

APPENDIX A

MODULE NO. B0-84: INITIAL CAPABILITY FOR GROUND SURVEILLANCE

Summary	This module provides initial capability for lower cost ground surveillance supported by new technologies such as ADS-B OUT and wide area multilateration (MLAT) systems. This capability will be expressed in various ATM services, e.g. traffic information, search and rescue and separation provision.	
Main performance impact as per Doc 9854	KPA- 02 – Capacity, KPA-04 – Efficiency, KPA-10 – Safety	
Operating environment/ Phases of flight	All airborne flight phases in continental or subsets of oceanic airspace and on aerodrome surfaces.	
Applicability considerations	This capability is characterized by being dependent/cooperative (ADS-B OUT) and independent/cooperative (MLAT). The overall performance of ADS-B is affected by avionics performance and compliant equipage rate. The overall performance of MLAT is affected by ground station geometry, aircraft altitude, ground interrogation capability and communication link performance.	
Global concept component(s) as per Doc 9854	CM – Conflict management	
Global plan initiatives (GPI)	GPI-9: Situational awareness GPI-16: Decision support and alerting systems	
Main dependencies	NIL	
Global readiness checklist		Status (ready now or estimated date)
	Standards readiness	Ready now
	Avionics availability	Ready now
	Ground systems availability	Ready now
	Procedures available	Ready now
	Operations approvals	Ready now

1. NARRATIVE

1.1 General

1.1.1 The surveillance service delivered to users may be based on a mix of three main types of surveillance as defined in the ICAO *Aeronautical Surveillance Manual* (Doc 9924):

- a) independent non-cooperative surveillance: The aircraft position is derived from measurement not using the cooperation of the remote aircraft;
- b) independent cooperative surveillance: The position is derived from measurements performed by a local surveillance subsystem using aircraft transmissions. Aircraft-derived information (e.g. pressure altitude, aircraft identity) can be provided from those transmissions; and

- c) dependent cooperative surveillance: The position is derived on board the aircraft and is provided to the local surveillance subsystem along with possible additional data (e.g. aircraft identity, pressure altitude).

1.1.2 The module describes the dependent/cooperative and independent/cooperative surveillance services.

1.2 Baseline

1.2.1 Currently, air to ground aircraft position and surveillance is accomplished through the use of primary, secondary radar surveillance, voice position report, ADS-C and CPDLC, etc. The primary surveillance radar derives aircraft position based on radar echo returns. The secondary radar is used to transmit and receive aircraft data for barometric altitude, identification code. However, current primary and secondary radars cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions, and have a heavy reliance on mechanical components with large maintenance requirements.

1.3 Change brought by the module

1.3.1 This module introduces the opportunity to expand ATC radar equivalent service with two new surveillance techniques that can be used, separately or jointly: ADS-B and MLAT. These techniques provide alternatives to classic radar technology at a lower implementation and maintenance cost, thereby allowing the provision of surveillance services in areas where they are currently not available for geographical or cost reasons. These techniques also allow, in certain conditions, a reduction of separation minima thereby potentially increasing the ability to accommodate larger volumes of traffic.

1.4 Element 1: ADS-B

1.4.1 Dependent surveillance with accurate position sources such ADS-B is recognized as one of the important enablers of several of the ATM operational concept components including traffic synchronization and conflict management (Recommendation 1/7, AN-Conf/11, 2003). The transmission of ADS-B information (ADS-B OUT) is already used for surveillance in some non-radar areas (Block 0).

1.4.2 Dependent surveillance is an advanced surveillance technology that allows avionics to broadcast an aircraft's identification, position, altitude, velocity, and other information. The broadcast aircraft position is more accurate than with conventional secondary surveillance radar (SSR) because it is normally based on the global navigation satellite system (GNSS) and transmitted at least once per second. The inherent accuracy of the GPS determined position and the high update rate will provide service providers and users improvements in safety, capacity, and efficiency.

Note.— ADS-B is dependent upon having a source of required positional accuracy (such as global navigation satellite system (GNSS) today).

1.4.3 Operationally, the lower costs of dependent surveillance ground infrastructure in comparison to conventional radars support business decisions to expand radar equivalent service volumes and the use of radar-like separation procedures into remote or non-radar areas. In addition to lower costs, the non-mechanical nature of the ADS-B ground infrastructure allows it to be sited in locations that are difficult for radar installations. For example, in the Gulf of Mexico, ADS-B receiver stations are installed on oil platforms to provide radar-like services using ADS-B as the surveillance source. Compared to non-radar services, flights are able to fly more direct routes, and service providers are able to handle more traffic in each sector.

1.4.4 Use of dependent surveillance also improves the search and rescue support provided by the surveillance network. In non-radar areas, ADS-B's positional accuracy and update rate allows for improved flown trajectory tracking allowing for early determination of loss of contact and enhances the ability for search and rescue teams to pinpoint the related location.

1.4.5 Additionally, dependent surveillance information can be an enabler for sharing of surveillance data across FIR boundaries and significantly improves the performance of predictive tools using aircraft derived velocity vector and vertical rate data. This is particularly useful to support safety net tools. It also downlinks other useful ATC relevant data similar to Mode S DAPS.

1.4.6 ADS-B OUT Standards and Recommended Practices (SARPs) (ICAO Annex 10 — *Aeronautical Telecommunications*, Volume IV — *Surveillance and Collision Avoidance Systems* and the *Manual on Technical Provisions for Mode S Services and Extended Squitter* (Doc 9871)) and MOPS (RTCA-DO260-B/Eurocae ED102-A) are available. AN-Conf/11 recommended ADS-B on 1090MHz for international use and this is happening. Equipage rate is growing together with Mode S, airborne collision avoidance system (ACAS) and ADS-B OUT mandates. ADS-B OUT, Version 2 also provides for ACAS RA DOWNLINK information in support of monitoring activities currently only possible in secondary surveillance radar (SSR) Mode S coverage.

1.5 Element 2: Multilateration (MLAT)

1.5.1 MLAT technique is a new technique providing independent cooperative surveillance. Its deployment is made easier by the use of airborne mode S equipment capability with the spontaneous transmission of messages (squitters). In this case the signal transmitted by aircraft is received by a network of receivers located at different places. The use of the different times of arrival at the different receivers allows an independent determination of the position of the source of signals. In theory this technique can be passive and use the existing transmissions made by the aircraft or be active and trigger replies in the manner of Mode S SSR interrogations. Conventional Mode A/C transponders respond when they are interrogated.

