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AMENDMENTS

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RECORD OF AMENDMENTS AND CORRIGENDA

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Table of Contents

FOREWORD	vii
1 ABBREVIATIONS, DEFINITIONS AND REFERENCES	1
1.1 ABBREVIATIONS	1
1.2 DEFINITIONS	3
1.3 REFERENCES	7
2 OVERVIEW OF AIRBORNE SURVEILLANCE APPLICATIONS (ASAs)	10
2.1 DESCRIPTION OF AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)	10
2.1.1 Overview	10
2.1.2 Interactions of ADS-B and airborne collision avoidance system (ACAS)	11
2.1.3 The limitations of ADS-B	11
2.2 ASAs – CONCEPT	13
2.2.1 Introduction	13
2.2.2 High level description of basic ASAs	13
2.2.3 Description of advanced ASAs	16
2.2.4 Description of other future applications	20
2.3 EVOLUTION OF ASAs	21
2.4 VALIDATION OF ASAs	22
2.5 ARCHITECTURE	23
2.5.1 Functional architecture	23
2.5.2 Description of cockpit solutions	29
2.6 OPERATIONAL ENVIRONMENTS AND BENEFITS	31
2.6.1 Operational environment for AIRB	31
2.6.2 Operational environment for VSA	31
2.6.3 Operational environment for SURF	31
2.6.4 Operational environment for ITP	32
2.6.5 Operational benefits	32

	<i>Page</i>
2.7 UNEQUIPPED AIRCRAFT CONSIDERATIONS	33
2.7.1 Partial equipage	33
2.7.2 Limitation of supplemental information by TIS-B	33
2.7.3 Segregation of airspace and flexible use of airspace	34
3 ADMINISTRATIVE PROVISIONS RELATED TO ASAs	36
3.1 AIR NAVIGATION SERVICE PROVIDER (ANSP) SERVICE PROVISIONS	36
3.1.1 General considerations	36
3.1.2 ANSP considerations for AIRB, VSA and SURF	36
3.1.3 ANSP considerations for ITP implementation	37
3.2 OPERATOR ELIGIBILITY	38
3.2.1 General considerations	38
3.2.2 Operator considerations for AIRB, VSA, SURF	38
3.2.3 Operator considerations for ITP	39
3.3 FLIGHT PLANNING	40
4 CONTROLLER PROCEDURES	41
4.1 OVERVIEW	41
4.2 AIRB, VSA and SURF	42
4.3 ITP	43
5 FLIGHT CREW PROCEDURES	45
5.1 AIRB	45
5.1.1 Operational assumptions	45
5.1.2 Procedures	45
5.2 VSA	47
5.2.1 Operational assumptions	47
5.2.2 Procedures	47
5.3 SURF	49
5.3.1 Operational assumptions	49
5.3.2 Procedures	49

5.4 ITP	51
5.4.1 Operational assumptions	51
5.4.2 Procedures	51
Appendix1 ITP ADDITIONAL MATERIALS	53
1. ITP IMPLEMENTATION	53
1.1 INTRODUCTION	53
1.2 IMPLEMENTATION CONSIDERATIONS	53
2. EXAMPLES OF ITP GEOMETRIES AND CPDLC MESSAGES	58

FOREWORD

The manual has been developed by the Airborne Surveillance Task Force (ASTAF) which has been established by ICAO in 2010 as a multidisciplinary team of experts for the timely development of ICAO provisions to ensure global uniformity and interoperability of operations that are based on the use of automatic dependent surveillance — broadcast (ADS-B) on the flight deck.

This manual has three main objectives:

- a) to support the implementation of airborne surveillance and the initial applications for which some industrial solutions are already available;
- b) to present guidance material and references related to the standards and recommended practices (SARPS), the procedures for air navigation services (PANS) and relevant industry documents, i.e.; safety, performance and interoperability requirements (SPR) and minimum operational performance standards (MOPS).
- c) to summarize / recapitulate within an ICAO document the main results of the work carried out in the air traffic management (ATM) community supported by ADS-B, which is recognized as an essential enabler of the ICAO global concept of operations.

The manual is composed as follows:

- a) Chapter 1 contains the definitions;
- b) Chapter 2 briefly describes all airborne surveillance applications, defined and under development, and discusses technical matters such as validation, architecture and partial equipage;
- c) Chapters 3, 4 and 5 address all applications available at the time of writing as follows: Chapter 3 deals with the air navigation service provider (ANSP) and aircraft operator perspective, Chapter 4 deals with controller procedures while Chapter 5 deals with flight crew procedures.

The manual will be updated to incorporate additional airborne surveillance applications when they are made available to the global ATM community.

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1 ABBREVIATIONS, DEFINITIONS AND REFERENCES

1.1 ABBREVIATIONS

ACAS	Airborne collision avoidance system
ACID	Aircraft identification
ADS-B	Automatic dependent surveillance–broadcast
AIRAC	Aeronautical information regulation and control
ANSP	Air navigation service provider
ASA	Airborne surveillance application
ASSAP	Airborne surveillance and separation assistance processing
ASTAF	Airborne Surveillance Task Force
ATC	Air traffic control
ATM	Air traffic management
ATS	Air traffic services
ATSA	Air traffic situational awareness
CAVS	CDTI assisted visual separation
CDTI	Cockpit display of traffic information
CPDLC	Controller pilot data link communications
CRM	Crew resource management
DCPC	Direct controller pilot communication
EASA	European Aviation Safety Agency
EFB	Electronic flight bag
EUROCAE	European Organization for Civil Aviation Equipment
FIM	Flight-deck based interval management
FMS	Flight management system
FUA	Flexible use of airspace
GNSS	Global navigation satellite system
HMI	Human machine interface
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
IM	Interval management
IMC	Instrument meteorological conditions
ITP	In trail procedure
MLAT	Multilateration (systems)
MOPS	Minimum operational performance standards
NAC	Navigation accuracy category
NCAA	National civil aviation authority
NIC	Navigation integrity category
NUC	Navigation uncertainty category
OEM	Original equipment manufacturer
OSA	Operational safety assessment
RSI	Runway status indication
RTCA	Radio Technical Commission for Aeronautics
SESAR	Single European Sky ATM Research

SIL	Source integrity level (ADS-B version 2)
SIL	Surveillance integrity level (ADS-B version 1)
SOP	Standard operating procedures
SPR	Safety, performance and interoperability requirements
SSR	Secondary surveillance radar
TIS-B	Traffic information service–broadcast
UAT	Universal access transceiver
VDL	VHF digital link
VFR	Visual flight rules
VMC	Visual meteorological conditions
VSA	Visual separation on approach
WAM	Wide Area multilateration

1.2 DEFINITIONS

Accuracy (for position and velocity information). Accuracy is the degree of conformance between a platform's true position and/or velocity and its estimated or reported position and/or velocity.

Airborne surveillance and separation assurance processing (ASSAP). The processing of surveillance and other data in support of ASAs. ASSAP Function - Function that processes surveillance data using ADS-B reports from the ADS-B receive function, and performs application-specific processing.

Airborne surveillance application (ASA). A set of operational procedures for controllers and flight crews that makes use of the capabilities of airborne surveillance to meet a clearly defined operational goal.

Airborne traffic situational awareness applications. These applications are aimed at enhancing the flight crews' knowledge of the surrounding traffic situation, both in the air and on the airport surface, and thus improving the flight crew's decision process for the safe and efficient management of their flight.

Aircraft address. A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Aircraft identification (ACID). A group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the aircraft call sign to be used in air-ground communications, and which is used to identify the aircraft in ground-ground air traffic services communications.

Automatic dependent surveillance-broadcast (ADS-B) OUT. A function on an aircraft or vehicle that periodically broadcasts its state vector (position and velocity) and other information derived from on-board systems in a format suitable for ADS-B IN capable receivers.

Automatic dependent surveillance-broadcast (ADS-B) IN. A function that receives surveillance data from ADS-B OUT data sources.

Closing ground speed differential. The difference between the ITP Aircraft's ground speed and a reference aircraft's ground speed that results in a reduction of the ITP distance.

Closing Mach speed differential. The difference in Mach speed between the ITP aircraft and the reference aircraft that results in a reduction of the ITP distance.

Cockpit display of traffic information (CDTI). A graphical plan-view (top down) traffic display and aural features necessary to display traffic information, guidance and alerts.

Note. - In the context of this document, the term traffic display is consistently used as a graphical cockpit display of traffic information, often referred as a CDTI.

Conflict. A predicted violation of parameterized minimum separation criteria for adverse weather, aircraft traffic, special use airspace, other airspace, turbulence, noise sensitive areas, terrain and obstacles, etc.

Continuous descent operation (CDO). An operation, enabled by airspace design, procedure design and ATC facilitation, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach fix /final approach point.

Note 1. — An optimum CDO starts from the top of descent and uses descent profiles that reduce segments of level flight, noise, fuel burn, emissions and air traffic controller / pilot communications, while increasing predictability to pilots and air traffic controllers and flight stability.

Note 2.— A CDO initiated from the highest possible level in the en route or arrival phases of flight will achieve the maximum reduction in fuel burn, noise and emissions.

Essential traffic. Essential traffic is that controlled traffic to which the provision of separation by ATC is applicable, but which, in relation to a particular controlled flight is not, or will not be, separated from other controlled traffic by the appropriate separation minimum.

Ground speed. The speed of an airborne aircraft relative to the ground.

Hazard. Any real or potential condition that can cause injury, illness, or death to people; damage to or loss of a system, equipment, or property; or damage to the environment.

Horizontal velocity. The horizontal component of velocity relative to a ground reference.

IM aircraft. An aircraft that is equipped with FIM Equipment that is instructed to perform an IM Operation.

Interval. The horizontal along-path spacing between the IM and target aircraft. The interval may be specified in time or distance.

ITP aircraft. An aircraft that is fully approved (from equipment, operator and flight crew qualifications stand point) to conduct an ITP. The ITP aircraft has ADS-B equipment that transmits and receives ADS-B information. Thus, the ITP aircraft has the state of the reference aircraft and its own state information. It is based on this information that the ITP request is made.

ITP criteria. A set of conditions that must be satisfied prior to initiating or executing an ITP clearance.

ITP distance. The distance between the ITP aircraft and the reference aircraft as defined by the difference in distance to an aircraft calculated common point along a projection of each aircraft's track in front of or behind the aircraft as appropriate. For the case where aircraft are on parallel tracks, the ITP Distance is measured along the track of one of the aircraft using its calculated position and the point abeam the calculated position of the other aircraft. This measurement technique is similar to the method described in Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) section 5.4.2.6.4.

ITP separation minimum. Longitudinal separation minima based on distance using ADS-B IN-TRAIL PROCEDURE (ITP) to be inserted as in Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444).

Mixed equipage. An environment where all aircraft do not have the same set of avionics, e.g., ADS-B OUT capability.

Own aircraft. From the perspective of a flight crew, or of the ASSAP and CDTI functions used by that flight crew, the own aircraft is the ASA participant that carries that flight crew and those ASSAP and traffic display functions.

Performance requirements. Minimum requirements needed for the application to function properly under nominal (no fault) conditions, and are generally quantitative in nature.

Potentially blocking aircraft. Aircraft at the Intervening Flight Level whose ADS-B report data are available to the ITP aircraft. A Potentially Blocking aircraft that is less than the standard longitudinal separation minimum will prevent an aircraft from climbing through the intervening Flight level under normal operating conditions (without an ITP procedure).

Preceding aircraft. The aircraft ahead of the one performing the VSA application.

Procedural control. Term used to indicate that information derived from an ATS surveillance system is not required for the provision of air traffic control service.

Procedural separation. The separation used when providing procedural control.

Reference aircraft. One or two aircraft with valid ADS-B data that meet the ITP criteria and are identified to ATC by the ITP aircraft as part of the ITP clearance request.

Runway status indication (RSI). Runway Status Indications (RSIs) are provided if the flight crew should verify runway status prior to proceeding.

Safety requirement. A safety requirement is a risk mitigation means that when implemented will help the system meet the safety objective.

Secondary surveillance radar (SSR). A surveillance radar system which uses transmitters/receivers (interrogators) and transponders.

Separation. The minimum distance between aircraft allowed by regulations.

State (vector). An aircraft's current horizontal position, vertical position, horizontal velocity, vertical velocity, turn indication, and navigational accuracy and integrity.

Succeeding aircraft. The aircraft performing VSA application and maintaining own visual separation from the Preceding Aircraft.

Surveillance radar. Radar equipment used to determine the position of an aircraft in range and azimuth.

