAS Validation Framework (VF) project. The objective is to deliver by end of 2002 firm recommendations for a feasible generic Validation Framework for ASAS applications, comprising standards for scenarios and metrics and to provide guidance materials and case study examples for its application.
- Activity 3 - ASAS and Safety: This activity has delivered a first report CARE/ASAS/Glasgow University/01-019 - CARE/ASAS Activity 3: Investigation of Experience in Modelling and Determining Separation Minima - version 1.8 - February 22, 2001 [5]. This A3 report was disseminated in September 2001. In 2001, a consortium of five organisations lead by Sofreavia conducted the ASM (Airborne Separation Minima) project. The final report - CARE/ASAS/Sofreavia/01-018 - CARE/ASAS Activity 3: Airborne Separation Minima – Final Report – Version 2.1 - April 3, 2002 [6] - was delivered and disseminated beginning of 2002. Currently, a small extension of the ASM project is elaborating on the lessons learnt during the ASM project. The report should be available in June 2002.
- Activity 4 – ASAS applications: The main deliverable for this activity, which was launched very recently, is the document CARE/ASAS/CENA/02-037 – CARE/ASAS Activity 4 – Review of ASAS applications studied in Europe – version 1.0 – February 8, 2002 [1].
- Activity 5 - Definition of an ASAS Implementation programme: This document is the first contribution to this activity. Two other contributions are currently being developed:
  - CARE/ASAS/EUROCONTROL/02-042 - Proposal for working arrangements to develop Package I of AS/GS applications; and
  - CARE/ASAS/EUROCONTROL/02-044 – Joint Coordination Board (JCB) Projects mapping to Package I Applications.

2.3.3. European Air Traffic Management Programme (EATMP)

Several EATMP management units, domains and programmes are involved GS/AS application related work:

- The SCS management unit is maintaining the ATM 2000+ strategy [7] and the Operational Concept Document (OCD) [8]. It also works on CNS/ATM Architecture and Validation;
- The ATD management unit through the AGC programme and the ASA programme is the owner of the COOPATS concept [9];
- The Airport Operations programme is defining the requirements for airport surface surveillance (i.e. A-SMGCS project) and AMAN/DMAN tools in cooperation with the ATD management unit;
- The SUR management unit, through the ADS and the Mode S programmes, is responsible for the surveillance strategy, the ADS concept [10], the ADS requirements and the ADS infrastructure specifications; and
- The ACAS programme is playing an important role in the integration of AS application functionalities in the cockpits.

2.4. European projects and studies

Europe is very active in this area. Projects and studies can be internal to an organisation but they more often run by a consortium co-sponsored by the European Commission.

The CARE/ASAS Activity 1 report [3] reviewed several projects (e.g. 3FMS, EMERALD, EMERTA, TORCH, MAICA, GLASGOW, CENA, FREER, NEAN/NEAP, FARAWAY, SUPRA, NLR).

Among these projects, it should be noted that the EMERALD project [11] in 1998:

- Classified the ASAS applications in three categories;
- Made a global assessment of ADS-B techniques for AS applications. It was concluded that 1) none of the available techniques was suitable to support all the applications, 2) with the exception of TSA applications, 'a dual communication channel' could be necessary to satisfy the integrity and availability requirements and 3) TIS or TIS-B could be necessary during the transition period;
- Identified Research and Technical Development (RTD) issues to be addressed; and
- Developed a high level RTD plan with an indicative schedule.

More recently, the CARE/ASAS Activity 4 document [1] reviewed 34 ASAS applications currently studied in Europe by the various projects or organisations: MFF, MA-AFAS, NUP, CARE/ASAS, AGC programme, EEC, NLR and CENA. These applications are briefly described using a standard template. An analysis was performed and 14 different ASAS applications were actually identified.

2.5. Users initiatives

IATA/Europe and NLR have set up a 'Free Flight Working Group-Operational' (F2WGO). The objective of this group is to deliver two documents: 1) an end-goal state document and 2) a transition path document. The first meeting of the F2WGO was held on 28 September 2001.

In February 2002, the AEA/IATA ATM-CNS Joint User Requirements Group (JURG) decided to launch the JURG ADS Fast Track Initiative (JAFTI) with the objective to speed-up the implementation of ADS-B in Europe. A pragmatic approach was favoured in resolving outstanding issues as soon as possible. A list of selected initial application has been drafted [14]. The airspace users have specifically requested that the focus be put on the core European high-density traffic areas.

2.6. Airworthiness authorities and other standardisation organisations

2.6.1. JAA

The JAA CNS/ATM Steering Group is currently developing a position paper on ASAS (pp 009_7 – Considerations for the Use of Airborne Separation Assurance Systems (ASAS)). The document reviews the impact of ASAS and ADS-B airborne surveillance on aircraft architecture and certification standards. It should be noted that the FAA is participating in the JAA CNS/ATM group and particularly in the development of this position paper. In addition, it should be noted that the current version of this position paper is mainly based on available documents such as PO-ASAS document [2].

A JAA position paper is developed when no regulation is available for a dedicated system or function. When the concept is mature and when the appropriate documentation for certification is available, a JAA Temporary Guidance Leaflet (TGL) is produced and includes the requirements that shall be fulfilled in order to certify the system installation or the use of the function.

2.6.2. RTCA

RTCA SC-186 is developing or maintaining several documents:

- ASA MASPS. The need for this top-level document was recognised after the release of the ADS-B MASPS to answer the question 'Why ADS-B or TIS-B?'. The document is currently under development.

- ADS-B MASPS. ADS-B MASPS (DO-242) was published by RTCA SC-186 in February 1998 and revised in April 2002. EUROCAE WG51 did not endorse the document as a EUROCAE MASPS, because the European operational requirements were not sufficiently mature.
- TIS-B MOPS. The document is currently under development.
- 1090 MHz MOPS: The document was jointly developed with EUROCAE WG51. The document is currently under revision.
- UAT MOPS: SC186 has completed the first version of this document, and recommended it for publication.
- ASSAP MOPS: The development of this document is on stand-by due to priority given to the ASA MASPS.

Addressing several levels in the hierarchy simultaneously to develop several interdependent documents has presented difficulties in coordination and synchronisation leading to risks in producing a coherent and consistent set of documents, due to the mutual impacts of each document on the others.

2.6.3. EUROCAE

EUROCAE WG51 is considering the operational airborne and ground user needs for Automatic Dependent Surveillance-Broadcast (ADS-B) and the preparation of the consequential guidance documents for its component and associated systems in accordance with ICAO and RTCA activities.

Annex 1 gives an overview of the standard document organisation and relationships. Three levels are identified: 1) Application MASPS, 2) Functional MASPS and 3) Equipment standards.

To gather airborne users needs and ground users needs, EUROCAE WG51 is planning to develop ASA MASPS and GSA MASPS (i.e. Application MASPS). These two documents are necessary to develop the ADS-B MASPS and the TIS-B MASPS (i.e. Functional MASPS). ADS-B MASPS and TIS-B MASPS should gather the functional requirements for GS and AS applications.

When ADS-B and TIS-B MASPS are available (other MASPS may have also to be considered like MASPS for point-to-point communication), it is possible to develop MOPS for specific equipment (i.e. Equipment standards).

As well as the 1090 MHz MOPS developed jointly with RTCA (see above), EUROCAE WG51 has developed and has published MOPS for VDL Mode 4, describing equipment functionality to meet the requirements of DO-242, have been published.

To cope with the various maturity levels of GS/AS applications, the notion of a ‘Package of GS/AS applications’ emerged from EUROCAE WG51 discussions. The main reason was to develop a coherent set of documents (e.g. MASPS and MOPS) leading to the early implementation of defined GS/AS applications.

3. Users needs and expected operational improvements

3.1. Introduction

The ATM User Requirement document (URD) [12] gathers the ATM Stakeholder Needs expressed by the Aviation Community during user consultation workshops held by EUROCONTROL in 1994 and 1998.

These statements have been used as input to the development of the ATM Target Concept (OCD) [8] and the ATM Strategy for 2000+ [7]. Together, the OCD and the ATM Strategy for 2000+ provide a cohesive view of future ATM in Europe out to 2015.

In the context of the Strategic Performance Framework (SPF), Operational Improvements (OIs) necessary for an enhanced ATM system and to support the ATM 2000+ Strategy have been identified.

GS/AS applications are expected to contribute to improve the current ATM system and to allow the transition towards a future new ATM system. The following sections are reviewing the OCD, the ATM 2000+ strategy and the OIs so as to identify the roles GS/AS applications are going to play.

3.2. EATMP Operational Concept Document (OCD)

The Operational Concept Document (OCD) [8] provides a high-level description of a target operational concept for Europe for the early part of this Century based on the main operational and functional options available to realise the overall objective set out in the ATM Strategy for 2000+. The OCD is currently being updated.

The main drivers for change in the ECAC region airspace are the need to simultaneously create additional capacity in the congested airspace areas while reducing direct and indirect ATM-related costs, and to increase safety levels.