1.5.2 MLAT systems were initially deployed on main airports to make the surveillance of aircraft on the surface. The technique is now used to provide surveillance over wide area (wide area MLAT system - WAM). MLAT requires more ground stations than ADS-B and reliable linked network and has large geometric requirements than ADS-B, but has the early implementation advantage of using current Mode A/C aircraft equipage.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT/METRIC TO DETERMINE SUCCESS

<i>Safety</i>	Reduction of the number of major incidents. Support to search and rescue.
<i>Capacity</i>	Typical separation minima are 3 NM or 5 NM enabling a significant increase in traffic density compared to procedural minima. Improved coverage, capacity, velocity vector performance and accuracy can improve ATC performance in both radar and non radar environments. Terminal area surveillance performance improvements are achieved through high accuracy, better velocity vector and improved coverage.
<i>Efficiency</i>	Availability of optimum flight levels and priority to the equipped aircraft and operators. Reduction of flight delay and tool of handling air traffic at FIR boundaries. Reduce workload of air traffic controllers.

<i>Cost Benefit Analysis</i>	Either comparison between procedural minima and 5 NM separation minima would allow an increase of traffic density in a given airspace; or comparison between installing/renewing SSR Mode S stations using Mode S transponders and installing ADS-B OUT (and/or MLAT systems).
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3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 The relevant *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) provisions are available.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 For ADS-B surveillance services, aircraft must be equipped with compliant ADS-B OUT as specified for the airspace. Position with accuracy and integrity parameters are reported from the avionics. Users of the received data decide on the required accuracy and integrity for the application.

4.1.2 For MLAT, it is desirable for aircraft to be equipped with Mode S radar transponders.

4.2 Ground systems

4.2.1 Units providing surveillance services must be equipped with a ground-based surveillance data processing system able to process and display the aircraft positions. Connection to a flight data processing system is preferable at ATM centre to allow positive identification by correlating received data with flight plan data.

4.2.2 Units may provide ADS-B surveillance in environments where there is full or partial avionics equipage depending on the capabilities and procedures of the air traffic control (ATC) system.

4.2.3 ATM systems must also be designed to enable the delivery of separation services between ADS-B-to-ADS-B and ADS-B-to-radar and fused targets.

4.2.4 Ground stations and associated ground links that are capable to receive, process and forward the required data to the ATM systems are also required.

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 The air traffic controller has a direct representation of the traffic situation, and reduces the task of controllers or radio operators to collate position reports.

5.2 Training and qualification requirements

5.2.1 Controllers may need to receive specific training for separation provision, information service and search and rescue based on the ADS-B and WAM systems in use.

5.2.2 Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- For ADS-B based ground surveillance, authorities are required to issue necessary worthiness approval and where appropriate issue compliant equipage mandate for the specified airspace.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Current use

7.1.1 Advanced-surface movement guidance and control systems (A-SMGCS) using MLAT technology are operational at many locations worldwide.

- **Australia:** ADS-B is operational throughout the Australian continent for delivery of 5 NM separation services in radar and non-radar areas, in continental and oceanic airspace. ADS-B data sharing between Indonesia and Australia is fully operational allowing safety nets and situational awareness at the boundary. WAM is operational in Sydney, Australia supporting 3 NM TMA separation and PRM operations. WAM is operational in Tasmania, Australia supporting en-route separation.
- A number of States in the Asia and Pacific Regions are deploying ADS-B and enhancing their surveillance coverage.
- **United States:** ADS-B surveillance coverage for continental United States will be completed in 2013.

7.2 Planned or ongoing trials

7.2.1 Currently in use.

8. REFERENCE DOCUMENTS

8.1 Standards

- ICAO Annex 10 — *Aeronautical Telecommunications*, Volume IV — *Surveillance and Collision Avoidance Systems*
- ICAO Doc 9828, *Report of the Eleventh Air Navigation Conference (2003)*
- ICAO Doc 9871, *Technical Provisions for Mode S Services and Extended Squitter*
- RTCA MOPS DO260 and DO260A EUROCAE ED102 and ED102A.

8.2 Procedures

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*

8.3 Guidance material

- ICAO Doc 9924, *Aeronautical Surveillance Manual*
- ICAO *Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation* (Circular 326)
- ICAO Asia Pacific: ADS-B Implementation and Operations Guidance Document (AIGD) and other regional guidance materials

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APPENDIX B

MODULE N° B0-85: AIR TRAFFIC SITUATIONAL AWARENESS (ATSA)

Summary	Two air traffic situational awareness (ATSA) applications which will enhance safety and efficiency by providing pilots with the means to enhance traffic situational awareness and achieve quicker visual acquisition of targets: a) AIRB (basic airborne situational awareness during flight operations); and b) VSA (visual separation on approach).	
Main performance impact as per Doc 9854	KPA-04 – Efficiency, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route, terminal, approach.	
Applicability considerations	These are cockpit-based applications which do not require any support from the ground hence they can be used by any suitably equipped aircraft. This is dependent upon aircraft being equipped with ADS-B OUT. Avionics availability at low enough costs for GA is not yet available.	
Global concept component(s) as per Doc 9854	CM – Conflict management TS – Traffic synchronization	
Global plan initiatives (GPI)	GPI-9: Situational awareness GPI-15: Match IMC and VMC operating capacity	
Main dependencies	NIL	
Global readiness checklist		Status (ready now or estimated date).
	Standards readiness	√
	Avionics availability	√
	Infrastructure availability	√
	Ground automation availability	N/A
	Procedures available	√
	Operations approvals	2012

1. NARRATIVE

1.1 General

1.1.1 Basic airborne situational awareness during flight operations (AIRB), aims at improving flight safety and flight operations by assisting flight crews in building their traffic situational awareness through the provision of an appropriate on-board displays of surrounding traffic during all airborne phases of flight. It is expected that flight crews will perform their current tasks more efficiently; both in terms of decision-making and the resulting actions, and thus flight safety and flight operations should be enhanced. The actual benefits will vary depending on the airspace and operational flight rules.

1.1.2 Approaches flown where flight crews maintain own separation from the preceding aircraft may increase landing capacity and/or increase the number of movements achievable at many airports compared to rates obtained when ATC separation is applied. Through the use of an airborne traffic display, the visual separation on approach application (VSA) will enhance this type of operation by

providing improved visual acquisition of preceding aircraft and by extending the use of own separation clearances on approach.

1.2 **Baseline**

1.2.1 AIRB and VSA applications are available and this constitutes the baseline.

1.3 **Change brought by the module**

1.3.1 This module provides various efficiency benefits at all stages of flight. AIRB applies to all phases of flight; VSA applies to the approach phase of flight. Although each application provides capacity and efficiency improvements, the mechanism for each of them is different.

1.3.2 Flight crews use the AIRB application, the most basic aircraft surveillance (AS) application. AIRB is used as the foundation for all the other applications described in this document. The application uses cockpit displays to provide the flight crew with a graphical depiction of traffic using relative range and bearing, supplemented by altitude, flight ID and other information. It is used to assist the out-the-window visual acquisition of airborne traffic and enables the flight crew to build traffic situational awareness for traffic beyond visual range.

1.3.3 The display enables detection of traffic by the flight crew and aids in making positive identification of traffic advised by ATC. The information provided on the display is also expected to reduce the need for repeated air traffic information or advisories and is expected to increase operational efficiencies.