Target aircraft. A designated aircraft from which the IM aircraft achieves and/or maintains an assigned spacing goal.

Target level of safety (TLS). A generic term representing the level of risk which is considered acceptable in particular circumstances.

Track. (1) A sequence of reports from the ASSAP function that all pertain to the same traffic target. (2) Within the ASSAP function, a sequence of estimates of traffic target state that all pertain to the same traffic target.

Traffic display function. Appropriate flight deck tools and data to support the flight crew in the tasks of identifying runway and traffic status at or near the airport surface.

Traffic indication (TI). Traffic indications are provided by SURF-IA if there could be a collision hazard in the immediate future.

Traffic information. Information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision.

Traffic information service – broadcast (TIS-B). A function on ground systems that broadcasts an ADS-B-like message that includes current position information of aircraft/vehicles within its surveillance volume.

Traffic symbol. A depiction on the traffic display of an aircraft or vehicle other than the *own aircraft*.

1.3 REFERENCES

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Annex 2 — *Rules of the Air*

Annex 6 — *Operation of Aircraft*

- *Part I — International Commercial Air Transport — Aeroplanes*
- *Part II — International General Aviation — Aeroplanes*
- *Part III — International Operations — Helicopters*

Annex 10 — *Aeronautical Telecommunications,*

- *Volume I – Radio Navigation Aids*
- *Volume II – Communications procedures including those with PANS status*
- *Volume III – Communications Systems*
- *Volume IV – Surveillance Radar and Collision Avoidance Systems.*
- *Volume V – Aeronautical Radio Frequency Spectrum Utilization*

Annex 11 — *Air Traffic Services*

Annex 14 — *Aerodromes*

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Aeronautical Information Services Manual (Doc 8126) 6th edition, 2003

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SESAR ATM Operational Concept D3, DLM-0612-001-02-00a, September 2007

SESAR Master Plan D5, DLM-0710-001-01-00, April 2008

Federal Aviation Administration (FAA)

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Operational Role of Airborne Surveillance in Separating Traffic, FAA/EUROCONTROL AP23 D3 2008

Radio Technical Commission for Aeronautics (RTCA)/ European Organization for Civil Aviation Equipment (EUROCAE)

Minimum Operational Performance Standards (MOPS) for Aircraft Surveillance Applications (ASA) System, RTCA DO-317A / EUROCAE ED-194

Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness during Flight Operations (ATSA-AIRB), RTCA DO-319 / EUROCAE ED-164

Safety, Performance and Interoperability Requirements Document for Enhanced Visual Separation on Approach (ATSA-VSA), RTCA DO-314 / EUROCAE ED-160

Safety, Performance and Interoperability Requirements Document for ATSA-SURF Application, RTCA DO-322 / EUROCAE ED-165

Safety, Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ATSA-ITP) Application, RTCA DO-312 / EUROCAE ED-159

Safety Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA), RTCA DO-323

Safety, Performance and Interoperability Requirements Document for Airborne Spacing - Flight deck Interval Management (ASPA-FIM), RTCA DO-328 / EUROCAE ED-195

Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B), RTCA DO-260 / EUROCAE ED-102

Note. - It refers to ICAO Extended Squitter Version 0.

Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), RTCA DO-260A

Note. - It refers to ICAO Extended Squitter Version 1.

Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), RTCA DO-260B / EUROCAE ED-102A

Note. - It refers to ICAO Extended Squitter Version 2.

2 OVERVIEW OF AIRBORNE SURVEILLANCE APPLICATIONS (ASAs)

2.1 DESCRIPTION OF AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)

2.1.1 Overview

2.1.1.1 Automatic dependent surveillance broadcast (ADS-B) is recognized as one of the most important enablers of the ATM operational concept components, including traffic synchronization and conflict management (Report of the Eleventh Air Navigation Conference (Doc 9828)). ADS-B data (ADS-B OUT) is already used by some ground ATM systems and by some airborne ADS-B IN systems.

2.1.1.2 ADS-B is the broadcast by an aircraft of its position (latitude and longitude), altitude, velocity, aircraft identification and other information. ADS-B is dependent upon having a source of required positional accuracy (such as global navigation satellite system (GNSS) today) and requires information from other on-board systems. Every ADS-B message includes an indication of the quality of the position and velocity data. This allows recipients to determine whether the data is adequate to support the intended function.

2.1.1.3 Because ADS-B OUT information is broadcast, any suitable receiver can process the received messages. As a result, ADS-B supports both ground and ASAs. In ASAs, aircraft equipped with ADS-B IN receivers can process the data from surrounding ADS-B OUT equipped aircraft.

2.1.1.4 The global medium to support ADS-B is 1090 MHz extended squitters which are transmitted by SSR Mode S transponders. ADS-B has lesser impact on the 1090 MHz signal environment when compared to typical interrogation/reply mode used in systems like SSR, SSR Mode S or even airborne collision avoidance system (ACAS).

2.1.1.5 There are currently three different versions of ADS-B and hence ADS-B avionics with different levels of enhancement:

- a) Version 0 provides a basic ADS-B capability, with position integrity/accuracy provided by a parameter called navigation uncertainty category (NUC). This was the initial version of ADS-B and there are a variety of Version 0 installations; typically only those ADS-B version 0 installations complying with EASA AMC 20-24 are approved for use in ATC separation applications;
- b) Version 1 provides, among other things, separate accuracy and integrity parameters which replace NUC - navigation integrity category (NIC), navigation accuracy category (NAC) and surveillance integrity level (SIL); also, a new message provides Target State and Status data; and

- c) Version 2 provides, among other things, a renaming and new definition for source integrity level (SIL); includes several new fields, such as system design assurance (SDA) and Geometric Vertical Accuracy; removes vertical information from the NIC, NAC, and SIL parameters; provides improved support of surface operations through changes to NIC encoding; supports non-diversity antenna options for smaller (general aviation) aircraft plus various other fixes/improvements. Version 2 equipment is required by European and U.S. ADS-B mandates.

Note. — The formats and update rates of each register are specified in the Technical Provisions for Mode S Services and Extended Squitter (Doc 9871), as well as RTCA/EUROCAE documents in the DO-260x / ED-102y series.

2.1.2 Interactions of ADS-B and airborne collision avoidance system (ACAS)

2.1.2.1 ACAS is an airborne system based on SSR technology, which provides a last resort, safety net function. Its purpose is to prevent collision when the primary means of separation provision has failed or no ATC separation was required (e.g. visual flight rules (VFR) flights in uncontrolled airspace).

2.1.2.2 It is underlined that the basic ASAs do not affect the separation provision by ATC. As a consequence, it is noted that the main purpose of ACAS is maintained and its independence is preserved.

2.1.2.3 Hybrid surveillance is an optional technique within the ACAS surveillance function which takes advantage of passive acquisition of ADS-B squitters to reduce the number of active interrogations. This technique forms part of ACAS SARPS and is specified in Annex 10, Volume IV.

Note. – The Airborne Collision Avoidance System (ACAS) Manual (Doc 9863) contains operational and technical provisions on ACAS, in particular on hybrid surveillance.

2.1.2.4 In addition, airborne surveillance based on ADS-B can provide information on more traffic or provide greater coverage than ACAS, particularly in dense areas where ACAS interrogations are subject to additional constraints to limit interference.

2.1.2.5 The evolution of ASAs (see 2.3) shows collision avoidance systems evolving from existing ACAS, enhanced with optional and additional features like hybrid surveillance to a new collision avoidance system designed to better accommodate future ATM operations foreseen in the global ATM operational concept.

2.1.3 The limitations of ADS-B

2.1.3.1 There are known limitations of ADS-B. It depends on proper equipage of each aircraft. This requirement implies a process for installation and certification of the navigation source capable of supplying information (e.g. position/velocity) along with the necessary indication of accuracy/integrity of that information.

2.1.3.2 Current implementations rely solely on GNSS for horizontal position and velocity. As a result, outages may be experienced when the performance or geometry of the satellite constellation is not adequate to provide the surveillance performance required for a given application. Note that future systems that integrate GNSS information with data from other navigation sensors should overcome this limitation. In addition, the implementation of supplemental systems, such as satellite-based augmentation systems (SBAS) and ground-based augmentation systems (GBAS) should improve GNSS performance.

2.1.3.3 The broadcast information may need to be validated against errors. The requirements for validation only exist for early versions (Version 0 and Version 1) to ensure the surveillance data are provided with the required performance and quality. There is no validation requirement for Version 2. The requirements for validation will differ for each ASA.

2.1.3.4 The on-board architecture is discussed in 2.5. Unequipped aircraft considerations are discussed in 2.7. Partial equipage is also discussed in Chapter 4 with respect to Controller Procedures and Chapter 5 Flight Crew Procedures.

Note 1. —ADS-B SARPS on 1090 MHz are in Annex 10, Volume IV and Technical Provisions for Mode S Services and Extended Squitter (Doc 9871). Additional guidance material on ADS-B is described in the Aeronautical Surveillance Manual (Doc 9924).

Note 2. —For more details, refer to the MOPS (RTCA-DO260-B / EUROCAE ED102-A) and RTCA DO-317A / EUROCAE ED-194.

2.2 ASAs – CONCEPT

2.2.1 Introduction

2.2.1.1 This section provides overall descriptions of ASAs already existing or foreseen in the short term. An implementation timeline for each application is given in 2.3 – **EVOLUTION OF ASAs**. Operational procedures are given in Chapter 4 – Controller procedures and Chapter 5 – Flight crew procedures as applicable.

2.2.2 High level description of basic ASAs

2.2.2.1 Basic Airborne Situational Awareness (AIRB)

2.2.2.1.1 During flight operations, flight crews should, to the greatest extent possible, maintain a general awareness of the environment in which they are operating. In particular, flight crews must attempt to maintain traffic situational awareness.

2.2.2.1.2 Traffic situational awareness is an asset in terms of safety and flight efficiency. During flight operations, flight crews use all available sources of information to build their mental traffic picture by scanning for traffic out the window and listening to radio communications. However, these sources have some limitations. Visual acquisition of surrounding traffic is not usually possible in reduced visibility and can be difficult even in good conditions. Radio communications may only provide a partial picture (e.g. different VHF channels used in the same airspace for departures and arrivals).

2.2.2.1.3 The AIRB application aims at enhancing flight crews' traffic situational awareness through the provision of an appropriate on-board graphical display of surrounding airborne traffic transmitting ADS-B data which are qualified for AIRB (i.e. referred to as AIRB traffic) relative to their aircraft together with supporting information on that traffic. It is expected that this enhanced traffic situational awareness will contribute to improve flight safety and flight operations.

2.2.2.1.4 The AIRB application will supplement the other available sources of information (i.e. out the window and/or radio communication) on AIRB traffic and is expected to support the rapid and accurate mental integration of visual and radio communication information and help the flight crew to address the limitations of these sources.

2.2.2.2 Visual Separation on Approach (VSA)

2.2.2.2.1 Clearances to maintain own visual separation on approach are used in current operations. The objective of the VSA application is to allow the flight crew of the succeeding aircraft to safely perform an approach procedure while maintaining own visual separation from the preceding aircraft. This is applicable for both single and parallel runway operations so that it is more efficient, safer, and on a more regular basis.

Note. - In the context of this document, the aircraft ahead is referred to as the preceding aircraft and the aircraft performing the application and maintaining own visual separation from the preceding aircraft is referred to as the succeeding aircraft.

2.2.2.2.2 The traffic display will support flight crews in the visual search of the preceding aircraft in addition to the traffic information provided by the air traffic controller. Also the traffic display will support flight crews in visually maintaining a safe distance from the preceding aircraft.

Note 1. — In the context of this document, traffic display is consistently used as a graphical cockpit display of traffic information, often referred as a CDTI.

Note 2. — In the context of this document, the term flight crew refers to one or more pilots

2.2.2.2.3 The air traffic controller will provide traffic information to the flight crew of the succeeding aircraft as in current operations. On reception of this traffic information, the flight crew of an aircraft suitably equipped to support the VSA application, will look both out the window and at the traffic display to identify the preceding aircraft. If the traffic display depicts a traffic corresponding to the preceding aircraft and if the flight crew assesses that the traffic display, air traffic controller and visual information are consistent, the flight crew can then decide to use the VSA application. If there is no corresponding and qualified displayed traffic or if the traffic display information is not assessed consistent with the other sources of information, the flight crew must not use the traffic display as a support and must apply current visual procedures (see Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444).

2.2.2.2.4 Information provided by the traffic display is not a substitute to visual information and flight crews must maintain continuous visual contact with the preceding aircraft throughout the visual approach, even when using VSA application.