The concept incorporates a mix of route structuring, free routings and autonomous aircraft operations to answer the needs of a diverse user community. The concept involves fundamental changes to current roles both in the air and on the ground; a distribution of responsibilities for separation assurance between the air and ground ATM elements according to aircraft capabilities and the services provided; greater use of computer support tools to cope with increased levels of service and to keep ATC and cockpit workload within acceptable levels; and a more dynamic and flexible management of airspace.

A fundamental principle of ATM is to apply positive separation between aircraft receiving the appropriate ATM services. The main safety layer remains that of preserving minimum separation distances between aircraft. The way in which safe separation is provided, and the allocation of responsibilities to the humans involved, has a direct impact on workload, and is the central factor in shaping a concept and determining what it can deliver in terms of capacity and flight efficiency. Decisions made about separation provision also directly affect the choices that can be made in other concept component areas, particularly those concerned with airspace organisation and management, flow and capacity management and sequence optimisation and management.

There is a broad set of options on how separation can be applied, who should be responsible, over what time horizons, and how much computer support can or should be used. Distributed Air and Ground Responsibilities is one among several options. ACAS has already brought a new degree of situational awareness to the cockpit. This trend is likely to continue with the introduction of Airborne Separation Assistance Systems (ASAS), incorporating surveillance functions, longer look-head capabilities and improved cockpit HMI, so that flight-deck crews will become more aware of the surrounding airborne traffic situation. Distributed air and ground responsibilities involves ground ATC sharing the responsibility for separation provision with aircraft suitably equipped to ensure their own separation from other aircraft, thereby reducing ground ATC workload and enhancing flight efficiency.

The OCD target concept is built on three airspace regimes:

- Unmanaged Airspace (UMAS): unknown traffic environment and rules of the air;
- Managed Airspace (MAS): known traffic environment, 3-D routes and routings and responsibility for separation with the ground; and
- Free Flight Airspace (FFAS): known traffic environment, free routings and autonomous operations.

For each airspace regime, GS/AS applications are going to play an important role:

- UMAS: GS/AS applications will allow easier access to more accurate information, including the ability of equipped aircraft to negotiate with each other and agree separation action. The availability of low-cost and simple to use ASA systems, could be of particular benefit in this airspace regime. There will be no interaction with ATM for aircraft operating in UMAS, except for those flights that wish to notify their presence either by filing a flight plan (in the air or on the ground) or by broadcasting their position (and perhaps intentions) by electronic means. ATS, in particular, Flight Information Services, may be provided to aircraft on request providing major safety improvements in UMAS.
- MAS: The responsibility for separation provision will rest with the ground ATM organisation. GS applications will allow the enhancement of existing functions and tools through the provision of aircraft derived data. In some specific traffic situations, through AS applications, the responsibility for spacing or separation may be explicitly transferred to the flight crew of aircraft suitably equipped subject to the pilot's agreement (e.g. climb in trail, remain behind ahead, etc.).
- FFAS: The volumes of airspace that will be allocated to FFAS will be promulgated by the airspace planning and management service on a daily basis to reflect the demand patterns expected across the ECAC airspace. Suitably equipped aircraft will be authorised to enter the FFAS and will be responsible to provide their own separation provision from other aircraft operating in the same airspace. In exceptional circumstances (e.g. emergencies), some responsibility can be undertaken by ground-based ATM or delegated to other organisations (principally the military). AS applications are essential to support this type of operations. Aircraft operating within FFAS will be supported by a ground ATM network (including GS applications) that will provide information and alert services to guarantee safe operations, including degraded mode operations.
- In all types of airspace, GS/AS applications have the potential to enhance safety.

3.3. ATM2000+ strategy

The EUROCONTROL ATM Strategy for the Years 2000+ is currently being updated (version 1.0c) [7]. The Strategy defines the path for change and identifies those measures that will deliver adequate early, lasting benefits for society and the airspace users.

The overall objective of the European ATM network is:

> For all phases of flight, to enable the safe, economic, expeditious and orderly flow of traffic through the provision of ATM services which are adaptable and scaleable to the requirements of all users and areas of European airspace. The services shall accommodate demand, be globally inter-operable, operate to uniform principles, be environmentally sustainable and satisfy national security requirements.

Best use of European airspace can only be achieved if the traditional Air Traffic Control (ATC) concept is replaced, in a controlled way, by a new ATM concept implying a structural revision of the ATM processes.

The core ATM processes are:

- Airspace Organisation and Management - the structure, division and categorisation of airspace, and the rules which apply;
- Flow and Capacity Management - managing the dynamic balance between capacity and demand;
- En-route & Terminal Air Traffic Control - the monitoring and separation of aircraft, traffic sequencing, and management of the capacity and flexibility of airspace;
- Airport Air Traffic Control - air-side traffic management, separation and sequencing of traffic on the airport and on final approach and departure, and other airport issues, including environmental impacts.

For each core ATM processes, the Directions for Changes are defined. GS/AS applications are going to contribute to these Directions for Change which are listed below:

- Airspace Organisation and Management:
  - Terminal airspace optimisation;
  - ATC sector design optimisation; and
  - Utilisation of user-preferred trajectories.
- Flow and Capacity Management:
  - Enhanced tactical flow and capacity management.
- En-route & Terminal Air Traffic Control:
  - Safety nets;
  - ATC Decision support;
  - Arrival, departure and surface movement management;
  - Interoperability, communications and surveillance efficiency; and
  - Co-operative ATS.
- Airport Air Traffic Control:
  - Safety nets;
  - Traffic management on the movement area;
  - Airport throughput; and
  - Airport airside capacity.

GS applications are going to contribute to the traditional Air Traffic Control concept through the provision of surveillance information and aircraft derived data.

AS applications are going to contribute, in a progressive and controlled way, to a new ATM concept through the provision of airborne traffic situational awareness, new ATC instructions and clearances using airborne spacing and airborne separation functions, and ultimately could lead to autonomous aircraft operations in designated airspace.

Each Direction of Change comprises Operational Improvements (OIs) which are associated to a given period of time. Annex 2 gives an overview of the main OIs impacted by GS/AS applications.

For each high-level area and for each OI, Annex 3 explains briefly how GS/AS applications can contribute to achieve the related OIs.

4. Rationale for a first package of GS/AS applications

4.1. Rationale for the 'packaging approach'

The potential scope of GS/AS applications is very large. These operational applications have different level of maturity and are associated with different issues, as identified in the PO-ASAS document [2]. Extensive R&D work is required to solve some of these issues. As a consequence, if the objective is to go for an early implementation, it seems reasonable to group the more mature GS/AS applications so as to form a first package of applications. Applications requiring more work will be also grouped so as to form future packages.

The fitting or retrofitting of systems and equipment must generally be considered with care since it may become complex and result in significant costs. To contain complexity, risks and costs, ground and airborne architectures need to evolve incrementally. This is particularly the case for airborne architecture where new functionalities are introduced with new generation of aircraft or during major retrofit programmes. Ground architecture is going also in the same direction because of harmonisation and standardisation.

Because the implementation of GS/AS applications involve changes in the airborne AND in the ground architectures, these architectures need to evolve in a coordinated manner with time objectives and, as far as possible, taking into account anticipated constraints for future applications.

For the above reasons, the 'packaging approach' is proposed. This approach has also the benefit of focussing energies towards well-identified goals:

- Developing operational and technical standards to allow the early implementation of the GS/AS applications included in Package I; and
- Conducting the necessary R&D studies for the GS/AS applications foreseen in future packages.

4.2. Rationale for Package I

It is proposed to group the more mature applications into a first package of GS/AS applications called 'Package I'. To make this selection, the following criteria have been considered:

- Users' needs: Each application has its own main objective, but the set of applications is intended to bring safety as well as flexibility and capacity benefits. For example, despite the challenge they represent, airborne spacing applications have been specifically included in Package I because they are expected to bring capacity benefits in the core area of Europe (e.g. in TMAs) hence providing a significant incentive for aircraft operators to equip.
- Complexity: Concerning the AS applications, the selected AS applications encompass ASAS applications belonging to the first two categories of the PO-ASAS document (i.e. Airborne traffic situational awareness applications and airborne spacing applications). From an operational perspective, these applications are less complex because they do not involve any change in the current responsibility for separation provision, which remains with the ground system. From a technical perspective, requirements on the systems should be less stringent and safety studies should be less complex (but still necessary and challenging), because the safety of the flight operations is still based on the provision of ATC separation minima.
- Feasibility: The validation of the selected applications is well advanced and, for most of them, simulations or flight trials have been already performed in Europe or in the USA. The display of traffic on an airport map in the cockpit has been demonstrated and brings safety benefits during low visibility conditions or at night. The results of the Co-Space real-time simulation at EEC [13] are showing clear evidence of potential benefits for airborne spacing applications.
- Market: The industry sees opportunities to equip and retrofit existing equipment to fulfil the requirements.
- Time-scale: The selected applications are foreseen to be implemented within a 5-to-10 year timeframe. This objective is a challenge but experts consider it feasible. Even so, it is still

possible for the local implementation of specific applications to go faster, but Package I concerns a set of applications offering benefits for a large majority of airspace users.