1.3.4 The objective of the ATSA-VSA application is to make it an own separation approach procedure easier and more reliable for flight crews to visually acquire the preceding aircraft and by supporting them in maintaining own separation from the preceding aircraft. This application will improve efficiency, safety and regularity of arrival traffic at airports. In addition to the traffic information provided by the controller, the traffic display will support the flight crew in the visual search for the preceding aircraft whenever this one is equipped with ADS-B OUT. Additionally, the traffic display will provide up-to-date information that will support the flight crews to visually maintain a safe and not unnecessarily large distance and to detect unexpected speed reductions of the preceding aircraft. In these situations, the flight crew will be able to manoeuvre by adjusting own speed more precisely whilst maintaining the preceding aircraft in sight. The objective is not to reduce the distance between the two aircraft in comparison with current operations when own separation is applied but to avoid that this distance become too low due to a late detection of unexpected closing situation. The use of the traffic display is expected to support improved visual acquisition of preceding aircraft, and extend the use of own separation clearances on approach.

1.3.5 Voice communications associated with traffic information are expected to be reduced. Safety of operations improvement is expected as it is anticipated that this procedure will decrease the likelihood of wake turbulence encounters. Some efficiency benefits are also expected to be derived when the preceding and succeeding aircraft are approaching the same runway because of a reduction in the number of missed approaches.

1.4 **Element 1: ATSA-AIRB**

1.4.1 AIRB application can be used in all types of aircraft fitted with certified equipment. (ADS-B IN and a traffic display). The details are provided below.

1.4.2 AIRB application can be used in all types of airspaces, from class A to class G. The use of this application is independent of the type of ATC surveillance (if any) and of the type of air traffic services provided in the airspace in which the flight is conducted.

1.5 Element 2: ATSA-VSA

1.5.1 The application is mainly intended for air transport aircraft but it can be used by all suitably equipped aircraft during approach to any airports where own separation is used.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Efficiency</i>	Improve situational awareness to identify level change opportunities with current separation minima (AIRB) and improve visual acquisition and reduction of missed approaches (VSA).
<i>Safety</i>	Improve situational awareness (AIRB) and reduce the likelihood of wake turbulence encounters (VSA).
<i>Cost Benefit Analysis</i>	The benefit is largely driven by higher flight efficiency and consequent savings in contingency fuel. The benefit analysis of the EUROCONTROL CRISTAL ITP project of the CASCADE Programme and subsequent update had shown that ATSAW AIRB and ITP together are capable of providing the following benefits over N. Atlantic: a) saving 36 million Euro (50k Euro per aircraft) annually; and b) reducing carbon dioxide emissions by 160,000 tonnes annually. The majority of these benefits are attributed to AIRB. Findings will be refined after the completion of the pioneer operations starting in December 2011.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 The procedure for the use of ADS-B traffic display is being proposed for inclusion in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS OPS, Doc 8168) for applicability in November 2013.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 ADS-B OUT compliant with AMC2024 / DO-260A/DO-260B /ED102 A is needed on the majority of the aircraft population. There is a potential need to certify ADS-B OUT data.

4.1.2 ADS-B IN compliant with DO-314/ED160 or DO-317A/ED194 is required to support VSA.

4.1.3 ADS-B IN compliant with DO-319/ED164 or DO-317A/ED194 is required to support AIRB.

4.2 **Ground systems**

4.2.1 In some environments (e.g. United States) it is anticipated to modify ground infrastructure to provide ADS-R and traffic information service — broadcast (TIS-B).

5. **HUMAN PERFORMANCE**

5.1 **Human factors considerations**

5.1.1 The AIRB and VSA applications do not change roles and responsibilities for controllers and pilots.

5.1.2 The controllers remain responsible for the provision of separation between aircraft in compliance with the definition of the air traffic services.

5.1.3 The pilots are still responsible for the safe and efficient control and navigation of their individual aircraft in all airspace. In controlled airspace, they still have to follow the clearances and instructions provided by controllers. The only difference in comparison with current operations is that pilot's procedures will include the use of the traffic display to enhance traffic situational awareness. It is the flight crew's decision to use the AIRB or VSA application.

5.1.4 The flight crew must be aware that there can be surrounding aircraft that are not displayed on the traffic display for various reasons (surrounding aircraft without ADS-B OUT capability, emitting non-qualified data, or out of the display volume, and traffic display de-cluttering for traffic on ground).

5.2 **Training and qualification requirements**

5.2.1 Flight crews must be trained on the proper use of AIRB and VSA applications. Several aspects which should be addressed in training include overreliance on the traffic display to the detriment of other sources of information, excessive head-down time, awareness of latency issues and operation in a partial ADS-B equipage environment.

- It is important to provide appropriate training for the flight crews to use and understand the traffic display and how the information is presented on it.
- Training on the use of the AIRB and VSA applications should emphasize the use of the traffic display as supplemental information to existing sources of information, to avoid over reliance on the AIRB and VSA applications to the detriment of other sources or interference with existing procedures.
- Flight crews, especially if flying visual flight rules (VFR), should be trained to avoid excessive head-down time to the detriment of regular out the window scans.

- Training should address the evolution of the traffic situation, considering that the displayed information is continuously updated and can vary from the information received from the controller, which is based on a past situation.
- Training should ensure flight crews are aware that the traffic picture displayed may be incomplete, due to a partial equipage situation, or filtering of poor quality data.
- Periodic refresher training on the proper use of the AIRB and VSA applications should be provided to prevent flight crew complacency when using the traffic display as a supplemental source of traffic information.

5.2.2 Additionally, the following training consideration should also be taken into account:

- Training should also be provided on the hazard of misinterpreting the traffic display and manoeuvring inappropriately because the display provides only partial information and is based upon a moving reference.
- Training should ensure flight crews are aware of the need to reference the traffic alert and collision avoidance system (TCAS) traffic display for assistance in the visual acquisition of traffic when a traffic advisory is generated by TCAS and TCAS traffic is shown on a separate display.

5.3 Others

5.3.1 Special attention should be given to training for general aviation (GA) flight crews regarding the appropriate uses of the AIRB and VSA applications. Some expected means of providing this information and emphasizing the appropriate uses and limitations of displayed AIRB traffic to the GA community include, but are not limited to the following: airplane flight manual supplements (AFMS), training material supplied directly from the avionics manufacturer, specific training during bi-annual flight reviews, and direct instructions from fixed-base operators during any rental checkout procedures.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: current published criteria that includes the material given in Section 8.4.
- Approval plans: operational approval guidance/criteria may be needed based upon regional application for ATSA.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Current use

- **United States:** ADS-B/TIS-B/FIS-B services will be available over continental United States by 2013.

- **Europe:** AIRB has been used operationally from February 2012 (by Swiss International Airlines) in the context of the ATSAW Pioneer project of the EUROCONTROL CASCADE Programme. The other pioneer airlines (British Airways, Delta Airlines, US Airways and Virgin Atlantic) will follow.