2.2.2.3 Basic Surface Situation Awareness (SURF)

2.2.2.3.1 The SURF application is for use by the flight crew to improve situational awareness of surrounding aircraft and ground vehicles operating in the vicinity of the aerodrome, when operating on the aerodrome surface, during final approach and landing, and during take-off. It provides the flight crew with a display of surrounding traffic position and identity that, together with the own aircraft position overlaid on a map of the aerodrome, improves the flight crew traffic situational awareness. The information provided by the display is to supplement the normal out the window scan to enhance traffic situational awareness on the aerodrome surface for both taxiway and runway operations. The supplemental information provided by this application may be utilized whenever aerodrome surface operations are conducted.

Note. - SURF represents the ASA providing situational awareness in support of airport surface operations as well as nearby traffic departing or landing at that airport. The use of indications and alerts are outside the scope of this SURF application, but are described in 2.2.3.4.

2.2.2.3.2 The enhanced situational awareness provided by the SURF application will improve the safety of aerodrome surface operations, in particular at taxiway and runway intersections, and for aircraft landing and taking off. A secondary outcome is to enhance taxi efficiency through improved traffic situational awareness during operations such as conditional taxi clearances, especially during low visibility conditions, night operations or at an aerodrome unfamiliar to the flight crew. The application is also expected to decrease flight crew and air traffic controller workload by reducing requests for repeated information with respect to surrounding traffic.

2.2.2.3.3 The SURF application does not modify current pilot and air traffic controller responsibilities or the use of visual information, as the primary basis of aerodrome surface operations. As in today's operations, the flight crew must continue to maintain visual contact with other traffic, as well as looking out the window to verify their position on the aerodrome surface and should not rely solely on displayed traffic information. Surface navigation and own separation must be based on visual information and radio communications using the traffic display only as an aid to situational awareness.

2.2.2.3.4 In order to enhance and maximize the benefits of SURF deployment, traffic information service –broadcast (TIS-B) may substitute for ADS-B OUT for unequipped aircraft and ground vehicles to provide a complete picture of nearby traffic. However, TIS-B is not considered to be a requirement for the deployment of SURF and mixed equipage ADS-B OUT environments.

Note. - TIS-B is described in 2.5.1.

2.2.2.4 In -Trail Procedure (ITP)

2.2.2.4.1 In many areas of the world where procedural separation is being applied, the combination of current separation standards and local traffic characteristics often restrict desired flight level changes. Many times these restrictions are a result of potential traffic conflicts at altitudes between the aircraft's current position and the desired altitude. ITP is meant to enable aircraft that desire flight level changes in procedural airspace to achieve these changes on a more frequent basis, thus improving flight efficiency and safety. When specified criteria are met, ITP achieves this objective by permitting a climb-through or descend-through manoeuvre past reference aircraft, in compliance with an assumed distance-based longitudinal separation minimum (the ITP separation minimum) during the manoeuvre. This assumed separation standard is known as "longitudinal separation minima based on distance using ADS-B In-Trail Procedure (ITP)".

2.2.2.4.2 Flight level changes can significantly improve flight efficiency by reducing fuel use. This is because there is no single flight level that provides an optimum cruising flight level over the substantial period of time that aircraft spend in procedural airspace. As the optimum, no-wind flight level increases throughout the flight (as fuel is burned and aircraft weight is reduced); the aircraft would need to climb to maintain optimum cruise efficiency. Additionally, higher or lower flight levels may be more efficient because of more favorable winds.

2.2.2.4.3 In addition to efficiency improvements, flight level changes can increase safety when turbulent conditions exist at the current flight level. A flight level change for this reason would reduce the risk of injury to passengers or cabin crew, and increase passenger comfort.

2.2.2.4.4 ITP does not change the responsibilities of either flight crews or air traffic controllers. The flight crew continues to be responsible for the operation of the aircraft and conformance to its clearance, and the air traffic controller continues to be responsible for separation and the issuance of clearances throughout the ITP application. ITP does include new tasks for the flight crew in determining that the specified criteria are met. ITP does not require the crew to monitor or maintain spacing to any aircraft during the ITP manoeuvre however the ability to monitor spacing is recommended. The safety of the ITP manoeuvre is attained by satisfying the initial conditions which include the ITP distance, ground speed differential, vertical speed, and the vertical distance for the flight level change. Once the ITP manoeuvre is begun, the target level of safety (TLS) is assured by the crew's compliance with the flight level change clearance.

Note. - For the complete list of ITP assumptions, refer to RTCA DO-312 / EUROCAE ED-159 and their supplement - Safety Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ATSA-ITP) Application.

2.2.3 Description of advanced ASAs

Note. - This section provides descriptive material on ASAs for which some development work has been done by one of the ICAO States; one or more of these applications may be included in future ADS-B IN avionics standards. The inclusion of this material in this document is for informational purposes only and it does not constitute endorsement or guidance by ICAO or any ICAO States.

2.2.3.1 CDTI Assisted Visual Separation (CAVS)

2.2.3.1.1 CAVS is similar to the VSA application. Both applications are designed to provide the flight crew with enhanced situation awareness while performing own visual separation on approach. CAVS and VSA functions can only be used in visual meteorological conditions (VMC). With CAVS, the flight crew is still required to visually acquire the preceding aircraft, during approach procedures. However, after visual contact is made, the flight crew will cross-check the information on the cockpit display of traffic information (CDTI) with what they see out of the window. Once the preceding aircraft is identified on the CDTI, the flight crew is allowed to use the CDTI to continue approach procedures even if visual contact is temporarily lost (e.g. lost in the lights at night).

2.2.3.1.2 CAVS was originally developed and certified within the U.S. A key CAVS limitation is that the CDTI is not approved as a substitute for visual contact of the preceding aircraft when less than 4.6 km (2.5 NM) in trail. Therefore, the CAVS equipment must provide a cockpit indication when the range to preceding aircraft becomes less than 4.6 km (2.5 NM), and/or if the ADS-B information from the preceding aircraft do not meet quality requirements during the approach operation.

2.2.3.1.3 RTCA/EUROCAE plan to add CAVS to the ASA MOPS (RTCA DO-317x / EUROCAE ED-194x).

2.2.3.2 Interval Management (IM)

2.2.3.2.1 IM is defined as the overall system that enables improved means for managing traffic flows and aircraft spacing.

2.2.3.2.2 This includes both the use of ground and airborne tools as follows:

- a) Ground tools/capabilities that assist the air traffic controller in evaluating the traffic picture and determining appropriate clearances to merge and space aircraft efficiently and safely, and allow the air traffic controller to issue IM clearance; and
- b) Airborne tools that allow the flight crew to conform to the IM clearance. These airborne capabilities are referred as the flight-deck based interval management (FIM) capabilities.

2.2.3.2.3 The objective of the IM application is for the IM aircraft to achieve and/or maintain an assigned spacing goal relative to one designated aircraft, referred as target aircraft with the provision of guidance within the flight deck to enable the flight crew to actively manage the spacing relative to the target aircraft.

2.2.3.2.4 During IM Operations, the air traffic controller retains responsibility for separation. Compared with current operations, the air traffic controller is relieved of the provision of speed and turn clearance to manage traffic by assigning an interval to the flight crew.

2.2.3.2.5 IM operations can occur in a variety of environments and situations and can be used during all phases of flight (i.e. departure, en-route and arrival phases).

2.2.3.2.6 Potential benefits of IM operations include:

- a) Early speed advisories removing requirement for later path-lengthening;
- b) Consistent and low variance spacing between paired aircraft (e.g., at the entry to an arrival procedure and on final approach). More precise spacing can allow for higher throughput and more efficient aircraft operations;
- c) Continuous descent operations (CDO) in higher density environments than in current operations;
- d) Reduced ATC instructions due to the need to communicate fewer speed and vector instructions; and
- e) When an arrival manager (AMAN) is used, the IM procedure will support more efficient aircraft operations for FIM-equipped aircraft.

2.2.3.2.7 Air traffic controllers and flight crews will be provided with new procedures and a new phraseology for IM operations. These provisions will be developed after the IM application is fully defined.

2.2.3.2.8 The air traffic controller chooses to use IM operations to manage the interval between aircraft when the aircraft need to be spaced closely together in an orderly manner or their timing synchronized. This is accomplished by the air traffic controller providing a clearance to the IM aircraft which includes the assigned interval. As IM uses only a limited number of degrees of freedom to achieve the assigned interval, IM may not work in all conditions. A combination of air traffic controller judgment and ATC automation will be needed to determine the conditions where IM can be completed successfully. The assigned interval can be defined in time or distance.

2.2.3.2.9 The flight crew is responsible for identifying the target aircraft and to implement the IM clearance. While some IM clearances will keep the IM aircraft on its current route and result only in speed management, other clearances may include a turn for path lengthening or shortening.

2.2.3.2.10 As in today's operations the air traffic controller is responsible for:

- a) ensuring separation; and
- b) expediting and maintaining the orderly flow of traffic, for example by:
 - 1) building a sequence of traffic; and
 - 2) anticipating and delivering required spacing based on altitude, aircraft performance, and environmental conditions.

2.2.3.2.11 ASPA-FIM Safety, Performance and Interoperability Requirements document RTCA DO-328 / EUROCAE ED-195 have been published in 2011. RTCA/EUROCAE plan to develop FIM MOPS.

2.2.3.3 Traffic Situational Awareness with Alerts (TSAA)

2.2.3.3.1 Traffic situational awareness with alerts (TSAA) is an ASA that reduces the number of mid-air collisions and near mid-air collisions involving general aviation aircraft. TSAA will provide voice annunciations to flight crews to draw attention to alerted traffic and will add visual cues to the underlying basic traffic situation awareness application (e.g. AIRB) in installations with a traffic display. The TSAA application will use ADS-B information to provide the flight crew with indications and alerts of nearby aircraft in support of their see-and-avoid responsibility. The TSAA is envisioned for use in instrument meteorological conditions (IMC) and VMC by aircraft operating under instrument flight rules (IFR) and VFR.

2.2.3.3.2 The TSAA application will be installed on and provide alerts to flight crews of airplanes and rotorcraft not equipped with ACAS.

2.2.3.3.3 The TSAA application will not change the roles or responsibilities of flight crews who remain responsible for the safe and efficient control and navigation of their aircraft in all airspace.

2.2.3.3.4 The TSAA application does not provide alerts on the surface.

Note. - These provisions of alerts during surface operations are covered by SURF-IA.

2.2.3.3.5 TSAA alerts will not be directive and are therefore similar to traffic advisories (TA) of ACAS, though based on ADS-B information.

2.2.3.3.6 The flight crew will only use the TSAA application as a supplement to existing traffic avoidance procedures (e.g., see-and-avoid, radio communications). The flight crew will not undertake any manoeuvres relative to another aircraft based solely on the TSAA alert or indication.

2.2.3.3.7 RTCA/EUROCAE plan to add TSAA to the ASA MOPS (RTCA DO-317x / EUROCAE ED-194x).

2.2.3.4 Enhanced traffic situational awareness on the airport surface with indications and alerts (SURF IA)

2.2.3.4.1 The SURF IA application intends to help decrease the likelihood and severity of runway incursions and collisions on or near the airport surface by:

- a) increasing pilot awareness of runway safety-related traffic information;
- b) increasing the likelihood that this information is correctly processed by the flight crew in a timely manner; and
- c) facilitating an appropriate compensatory response by the crew once an error has occurred.

2.2.3.4.2 The SURF IA application adds two distinct components to the SURF application:

- a) SURF IA indications, which are provided for normal operational situations where potential collision hazard exists; and
- b) SURF IA alerts, which are provided for non-normal operational situations where collision hazard exists or a collision appears imminent.

2.2.3.4.3 SURF IA indications identify the runway traffic status and traffic as relevant to own aircraft operations under normal operational conditions to improve situation awareness beyond the sole display of traffic information. Two types of indications can be triggered:

- a) Runway Status Indications (RSIs) are provided if the flight crew should verify runway status prior to proceeding. A collision hazard could result if own aircraft were to enter a runway with an RSI, takeoff when own aircraft is in position and hold on a runway with an RSI, or land when own aircraft is lined up on approach for a runway with an RSI. The causality of the runway status must be clearly distinguishable. The absence of an RSI does not alleviate pilots from verifying the runway status prior to proceeding; and
- b) Traffic indications are provided if there could be a collision hazard in the immediate future. Traffic indications increase the flight crew's situational awareness about traffic of interest that could affect runway safety.