The implementation of Package I is also an opportunity to build the future packages on experience. Further than this, it is essential to collect data on the performance of Package I applications to allow the development and implementation of Package II applications. The collection of objective data will allow analysis of:

- how the increased involvement of the flight deck (the flight crew and the aircraft systems) in ATM is affecting air traffic operations positively; and
- what is the real performance of airborne surveillance. This will be of particular importance for the definition of airborne separation minima for airborne separation or airborne self-separation applications.

5. Package I description

5.1. Introduction

Package I is a coherent set of applications that can realistically be implemented together within the next 5 to 10 years. Ground Surveillance (GS) applications and Airborne Surveillance (AS) applications are considered.

The document uses the terms 'GS applications' and 'AS applications'. No specific definitions are proposed for these terms and the following sections describe them in plain text.

5.2. GS applications

GS applications included in Package I are described in Annex 4. These applications are aimed at improving ATC surveillance in the air and on the airport surface and at enhancing ATC tools through the provision of aircraft derived data. In non-radar areas, it is expected that an ATC separation service will be provided although the separation minima that can be supported are not yet defined and could be different from radar separation minima.

Five GS applications are identified and are summarised in the following table:

GS application	**Short description**
ATC surveillance for en-route airspace (ADS-B-ACC)	This application will enhance ATC surveillance currently provided with radars. An example of many is the case of surveillance in areas where single radar coverage is provided.
ATC surveillance in terminal areas (ADS-B-TMA)	This application will enhance ATC surveillance currently provided with radars. An example of many is the case of surveillance at low altitude and close to the terrain and also in areas where single radar coverage is provided.
ATC surveillance in non-radar areas (ADS-B-NRA)	This application will provide ATC surveillance in non-radar areas; e.g. remote areas, offshore operation areas, any continental areas and certain oceanic areas, which, due to the level of traffic or the cost of the equipment, could not justify the installation of radars. The purpose is to enhance traffic information and separation services
Airport surface surveillance (ADS-B-APT)	This application will provide a new source of surveillance information for a safer and more efficient ground movement management at airports with or without SMGCS. Airport ground vehicles can also be fitted with the necessary equipment and displayed on an airport map, together with aircraft.
Aircraft derived data for ground tools (ADS-B-ADD)	This application will provide additional aircraft derived data through ADS-B to be used by the ATC ground system for developing or enhancing ATC tools like displays, MTCD, AMAN, DMAN and ground based safety nets. CDM applications will also share the benefits. It should be noted that this application does not encompass the ground tools themselves; it only provides additional input data for these tools.

5.3. AS applications

As already mentioned in section 2.2.3, Working Group A of SCRSP is finalising an 'ICAO Airborne Separation Assistance Circular' which defines the terms 'ASAS' and 'ASAS applications'.

An initial study was carried out within the framework of the Activity 4 of CARE/ASAS [1]. Thirty-four ASAS applications currently studied in Europe were reviewed. After analysis, the document identifies fourteen distinct ASAS applications, which are addressing the four PO-ASAS categories.

For Package I:

- Only ASAS applications belonging to the two first categories of the PO-ASAS document; namely airborne traffic situational awareness and airborne spacing applications were considered.
- Airborne separation applications and airborne self-separation applications were not considered in Package I because solving the associated operational and technical issues is going to require more time.

In the context of this document, ASAS applications having the same operational objectives were merged into a single AS application. This grouping was used to better capture the needs of the users and to highlight the need for harmonisation of the ASAS applications currently studied.

ASAS applications are defined by the operational procedures involved. Thus each AS application can contain many ASAS applications, which can require varying levels of functionality:

- From an operational perspective, different sets of procedures could be necessary depending on the operational environment in which the application is performed.
- From a technical perspective, different level of automation could be necessary depending on the required performances of systems or functions.

The AS applications included in Package I are described in Annex 5. Seven AS applications are identified and are summarised in the following table:

AS application	Cat.	Short description
Enhanced traffic situational awareness on the airport surface (ATSA-SURF)	1	This application provides the flight crews with an "enhanced traffic situational awareness" on the airport surface for both taxi and runway operations, in all weather conditions. The objectives are to improve safety (e.g. at taxiway crossings, before entering a runway, on pushback) and to reduce taxi time in particular during low visibility conditions or at night.
Enhanced traffic situational awareness during flight operations (ATSA-AIRB)	1	This application provides the flight crews with an "enhanced traffic situational awareness" irrespective of visual conditions. Additional data is provided to flight crews to supplement traffic information provided either by controllers or other flight crews. The objectives are to improve safety of flight and the efficiency of air traffic control. In all airspace, the flight crews will be better able to detect an unsafe situation.
Enhanced visual acquisition for see & avoid (ATSA-S&A)	1	This application is an aid for the flight crews to perform their collision avoidance task when separation service in not provided by ATC (e.g. IFR/VFR in class D and E airspace, class G airspace). The objective is safer flight operations.

AS application	Cat.	Short description
Enhanced successive visual approaches (ATSA-SVA)	1	This application is an aid for the flight crews to perform successive visual approaches when they are responsible for maintaining visual separation from the aircraft they are following. The objectives are to perform successive visual approach procedures on a more regular basis to enhance the runway throughput, and to conduct safer operations especially in high-density areas.
Enhanced sequencing and merging operations (ASPA-S&M)	2	The objective is to redistribute tasks related to sequencing (e.g. in-trail following) and merging of traffic between the controllers and the flight crews. The controllers will be provided with a new set of instructions directing, for example, the flight crews to establish and to maintain a given time or distance from a designated aircraft. The flight crews will perform these new tasks using a suitable human-machine interface. The main expected benefit is increased controller availability, but increased capacity through better adherence to ATC separation minima is also expected especially in high-density areas.
In-trail procedure in oceanic airspace (ASPA-ITP)	2	The In-Trail Procedure in non-radar oceanic airspace is a procedure allowing in-trail ADS-B equipped aircraft, which may not be longitudinally separated from each other, to climb or descend through each other's flight levels. The objective is to improve the utilisation of the NAT oceanic airspace by facilitating a higher rate of flight level changes than is currently provided, yielding better flight efficiency (e.g. fuel savings, avoiding turbulent flight levels).
Enhanced crossing and passing operations (ASPA-C&P)	2	The objective is to provide the controller with a new set of instructions to solve conflicts directing, for example, the flight crews to cross or pass a designated traffic while maintaining a given spacing value. The flight crews will perform these new tasks using a suitable human-machine interface. The main expected benefit is increased controller availability through the reorganisation and the streamlining of tasks.

The last AS application (ASPA-C&P) was added to Package I in version 1.3 of the document as the result of discussion within EUROCAE/WG51. It is currently defined as a PO-ASAS category II application (i.e. Airborne spacing application). There is no real consensus amongst the experts:

- Some experts consider that this application should be included in Package I as a PO-ASAS category III application (i.e. Airborne separation application) involving a transfer of separation responsibility from the controller to the flight deck.
- Other experts consider that there is no mature work on this application as currently defined in the document and that there is a high risk of compromising Package I itself if the application is 'upgraded' to PO-ASAS category III.

The current proposal is seen as the best compromise: it is possible to start working on enhanced crossing & passing operations while complying with the rationale for Package I. If there are no customers for the application as currently defined in the document, it is proposed to discard the application for Package I and to consider it as a PO-ASAS category III application in Package II.

5.4. Harmonisation, validation, safety and costs

GS and AS applications included in Package I, and which are described in annexes 4 and 5, correspond to generic applications. Programmes and projects in Europe are studying variations of

these applications and there is a strong need for harmonisation. The aircraft operators and the aircraft industry require regional or global interoperability.

The harmonisation of AS applications should be based on material coming from the AGC programme (e.g. ATSAW services from ODIAC) and from European projects.

The harmonisation of GS applications should be based on material coming from the ADS programme (e.g. surveillance applications), the AGC programme (e.g. use of aircraft derived data) and from European projects.

As important as the harmonisation process, Package I applications need to be validated both operationally and technically. This validation exercise is currently taking place in the EATMP programmes and European projects. Nevertheless, particular attention should be given to the completeness of this validation. It should be noted that validation is the only efficient means to identify mature operational and technical requirements.

Safety of operations has to be demonstrated. Each application may present different challenges depending on its objective (e.g. improve safety or improve capacity).

Cost/benefit analyses (CBA) have to be performed in the early phases of the development of the applications. Even if very simplistic hypotheses have to be made, the results of these analyses are very helpful for taking decisions during the development process (e.g. choices in the architecture definition).

During this phase of development (i.e. harmonisation, validation, safety and costs), it could be necessary to reassess the GS/AS applications currently included in Package I:

- Some applications may be ready for earlier implementation than envisaged at present.
- Some applications may need to be made more specific to better match the users' needs.
- Some applications may be discarded because they do not have real customers.
- Some applications may be postponed to future packages because they are not mature enough and they could delay the implementation of Package I.