7.2 **Planned or ongoing activities**

7.2.1 Currently in operation.

8. **REFERENCE DOCUMENTS**

8.1 **Standards**

- EUROCAE ED-160/RTCA DO-314, Safety, Performance and Interoperability Requirements Document for Enhanced Visual Separation on Approach (ATSA-VSA)
- EUROCAE ED-164/RTCA DO-319, Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness During Flight Operations (ATSA-AIRB)
- RTCA Document DO-317A/EUROCAE Document ED-194, Minimum Operational Performance Standards (MOPS) for Aircraft Surveillance Applications (ASA) System

8.2 **Procedures**

8.2.1 The procedure for the use of ADS-B traffic display is being proposed for inclusion in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) for applicability in November 2013.

8.3 **Guidance material**

- EUROCONTROL Flight Crew Guidance on Enhanced Traffic Situational Awareness during Flight Operations;
- EUROCONTROL Flight Crew Guidance on Enhanced Visual Separation on Approach;
- EUROCONTROL ATSAW Deployment Plan (draft); and
- Draft ICAO Manual on Airborne Surveillance Applications (Doc xxxx) (available 2012).

8.4 **Approval documents**

- RTCA/EUROCAE ASA MOPS, DO-317A/ED-194;
 - AC 20-172;
 - TSO C195.
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APPENDIX C

MODULE NO. B0-86: IMPROVED ACCESS TO OPTIMUM FLIGHT LEVELS THROUGH CLIMB/DESCENT PROCEDURES USING ADS-B

Summary	This module enables an aircraft to reach a more satisfactory flight level for flight efficiency or to avoid turbulence for safety. The main benefit of in-trail procedures (ITP) is significant fuel savings and the uplift of greater payloads.	
Main performance impact as per Doc 9854	KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route	
Applicability considerations	This can be applied to routes in procedural airspaces,	
Global concept component(s) as per Doc 9854	CM – conflict management AOM – airspace organization and management AUO – airspace user operations	
Global plan initiatives (GPI)	GPI-7: Dynamic and flexible ATS route management GPI-9: Situational awareness	
Main dependencies	Nil	
Global readiness checklist		Status (ready now or estimated date).
	Standards readiness	√
	Avionics availability	√
	Infrastructure availability	√
	Ground automation availability	√
	Procedures available	√
	Operations approvals	√

1. NARRATIVE

1.1 General

1.1.1 The use of in-trail procedures (ITP) facilitates en-route climb or descent to enable better use of optimal flight levels from a flight efficiency or safety perspective in environments where a lack of ATC surveillance and/or the large separation minima currently implemented was a limiting factor. ITP is designed to enable an aircraft to climb or descend through the altitude of other aircraft when the requirements for procedural separation would not be met. The system benefits of ITP are significant fuel savings and less passenger and cabin crew injuries by leaving a turbulent altitude. This is the first airborne surveillance application to generate operational benefits through a new separation minimum.

1.1.2 The ability of an aircraft to climb through the altitude of another aircraft when normal separation procedures would not allow this prevents an aircraft being trapped at an unsatisfactory altitude and thus incurring non-optimal fuel burn for prolonged periods or possible injuries to cabin crew and passengers. This immediately results in reduced fuel-burn and emissions. Once the procedure has been field proven, it will also allow for a reduction in the contingency fuel carriage requirement, which in turn will result in reduced fuel-burn and emissions.

1.2 Baseline

1.2.1 In-trail procedure (ITP) using automatic dependent surveillance — broadcast (ADS-B) became operational within the Oakland Oceanic FIR in August 2011 and hence can be considered to be a baseline.

1.3 Improvement brought by the module

1.3.1 The introduction of ITP and ADS-B based separation minima enable aircraft to climb or descend through the altitude of other aircraft when the requirements for procedural separation cannot be met. This reduces fuel-burn and emissions by allowing aircraft to overcome altitude constraints due to aircraft flying at higher or lower altitudes and fly at a more efficient altitude. ITP also provides safety benefits by providing a tool to manage contingency scenarios such as climbing or descend out of turbulence and potentially avoiding hazardous meteorological conditions. Once the procedure has been field proven, it will also allow for a reduction in the contingency fuel carriage requirement, which in turn will result in reduced fuel-burn and emissions and the uplift of greater payloads.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Capacity</i>	Improvement in capacity on a given air route.
<i>Efficiency</i>	Increased efficiency on oceanic and potentially continental en-route.
<i>Environment</i>	Reduced emissions.
<i>Safety</i>	A reduction of possible injuries for cabin crew and passengers.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 Procedures for ITP using ADS-B have been developed and are in use within the Oakland Oceanic flight information region (FIR) and a *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) amendment is in progress. Additional information will be available in an ICAO circular – Safety Assessment for the development of Separation Minima and Procedures for ITP using Automatic Dependant Surveillance – Broadcast (ADS-B) Version 1.5.4.

3.2 ITP requires the use of controller-pilot data link communications (CPDLC) as per the PANS-ATM amendment for an applicability date of November 2013.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 The aircraft performing the in-trail procedure will require an ADS-B IN capability compliant with DO-312/ED-159 or DO-317A/ED-194. The other aircraft involved in the procedure will require an ADS-B OUT capability compliant with AMC 20-24/DO-260A/DO-260B/ED-102A, or DO-317A/ED-194.

4.1.2 CPDLC compliant with DO-306 chg 1/ED-122 chg 1 is required.

4.2 **Ground systems**

4.2.1 It is recommended that conflict probe logics be adapted to ITP separation minimum.

5. **HUMAN PERFORMANCE**

5.1 **Human factors considerations**

5.1.1 Responsibility for separation is not modified; the controller is still responsible to ensure separation between these aircraft.

5.1.2 Human factors have been taken into consideration during the development of the processes and procedures associated with this module. The human-machine interface for the automation aspects of this performance improvement have also been addressed both in terms of ergonomic considerations as well as in their practical application (see Section 6 for examples). The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, are reported to the international community through ICAO as part of any safety reporting initiative.

5.2 **Training and qualification requirements**

5.2.1 The flight crew needs to be trained and qualified to understand the limitations of the equipment and to ensure a correct usage of the in-trail procedure and supporting avionics. In particular, flight crews must be trained on the criticality of revalidating the ITP criteria prior to initiating an ITP climb or descent.

5.2.2 The controller needs to be trained and qualified to assume the tasks and to ensure a correct usage of the in-trail procedure and ground support tools.

5.3 **Other**

5.3.1 In procedural airspace where a conflict probe is provided for controller use, it is strongly recommended that such conflict probe software be adapted to the ITP separation minimum.

6. **REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)**

- Regulatory/standardization: use current published criteria that includes the documents given in Section 8.4.
- Approval plans: to be determined. Operational approval guidance/criteria may be needed based upon regional application for ATSA.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOW AT TIME OF WRITING)

7.1 Current use

7.1.1 The EUROPEAN (ISAVIA, NATS, EUROCONTROL, AIRBUS, SAS) CRISTAL ITP trial validated the concepts for ITP.

7.1.2 EUROCONTROL CASCADE pioneer project is undergoing an operational evaluation in the North Atlantic in Reykjavik and Shanwick FIR with British Airways, Delta Airlines, Swiss, US Airways, Virgin Atlantic, involving twenty-five Airbus and Boeing aircraft. The evaluation began on 7 February 2012.