2.2.3.4.4 SURF IA indications are expected to have the greatest benefits in the proximity of a runway while approaching, entering, crossing, or holding on a runway or during the early phases of an arrival to a runway when the flight crew has time to scan the traffic display.

2.2.3.4.5 SURF IA alerts are intended to draw the flight crew's attention to the traffic situation depicted on the traffic display and by doing so help prevent collisions between two aircraft or an aircraft and a vehicle. SURF IA includes two alert levels:

- a) Cautions require immediate flight crew awareness and require subsequent flight crew response. The flight crew may not respond to the caution by a compensatory action; they may, for example, search for additional information; and
- b) Warnings require immediate flight crew awareness and immediate flight crew response.

2.2.3.4.6 SURF IA alerts are expected to have greatest benefits in the early stages of a take-off or late in the approach or landing when flight crew attention is focused more out the window and therefore are less likely to observe the traffic display or any indications.

2.2.3.4.7 Current phraseology will be used for the SURF IA operations. No new phraseology is foreseen to be needed.

2.2.3.4.8 Controller procedures and responsibilities will not change with the SURF IA application and no changes in the basic responsibilities for flight crews are required.

2.2.3.4.9 The flight crew may scan their display for SURF IA indications or alerts at any time during surface operations as deemed safe by the crew (e.g. crossing a runway, prior to initiating the take-off roll, etc.). SURF IA indications are supplemental information to visual information which is the primary means of navigation. After a caution alert occurs, the flight crew uses all available information including radio communication, visual contact, and the SURF IA display to quickly assess the situation, determine the safety risk and appropriate action, and if deemed necessary, initiate the appropriate response. After a warning alert, the flight crew responds immediately to the warning as specified by their approved procedures or flight manual while still considering the overall safety of the situation.

Note. - These alerts are not directive, so the flight crew response is to assess the situation and to determine if additional action is required.

2.2.3.4.10 SURF IA Safety, Performance and Interoperability Requirements document (RTCA DO-323) was published by RTCA in 2010. Before progressing further towards implementation, a few issues to resolve have been identified (e.g. determination of mitigations to address the issue that ADS-B OUT rule compliant avionics may not provide sufficient surveillance accuracy needed for the SURF IA application, investigation of the issue with line of sight blockage and drop-outs resulting from multi path interference, etc.).

2.2.4 Description of other future applications

2.2.4.1 Some future applications are foreseen that rely on the delegation of separation responsibility to the flight crew. The flight crew ensure temporarily separation from suitably equipped, designated aircraft as communicated in new clearances, which relieves the air traffic controller from the responsibility for separation between these aircraft. Airborne separation minima have to be defined to support these future applications.

2.2.4.2 Other future applications are foreseen for airborne self-separation. Airborne self-separation occurs when the flight crew ensures separation of their aircraft from all surrounding traffic. The air traffic controller has no responsibility for separation. First applications will be in oceanic airspace and low density airspace.

2.2.4.3 Because of the strong impact on air traffic controller and flight crew responsibility, provisions for these applications are expected to require modifications to ICAO Annexes. No RTCA/ EUROCAE documents exist. These applications are still under research and development.

Note. - For more details, refer to modules B2-85: Airborne Separation (ASEP) and B3-85: Airborne Self-Separation (SSEP) contained in the Report of the 12th Air Navigation Conference.

2.3 EVOLUTION OF ASAs

2.3.1 In the preparation of the 12th Air Navigation Conference (November 2012), ICAO developed a new approach for the global air navigation plan (GANP) with new items such as, the introduction of technology roadmaps (Communication, Navigation, Surveillance, Avionics) as well as aviation system block upgrades (ASBUs).

2.3.2 The main changes from today's operations are the migration of functionality from ground to air including the increased capability of flight crew to be aware of surrounding traffic and to introduce new modes of aircraft separation based upon ADS-B IN, as well as an increasing choice of surveillance techniques for ground surveillance.

2.3.3 The ASBUs modules provide information on ADS-B Standards, both for ADS-B OUT (B0-84: Initial capability for ground surveillance) and for ADS-B IN which are the key enablers for airborne surveillance. The evolution is described in specific threads related to ASAs (B0-85: Air traffic situational awareness (ATSA) to B3-85: Airborne self-separation (SSEP)) as well as airborne collision avoidance (B0-101: ACAS improvements and B2-101: new collision avoidance system).

2.3.4 Airborne separation applications which involve separation minima less than current radar separation standards are expected to require commensurate changes in the Airborne Collision Avoidance System (ACAS). Therefore, implementation of various airborne separations applications are expected to be dependent on the availability for implementation of new collision avoidance system.

2.3.5 For surface applications, it is pointed out that SURF and SURF-IA (B1-75: Enhanced safety and efficiency of surface operations – SURF, SURF-IA and enhanced vision systems (EVS)) are expected to complement A-SMGCS level 1&2 (B0-75: Safety and efficiency of surface operations (A-SMGCS Level 1-2)) and A-SMGCS level 3&4 (B2-75: Optimized surface routing and safety benefits (A-SMGCS Level 3-4 and synthetic vision systems (SVS))).

2.4 VALIDATION OF ASAs

2.4.1 Several validation methodologies have been used for the applications described in section 2.2.2:

- a) model-based simulations to support operational benefits evaluation and impact assessment;
- b) real-time simulations which focus on both the cockpit perspective and ATC perspective, including the air traffic controller / flight crew cooperation aspect and acceptability issues; and
- c) live operational evaluations (trials) in different traffic density environments (with different ADS-B OUT equipage mix).

2.4.2 Initial EUROCONTROL validation activities within the CRISTAL-ATSAW project were conducted for the AIRB, VSA and SURF. The main outcomes were as follows:

- a) The ADS-B traffic display contributes to a better traffic situational awareness of the flight crew, it could decrease their stress and effort while analyzing the traffic situation during flight and surface operations;
- b) The ADS-B traffic display also contributes to better air traffic controller / flight crew cooperation thanks to the improved pilots' understanding of the traffic situation;
- c) If appropriately used, the ADS-B traffic display should not have a major impact on the pilots' workload nor on the air traffic controllers' activity; and
- d) For VSA, phraseology for traffic identification needs to be defined (use of third-party aircraft identification in voice communications) considering operational goals, air traffic controller /flight crew workload issues, and possible radiotelephony communication increases.

2.4.3 Initial EUROCONTROL validation activities within the CRISTAL-ITP project demonstrated the feasibility and potential benefits of the In-Trail Procedure (ITP).

2.4.4 The FAA initiated an operational evaluation (trial) of ITP in the Oakland Oceanic FIR in August 2011 with equipped aircraft from a pioneer airline.

2.4.5 The FAA is working with New Zealand and Fiji to expand this trial to the Auckland Oceanic FIR and the Nadi Oceanic FIR by the end of 2012. FAA is also in discussions with at least one other airline interested in joining this operational evaluation.

2.4.6 Under EUROCONTROL ATSAW pioneer project, activities are underway in the Reykjavik and Shanwick FIRs to further assess ITP feasibility and AIRB benefits with revenue aircraft in daily operations.

2.5 ARCHITECTURE

2.5.1 Functional architecture

2.5.1.1 The functional architecture described in this section provides information on necessary systems to implement the ASA capability. The airborne surveillance system has three components as follows:

- a) Subsystems for ASA transmit participant;
- b) Subsystems for ASA receive participant; and
- c) Ground systems supporting TIS-B.

Note 1. - Two of them, a) and b), are essential to implement air-to-air surveillance function as indicated in Figure 2-1. Another element, c), may be added to support air-to-air surveillance.

Note 2. - 1090 MHz extended squitter is the globally accepted system. UAT and VDL 4 are regional systems which have been included for completeness.

2.5.1.2 The subsystems for ASA transmit participant are used to support the surveillance function by transmitting signals to provide surveillance data such as aircrafts' position (latitude and longitude), altitude, velocity, aircraft identification and other information. The following subsystems are used for the transmit participant:

- a) ADS-B transmit subsystem to generate and transmit the ADS-B signals; and
- b) Data sources on transmitting aircraft to provide surveillance data.

2.5.1.3 On-board equipment to implement subsystems for transmit participant are listed in the table below.

Subsystem	Function	Equipment
ADS-B transmit subsystem	To transmit ADS-B signal with 1090 MHz extended squitter	ATC transponder with 1090 MHz extended squitter function
	To transmit ADS-B signal with VDL mode 4	VDL mode 4 transceiver
	To transmit ADS-B signal with UAT	UAT transceiver
On-board data source	To provide the aircraft position and speed	GNSS receiver and/or FMS with INS and other navigation sensors
	To provide the altitude and altitude rate	Air data sensors and air data computer
	To provide identification data	FMS or direct input by pilot
	To synchronize with common time base	GNSS receiver or on-board time base synchronized to GNSS

Table 2-1. - On-board equipment for ASA transmit participant

2.5.1.4 The subsystems for ASA receive participant are used to support the surveillance function by receiving signals and decoding surveillance data, and to provide information for flight crew with processing surveillance data appropriately for intended application. The following subsystems are used for the receive participant:

- a) ADS-B/TIS-B receive subsystem to receive the signals and to decode the surveillance messages for extracting surveillance data;
- b) Airborne surveillance and separation assurance processing (ASSAP) function to process received surveillance data on other aircraft and if required referring surveillance data to own aircraft data for the intended application;
- c) Data sources on receiving aircraft to provide surveillance data measured by equipment on-board own aircraft or any other data required for intended application; and
- d) Human Machine Interface (HMI), to provide display and control means for flight crew.

2.5.1.5 On-board equipment to implement subsystems for receive participant are listed in the table below.

Subsystem	Function	Equipment
ADS-B/TIS-B receive subsystem	To receive ADS-B/TIS-B signals with 1090 MHz extended squitter	Modified ACAS or independent receiver with antenna for 1090 MHz extended squitter
	To receive ADS-B/TIS-B signals with VDL mode 4	VDL mode 4 transceiver with antenna
	To receive ADS-B/TIS-B signals with UAT	UAT transceiver with antenna
ASSAP	To support for surveillance data processing and for airborne surveillance assurance processing	Computer in modified ACAS or in independent receiver for 1090 MHz extended squitter
On-board data sources	To provide the aircraft position and speed	GNSS receiver and/or FMS with INS and other navigation sensors
	To provide the altitude and altitude rate	Air data sensors and air data computer
	To measure the data for independent validation	Modified ACAS with output for independent surveillance data
	To synchronize to common time base	GNSS receiver or on-board time base synchronized to GNSS
HMI	To provide the display for situational awareness	Traffic display
	To provide control means or dialogue method	Control panel, modified CDU for FMS or other suitable options

Table 2-2. On board equipment for ASA receive participant

2.5.1.6 The ground systems can be used to support the airborne surveillance function by providing supplemental signals with encoding surveillance data for TIS-B. Following subsystems are used for the ground receive participant:

- TIS-B transmit subsystem to generate and transmit the TIS-B messages;
- TIS-B surveillance processing and distribution function to generate TIS-B messages by choosing and encoding the surveillance data to be transmitted; and
- Surveillance sources on the ground to measure and to provide surveillance data.

2.5.1.7 The equipment to implement ground systems are listed in the table below.

Subsystem	Function	Equipment
TIS-B transmit subsystem	To transmit TIS-B signal with 1090 MHz extended squitter	1090 MHz extended squitter transmitter
	To transmit TIS-B signal with VDL mode 4	VDL mode 4 transceiver
	To transmit TIS-B signal with UAT signals	UAT transceiver for ground
TIS-B surveillance processing and distribution	To generate TIS-B messages	Surveillance data processor to support transmitter or transceivers above in this table
Surveillance sources	To provide the surveillance data with synchronized to common time base	SSR, WAM, MLAT, ADS-B by other media or any other appropriate surveillance sources

Table 2-3. - Ground systems

2.5.1.8 The interactions between the subsystem for ASAs and other systems are described in Figure 2-2 with the following characteristics:

- a) GNSS provides the time base to synchronize various systems in addition to its positioning service;
- b) Data link communication between air traffic controllers and flight crews will support ASAs to reduce communication latency in remote airspaces. The addressed data link message also reduces the misrecognition by unintended receiver of ATC instruction. Voice communications between air traffic controllers and flight crews will continue to support some ASAs;
- c) HMI provides organized means of operation for ASAs with surveillance and communication data for flight crew (and air traffic controller when necessary). HMI in flight deck may also provide the flight crew with control function on the data feeding from on-board surveillance / communication systems to flight control system;
- d) Independent cooperative surveillance systems such as ACAS, Wide Area Multilateration (WAM) and SSR can provide surveillance data to validate or to supplement the surveillance data obtained with dependent surveillance system such as ADS-B. ACAS surveillance data can be used to validate ADS-B data on the airborne side while WAM / Multilateration (MLAT) and/or SSR can be used to validate ADS-B data on the ground side; and
- e) Other aircraft without compatible ADS-B are covered by other ground surveillance. The surveillance data on these unequipped aircraft are processed and provided via TIS-B to on-board systems.