5.5. Identification of Operational and Technical Requirements for Package I

At the end of the harmonisation/validation process, when each application is sufficiently described, it should be possible to identify the operational and technical requirements for Package I.

Because Package I is envisaged in a short time frame, and to avoid delaying its implementation, it is necessary to define equipment standards based on mature/validated requirements. When such maturity is not yet established or when the requirements are not stable enough, there is the possibility of defining options or provisions in Package I standards so as to allow development activities and future enhancements.

Some applications included in Package I are going to be further improved in Package II for better performance through new or more stringent requirements. For those applications, Package I should be seen as a first step leading eventually to the full benefits.

It is obvious that GS and AS applications are enabled by ADS-B and that ADS-B techniques will have to fulfil Package I requirements.

TIS-B was never envisaged to be the sole means to provide surveillance data for AS applications. Initially, the main role of TIS-B was to facilitate the implementation transition from minimal to full ADS-B equipage in continental areas. TIS-B can also play other roles such as the validation of aircraft data (e.g. for integrity purposes) or providing interoperability between different ADS-B techniques. Depending on the requirements, TIS-B may not be able to support all AS applications included in Package I (e.g. airborne spacing applications).

For most of the AS applications, a display of traffic information is likely to be required. Most work to date has involved a Cockpit Display of Traffic Information (CDTI).

It is acknowledged that aircraft intent information is a necessary input for some AS and GS applications. A need for intent information and a minimum capability of initially at least 2 TCPs has been clearly expressed from airspace user side [14]. The requirements for aircraft intent information in Package I will have to be evaluated and validated based on the applications included in Package IThe

GS application (ADS-B-ADD) is also a means of providing aircraft intent information to the ATC ground systems so as to develop or enhance ATC tools.

Within Package I, airborne spacing applications seem to be the more complex applications. Depending on the requirements, more or less automated spacing functions will be necessary on board the aircraft. For these applications, it is possible to phase their implementation and to start with the easiest applications, those that do not need complex automation (e.g. new autopilot or FMS functions).

5.6. Implementation of Package I

Package I applications are clearly meant to be taken as a whole in terms of standards and equipment. While the implementation of the complete Package I shall be aimed for at a global scale to derive full benefits, it is acknowledged that the applicability at the local level may be limited to a sub-set of applications.

Package I provides States, ATS providers and aircraft operators with a set of GS/AS applications that can be implemented through the rule-making and ECIP/LCIP processes.

Depending on the needs and the airspace characteristics, a sub-set of applications can be implemented. It is also possible to phase the implementation of the applications.

If an ATS provider wants to implement a GS application and use the ADS-B surveillance information to provide separation between aircraft, it is its responsibility to conduct the safety studies to demonstrate to its authority that these operations are achieving the required target level of safety. This could necessitate the establishment of an ADS-B separation minimum to be used by controllers for separating aircraft.

5.7. Time scale for Package I

5.7.1. Relationship with the ATM2000+ roadmap

The ATM2000+ strategy is currently being reviewed. **This section gives the reader an idea** about the relationship between the GS/AS applications included in Package I and the ATM2000+ roadmap.

The ATM2000+ roadmap defines four periods:

- Period 1: 2001-2004;
- Period 2: 2005-2007;
- Period 3: 2008-2011; and
- Period 4: 2012-2020.

In the ATM2000+ road map, the periods given for an OI correspond to the ‘Most challenging environments’ capacity target’. Therefore, it is foreseen to realise some OIs in the ‘Less challenging environments’ at an earlier period.

Annex 3 gives more details about the relationship between the GS/AS applications, the related OIs and their periods in the ATM2000+ road map as currently defined:

In general, the GS/AS applications included in Package I are designed to achieve benefits for period 2 and period 3 of the ATM2000+ roadmap. It should be noted that:

- all the GS applications included in Package I are expected to be enhanced in Package II and so they are going to contribute to the realisation of the associated OIs in Period 4; and
- all the AS applications included in Package I could contribute to the realisation of the associated OIs earlier than expected. This is particularly the case for airborne spacing applications (i.e. ASPA-S&M and ASPA-ITP). This is due to the fact that the OI-030502 (Delegate separation service) does not make the difference between airborne separation applications and airborne spacing applications. Airborne spacing applications could be implemented at an earlier stage.

The implementation of Package I applications will require the update of the ATM2000+ strategy.

5.7.2. Timescale for Package I

As already expressed in section 4.2 ‘Rationale for Package I’, the selected GS/AS applications are foreseen to be implemented within a 5-to-10 year timeframe. This objective is a challenge but experts consider it feasible. It is possible to go faster for the local implementation of specific applications but Package I concerns a set of applications offering benefits for a large majority of airspace users.

As soon as the content of Package I is recommended as a way forward by decision makers, a work-plan for Package I should be developed. It should identify the deliverables (e.g. Standards), the phases of development (e.g. validation), the tasks (e.g. developing a standard) and any relevant activities or deadlines. At the end of this exercise, a more realistic timescale should be available. If necessary, once the critical path is known, decisions could be taken to accelerate the development process. On behalf of the Joint Coordination Board (JCB), this planning task has started as part of CARE/ASAS Activity 5 (see section 2.3.2).

6. Future Packages

As already stated in section 5.2, future packages are going to be built on the experience gained from Package I and data collected during the operation of Package I applications.

It is too early to define the number and the content of the future packages because much R&D is required to better define the future applications and to validate these applications.

Nevertheless, future applications can be split in two groups:

- Enhancement of applications already included in Package I; and
- New GS/AS applications.

Package I enhanced applications could be for example:

- For GS applications, to provide separation service in medium/high traffic density areas or to provide new aircraft derived data for enhancing ATC tools.
- For AS applications, to enhance spacing applications with new automated airborne spacing functions on board the aircraft which may require the exchange of aircraft intent parameters.

For new GS/AS applications, the selection of applications belonging to the two last categories of the PO-ASAS document (i.e. Airborne separation and airborne self-separation applications) is, of course, envisaged. These applications are expected to bring further benefits in terms of capacity and flexibility.

The following definitions for future packages are provided as an indication:

- Package II:
  - Enhanced GS/AS applications from Package I;
  - ADS-B as a sole mean of surveillance in high density airspace;
  - Airborne separation applications (i.e. PO-ASAS category III applications); and
  - Airborne self-separation application (i.e. PO-ASAS category IV applications) in low-density airspace.
- Package III:
  - Enhanced GS/AS applications from Package II; and
  - Airborne self-separation application (i.e. PO-ASAS category IV applications) in medium/high-density airspace.

As more precisely defined in Annex 5 section 7, the specific case of the AS application ‘in-trail procedures in oceanic airspace’ could be an opportunity to introduce an airborne separation application in Package I as a ‘bridge’ between Package I and Package II.

7. Conclusion

This document proposes the description of a first package of GS/AS applications. The approach is pragmatic and aims at the early implementation of these applications.

A consensus is necessary among the ATM stakeholders to decide to adopt the 'packaging approach' and for the successful achievement of Package I. Participation of the aircraft and avionics industry is essential.

The approach is flexible. States, ANS providers 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 are clearly meant to be taken as a whole in terms of standards and equipment.

Package I is going to help to focus the energies required for the development of the appropriate operational/technical standards and equipment.

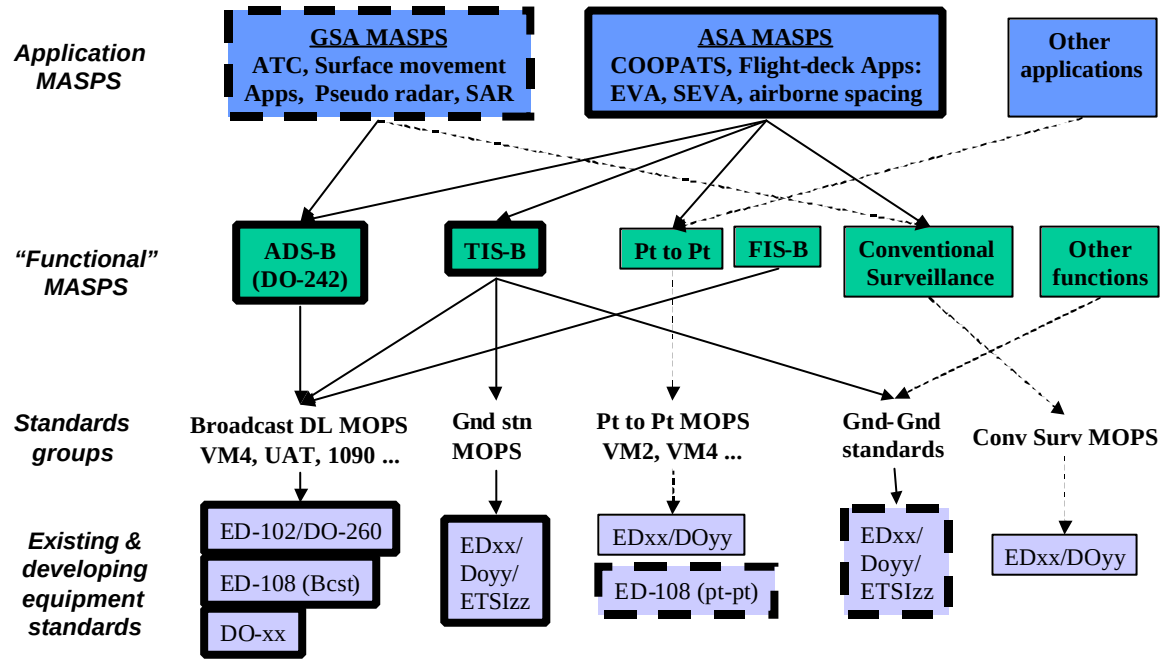
Nevertheless, in parallel to the development of Package I, it is necessary to work on the definition of future packages. Several important issues have already been identified and R&D work has to be carried out.