7.1.3 ITP is a part of trials to be undertaken under the Asia and South Pacific initiative to reduce emissions (ASPIRE) programme. ASPIRE is a joint programme between AirServices Australia, the Airways Corporation of New Zealand, Civil Aviation Authority of Singapore and the Japan Civil Aviation Bureau.

7.1.4 ITP is undergoing an operational evaluation (trial) in the Oakland Oceanic FIR, using twelve equipped B474-400s operated by United Airlines. This operational evaluation began on 15 August 2011 and is expected to last about two years.

7.2 Planned or ongoing activities

United States: trials are currently being completed to demonstrate the use of in-trail procedures using ADS-B IN.

8. REFERENCE DOCUMENTS

8.1 Standards

- EUROCONTROL ATSAW Deployment Plan(draft)
- EUROCAE ED-159/RTCA DO-312 “Safety, Performance and Interoperability Requirements Document for the In-trail Procedure in Oceanic Airspace (ATSA-ITP) Application”.

8.2 Approval documents

- FAA AC 20-172a
 - FAA TSO-C195a
 - FAA Memo; Interim Policy and Guidance Automatic Dependent Surveillance Broadcast (ADS-B) Aircraft Surveillance Systems Supporting Oceanic In-Trail Procedures (ITP). Dated: May 10, 2010
 - DO-312/ED-159
 - DO-317A/ED-194
 - ICAO circular – “*Safety Assessment for the development of Separation Minima and Procedures for In-Trail Procedure (ITP) using automatic dependant surveillance – broadcast (ADS-B) Version 1.5.4*”
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APPENDIX D

MODULE NO. B1-85: INCREASED CAPACITY AND EFFICIENCY THROUGH INTERVAL MANAGEMENT

Summary	Interval management (IM) improves the management of traffic flows and aircraft spacing. This creates operational benefits through precise management of intervals between aircraft with common or merging trajectories, thus maximizing airspace throughput while reducing ATC workload along with more efficient aircraft fuel burn reducing environmental impact.	
Main performance impact as per doc 9854	KPA-03 – Cost-effectiveness, KPA-04 – Efficiency, KPA-05 – Environment, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route, arrival, approach, departure.	
Applicability considerations	En-route and terminal areas.	
Global concept component(s) as per Doc 9854	CM – conflict management DCB – demand and capacity balancing TS – traffic synchronization	
Global plan initiatives (GPI)	GPI-7: Dynamic and flexible ATS route management GPI-9: Situational awareness GPI-17: Data link applications.	
Main dependencies	B0-85	
Global readiness checklist		Status (ready now or estimated date).
	Standards readiness	Est. 2014
	Avionics availability	Est. 2016
	Ground system availability	Est.2014
	Procedures available	Est.2014
	Operations approvals	Est.2016

1. NARRATIVE

1.1 General

1.1.1 Interval management is defined as the overall system that enables the improved means for managing traffic flows and aircraft spacing, including the use of ground tools that assist the controller in evaluating the traffic picture and determining appropriate clearances to merge and space aircraft efficiently and safely and the use of airborne tools that allow the flight crew to conform with the IM clearance. The objective is for an instructed aircraft to achieve and/or maintain an assigned interval relative to another one. The interval can be defined in time or distance.

1.1.2 IM operations in the first phase will cover the arrival phase of flight (from the top of descent to initial or final approach fix) of airspace under surveillance, where direct controller pilot communications (voice or CPDLC) exist. As the applications evolve they will be applied to other phases of flight.

1.1.3 IM includes both the ground capabilities needed for the controller to support an IM clearance and the airborne capabilities needed for the flight crew to follow the IM clearance.

1.1.4 IM application is also seen as a complement to continuous descent operations (CDO) by enabling fuel-efficient near-idle continuous descent profiles. The joint use of CDO and IM is expected to allow for CDOs in higher density traffic than where they are currently used.

1.2 Baseline

1.2.1 As these applications are under development there is no existing baseline.

1.3 Improvement brought by the module

1.3.1 Interval management is a suite of functional capabilities that can be combined to produce operational applications to achieve or maintain an interval or spacing from a designated aircraft (referred as target or reference aircraft). ATC will be provided with a new set of (voice or data link) clearances directing, for example, that the flight crew establish and maintain a given time spacing from a reference aircraft. These new clearances will reduce the use of ATC vectoring and speed control, which is expected to reduce the overall number of transmissions. These reductions are expected to reduce ATC workload per aircraft.

1.3.2 The flight crew will perform these new tasks using new avionics functions e.g. airborne surveillance, display of traffic information, and spacing functions with advisories. A few examples of IM in various phases of flight include: cruise - delivering metering or miles-in-trail prior to top-of-descent; arrival – interval management during optimum profile descents; approach – achieve and maintain appropriate interval to stabilized approach point; and departure – maintain interval no-closer-than to previous departure. These examples provide more efficient flight trajectories, better scheduling performance, and reduced fuel burn and decreased environmental impacts when combined with CDO. Other benefits include:

- a) reduced ATC instructions and controller workload; and
- b) without unacceptable increase in flight crew workload

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Cost-Effectiveness</i>	Consistent, low variance spacing between paired aircraft (e.g., at the entry to an arrival procedure and on final approach) resulting in reduced fuel burn.
<i>Efficiency</i>	Early speed advisories removing requirement for later path-lengthening. Continued optimized profile descents (OPDs) in medium density environments expected to allow OPDs when demand $\leq 70\%$. Resulting in reduced holding times and flight times.
<i>Environment</i>	All efficiency benefits have an impact of the environment. Resulting in reduced emissions.
<i>Safety</i>	Reduced ATC instructions and workload: Without unacceptable increase in flight crew workload.
<i>Cost Benefit Analysis</i>	TBD

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 Air and ground procedures for interval management have yet to be developed. They will include conditions of application, phraseology and messages exchanges.

4. **NECESSARY SYSTEM CAPABILITY**

4.1 **Avionics**

4.1.1 Necessary technology includes for the aircraft performing IM operation: ADS-B IN capability, avionics component (FIM equipment /spacing functions with advisories) that provide IM capabilities (i.e. to provide IM speed and IM Turn), and a cockpit based CDTI.

4.1.2 For the reference/target aircraft: ADS-B OUT capability compliant with the same as for ITP.

4.1.3 If CPDLC is used, it must comply with message set developed by SC-214.

4.2 **Ground systems**

4.2.1 Ground automation to support the interval management application may be required. Where implemented this will most likely be customized based on the set of interval management procedures allowed in a given terminal area. This may include the implementation of additional CPDLC messages. For arrival operations an arrival manager (AMAN) tool is recommended.