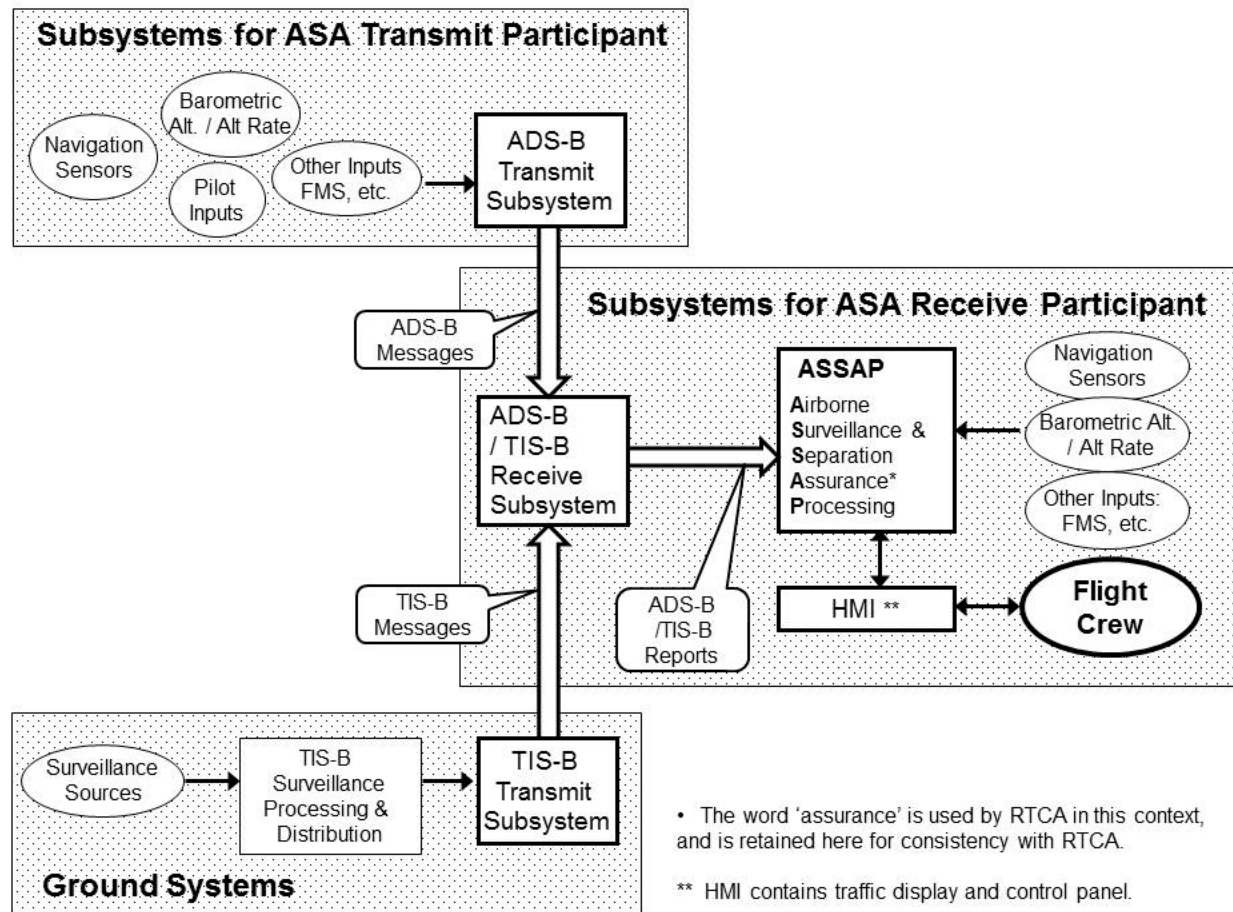
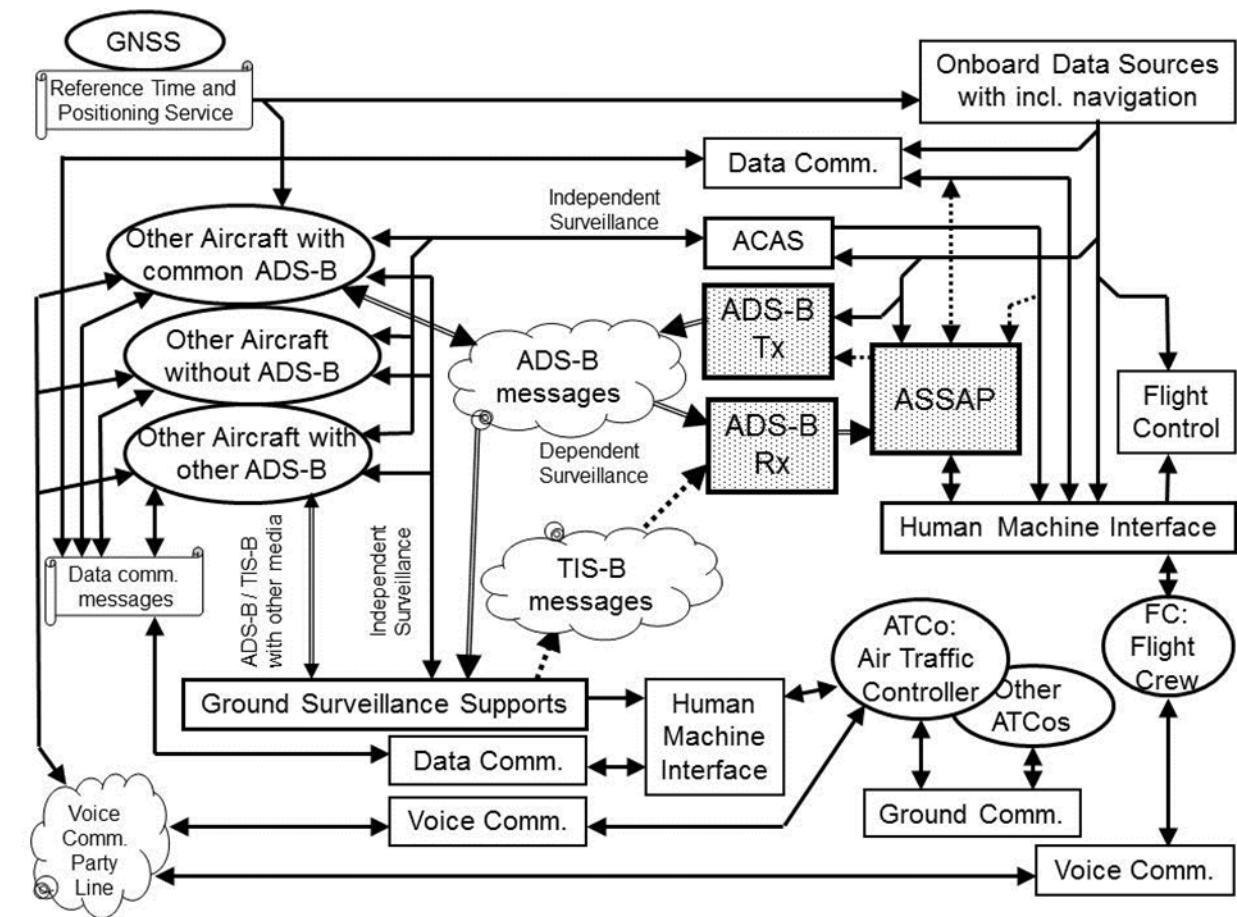


Figure 2-1. Airborne surveillance functional diagram



Note. - Dotted lines represent optional or provisional links.

Figure 2-2. Interactions with other systems

2.5.2 Description of cockpit solutions

2.5.2.1 The implementation of ASAs is via two primary means:

- a) Implementations which are typically provided by the aircraft manufacturer and integrate the traffic display and some of its key controls into the flight deck primary field of view (± 15 degrees from the pilot's normal line-of-sight). These solutions are referred to integrated display solutions; and
- b) Implementations where the traffic display is provided on an auxiliary display or displays. These solutions are referred to auxiliary display solutions.

2.5.2.2 Integrated display solutions

2.5.2.2.1 Integrated display solutions provide traffic information on a single display for:

- a) Collision avoidance; and
- b) ASAs.

2.5.2.2.2 This single display is usually the one already used for collision avoidance, i.e., ACAS traffic display.

2.5.2.2.3 Benefits of integrated display solutions are:

- a) Graphical correlation of ACAS and ADS-B traffic information: reduced mental effort for the flight crew;
- b) Seamless workflow for flight crew while handling ACAS and ADS-B traffic information: immediate reversion to ACAS Standard Operating Procedures (SOPs) when a traffic advisory (TA) or a resolution advisory (RA) is triggered;
- c) Display in the primary field of view: improves ease of utilization of applications and may limit head-down time; and
- d) Control of key features in the primary field of view, such as traffic selector.

2.5.2.3 Auxiliary display solutions

2.5.2.3.1 Auxiliary display solutions provide traffic information for ASAs on an auxiliary display, which can be an electronic flight bag (EFB). It means that monitoring of the traffic for collision avoidance (both for TAs and RAs) remains on the currently used flight deck displays, while ASAs use the auxiliary displays on either side of the flight deck. ASAs meeting the latest ADS-B IN avionics standards integrate ACAS and ADS-B IN information on these auxiliary displays for traffic awareness only.

2.5.2.3.2 Limitations of auxiliary display solutions may include:

- a) Restricted use operational approval due to display location not being in the primary field of view when intended function includes more critical functionality than situational awareness;
- b) VMC restrictions due to failure mode analysis and procedural use requirements which are more critical during IMC operations; and
- c) Human factors evaluation on the effective location of the displayed information and resulting workload for the flight crew.

2.5.2.3.3 Benefits of auxiliary display solutions are:

- a) Cost effectiveness: As integrated solutions require the latest generation flight deck displays (e.g. liquid crystal display) and related avionics, this may be the only viable option for some older aircraft with cathode ray tube (CRT) displays; and
- b) Auxiliary display solutions are available from a variety of manufacturers, with many choices to meet different operational needs.

2.6 OPERATIONAL ENVIRONMENTS AND BENEFITS

2.6.1 Operational environment for AIRB

2.6.1.1 The AIRB application is defined to be used by aircraft operating in any airspace both controlled and uncontrolled (i.e. class A to G), in which the traffic density can range from low to very high. The application is relevant to both IFR and VFR traffic and applicable from the runway departure on take-off until touchdown on landing.

2.6.1.2 There are no specific requirements on ground systems when AIRB is used; from communication, navigation and surveillance perspectives the application can be used in the exact same environments as the existing current operations.

2.6.1.3 The AIRB application can be conducted under both VMC and IMC.

2.6.2 Operational environment for VSA

2.6.2.1 The VSA application is defined to support aircraft performing approach and landing operations in VMC. VSA is applicable for all types of runway configuration: single runway, independent parallel runways, dependent parallel runways and closely-spaced parallel runways.

2.6.2.2 There are no new requirements on ground systems when VSA is used; from communication, navigation and surveillance perspectives the application can be used in the exact same environments as the existing current operations.

2.6.2.3 The VSA application is defined to be used in airspace of any traffic density.

2.6.3 Operational environment for SURF

2.6.3.1 The SURF application is defined to be used by aircraft conducting operations on or near the aerodrome surface, and is for use at the range of aerodromes as specified by ICAO Annex 14, Section 3.1.10, Section 3.9.4, and Section 3.9.5. The SURF application utilizes an aerodrome map database that is updated by the latest AIRAC cycle (See table 2-1 Schedule of AIRAC effective dates, Aeronautical Information Services Manual (Doc 8126)).

Note. - The SURF application is designed to account for operations carried out by larger aircraft with higher takeoff and/or final approach speeds. For this reason, runways considered in the definition of SURF have distances valid for ICAO code 3 and 4 aerodromes. SURF operations by smaller aircraft with lower takeoff or final approach speeds operating at these aerodromes are within the scope of this application.

2.6.3.2 SURF applies to operations at both controlled aerodromes and uncontrolled aerodromes. There are no specific requirements for communication and surface ground surveillance capability when SURF is used. This application may be introduced in a partial or mixed equipage environment in which some aircraft and ground vehicles are equipped only with ADS-B OUT.