The document is a contribution to enhance the ATM system. It is offered to the European Commission, EUROCONTROL and ANSPs, IATA and aircraft operators, and the industry. It is hoped that the document will support their strategic decisions and recommendations. It was also developed with the objective of facilitating the development of common standards between EUROCAE and RTCA for global interoperability.

Ownership - If CARE/ASAS was in a good position to elaborate such a proposal, this work was only possible with the active participation of a large number of experts from various organisations/companies.

Annex 1 - Standard document organisation and relationships

(source EUROCAE/WG51)



Key: Boxes - only those documents in thick lines are in scope for WG51. Thick dashed lines indicate partially in scope. Other items are shown for completeness.
Lines - mean "puts requirements on" or "takes requirements from". Only solid lines are in scope for WG51.

Annex 2 - Operational Improvements related to GS/AS Applications (extracted from [7])

			Most challenging environments' capacity targets			
		ACC	15-25%	7-13%	10-15%	17-29%
		TMA	14-32%	1-15%	3-18%	6-35%
		Airport	4-31%	0-14%	2-18%	3-35%
	OI # ROAD	**OPERATIONAL IMPROVEMENTS (as defined in ROAD, September 2001)**	**Period 1: 2001-2004**	**Period 2: 2005-2007**	**Period 3: 2008-2011**	**Period 4: 2012-2020**
Airspace Organisation and Management	**010403**	**Enhance Terminal Airspace Organisation Using Improved Aircraft Capabilities (4E+5E)**		TMA	TMA	
	010501	**Adaptation of Sectors to Variations in Traffic Flows (2F + 3F)**	ACC	ACC	ACC	
	010602	**Free Routing in ECAC Airspace (2C+3C+4C)**			ACC	
	010603	**Allow Autonomous Operations in Free Flight Airspace (5C+6C)**				
Flow and Capacity Management	**020401**	**Enhance Tactical Flow and Capacity Management**	ACC	ACC		
En-Route and TMA ATC	**030102**	**Use Aircraft Derived Data for Ground Based Safety Nets**				
	030204	**Enhance ATC Decision Support by Using Aircraft Derived Data**				ACC, TMA
	030304	**Use Aircraft Derived Data for Arrival, Departure and Surface management**				TMA, APT
	030403	**Automatic Provision of Airborne Data to Enhance Ground Systems Functions including Surveillance**			ACC	ACC, TMA

			Most challenging environments' capacity targets			
		ACC	15-25%	7-13%	10-15%	17-29%
		TMA	14-32%	1-15%	3-18%	6-35%
		Airport	4-31%	0-14%	2-18%	3-35%
	OI # ROAD	OPERATIONAL IMPROVEMENTS (as defined in ROAD, September 2001)	Period 1: 2001-2004	Period 2: 2005-2007	Period 3: 2008-2011	Period 4: 2012-2020
	030404	Maintain and Improve the Quality of Surveillance		ACC, TMA, APT	ACC	
	030501	Provide Airborne Traffic Situational Awareness				
	030502	Delegate Separation Service				
	030504	Empower Autonomous Aircraft Operations				
Airport Operations	040101	Improvement of Aerodrome Control Service on the Movement Area	APT	APT		
	040102	Improvement of Conflict Detection and Alert for the Movement Area		APT	APT	
	040301	Enhancement of Aerodrome Operations Trough Arrival Management			APT	APT
	040302	Enhancement of Aerodrome Operations Trough Departure Management			APT	APT
	040401	Enhancement of Movement Area Utilisation	APT	APT		
	040501	Implementation of Best Practises and Refined procedures	APT	APT		
Other	060101	Implementation of ACAS II (TCAS II, Version 7) in ECAC Airspace				
	060102	Improved airborne safety nets				

Delivers Capacity in Period 1 (01 - 04)
Delivers Capacity in Period 2 (05 - 07)
Delivers Capacity in Period 3 (08 - 11)
Delivers Capacity in Period 4 (12 - 20)
Pre-requisite for increased capacity
Not capacity-driven

Annex 3 - Operational Improvements, GS/AS applications included in Package I and the ATM2000+ roadmap

1. Introduction

Within EUROCONTROL, in support to Strategic Performance Framework (SPF), the SCS Unit identified operational improvements (OIs) necessary for an enhanced ATM system. These OIs are classified in the following main processes:

- 01 – Airspace Organisation and Management;
- 02 – Flow and Capacity Management;
- 03 – En-Route and TMA ATC;
- 04 – Airport Operations; and
- 05, 06 & 07 – Others.

Each OI is expected to deliver benefits for a targeted period of time for the most challenging Environments in ECAC. Four periods are defined:

- Period 1: 2001-2004;
- Period 2: 2005-2007;
- Period 3: 2008-2011; and
- Period 4: 2012-2020.

Annex 2 gives an overview of the main OIs impacted by GS/AS applications and their targeted periods of time.

2. OIs and GS/AS applications included in Package I

For each high-level area, the following sections explain briefly how GS/AS applications included in Package I can contribute to the OIs.

2.1. Airspace Organisation and Management

0101 – Simplification of Airspace Organisation:
GS/AS applications are not expected to contribute to these OIs.

0102 – Airspace Management & Civil/Military Co-ordination:
GS/AS applications are not expected to contribute to these OIs.

0103 – Route Network Optimisation:
GS/AS applications are not expected to contribute to these OIs.

0104 – Terminal Airspace Optimisation:

010403 – Enhance Terminal Airspace Organisation Using Improved Aircraft capabilities	This OI is enabled mainly by RNAV capabilities nevertheless airborne spacing applications can play also a significant role allowing more consistent spacing between aircraft.

0105 – ATC sector Design Optimisation:

010501 – Adaptation of Sectors to Variations in Traffic Flows (2F + 3F)	It is expected that AS applications are going to have a positive impact in reducing the traffic complexity and thus allowing the design of more optimal sectors.

0106 – Utilisation of User-Preferred Trajectories:

010602 – Free Routing in ECAC Airspace	This OI is related to period 3 and 4. Increased capacity is expected through the reduction of the number of conflicts. Nevertheless conflicts may be more difficult to manage and airborne separation applications that are considered in the next GS/AS application packages could help to solve these problems.
010603 – Allow Autonomous Operations in Free Flight Airspace	This OI is related to period 4 and will be addressed by airborne self-separation applications considered in the next GS/AS application packages.

0107 – Airspace Organisation & Management Horizontal Activities:

GS/AS applications are not expected to contribute to these OIs.

2.2. Flow and Capacity Management

020401 – Enhanced Tactical Flow and Capacity Management	GS applications included in Package I can contribute through the provision of aircraft derived data.

2.3. En-Route and TMA ATC

0301 – Improve Safety Nets:

030102 - Use Aircraft Derived Data for Ground Based Safety Nets	GS applications included in Package I can contribute through the provision of aircraft derived data (e.g. speed vector).

0302 – Improve ATC Decision Support:

030204 - Enhance ATC Decision Support by Using Aircraft Derived Data	This OI is related to period 4. GS applications included in the next GS/AS application packages can contribute through the provision of aircraft derived data (e.g. selected flight level).

0303 – Improve Arrival, Departure and Surface Movement Management:

030304 - Use Aircraft Derived Data for Arrival, Departure and Surface management	This OI is related to period 4. GS applications included in the next GS/AS application packages can contribute through the provision of aircraft derived data (e.g. estimated time of arrival at the IAF).

0304 – Improve Interoperability, Communications and Surveillance Efficiency:

030403 - Automatic Provision of Airborne Data to Enhance Ground Systems Functions including Surveillance	This OI is related to period 3 and 4. GS applications included in the next GS/AS application packages can contribute through the provision of airborne data (e.g. system access parameters).
030404 - Maintain and Improve the Quality of Surveillance	GS applications included in Package I can contribute through the provision of surveillance data in areas currently not covered by radar or the provision of additional redundancy in radar areas if needed.