5. **HUMAN PERFORMANCE**

5.1 **Human factors considerations**

5.1.1 Responsibility for separation is not modified; the controller is still responsible to ensure separation between these aircraft.

5.2 **Training and qualification requirements**

5.2.1 The pilot needs to be trained and qualified to assume the new tasks and to ensure a correct usage of the new procedures and avionics.

5.2.2 The controller needs to be trained and qualified to assume the tasks and to ensure a correct usage of the new procedures and ground support tools.

6. **REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)**

- Regulatory/standardization: updated/new published criteria required that includes the material given in Sections 8.1 and 8.4.
- Approval plans: to be determined.

7. **IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)**

7.1 **Current use**

7.1.1 In the United States, operational trials of IM were conducted at Louisville (Kentucky) from 2009 to 2010.

7.2 Planned or ongoing activities

- **SESAR:** validation in TMA environment with PRNAV structure of the two basic ASAS sequencing and merging manoeuvres during 2012-2013 timeframe.
- **SESAR Project 05.06.06 ASPA-S&M:** the objective of P5.6.6 – “ASAS Sequencing and Merging” project is to contribute to the consolidation of the operational concept and to validate the “Airborne Spacing Sequencing & Merging Application” (ASPA S&M).
- **United States:** plans are currently being developed to demonstrate the flight interval management functionality in 2013 by NASA. The FAA is implementing the requirements for ground interval management-spacing (GIM-S) via two FAA automation programmes: time-based flow management (TBFM) and en-route automation modernization (ERAM). The FAA has several airline partners prepared to support operational data collection and benefits measurement as the initial flight interval management – spacing (FIM-S) capabilities are established. The FAA supported the efforts of a joint RTCA/EUROCAE working group to develop the safety, performance and interoperability requirements (SPR) document for FIM-S (also known as ASPA-IM), which resulted in RTCA DO-328. RTCA SC-186 and EUROCAE WG-51 have begun initial work on the MOPS material for FIM-S avionics. This effort is expected to conclude in late 2013.

8. REFERENCE DOCUMENTS

8.1 Standards

- EUROCAE ED-195 / RTCA DO-328, Safety, Performance and Interoperability Requirements Document for Airborne Spacing – Flight Deck Interval Management (ASPA-FIM);
- RTCA DO-xxxx (in preparation), Enhanced CPDLC Message set per SC214/WG/78;
- ASA MOPS DO-317A/ED-194 will be updated to include FIM equipment standards by the end of 2013; and
- Standards for FIM would need to be developed for Annex 10, Volume IV.

8.2 Procedures

8.2.1 To be determined.

8.3 Guidance material

- EUROCONTROL, Flight Crew Guidance on Enhanced Traffic Situational Awareness during Flight Operations;
- EUROCONTROL, Flight Crew Guidance on Enhanced Situational Awareness on the Airport Surface;
- EUROCONTROL, Flight Crew Guidance on Enhanced Visual Separation on Approach.

8.4 Approval documents

- RTCA DO-xxxx (in preparation), Enhanced CPDLC Message set per SC214/WG78.

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APPENDIX E
MODULE NO. B2-85: AIRBORNE SEPARATION (ASEP)

Summary	Creation of operational benefits through temporary delegation of responsibility to the flight deck for separation provision with suitably equipped designated aircraft, thus reducing the need for conflict resolution clearances while reducing ATC workload and enabling more efficient flight profiles. The flight crew ensures separation from suitably equipped designated aircraft as communicated in new clearances, which relieve the controller from the responsibility for separation between these aircraft. However, the controller retains responsibility for separation from aircraft that are not part of these clearances.	
Main performance impact as per Doc 9854	KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment, KPA-06 – Flexibility, KPA-09 – Predictability.	
Operating environment/ Phases of flight	En-route phase, oceanic, and approach, departure and arrival.	
Applicability considerations	The safety case needs to be carefully done and the impact on capacity is still to be assessed in case of delegation of separation for a particular situation implying new regulation on airborne equipment and equipage roles and responsibilities (new procedure and training). First applications of ASEP are envisaged in Oceanic airspace and in approach for closely-spaced parallel runways.	
Global concept component(s) as per Doc 9854	CM – conflict management	
Global plan initiatives (GPI)	GPI-16: Decision support systems and alerting systems.	
Main dependencies	B1-85	
Global readiness checklist		Status (ready or date)
	Standards readiness	Est. 2023
	Avionics availability	Est. 2023
	Ground systems availability	Est. 2023
	Procedures available	Est. 2023
	Operations approvals	Est. 2023

1. NARRATIVE

1.1 General

1.1.1 Airborne separation is described as follows in the ICAO *Global Air Traffic Management Operational Concept* (Doc 9854):

1.2 Cooperative separation

1.2.1 Cooperative separation occurs when the role of separator is delegated. This delegation is considered temporary, and the condition that will terminate the delegation is known. The delegation can be for types of hazards or from specified hazards. If the delegation is accepted, then the accepting agent is responsible for compliance with the delegation, using appropriate separation modes.

1.3 Baseline

1.3.1 The baseline is provided by the first airborne surveillance application described in the modules B0-86 and B1-85. These ASAS-ASEP operations will be the next step.

1.4 Change brought by the module

1.4.1 This module will introduce new modes of separation relying on aircraft capabilities including airborne surveillance supported by ADS-B and giving responsibility for separation to the pilot by delegation from the controller. This relies on the definition of new airborne separation minima.

1.4.2 With Element: Airborne separation (ASEP) the flight crew ensures separation from designated aircraft as communicated in new clearances, which relieve the controller from the responsibility for separation between these aircraft. However, the controller retains responsibility for separation from aircraft that are not part of these clearances and from aircraft involved in ASEP and surrounding aircraft.

1.4.3 Airborne separation: the flight crew ensures separation from designated aircraft as communicated in new clearances, which relieve the controller from the responsibility for separation between these aircraft. However, the controller retains responsibility for separation from aircraft that are not part of these clearances and from aircraft involved in ASEP and surrounding aircraft.

1.4.4 Typical airborne separation applications include:

- a) interval management with delegation of separation: the flight crews maintain a time-based separation behind designated aircraft;
- b) lateral crossing and passing: the flight crews adjust the lateral flight path to ensure that horizontal separation with designated aircraft is larger than the applicable airborne separation minimum;
- c) vertical crossing: the flight crews adjust the vertical flight path to ensure that vertical separation with designated aircraft is larger than the applicable airborne separation minimum;
- d) paired approaches in which the flight crews maintain separation on final approach to parallel runways; and
- e) in oceanic airspace many procedures are considered as improvement of in trail procedure (ITP) using new airborne separation minima:
 - 1) ASEP-ITF In-trail follow;

- 2) ASEP-ITP In-trail procedure; and
- 3) ASEP-ITM In-trail merge.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Capacity</i>	Increase by allowing reduced separation minima and potential reduction of air traffic controller workload.
<i>Efficiency</i>	Optimum flight trajectories.
<i>Environment</i>	Less fuel consumption due to more optimum flight trajectories.
<i>Flexibility</i>	More flexibility to take in account a constraint, such as meteorological conditions.
<i>Predictability</i>	Conflict resolution is optimized and potentially more standardized thanks to the airborne equipment performance standards.
<i>Cost Benefit Analysis</i>	To be determined by balancing cost of equipment and training and reduced penalties.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 ASAS-ASEP procedures need to be defined for PANS-ATM and PANS-OPS with clarifications of roles and responsibilities.