2.6.3.3 SURF is designed to be used in all visibility conditions without modifying air traffic controller / flight crew responsibilities and procedures compared to current operations. (See Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830))

2.6.3.4 The surveillance environment that provides traffic surveillance information for SURF consists of ADS-B and may include TIS-B.

Note. - TIS-B is not required for SURF. However, if available, it will increase the level of surveillance and provide additional traffic situational awareness. See section 2.5.1

2.6.4 Operational environment for ITP

2.6.4.1 ITP is designed to be applied in an en-route non-surveillance environment in which the airspace system is composed of fixed routes, flexible tracks, and random routes, where separation is procedurally supported by periodic position reports.

2.6.4.2 Random routes may cross each other at a variety of angles depending on city pairs served by the flights and on forecast winds. Random routes may also merge with each other. Random routes include user preferred routes (UPR) and the dynamic aircraft route planning (DARP) System used in the Pacific region.

2.6.4.3 ITP is only designed for an aircraft which is same track (as defined in 5.4.2.1 and figure 5-6 of Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) as another aircraft.

2.6.4.4 The ITP application can be used if direct controller pilot communications (DCPC) exist. Controller pilot data-link communication (CPDLC) if available should be used as main means of communications. Other communications means, such as SATCOM are under study.

2.6.5 Operational benefits

2.6.5.1 AIRB can improve the safety and efficiency of flight operations thanks to an increase in traffic awareness and better identification of flight opportunities (flight level change or lateral deviation).

2.6.5.2 VSA can improve visual separation procedures on approach, in particular thanks to a safer and more efficient visual acquisition process (i.e. easier traffic identification, less radio communication). VSA may also allow visual separation operations to continue in conditions where visibility (still VMC) would currently prevent them. A reduction in the number of missed approaches is also expected with VSA due to a better estimation of the distance from the preceding aircraft and the earlier detection of unexpected speed reductions of the preceding aircraft.

2.6.5.3 SURF can improve the safety and efficiency of surface operations thanks to better anticipation of potential conflicting situations, better understanding of the traffic situation on the surface and more efficient conditional taxi clearances.

2.6.5.4 ITP can reduce fuel burn due to increased ability to operate at near optimal aircraft cruise altitudes, reduce excess fuel carried as discretionary fuel and improve safety from being able to vacate an altitude where turbulence exists.

2.7 UNEQUIPPED AIRCRAFT CONSIDERATIONS

2.7.1 Partial equipage

2.7.1.1 Airborne surveillance function with ADS-B can provide information only if the surrounding traffic provides it (see section 2.2 of this manual). This means that aircraft without ADS-B OUT function cannot be processed by ADS-B IN to provide surveillance information.

2.7.1.2 This issue has an impact related to each ASA which will express requirements on the probability of missing surveillance information. This issue is described in the Operational Safety Assessment (OSA) in the Safety, Performance and Interoperability Requirements (SPR) associated to the application.

2.7.1.3 From an airspace perspective, the situation of partial equipage may exist for considerable time. The practical solution to reduce the number of unequipped aircraft is to promulgate a mandate requiring ADS-B OUT capability with required performance to all aircraft in the designated airspace. However, there are cases where ADS-B OUT capability cannot be fitted to a given aircraft. For example, some classes of State aircraft cannot accommodate avionics for ADS-B OUT function due to specific technical constraints (e.g., fighters, special radio measurement platforms, and very light airplanes). Another example for non-compliance is security: for example, some military operations, air policing, etc. are known cases where flight information is requested not to be broadcast.

2.7.1.4 The operational objectives of ASAs should be achieved for ADS-B equipped aircraft without degrading safety and efficiency by unequipped special aircraft. In addition, the unequipped special aircraft may operate with its own means to acquire airborne surveillance information.

2.7.1.5 The applicability of each ASA under partial equipage should be examined by the authority for airspace. Safety of each application is estimated with OSA or suitable procedure for safety case. It should be noted that the estimation needs appropriate assumptions on the operational conditions including the ADS-B OUT equipage.

2.7.1.6 To maximize benefits provided by AIRB, VSA and SURF, additional surveillance support may be required e.g., TIS-B. TIS-B provides the surveillance data from ground surveillance system such as SSR Mode S, WAM, to all the ADS-B IN aircraft in the area.

2.7.1.7 It is pointed out that partial equipage is not preventing implementation of the applications described in this manual.

2.7.2 Limitation of supplemental information by TIS-B

2.7.2.1 While TIS-B provides supplemental traffic information, it is not full the complement of information available through ADS-B. TIS-B has also performance limitations, such as latency and accuracy as well as possible incomplete traffic picture. The incomplete traffic picture can result from security requirements for civil/military exchanges.

2.7.2.2 As explained in 2.7.1, the broadcast mode may trigger security issues. As a result, filtering of surveillance information is required for civil/military exchanges. The surveillance information may be filtered by the gateway supporting the exchange of data between the broadcast services and the services to be secure. This example for civil/military exchanges of surveillance information is described in the Single European Sky ATM Research (SESAR) master plan with respect to Link16.

2.7.2.3 Other consideration should be required on the level of security for each user before providing surveillance information with TIS-B. For example, certain class of surveillance information may be provided to ATC but not to public users with ADS-B IN. In this case, another gateway for public users may filter the information.

2.7.2.4 However, in this context of mixed environment, the gateway architecture must be taken into account for the safety analysis related to the ASA. The gateway architecture is illustrated in Figure 2-3.

2.7.3 Segregation of airspace and flexible use of airspace

2.7.3.1 Until recently, it was usually possible to deal with unequipped aircraft by airspace design: only suitably equipped aircraft could access the airspace thus eliminating or reducing the effect of aircraft which are not equipped with ADS-B OUT function. The decision making to establish a specific type of airspace will be required after a study on safety and operational benefits with respect to each ASA. However, there is a new trend to implement flexible use of airspace (FUA) for which there could be frequent changes the class of users (e.g., civil vs. military). In this case, it should be essential to perform the operational safety analysis with various scenarios, in particular for the critical phase where airspace is handed off to another class of users. It is probable that additional safety hazards could occur through the delayed withdrawal of the unequipped aircraft from FUA with a temporary increase in the density of unequipped aircraft.

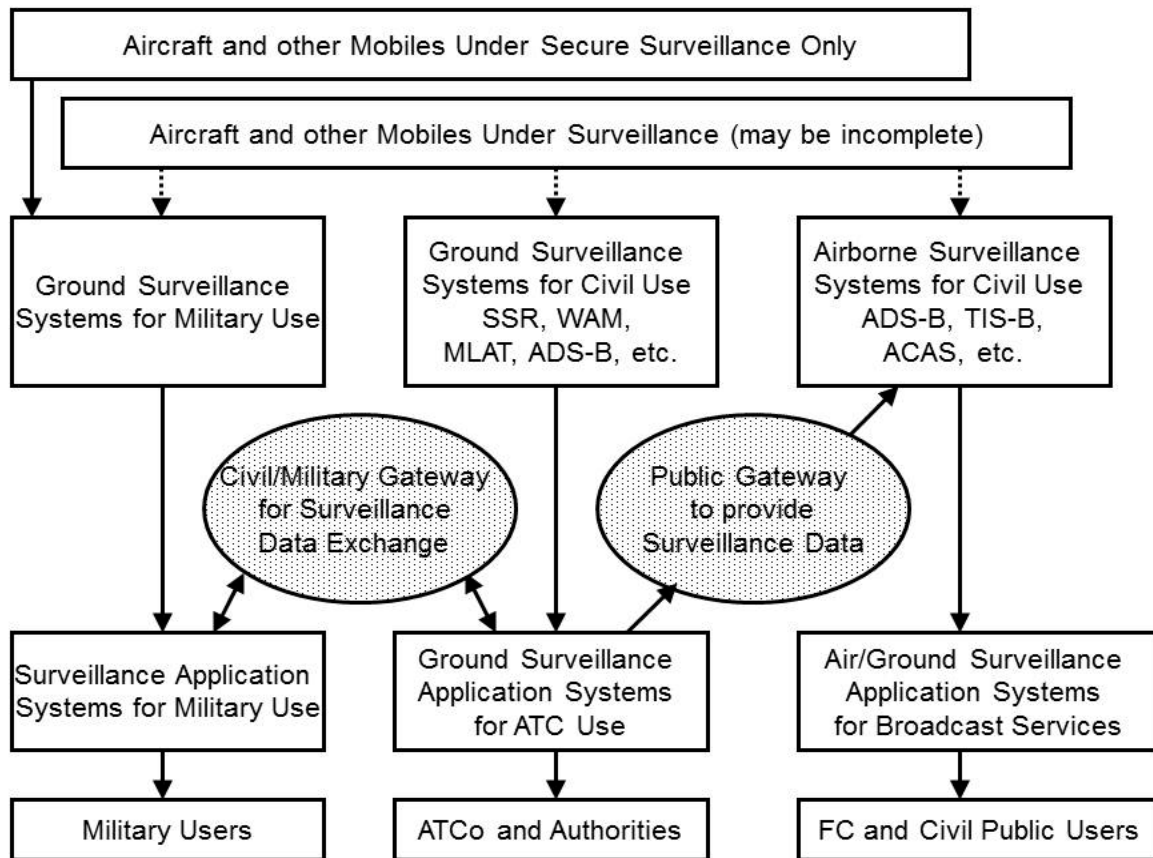


Figure 2-3. Gateway architecture for secure data exchange among various surveillance applications

3 ADMINISTRATIVE PROVISIONS RELATED TO ASAs

3.1 AIR NAVIGATION SERVICE PROVIDER (ANSP) SERVICE PROVISIONS

3.1.1 General considerations

3.1.1.1 By design, AIRB, VSA and SURF have no impact on the ground infrastructure or on the ATC procedures. However, air traffic controller training considerations should be addressed to inform them about this new airborne system and possible flight crew behaviour.

3.1.1.2 Conversely, the ITP has an impact on the ATC procedures and may impact ATC automation, depending on implementation.

3.1.2 ANSP considerations for AIRB, VSA and SURF

3.1.2.1 Ground infrastructure

3.1.2.1.1 As explained in 2.6, the use of AIRB, VSA and SURF does not require any changes to the ground infrastructure. These applications can be used in the exact same environments as the current operations from the communication, navigation and surveillance perspectives and from ATM systems perspectives.

3.1.2.1.2 However, some ANSPs may want to provide the information to the air traffic controller (i.e. whether the aircraft is ADS-B OUT and/or IN equipped) using the ADS-B capability field of the 2012 ICAO FPL format (item 10b (B1 and B2)).

3.1.2.2 Information and training for air traffic controller

3.1.2.2.1 Although the use of AIRB, VSA and SURF does not require any changes to ATC procedures, it is important to inform the air traffic controllers about possible new situations such as flight crews using the aircraft identification information of surrounding traffic. Air traffic controllers should be trained to discourage flight crew requests for confirmation of other surrounding aircraft identification as it may not be possible to ensure that ATC situation displays contain the same traffic information as what is displayed in the aircraft.

3.1.3 ANSP considerations for ITP implementation

3.1.3.1 General consideration

3.1.3.1.1 Appendix 1 provides detailed guidance for ITP implementation and in particular, the successive steps to be followed by all stakeholders.

3.1.3.2 Ground infrastructure

3.1.3.2.1 In terms of CNS infrastructure, the implementation of the ITP application in a given airspace by an ANSP requires the availability of DCPC. CPDLC if available should be used as main means of communications. Other communications means, such as SATCOM are under study.) There is no ground element of navigation or surveillance needed to support the ITP application.

3.1.3.2.2 In the absence of defined ITP CPDLC message elements in the FANS 1/A message set, initial implementations of ITP will make use of the free text message elements UM#169 and DM#67 using standardized message text. Until specific defined ITP CPDLC message elements have been implemented, ITP shall make use of standardized free text as given in DO306/ED-122. In air traffic control systems, UM#169 should be provided as a pre-formatted free text message when it is used to identify ITP reference aircraft. This method reduces the manual text entry, requiring the air traffic controller to only enter the reference aircraft identification. It is also recommended that advanced air traffic control systems automatically generate the ITP clearance based on the data received in the downlink ITP request. This method reduces the manual text entry required by the air traffic controller even further and therefore reduces the margin for error.

3.1.3.2.3 Some additional modifications to existing systems may be needed to support a safe and efficient implementation of the ITP application. For example, it is likely that ATC conflict probes will need to be adapted to include the separation minimum used for ITP.