0305 – Improve Cooperative ATS:

030501 - Provide Airborne Traffic Situational Awareness	This OI is related to period 3 and 4. Airborne traffic situational awareness applications are included in Package I.
030502 - Delegate Separation Service	This OI is related to period 4 and encompass both airborne spacing applications and airborne separation applications as defined in the PO-ASAS document [2]. Airborne spacing applications are included in Package I and airborne separation applications will be included in the next GS/AS application packages.
030504 - Empower Autonomous Aircraft Operations	This OI is related to period 4. Airborne self-separation applications will be included in the next GS/AS application packages.

2.4. Airport Operations

0401 – Improved Traffic Management on the Movement Area:

040101 - Improvement of Aerodrome Control Service on the Movement Area	This OI is related to period 1 and 2. GS applications included in Package I can contribute through the provision of additional surveillance data. AS applications, also included in Package I, can contribute through the improved traffic situational awareness provided in the cockpit.
040102 - Improvement of Conflict Detection and Alert for the Movement Area	This OI is related to period 2 and 3. AS applications included in Package I can contribute through the improved traffic situational awareness provided in the cockpit and the generation of advisories.

0402 – Airport Capacity Management:

These OIs are related to the management of the flows of traffic on the airport surface and Collaborative Decision Making (CDM). GS/AS applications are not expected to contribute to these OIs.

0403 – Enhancement of Airport Throughput:

040301 – Enhancement of Aerodrome Operations through Arrival Management	This OI is related to period 2, 3 and 4. Airborne spacing application included in Package I could contribute to a better spacing of arriving aircraft. For period 4, airborne separation applications that will be included in next Packages, can further improve airport throughput by a better adherence to separation minima.
040302 – Enhancement of Aerodrome Operations through Departure Management	This OI is related to period 2, 3 and 4. Airborne spacing application included in Package I could contribute to a better spacing of departing aircraft. For period 4, airborne separation applications that will be included in next Packages, can further improve airport throughput by a better adherence to separation minima.

0404 – Airport Airside Capacity Enhancement:

040401 - Enhancement of Movement Area Utilisation	This OI is related to period 1 and 2. AS applications included in Package I can contribute through the improved traffic situational awareness provided in the cockpit. With a better knowledge of the traffic situation, the flight crews will be in a better position to help Reducing Runway Occupancy Time (ROT).

0405 – Airport Horizontal Initiatives:

040501 – Implementation of Best Practises and Refined procedures	This OI is related to period 1 and 2. AS applications included in Package I will contribute to this OI. This is particularly the case for enhanced Successive Visual Approach (ATSA-SVA) application, which in appropriate circumstances, will allow increased runway utilisation.

2.5. Others: Human resources, Airborne Collision Avoidance Systems & Aeronautical Information Management

0501 – Human Factors and Manpower:

GS/AS applications are not expected to contribute to these OIs.

0601 – Airborne Safety Nets:

060101 - Implementation of ACAS II (TCAS II, Version 7) in ECAC Airspace	This OI is related to period 1. AS applications included in Package I will not contribute directly to this OI. Nevertheless, the number of airborne collisions between aircraft not fitted with ACAS II could be reduced. As a constraint, it is also essential to ensure that the implementation of AS applications will not have an adverse impact on this OI.
060102 - Improved airborne safety nets	This OI is related to period 4. From an airborne perspective, it is essential that improved airborne safety nets will be integrated with AS applications included in future Packages.

0701 – Improve Aeronautical Information Services:

GS/AS applications are not expected to contribute to these OIs.

3. GS/AS applications included in Package I and the ATM2000+ roadmap

The ATM2000+ strategy is currently being reviewed. This section gives the reader an idea about the relationship between the GS/AS applications included in Package I and the ATM2000+ roadmap.

3.1. GS applications

The following table gives the relationship between the GS applications included in Package I, the related OIs and their periods in the ATM2000+ road map as currently defined (see annex 2):

GS application	OIs	Period 1	Period 2	Period 3	Period 4
ATC surveillance for en-route airspace (ADS-B-ACC)	030403			X	X
	030404	X	X	X	
ATC surveillance in terminal areas (ADS-B-TMA)	030403			X	X
	030404	X	X		
ATC surveillance in non-radar areas (ADS-B-NRA)	030403			X	X

GS application	OIs	Period 1	Period 2	Period 3	Period 4
Airport surface surveillance (ADS-B-APT)	040101	X	X		
Aircraft derived data for ATC tools (ADS-B-ADD)	020401	X	X		
	030102			X	
	030204				X
	030304				X

It should be noted that all the GS applications included in Package I are expected to be enhanced in Package II and so they are going to contribute to the realisation of the associated OIs in Period 4.

3.2. AS applications

The following table gives the relationship between the AS applications included in Package I, the related OIs and their periods in the ATM2000+ road map as currently defined (see annex 2):

AS application	OIs	Period 1	Period 2	Period 3	Period 4
Enhanced traffic situational awareness on the airport surface (ATSA-SURF)	040101	X	X		
	040401	X	X		
Enhanced traffic situational awareness during flight operations (ATSA-AIRB)	030501			X	X
Enhanced visual acquisition for see & avoid (ATSA-S&A)	030501			X	X
Enhanced successive visual approaches (ATSA-SVA)	010403		X	X	
	030501			X	X
	040501	X	X		
Enhanced sequencing and merging operations (ASPA-S&M)	010403		X	X	
	030502				X
	040301			X	X
In-trail procedure in oceanic airspace (ASPA-ITP)	030502				X
Enhanced crossing and passing operations	030502				X

AS application	OIs	Period 1	Period 2	Period 3	Period 4
(ASPA-C&P)					

It should be noted that all the AS applications included in Package I could contribute to the realisation of the associated OIs earlier than expected. This is particularly the case for airborne spacing applications (i.e. ASPA-S&M and ASPA-ITP). This is due to the fact that the OI-030502 (Delegate separation service) does not make the difference between airborne separation applications and airborne spacing applications. Airborne spacing applications could be implemented at an earlier stage.

3.3. Findings

In general, the GS/AS applications included in Package I are designed to achieve benefits for period 2 and period 3 of the ATM2000+ roadmap.

The implementation of Package I applications will require the update of the ATM2000+ strategy.

Annex 4 - Description of GS applications included in Package I

1. Template for GS application description

The following template has been used to describe the GS applications to be included in Package I.

Name	Name of the GS application
Acronym	Acronym of the GS application
GS Application description	Overview, objectives and expected benefits
Roles and procedures for controllers and flight crews	Current or new procedures, description of tasks and responsibilities, etc Required equipment/tools for controllers and flight crews to perform their tasks
Implementation considerations	Assumptions in terms of CNS means (e.g. TIS-B, CPDLC, etc.), mixed environment or mandatory carriage, etc. Description of required ATC and aircraft equipment
Related programmes and projects	EUROCONTROL EATMP programmes, European Commission funded projects and other relevant projects (e.g. Safe Flight 21 and Australian ADS-B project) working on the GS applications.

2. ATC surveillance for en-route airspace

Name	ATC surveillance for en-route airspace
Acronym	ADS-B-ACC
GS Application description	This application will enhance ATC surveillance currently provided with radars. An example of many is the case of surveillance in areas where single radar coverage is provided. ADS-B surveillance could be considered as a safety mitigation factor or a back up in case of radar failures. This application can contribute to separation services. Subject to safety studies, it is envisaged in Package I that ADS-B could, as a sole means in low/medium-density areas, achieve the required surveillance performances (e.g. accuracy, integrity, update rate) to provide an operationally acceptable ADS-B separation minima. This application will be further enhanced in Package II.
Roles and procedures for controllers and flight crews	This application will allow the controllers to provide enhanced traffic information and separation services. The flight crews are not impacted because the aircraft parameters will be broadcast automatically. They will be provided with better services.
Implementation considerations	This application implies the implementation of a large network of ground ADS-B stations. The implementation could be phased and start first in the low-density areas. The full benefits from this application in a given area will be obtained when all aircraft are fitted with the necessary equipment.
Related programmes and projects	ADS programme, NUP II, Capstone (Alaska), MEDUP, MFF, SEAP

3. ATC surveillance in terminal areas

Name	ATC surveillance in terminal areas
Acronym	ADS-B-TMA
GS Application description	This application will enhance ATC surveillance currently provided with radars. An example of many is the case of surveillance at low altitude and close to the terrain and also in areas where single radar coverage is provided. ADS-B surveillance could be considered as a safety mitigation factor or a back up in case of radar failure. This application can contribute to separation services. Subject to safety studies, it is envisaged in Package I that ADS-B could, as a sole means in low/medium-density TMAs, achieve the required surveillance performance (e.g. accuracy, integrity, update rate) to provide operationally acceptable ADS-B separation minima. This application will be further enhanced in Package II.
Roles and procedures for controllers and flight crews	This application will allow the controllers to provide enhanced traffic information and separation services. The flight crews are not impacted because the aircraft parameters will be broadcasted automatically. They will be provided with better services.
Implementation considerations	This application implies the implementation of a network of ground ADS-B stations in the TMA. The full benefits from this application in a given TMA will be obtained when all aircraft are fitted with the necessary equipment.
Related programmes and projects	ADS programme, NUP II, Capstone (Alaska)