4. NECESSARY SYSTEM CAPABILITY (AIR & GROUND)

4.1 Avionics

4.1.1 Necessary technology includes for the aircraft performing ASEP: ADS-B IN capability, avionics component (ASEP equipment /conflict resolution functions with advisories), and a cockpit based CDTI.

4.1.2 For the reference/target aircraft: ADS-B OUT capability compliant with TBD.

4.1.3 If CPDLC is used, it must comply with message set developed by SC-214.

4.2 Ground systems

4.2.1 On the ground there is a need for specific tools to assess the aircraft capabilities and to support delegation function. This requires a full sharing of the trajectory information between all the actors. It may be necessary to tune STCA in a specific mode for this procedure (restricted to collision avoidance only).

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 Change of role of controllers and pilots need to be carefully assessed and understood by both parties however, this module is still in the research and development phase so the human factors considerations are still in the process of being identified through modelling and beta testing. Future iterations of this document will become more specific about the processes and procedures necessary to take the human factors considerations into account. There will be a particular emphasis on identifying the human-machine interface issue if there are any and providing the high risk mitigation strategies to account for them.

5.2 Training and qualification requirements

5.2.1 The pilot needs to be trained and qualified to assume the new role and responsibility and to ensure a correct usage of the new procedures and avionics.

5.2.2 The controller needs to be trained and qualified to assume the new role and responsibility and to ensure a correct usage of the new procedures and ground support tools (e.g. to well identify the aircraft/facilities which can use the services).

5.3 Others

5.3.1 Liability issues are to be considered.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: updates required to current published separation minima that include the material given in Section 8.4.
- Approval plans: to be determined.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Current use

7.1.1 None at this time.

7.2 Planned or ongoing trials

European projects

- ASSTAR (2005-2007) initiated the work on ASEP and SSEP applications in Europe which has been pursued by SESAR projects as follows:

– SESAR Project 04.07.04.b ASAS-ASEP Oceanic Applications

7.2.1 The airborne separation in-trail follow (ASEP-ITF) and in-trail merge (ASEP-ITM) applications have been designed for use in oceanic and other non-radar airspace.

7.2.2 ASEP-ITF transfers responsibility for separation between the ITF aircraft and a reference aircraft from the controller to the flight crew for the period of the manoeuvre. This transfer of responsibility will place high accuracy and integrity requirements on the avionics (both the ITF and reference aircraft positioning, airborne surveillance and ASEP-ITF ASAS logic). ASEP-ITF is intended as a means of improving vertical flexibility, allowing aircraft to make a level change where current procedural separation minima will not allow it, by enabling level changes to the flight level of a reference aircraft which is operating at a different flight level, but on the same identical track.

7.2.3 ASEP-ITM transfers responsibility for separation between the ITM aircraft and a reference aircraft from the controller to the flight crew for the period of the manoeuvre. This transfer of responsibility will place high accuracy and integrity requirements on the avionics (both the ITM and reference aircraft positioning, airborne surveillance and ASEP-ITM ASAS logic). ASEP-ITM is intended as a means of improving lateral flexibility, allowing aircraft to change their routing where current procedural separation minima will not allow it, by enabling a lateral manoeuvre to follow, and then maintain, a minimum interval behind a reference aircraft which is operating at a same direction flight level.

7.2.4 Both applications will require the crew to use airborne surveillance information provided on the flight deck to identify the potential opportunity to use the applications and to maintain a reduced separation from the Reference aircraft during the manoeuvres.

SESAR Project 04.07.06 En Route Trajectory and Separation Management – ASAS Separation (Cooperative Separation)

7.2.5 The main objective of this project is to assess the introduction of ASAS separation application in the SESAR context (taking into account all platforms, including military and UAS).

7.2.6 The project will be focused on the possibility to delegate in specific and defined conditions the responsibility for traffic separation tasks to the flight deck of suitable equipped aircraft.

7.2.7 The United States is planning to pursue “defined interval” applications per the ADS-B IN Aviation Rulemaking Committee (ARC) report dated 30-Sep-2011. The United States concept is that full separation responsibility remains with the controller, but that the controller assigns a task or tasks to the flight crew that allows an alternate separation standard to be applied for the operation. The United States is studying “interval management” applications of “defined interval” for terminal area operations (arrival and departure), as well as for oceanic operations in procedural airspace.

8. REFERENCE DOCUMENTS

8.1 Guidance material

- ICAO AN-Conf/11-IP/5 draft ASAS Circular (2003)

- FAA/EUROCONTROL ACTION PLAN 23 – D3 –The Operational Role of Airborne Surveillance in Separating Traffic (November 2008)
- FAA/EUROCONTROL ACTION PLAN 23 – D4 – ASAS application elements and avionics supporting functions (2010)

APPENDIX F
MODULE NO. B3-85: AIRBORNE SELF-SEPARATION (SSEP)

Summary	Creation of operational benefits through total delegation of responsibility to the flight deck for separation provision between suitably equipped aircraft in designated airspace, thus reducing the need for conflict resolution. Benefits will include reduced separation minima, reduction of controller workload, optimum flight trajectories and lower fuel consumption.	
Main performance impact as per Doc 9854	KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment; KPA-06 – Flexibility, KPA-08 – Participation by the ATM community, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route phase, oceanic.	
Applicability considerations	The safety case needs to be carefully assessed and the impact on capacity is still to be assessed, implying new regulation on airborne equipment and equipage roles and responsibilities (procedure and training). First area for SSEP application is in low density areas.	
Global concept component(s) as per Doc 9854	CM – conflict management	
Global plan initiatives (GPI)	GPI-16: Decision support systems and alerting systems	
Main dependencies	B0-86, B2-85 and B2-101	
Global readiness checklist		Status (ready or date)
	Standards readiness	Est. 2028
	Avionics availability	Est. 2028
	Ground systems availability	Est. 2028
	Procedures available	Est. 2028
	Operations approvals	Est. 2028

1. NARRATIVE

1.1 General

1.1.1 Airborne separation is described in the *Global Air Traffic Management Operational Concept* (Doc 9854).

Self-Separation

1.1.2 Self-separation is the situation where the airspace user is the separator for its activity in respect of one or more hazards.

1.1.3 Full self-separation is the situation where the airspace user is the separator for its activity in respect of all hazards. In this case, no separation provision service will be involved; however, other ATM services, including strategic conflict management services, may be used.