3.1.3.3 Training for air traffic controller

3.1.3.3.1 The ITP application defines some new procedures for air traffic controllers. Therefore, specific training must be given to air traffic controllers in order to enable ITP to include procedure conditions, communications with the flight crews, and management and / or identification of abnormal situations (See also 4.3 and Appendix 1).

3.2 OPERATOR ELIGIBILITY

3.2.1 General considerations

3.2.1.1 The National Civil Aviation Authority (NCAA) of the operator will define the conditions required to operate ASAs. The following sections provide guidelines about training and documentation.

3.2.2 Operator considerations for AIRB, VSA, SURF

3.2.2.1 Operational Considerations

3.2.2.1.1 Operators must produce SOPs for their flight crews, and during the development of these SOPs, care must be given to properly mitigate any potential information overload and other threats to flight crew mental engagement and cognitive ability.

3.2.2.1.2 These applications may be used during critical phases of flight and great care must be used to avoid injecting excessive workload.

3.2.2.1.3 It is recalled that the information displayed is meant to augment and complement the traffic situational awareness acquired visually and from radio communications by the flight crew and may not represent a complete picture of the situation.

3.2.2.1.4 Operators must develop crew resource management (CRM) procedures to effectively and safely employ AIRB, VSA and SURF.

3.2.2.2 Operator's training program

3.2.2.2.1 Operators must ensure that their personnel (flight crew, flight operations engineers, and maintenance staff) are trained to operate AIRB, VSA, SURF in conformance with the provisions of the Procedures for Air Navigation Services – Aircraft Operations (PANS OPS) (Doc 8168). The training materials may be developed by the operator, or suggested by the Original Equipment Manufacturer (OEM).

3.2.2.2.2 Recommended items to address include but are not limited to:

- a) displayed information is intended to be supplemental in nature;
- b) avoidance of overreliance on the traffic display;
- c) avoidance of excessive head-down time;
- d) awareness of the partial ADS-B OUT equipage environment; and
- e) recognition of expected performance characteristics and limitations of the system.

3.2.2.2.3 For the specific case of SURF, an additional training issue is the situational awareness of displayed traffic as it pertains to the selection and de-selection of ground vehicles for display on the SURF traffic display. As part of their training, flight crews should consider when ground vehicles are deselected in order to maintain proper situational awareness of traffic.

3.2.2.3 Documentation

3.2.2.3.1 It is expected that operators update their documentation with regard to flight operations (e.g. Operations Manuals – Parts A, B, C, and D) and maintenance. This documentation may be provided by the OEM.

3.2.3 Operator considerations for ITP

3.2.3.1 Operators must comply with the rules published by their NCAA before operating ITP.

3.2.3.2 Operator's training program

3.2.3.2.1 Operators must ensure that their personnel (flight crew, flight operations engineers, and maintenance staff) are trained to operate ITP in conformance with the provisions of the Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444). The training materials may be developed by the operator, or suggested by the OEM. Recommended items to be addressed are given in Appendix 1.

3.2.3.3 Documentation

3.2.3.3.1 It is expected that operators update their documentation with regard to flight operations (e.g. Operations Manuals – Parts A, B, C, and D) and maintenance. This documentation may be provided by the OEM.

3.3 FLIGHT PLANNING

3.3.1 All operators with ADS-B capability will be requested to provide the following information in their flight plans, effective with the Flight Plan form (Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444):

- a) ADS-B capabilities (ADS-B OUT/ IN) (item 10);
- b) aircraft identification (flight number) format (ICAO format) (item 7) : operators must take appropriate steps to ensure that flight crews input this information into their on-board systems for each flight; and
- c) Optionally ICAO aircraft address (item 18).

3.3.2 For all of the applications described in section 2.2, operators will be requested to populate the ADS-B IN field so that ANSPs are aware that the aircraft has such capability. None of the applications described in section 2.2 are known to require any additional information.

3.3.3 ITP requests can only be made by appropriately equipped and authorized flights. ITP has no special requirements for flight plan information.

4 CONTROLLER PROCEDURES

4.1 OVERVIEW

4.1.1 This chapter will give air traffic controllers some general and useful information about the operation and interaction with flight crew of aircraft equipped with airborne surveillance systems (ADS-B traffic displays or CDTIs). The information provided here is complementary to the ANSP service provisions described in Chapter 3.

4.1.2 There are two kinds of ASAs. The traffic situational awareness applications (AIRB, VSA and SURF) do not change existing controller procedures. The ITP application requires new controller procedures. Their considerations are described in the sections below.

4.2 AIRB, VSA and SURF

4.2.1 The capability of flight crews of equipped aircraft using AIRB, VSA and/or SURF is expected to be transparent from an air traffic controller ground perspective.

4.2.2 The availability of such applications on-board the aircraft does not exonerate either air traffic controllers or flight crews from applying the current procedures related to the provision of traffic information. Current requirement for providing essential traffic information and the content of the traffic information to be provided to concerned flights remain unchanged (see Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) sections 5.10, 5.10.2, 7.4.1.3, 9.1.4.3.1)

4.2.3 Because AIRB and SURF have been defined as supporting only traffic situational awareness or visual acquisition in case of VSA, flight crews must not use the displayed traffic information to presume control instructions or to self-separate in any class of airspace.

4.2.4 However, there may be situations in which flight crews, upon receiving traffic information from ATC, would like to correlate such information with the additional information available on-board through AIRB, VSA and/or SURF. When doing so, flight crews could use elements of the information presented on-board in communication to ATC (e.g. aircraft identification). Although theoretically the aircraft identification is unique at a given moment, there are a number of circumstances where the information (aircraft identification) provided through AIRB, VSA and/or SURF could be different than the aircraft identification displayed to the air traffic controller.

4.2.5 The flight crew should, to the extent possible, avoid using references to aircraft identification observed on the traffic display in their communication with ATC directly or as a response to traffic information, except the cases where a reference to the observed aircraft identification would eliminate ambiguities with regard to essential traffic.

4.2.6 In such cases:

- a) for ATM systems using Mode S or ADS-B (surveillance technologies using the same aircraft identification parameters as AIRB, VSA and/or SURF) and provided that the aircraft identification of the essential traffic has been verified, air traffic controllers may confirm the traffic information refers to the observed aircraft identification; and
- b) for all the other cases (including the situation in which the traffic in question is not under ATC control, e.g. VFR), air traffic controllers must avoid using the aircraft identification and should provide additional information (if available) to facilitate the recognition by the flight crew of the essential traffic.

4.3 ITP

4.3.1 The ITP is described in detail in the Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444). Examples of ITP geometries and CPDLC messages are provided in the appendix 1 to this manual. The following paragraphs summarize the procedure.

Note. - For more details, refer to RTCA DO-312 / EUROCAE ED-159 and their supplements.

4.3.2 The ITP is initiated only by the flight crew. The flight crew checks that the ITP criteria are met (see Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444)), and if so, then requests an ITP clearance.

4.3.3 ITP will be applied so that the distance between the ITP aircraft and the reference aircraft is never less than the ITP separation minimum (18.5 km (10 NM)).

4.3.4 Upon receiving a request for an ITP manoeuvre the ITP separation minimum is obtained by an ATC unit by ensuring the following criteria are simultaneously met:

- a) all potentially blocking aircraft are identified as reference aircraft in the ITP request;
- b) there are no more than 2 reference aircraft; and
- c) for each of the reference aircraft, the following criteria must be met:
 - 1) ITP aircraft and the reference aircraft are following the same track (as defined in 5.4.2.1 and figure 5-6, Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) and are not in vertical evolution;
 - 2) the flight crew reported an ITP distance of at least 28 km (15 NM);
 - 3) the closing Mach difference between the ITP aircraft and the reference aircraft is less than or equal to 0.06 Mach;
 - 4) the reference aircraft altitude is within 600 m (2000ft) of the ITP aircraft; and
 - 5) separation is ensured at the requested altitude.

4.3.5 If it is expected that the ITP aircraft will not reach the requested altitude within the area of responsibility of the unit authorizing the manoeuvre, the ATC unit will ensure that the manoeuvre is coordinated with the next unit before clearing the ITP altitude change.

4.3.6 Upon an ITP request, the air traffic controller can grant an altitude change by applying alternative separation minimum applicable to that airspace.

4.3.7 An ITP request must be rejected if:

- a) DCPC is not available (CPDLC is the preferred means of communication and other means such as SATCOM are under study); or
- b) the aircraft requesting an ITP clearance is a reference aircraft for an on-going ITP manoeuvre.

4.3.8 An ITP request may be rejected if:

- a) it is known that due to weather conditions the reference aircraft is/are likely to deviate from the cleared route during the ITP manoeuvre; or
- b) reference aircraft speed changes are likely to occur.

4.3.9 In abnormal situations or emergency during the ITP manoeuvre, the flight crew must follow the appropriate contingency procedures contained in Chapter 15.2 of the Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444).

Note. — Nothing in the provisions detailed in paragraphs above precludes a State from establishing:

- a) *other minima or criteria for use in circumstances not prescribed; or*
- b) *additional conditions/procedures to those prescribed for the use of an ITP criteria minimum; provided that the level of safety inherent in the provisions detailed in section above is at all times assured.*

5 FLIGHT CREW PROCEDURES

Note.- The following sections provide general guidance on the use of ASAs by flight crews. The aircraft operator should refer to the OEM documentation for the exact SOP to apply. Flight crew procedures for the use of ADS-B traffic display for AIRB, VSA and SURF will be included in the Procedures for Air Navigation Services – Aircraft Operations (PANS OPS) (Doc 8168) Volume 1.

5.1 AIRB

5.1.1 Operational assumptions

- a) The AIRB application does not change roles or responsibilities for flight crews in comparison with existing operations.
- b) It is a flight crew's decision whether to use the traffic display during flight operations. The scope of the AIRB application only includes the situations where the flight crew uses the traffic display.

5.1.2 Procedures

- a) The AIRB application does not modify the ACAS procedures.
- b) In any weather conditions, the flight crew uses the traffic display as a tool for assisting the visual search.
- c) Whenever information on displayed traffic of interest is available by visual contact or radio communications, the flight crew must check consistency between the information provided by the traffic display with the visual information and radio communications.

Note. - Inconsistency may come from partial ADS-B OUT equipage or incorrect ADS-B transmissions.

- d) If the flight crew detects an inconsistency between the information for traffic of interest on traffic display and out the window, the flight crew must disregard the inconsistent piece of information for this traffic provided by traffic display and use the visual information.

- e) If the flight crew detects an inconsistency between the information for traffic of interest on the traffic display and the radio communication and when necessary from a safety perspective, the flight crew must cross-check with the air traffic controller in controlled airspace or the pilot of the traffic of interest in uncontrolled airspace for confirmation before using the displayed information.

Note. - When assessing the consistency between information provided by the traffic display and by the air traffic controller, flight crew should take into account the evolution of the traffic situation, as the information displayed is continuously updated and it can slightly differ from the information received from the air traffic controller.

- f) The use of the traffic display should reduce radio communications. However, when necessary from a safety perspective, pilots may decide to contact the air traffic controller. Such contact must not be used to routinely question the air traffic controller about received clearances or to request information for aircraft correctly separated.
- g) Pilots must not undertake any manoeuvres relative to traffic of interest based solely on the traffic display:
 - 1) that would lead to either a deviation from or a non-execution of a clearance or instruction (e.g. heading, speed, flight level, etc.); or
 - 2) for which visual contact (e.g. see-and-avoid) or air-to-air radio communication (e.g. traffic information broadcast by aircraft (TIBA)) is currently a pre-requisite.
- h) Nevertheless, flight crews are still ultimately responsible for the prevention of collisions and these procedures must not prevent pilots-in-command from exercising their best judgment and full authority in their choice of the best course of action to resolve a traffic conflict or to avert a potential collision.

Note. - Pilots must comply with the rules included in ICAO Annex 2, and particularly those described in 3.2 Avoidance of collisions and 3.6.2 Adherence to Flight Plan.

5.2 VSA

5.2.1 Operational assumptions

- a) It is a decision of the flight crew to use the traffic display. The VSA application only includes the situations where the flight crew uses the traffic display.
- b) The flight crew assesses the meteorological conditions as in current operations.

5.2.2 Procedures

5.2.2.1 The VSA application is comprised of three phases (i.e. visual acquisition, clearance for maintaining own separation and maintaining own separation on the approach) and can be initiated either by the air traffic controller or the flight crew of the succeeding aircraft.

5.2.2.2 The procedure is based on non-VSA ATC procedures where flight crew's sequence of actions is adapted to include the use of the traffic display.