4. ATC surveillance in non-radar areas

Name	ATC surveillance in non-radar areas
Acronym	ADS-B-NRA
GS Application description	This application will provide ATC surveillance in non-radar areas; e.g. remote areas, offshore operation areas, any continental areas and certain oceanic areas, which, due to the level of traffic or the cost of the equipment, could not justify the installation of radars. This application can be used for two main purposes: o for surveillance; e.g. traffic information, search and rescue; and o to provide separation services. Subject to safety studies, it is expected that ADS-B separation minima could be smaller than separation minima for procedural control.
Roles and procedures for controllers and flight crews	This application will allow the controllers to provide enhanced traffic information and separation services. The flight crews are not impacted because the aircraft parameters will be broadcast automatically. They will be provided with better services.
Implementation considerations	The full benefits from this application in a given area will be obtained when all aircraft are fitted with the necessary equipment.
Related programmes and projects	ADS programme, NUP II (Kiruna area), Capstone (Alaska)

5. Airport surface surveillance

Name	Airport surface surveillance
Acronym	ADS-B-APT
GS Application description	This application will provide a new source of surveillance information for a safer and more efficient ground movement management at airports with or without SMGCS. Airport ground vehicles can also be fitted with the necessary equipment and displayed on an airport map, together with aircraft. This application can contribute to enhancing the runway incursion function in SMGCS but it is not envisaged in Package I that ADS-B could, as a sole means, achieve the required surveillance performance (e.g. accuracy, update rate).
Roles and procedures for controllers and flight crews	The controllers will use new tools or enhanced tools The flight crews are not impacted because the aircraft parameters will be broadcast automatically.
Implementation considerations	For a successful use of this application at a given airport, it could be necessary to fit all aircraft/vehicles with the necessary equipment.
Related programmes and projects	Airport operations programme, Mode S programme, ADS programme, NUP II

6. Aircraft derived data for ATC tools

Name	Aircraft derived data for ATC tools
Acronym	ADS-B-ADD
GS Application description	This application will provide additional aircraft derived data through ADS-B to be used for ground applications; for example by the ATC ground system for developing or enhancing ATC tools like displays, MTCD, AMAN, DMAN and ground based safety nets. CDM applications will also share the benefits. It should be noted that this application does not encompass the ground tools themselves; it only provides additional input data for these tools. Only mature/validated requirements should be included in this application taking advantage of previous studies in this area leading to a basic set of aircraft parameters. This set of aircraft parameters may depend on the environment (e.g. en-route airspace, terminal area, airport). Services like CAP (Controller Access Parameters) and SAP (System Access Parameters) are already defined in the Operational Requirement Document (ORD) from the AGC Programme. The Flight Path Intent (FLIPINT) service is currently being defined.
Roles and procedures for controllers and flight crews	The controllers will use enhanced tools The flight crews are not impacted because the aircraft parameters will be broadcasted automatically.
Implementation considerations	Harmonisation is necessary with other data-link (e.g. Mode S, ADS-C) to facilitate the integration of these functionalities on board the aircraft.
Related programmes and projects	AGC Programme, ASA Programme, Mode S programme, ADS programme, NUP II

Annex 5 - Description of AS applications included in Package I

1. Template for AS application description

The following template has been used to describe AS applications to be included in Package I.

Name	Name of the AS application
Acronym	Acronym of the AS application
PO-ASAS category	Airborne traffic situational awareness / Airborne spacing / Airborne separation / Airborne self-separation
AS application description	Overview, objectives and expected benefits
Roles and procedures for flight crews and controllers	Current or new procedures, description of tasks and responsibilities, etc Required equipment/tools for flight crews and controllers to perform their tasks
Implementation considerations	Assumptions in terms of CNS means (e.g. TIS-B, CPDLC, etc.), mixed environment or mandatory carriage, etc. Description of required aircraft and ATC equipment
Related programmes and projects	EUROCONTROL EATMP programmes and European Commission funded projects working on the GS application.

2. Enhanced traffic situational awareness on the airport surface

Name	Enhanced traffic situational awareness on the airport surface
Acronym	ATSA-SURF
PO-ASAS category	Airborne traffic situational awareness
AS application description	This application provides the flight crews with an "enhanced traffic situational awareness" on the airport surface for both taxi and runway operations, in all weather conditions. The objectives are to improve safety (e.g. at taxiway crossings, before entering a runway, on pushback) and to reduce taxi time in particular during low visibility conditions or at night. Surrounding traffic, which could include both aircraft and airport vehicles, are going to be displayed to the flight crews. Information is going to include at least identification and position of the traffic. Traffic need to be displayed on an airport surface map. In addition to the display of traffic, aircraft functions could include advisories when approaching an active runway (e.g. traffic is sited on the runway). Note: This AS application is focused on traffic situational awareness. Independent from the display of traffic, it is obvious that flight crews could benefit from a 'navigation function' displaying their aircraft position on an airport surface map.
Roles and procedures for flight crews and controllers	This application does not modify the core roles of flight crews and controllers. The procedures are also very similar to the current situation. Nevertheless, the traffic identification procedure will have to be revisited (e.g., vehicle or aircraft type, call-sign, operator ID).
Implementation considerations	As it is essential to display all surrounding (e.g. close to own aircraft) or relevant (e.g. on the active runway) traffic, TIS-B functionality could be necessary during the ADS-B implementation period. For that purpose ground surveillance should be available and TIS-B should have the required performance (e.g. accuracy, update rate). This application is subject to the availability of airport surface maps to a defined standard.
Related programmes and projects	AGC programme, Airport operation programme, NUP II, MA-AFAS

3. Enhanced traffic situational awareness during flight operations

Name	Enhanced traffic situational awareness during flight operations
Acronym	ATSA-AIRB
PO-ASAS category	Airborne traffic situational awareness
AS application description	This application provides the flight crews with an "enhanced traffic situational awareness" irrespective of visual conditions. Additional data is provided to flight crews in supplement of traffic information provided either by controllers or other flight crews. The objectives are to improve safety of flight and the efficiency of air traffic control in all airspace. In all airspace, the flight crews will be better able to detect an unsafe situation. Surrounding traffic is going to be displayed to the flight crews. Information is going to include at least identification and position of the traffic. In addition to the display of traffic, aircraft functions could include advisories when an unsafe traffic situation is detected. The notion of 'unsafe situation' is heavily dependent on the airspace environment (e.g. traffic density and complexity).
Roles and procedures for flight crews and controllers	The core roles of the flight crews and the controllers are not changed with this application. It is possible to enhance some existing procedures like: o the need for traffic information service (e.g. during radar separation or in a future environment with silent communications (CPDLC)).; o Traffic Information Broadcast by Aircraft (TIBA). The traffic identification procedure will have to be revisited (e.g., aircraft type, call-sign, operator ID, others).
Implementation considerations	As it is essential to display all relevant traffic. o First, traffic needs to be known by the aircraft surveillance function. TIS-B functionality could be necessary during the ADS-B implementation period. In remote area like oceanic airspace, the full benefit of the application will be obtained only when all aircraft are fitted with operating ADS-B equipment. o Second, traffic will have to be filtered so as to display to the flight crews only relevant traffic. This filtering function is dependent on the airspace environment (e.g. traffic density and complexity).
Related programmes and projects	AGC Programme, MA-AFAS and MFF

4. Enhanced visual acquisition for see & avoid

Name	Enhanced visual acquisition for see & avoid
Acronym	ATSA-S&A
PO-ASAS category	Airborne traffic situational awareness
AS application description	This application is an aid for the flight crews to perform their collision avoidance task when separation service in not provided by ATC (e.g. IFR/VFR in class D and E airspace, class G airspace). The objective is safer flight operations. Surrounding traffic, which is within a visual range, is going to be displayed to the flight crews. Information is going to include at least identification and position of the traffic. In addition to the display of traffic, aircraft functions could include advisories when a traffic situation requiring the application of see & avoid rules is detected.
Roles and procedures for flight crews and controllers	This application does not modify the core roles of flight crews and controllers. The procedures are also similar to the current situation.
Implementation considerations	This application is more dedicated to General Aviation or helicopter operations. For larger aircraft, the ATSA-AIRB will provide the same benefits To get the maximum safety benefits, it is necessary to have all aircraft flying in the considered airspace to be fitted with ADS-B equipment. Around an airport, TIS-B functionality will provide the benefits in its service volume.
Related programmes and projects	AGC programme and NUP I (TT Nice)

5. Enhanced successive visual approaches

Name	Enhanced successive visual approaches
Acronym	ATSA-SVA
PO-ASAS category	Airborne traffic situational awareness
AS application description	This application is an aid for the flight crews to perform successive visual approaches when they are responsible for maintaining visual separation from the aircraft they are following. The objectives are to perform successive visual approach procedures on a more regular basis to enhance the runway throughput, and to conduct safer operations especially in high-density areas. Surrounding traffic, which is within a visual range, is going to be displayed to the flight crews. Information is going to include at least identification and position of the traffic. The aircraft to follow will be highlighted and specific parameters may be displayed for this aircraft (e.g. range and speed in a numerical format).
Roles and procedures for flight crews and controllers	This application does not modify the core roles of flight crews and controllers. The procedure is similar to the current situation. The traffic identification procedure will have to be revisited (e.g., aircraft type, call-sign, operator ID, others).
Implementation considerations	Contrary to most applications in the airborne traffic situational awareness category, this application does not need all aircraft to be fitted with ADS-B equipment. This could be advantageous for an aircraft operator operating at a hub airport to equip its fleet.
Related programmes and projects	AGC programme, MA-AFAS and NUP II (TT Frankfurt)

6. Enhanced sequencing and merging operations

Name

Enhanced sequencing and merging operations

Acronym

ASPA-S&M

PO-ASAS category

Airborne spacing

AS application description

This application is designed for en-route airspace and TMA in a radar environment. The applicable flight phases include cruise and descent from top of descent to the runway. The core area of Europe is considered.