1.2 Baseline

1.2.1 The baseline is provided by the first airborne surveillance application described in Modules B0-86 in-trail procedures, B1-85 ASAS-ASPA interval management and B2-85 airborne separation by temporary delegation. These ASAS-SSEP operations will be the next step, giving more autonomy to the equipped aircraft.

1.3 Change brought by the module

1.3.1 This module will introduce self-separation relying on aircraft capabilities including airborne surveillance supported by ADS-B and giving responsibility for separation to the pilot in designated airspace.

1.3.2 Airborne self-separation: the flight crew ensures separation of their aircraft from all surrounding traffic. The controller has no responsibility for separation. First applications are in oceanic airspace and low density airspace.

1.3.3 Typical airborne self-separation applications include:

- a) airborne self-separation in ATC-controlled airspace;
- b) airborne self-separation in segregated en-route airspace;
- c) airborne self-separation in mixed-equipage en-route airspace; and
- d) SSEP – FFT free flight on an oceanic track.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Capacity</i>	Increase by allowing reduced separation minima and potential reduction of air traffic controller workload and even suppression of the tactical role of the ATS in low density airspace.
<i>Efficiency</i>	Optimum flight trajectories
<i>Environment</i>	Less fuel consumption due to more optimum flight trajectories.
<i>Flexibility</i>	More flexibility to take in account change in constraint, weather situation.
<i>Participation by the ATM community</i>	Increased role of the pilot.
<i>Safety</i>	To be demonstrated.
<i>Cost Benefit Analysis</i>	To be determined by balancing cost of equipment and training and reduced penalties.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 ASAS - SSEP procedures need to be defined for PANS-ATM and PANS-OPS with the need to determine applicable separation minima. Operational procedures to enter and exit the designated airspace must be defined.

4. NECESSARY SYSTEM CAPABILITY (AIR AND GROUND)

4.1 Avionics

4.1.1 For self-separation (SSEP) the main capabilities are on SSEP. The SSEP is composed of three main functions, i.e., airborne surveillance, conflict detection and conflict resolution.

4.2 Ground systems

4.2.1 For self-separation in a mixed airspace where a mix of equipped and non-equipped is authorized, on ground there is a need for specific tools to assess the aircraft capabilities, to support and to monitor the execution of separation by self-separating aircraft, while managing the separation of the others aircraft. This requires a full sharing of the trajectory information between all the actors.

4.2.2 For self-separation in a segregated airspace, there is a need to check that the predicted density allows this mode of mitigations and that the aircraft are authorized to fly through this airspace. Specific tools could be necessary to manage the transfer from self-separation airspace to conventional airspace.

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 Change of role of controllers and pilots need to be carefully assessed. Specific training and qualification are required.

5.2 Training and qualification requirements

5.2.1 The pilot needs to be trained and qualified to assume the new role and responsibility and correct usage of the new procedures and avionics. Automation support is needed for the pilot and the controller which therefore will have to be trained to the new environment and to identify the aircraft/facilities which can use the services in mixed mode environments.

5.3 Others

5.3.1 Liability issues are to be considered.

6. **REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)**

Regulatory/standardization: updates as required for enhanced exchange of flight information in:

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 8168, *Aircraft Operations*
- FAA AC TBD, EASA AMD TBD
- Changes to Annex 2 — *Rules of the Air*, Annex 6 — *Operation of Aircraft*, Annex 10 — *Aeronautical Telecommunications* and Annex 11 — *Air Traffic Services* are anticipated

7. **IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)**

7.1 **Current use**

7.1.1 None at this time.

7.2 **Planned or ongoing trials**

- ASSTAR
- SESAR Project 04.07.04.b
- ASAS-ASEP Oceanic applications

7.2.1 The airborne separation in-trail follow (ASEP-ITF) and in-trail merge (ASEP-ITM) applications have been designed for use in oceanic and other non-radar airspace.

7.2.2 ASEP-ITF transfers responsibility for separation between the ITF aircraft and a reference aircraft from the controller to the flight crew for the period of the manoeuvre. This transfer of responsibility will place high accuracy and integrity requirements on the avionics (both the ITF and reference aircraft positioning, airborne surveillance and ASEP-ITF procedure). ASEP-ITF is intended as a means of improving vertical flexibility, allowing aircraft to make a level change where current procedural separation minima will not allow it, by enabling level changes to the flight level of a reference aircraft which is operating at a different flight level, but on the same identical track.

7.2.3 ASEP-ITM transfers responsibility for separation between the ITM aircraft and a reference aircraft from the controller to the flight crew for the period of the manoeuvre. This transfer of responsibility will place high accuracy and integrity requirements on the avionics (both the ITM and reference aircraft positioning, airborne surveillance and ASEP-ITM procedure). ASEP-ITM is intended as a means of improving lateral flexibility, allowing aircraft to change their routing where current procedural separation minima will not allow it, by enabling a lateral manoeuvre to follow, and then maintain, a minimum spacing behind a reference aircraft which is operating at a same direction flight level.

7.2.4 Both applications will require the crew to use airborne surveillance information provided on the flight deck to identify the potential opportunity to use the applications and to maintain a reduced separation from the reference aircraft during the manoeuvres.

SESAR Project 04.07.05 Self Separation in Mixed Mode Environment

7.2.5 One goal of the ASAS development path is to enable self separation (SSEP) in mixed mode operations. The intention is to allow self-separating flights and ANSP separated flights to operate in the same airspace. The project has two phases with following objectives:

- first phase: assess compatibility between 4D-contract and ASEP applications as a step towards autonomous operations.
- second phase: develop and validate the operating concept for the SSEP applications in mixed mode, i.e. together with conventional, new airborne mode (ASEP-C and P) and new ANSP modes.

7.2.6 The main objective is to validate the integration of 4D, ASAS, and conventional traffic in the separation management task. The focus will be the interaction of conventional and new separation modes and the consequences for capacity, efficiency, safety, and predictability. Moreover, relations between safety and capacity will be studied aiming at decreasing the number of critical incidents despite increasing traffic.

SESAR WP4.7.6 En Route Trajectory and Separation Management – ASAS Separation (Cooperative Separation)

7.2.7 The main objective of this project is to assess the introduction of ASAS separation application in the SESAR context (taking into account all platforms, including military and UAS). The project will be focused on the possibility to delegate in specific and defined conditions the responsibility for traffic separation tasks to the flight deck of suitable equipped aircraft.

8. REFERENCE DOCUMENTS**8.1 Guidance materials**

- ICAO AN-Conf/11-IP/5 draft ASAS Circular (2003)
- FAA/EUROCONTROL ACTION PLAN 23 – D3 -The Operational Role of Airborne Surveillance in Separating Traffic (November 2008)
- FAA/EUROCONTROL ACTION PLAN 23 – D4 –ASAS application elements and avionics supporting functions (2010)

8.2 Approval documents

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 8168, *Aircraft Operations*
- FAA AC TBD, EASA AMD TBD