The objective is to redistribute tasks related to sequencing (e.g. in-trail following) and merging of traffic between the controllers and the flight crews. The controllers will be provided with a new set of instructions directing, for example, the flight crews to establish and to maintain a given time or distance from a designated aircraft. The flight crews will perform these new tasks using new aircraft functions (e.g. Airborne surveillance, display of traffic information, spacing functions with advisories).

The main expected benefit is increased controller availability by the reorganisation and the streamlining of tasks. This should allow accepting more aircraft in a given sector or designing greater sectors. It also expected to assure more regular spacing based on actual separation minima and thus an increase in capacity especially in high-density areas.

Roles and procedures for flight crews and controllers

The core roles of controllers and flight crews remain unchanged. The controller keeps the initiative and overall authority on traffic management. New ATC instructions are provided and the controllers are still in charge of providing separation service and therefore to maintain ATC separation minima between aircraft.

The new set of spacing instructions will include:

- Instructions to merge behind a preceding traffic or to establish a given spacing time or distance relative to this aircraft. This could be done through the increase or the reduction of aircraft speed or through path stretching.

- Instructions to maintain a given spacing time or distance relative to a preceding aircraft. If the preceding aircraft is following a predefined trajectory (e.g. a STAR), the following aircraft will be asked to follow the same trajectory while maintaining the spacing value (i.e. Nav-trail). If the preceding aircraft is not following a predefined trajectory (e.g. radar vectoring), the following aircraft will be asked to follow the same trajectory while maintaining the spacing value (i.e. Target-trail).

These new instructions are going to require specific functions on board the aircraft related both to human machine interfaces (e.g. Display of relevant traffic information, generation of advisories) and also to automation functions (e.g. new Auto-pilot or FMS functions). Each phase of flight (i.e. Cruise, descent, approach, final approach) presents different challenges with regards to the automation of the spacing functions.

Implementation considerations

To perform this application, only the aircraft involved in the procedure need to be fitted with equipment supporting airborne surveillance. Nevertheless, to achieve meaningful capacity benefits, a suitable number of aircraft need to be equipped from an ATC perspective. The controllers will have then the opportunity to use the new spacing instructions when necessary. This could be particularly the case if, in a hub airport type of operation, the predominant aircraft operator decides to equip its fleet.

To solve this issue, TIS-B functionality could be substituted during the ADS-B implementation period. To be used in this way, TIS-B must have the required performance parameters (e.g. update rate, latency) to perform the spacing functions.

To get more benefits, time or distance spacing values maybe set close to ground radar separation minima. It is therefore essential to demonstrate that these new procedures are safe and that they do not compromise the provision of ground separation by ATC.

Related programmes and projects

EEC, MFF, MA-AFAS, NUP II, Glasgow T-MAT

7. In-trail procedure in oceanic airspace

Name	In-trail procedure in oceanic airspace
Acronym	ASPA-ITP
PO-ASAS category	Airborne spacing
AS application description	The In-Trail Procedure in non-radar oceanic airspace is a procedure allowing in-trail ADS-B equipped aircraft, which may not be longitudinally separated from each other, to climb or descend through each other's flight levels. The objective is to improve the utilisation of the NAT oceanic airspace by facilitating a higher rate of flight level changes than is currently provided, yielding better flight efficiency (e.g. fuel savings, avoiding turbulent flight levels).
Roles and procedures for flight crews and controllers	This application does not modify the core roles of flight crews and controllers. Under the appropriate circumstances, the controller will clear the flight crew to climb or descend to a given flight level. In addition, during the climb or the descent, the flight crews will be instructed to maintain a relative distance or time from designated aircraft that they are going to cross vertically. Safety studies have to be performed to determine the spacing value (i.e. given time or distance) so that the risk of collision is maintained to the required target level of safety. Note 1: The ICAO PANS-RAC document (Doc. 4444) contains provisions allowing the reduction of separation standards when aircraft are climbing or descending. Section 8.3.1.2 (Part III) is related to aircraft climbing or descending on the same track where ATC separation is established by obtaining simultaneous DME readings from the aircraft. Note 2: In 1994, the FAA performed operational trials of the In-Trail Climb (ITC) procedure in the Pacific. TCAS was used to measure the distance at the start of the procedure (i.e. 15 NM minimum) and the closure rate between aircraft had to be less than 20 knots.

Implementation considerations

The application is designed for non-radar oceanic airspace where aircraft are flight along predefined tracks. It seems possible to extend this application to non-radar airspace where aircraft are navigating on a fixed route network.

For ATC monitoring purposes, the ASPA-ITP application, as currently defined, requires aircraft to be also ADS-Contract and CPDLC capable. It is envisaged to investigate within Package I the possibility to develop an also application, having the same operational goal, requiring aircraft to provide airborne separation.

The operational goal could be similar to the current VMC clearances (ICAO Doc. 4444 section 13. Part III) where during daylight and VMC conditions, the flight crews are allowed to maintain their own separation to climb or to descend through the level of other aircraft.

Note 3: Airborne separation applications are not included in Package I. Nevertheless for the specific case of in-trail procedure in oceanic airspace, the Package I technical requirements could be sufficient to support an airborne separation application with the same operational objective. Indeed, in this type of airspace, minima for longitudinal separation are very large (e.g. 10 minutes) and it seems possible to perform efficient and safe operation with airborne minima in the order 15-20 NM. The issues related to airborne separation applications still need to be addressed and resolved but this specific application could be seen as a bridge between Package I and Package II.

Related programmes and projects

NUP II (TT Reykjavik)

8. Enhanced crossing and passing operations

Name

Enhanced crossing and passing operations

Acronym

ASPA-C&P

PO-ASAS category

Airborne spacing

AS application description

This application is designed for en-route airspace and TMA. All phases of flight are considered.

The objective is to provide the controller with a new set of instructions to solve conflicts directing, for example, the flight crews to cross or pass a designated traffic while maintaining a given spacing value. The flight crews will perform these new tasks using new aircraft functions (e.g. Airborne surveillance, display of traffic information, crossing and passing functions with advisories).

The main expected benefit is increased controller availability through the reorganisation and the streamlining of tasks. For example, the resolution of conflicts could be anticipated. This should allow accepting more aircraft in a given sector or designing greater sectors.

Roles and procedures for flight crews and controllers

The core roles of controllers and flight crews remain unchanged. The controller keeps the initiative and overall authority on traffic management. New ATC instructions are provided and the controllers are still in charge of providing separation service and therefore to maintain ATC separation minima between aircraft.

The new set of spacing instructions will include:

- Instructions to report clear from traffic. The controller provides the separation from a designated traffic by issuing the appropriate clearance and the flight crew reports clear from traffic when specific conditions occur (e.g. traffic is diverging and spacing is greater than a specified value).
- Instructions to resume climb/descent or navigation. The controller provides the separation from a designated traffic by issuing the appropriate clearance and the flight crew resumes its navigation when specific conditions occur.
- Instructions to pass behind, abeam, above and below. The controller selects the type of manoeuvre that provides the separation from a designated traffic. He instructs the flight crew to perform the manoeuvre and to provide a minimum spacing value from the designated aircraft. The minimum spacing value can be expressed as a time or a horizontal or vertical distance.

These new instructions are going to require specific functions on board the aircraft related both to human machine interfaces (e.g. Display of relevant traffic information, generation of advisories) and also to automation functions (e.g. new Auto-pilot or FMS functions).

Implementation considerations	To perform this application, only the aircraft involved in the procedure need to be fitted with equipment supporting airborne surveillance. Nevertheless, to achieve meaningful benefits, a suitable number of aircraft need to be equipped from an ATC perspective. The controllers will have then the opportunity to use the new crossing/passing instructions when necessary. To solve this issue, TIS-B functionality could be substituted during the ADS-B implementation period. To be used in this way, TIS-B must have the required performance parameters (e.g. update rate, latency) to perform the spacing functions. To get more benefits, time or distance spacing values maybe set close to ground separation minima. It is therefore essential to demonstrate that these new procedures are safe and that they do not compromise the provision of ground separation by ATC.
Related programmes and projects	EEC, MA-AFAS, Glasgow T-MAT