5.2.2.3 The phraseology used for VSA is same as the current ICAO phraseology in chapter 12 in the Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444).

5.2.3 Visual acquisition

5.2.3.1 Procedure initiation by the air traffic controller

5.2.3.1.1 On receipt of the traffic information provided by the air traffic controller, the flight crew:

- a) looks out the window to visually acquire the preceding aircraft;
- b) looks at the traffic display to detect the preceding aircraft;
- c) if visual contact is not made:
 - 1) reports to the air traffic controller that traffic is not in sight;
 - 2) continues to search in order to make visual contact;
 - 3) asks the air traffic controller for updates of traffic information if visual contact is not quickly made;
- d) if visual contact is made:
 - 1) checks the consistency between the visual contact and the traffic display with the support of information provided by the air traffic controller; and
 - 2) informs the air traffic controller that the preceding aircraft is in sight.

5.2.3.1.2 If no target is displayed that corresponds to the traffic information provided by the air traffic controller or if the flight crew does not look at the traffic display anymore, the non-VSA procedures for visual acquisition are applied, using only the traffic information from the air traffic controller.

5.2.3.2 Procedure initiation by the flight crew

5.2.3.2.1 The flight crew:

- a) uses the information provided by the traffic display in addition to the out of window scan and the party-line effect to visually acquire the preceding aircraft;
- b) checks, when the visual contact is made, the consistency between the visual contact and the traffic display; and
- c) informs the air traffic controller that the preceding aircraft is in sight and requests a clearance for own separation.

5.2.3.3 Clearance for maintaining own separation

5.2.3.3.1 Upon reception of the clearance received from the air traffic controller, the flight crews decide, as in non-VSA operations, to either accept or refuse it and reports the decision to the air traffic controller.

5.2.3.4 Maintaining own separation on the approach

5.2.3.4.1 Once cleared to maintain own separation, the flight crew:

- a) flies the approach;
- b) maintains visual contact with the preceding aircraft making use of the traffic display as needed;
- c) based on visual and displayed information, decides if a manoeuvre is appropriate; and
- d) manoeuvres the aircraft to maintain own separation as in non-VSA operations.

5.2.3.4.2 If the flight crew loses the preceding aircraft on the traffic display only, the visual separation approach may be pursued according to non-VSA procedures.

5.2.3.4.3 If the flight crew loses the visual contact on the preceding aircraft, then the visual separation approach may not be pursued and the flight crew must inform the air traffic controller.

5.3 SURF

5.3.1 Operational assumptions

5.3.1.1 The SURF application does not change roles or responsibilities for flight crews in comparison with existing operations.

5.3.1.2 It is a flight crew's decision whether to use the traffic display during surface operations. The scope of the SURF application only includes the situations where the flight crew uses the traffic display.

5.3.2 Procedures

5.3.2.1 The flight crew uses the traffic display as part of their regular instrument scan. This supports but does not replace the out the window scan by providing updated information on where to search for traffic. Continued out the window scan is critical to safety because there may be aircraft which are not displayed on the traffic display (e.g. partial ADS-B equipage environment).

5.3.2.2 When both visual and traffic display information is available, flight crew proceeds according to the visual information and makes use of all additional information provided by the traffic display (e.g. speed, aircraft identification, etc.).

5.3.2.3 The flight crew is not allowed to manoeuvre based on the traffic display information alone. However if the traffic, identified only on the traffic display (i.e. not identified visually), is considered to be a threat to the safety of the own aircraft, the flight crew will take any measures considered necessary to preserve the safety of the own aircraft. This may include, depending on the situation, request for information from ATC (or other pilot at uncontrolled airports), or decision to stop or to manoeuvre the aircraft into a position (e.g. taxi, go around, abort the take-off, etc.) that the flight crew considers to be safe. When under ATC control, the flight crew should inform the air traffic controller as soon as practical, preferably before acting.

5.3.2.4 Where relevant, the flight crew correlates the surrounding traffic information displayed with:

- a) the visual information; and / or
- b) the ATC radio communications at controlled airports or position reports of other aircraft broadcast on the common frequency at uncontrolled airports.

5.3.2.5 Traffic information provided by the air traffic controller

5.3.2.5.1 On receipt of traffic information provided by the air traffic controller, the flight crew:

- a) looks out the window to visually acquire aircraft; and
- b) looks at the traffic display to detect the aircraft of interest.

5.3.2.5.2 If visual contact is made, the flight crew:

- a) checks the consistency between the visual contact and the traffic display with the support of information provided by the air traffic controller; and
- b) when relevant informs the air traffic controller that the aircraft is in sight.

5.3.2.5.3 If visual contact is not made, the flight crew informs the air traffic controller that the traffic is not in sight.

5.3.2.5.4 When reporting traffic in sight and during subsequent voice communications, the flight crew should not use the aircraft identification of the preceding aircraft as displayed.

5.3.2.6 Traffic of interest heard through the party-line at uncontrolled airports

5.3.2.6.1 Upon identification of a traffic of interest through the party-line, the flight crew:

- a) uses the party-line information to identify the traffic on the traffic display and, if correlation is established; and
- b) uses the information provided by the traffic display as an assistance to visually acquire the traffic.

5.4 ITP

5.4.1 Operational assumptions

5.4.1.1 The ITP flight crew is responsible for:

- a) determining that the ITP criteria are met prior to requesting an ITP clearance;
- b) upon receiving a clearance to execute a requested ITP manoeuvre, reassessing the ITP criteria prior to initiating the vertical manoeuvre;
- c) notifying the air traffic controllers if unable to execute an ITP clearance for any reason.

Note. - For the complete list of ITP assumptions, refer to RTCA DO-312 / EUROCAE ED-159 - Safety Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ITP) Application and its Supplements issued by RTCA / EUROCAE.

5.4.2 Procedures

5.4.2.1 The In-Trail Procedure is described in detail in the Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444). Examples of ITP geometries and CPDLC messages are provided in the appendix 1 to the manual. The following summarizes the procedure.

5.4.2.2 The In-Trail Procedure (ITP) is initiated only by the flight crew. To make a valid request for an ITP manoeuvre, the flight crew uses on-board avionics to ensure that the following criteria are simultaneously met:

- a) all potentially blocking aircraft are identified as reference aircraft in the ITP request;
- b) there are no more than 2 reference aircraft; and
- c) For each reference aircraft,
 - 1) The ITP aircraft and the reference aircraft are following the same track (as defined in 5.4.2.1 and Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) figure 5-6) and are in level flight;
 - 2) the ITP distance is at least 28 km (15 NM) with a closing ground speed differential of no more than 20 knots, OR the ITP distance is at least 37 km (20 NM) with a closing ground speed differential of no more than 30 knots; and
 - 3) the reference aircraft altitude is within 600 m (2000ft) of the ITP aircraft.

5.4.2.3 If the ITP criteria are met, the flight crew requests an ITP clearance using standardized or pre-formatted free-text combined with CPDLC message elements.

5.4.2.4 After having received the ITP request, the air traffic controller performs a series of checks the conditions to ensure safe separation; these checks are described in section 4.3. If these conditions are met, the air traffic controller approves the ITP manoeuvre and sends the ITP clearance to the requesting aircraft.

Note. - Flight crews should be aware that in order to ensure an acceptable closure throughout the ITP manoeuvre, the air traffic controller will not issue an ITP clearance if it is determined that the closing Mach differential between the ITP aircraft and any reference aircraft is greater than 0.06 Mach.

5.4.2.5 Upon receiving the ITP clearance, the flight crew confirms that all criteria remain satisfied prior to initiating the manoeuvre. The flight crew must not commence the ITP under any of the following circumstances:

- a) ITP criteria are no longer met;
- b) Traffic information is lost;
- c) Either the flight level or reference aircraft in the clearance does not match those requested; or
- d) Air traffic controller provides an unsolicited ITP clearance.

5.4.2.6 If the ITP criteria are still met, the flight crew accepts the clearance and immediately initiates the climb or descent. If the ITP criteria are no longer met, the flight crew should not accept the clearance or perform the manoeuvre.

Note. - If the air traffic controller responds to the ITP request with a standard altitude change clearance, the flight crew should execute the altitude change as instructed and consider the ITP request as rejected by ATC.

5.4.2.7 During the ITP manoeuvre, the flight crew must maintain a minimum vertical speed of 300 ft / min (or the minimum specified by the local authorities if it is above 300ft/min constraint) and maintain the aircraft's current cruise Mach number.

5.4.2.8 In abnormal situations or emergency during the ITP manoeuvre, the flight crew applies the existing regional contingency procedures.

Note. - Flight crews should be aware that the air traffic controller may reject an ITP request for a variety of reasons that are unknown to the ITP aircraft, including, but not limited to:

- 1) *The presence of an aircraft that is not equipped with ADS-B Out at either an altitude to be traversed, or occupying the destination altitude;*
 - 2) *It is known that due to weather conditions a reference aircraft is likely to deviate from the current track during the ITP manoeuvre; and*
 - 3) *Reference aircraft speed changes are likely to occur.*
-

Appendix 1

ITP ADDITIONAL MATERIALS

1. ITP IMPLEMENTATION

1.1 INTRODUCTION

1.1.1 The successful implementation of an ICAO developed separation minimum is not possible at the Regional, State or local level without undertaking an implementation safety assessment. When undertaking this activity, reference should be made to the requirements detailed in Annex 11 (section 2.26), Procedures for Air Navigation Services –Air Traffic Management (PANS ATM) (Doc 4444) (Chapter 2, Section 2.6), and the guidance material contained in the Safety Management Manual (Doc 9859). Other provisions may also be contained in Annex 6. Furthermore, Safety and Performance Requirements analysis (SPR RTCA DO-312 / EUROCAE ED-159) including its supplements may be used as a reference, to conduct safety cases in detail for the ITP.

1.1.2 This chapter provides an overview of the minimum steps that the ICAO considers necessary for a Region or State to undertake a safety assessment.

1.2 IMPLEMENTATION CONSIDERATIONS

1.2.1 When undertaking a Regional or State implementation, the following step through process is provided as guidance:

Step 1: Undertake widespread regional consultation with all possible stakeholders and other interested parties.

Step 2: Develop an airspace design concept or ensure that the proposed standard being implemented will fit the current airspace system and regional or state airspace planning strategy.

Step 3 Review the ITP Circular and its referenced documents in its chapter 3, noting specific assumptions, constraints, enablers and system performance requirements.

Step 4 Compare ITP assumptions, enablers and system performance requirements with the Regional or State's operational environment, infrastructure and capability.

Step 5 If a Region or State has determined that the change proposal **is equal to or better than** the referenced materials in Step 3, then: -

The region or State must undertake safety management activities including:

- i) Formal hazard identification and analysis activities including identification of preventive controls and mitigating actions;
- ii) Development of an implementation plan;
- iii) Techniques for hazard identification/risk assessment may include:
 - Examination of data or experience with similar services/changes;
 - Quantitative modeling based on sufficient data, a validated model of the change, and analyzed assumptions;
 - Application and documentation of expert knowledge, experience and objective judgment by specialist staff;
 - Formal analysis in accordance with appropriate risk management techniques as set out in the Safety Management Manual (Doc 9859).
- iv) Identification and analysis of human factor issues identified with the implementation including those associated with Human Machine Interface matters;
- v) Simulation where appropriate;
- vi) Review of State regulatory approval process as it relates to safety management activities.

Step 6 If a Region or State has determined that the change proposal **is not equal to** the referenced materials in Step 3, and then the Region or State must:

- i) Consider trade-offs to achieve technical and safety performance that matches the referenced materials in Step 3; or,
- ii) Conduct appropriate quantitative or qualitative risk analysis for the development of mitigating measures if needed.

Step 7: Develop suitable safety assessment documentation including a safety plan and associated safety cases.

Step 8: Develop an ANSP **Operational Implementation Plan to:**

- a) Identify training and operational approval requirements;
- b) Develop ITP procedures and incorporate them into air traffic controller training and documentation;

- c) Establish air traffic controller recurrent training requirements;
- d) Develop and train ITP specific contingency procedures for the State or Region, where necessary;
- e) Ensure CPDLC message sets are available in the ATM system;
- f) Plan and conduct an operational trial with operator(s) under appropriate conditions with clearly identified success/failure criteria;
- g) Review and evaluate operational trial results;
- h) Develop a suitable post-implementation monitoring and review processes;
- i) Ensure transition to full implementation;
- j) Promulgate State AIS Publications. Individual publications- procedures, implementation and timelines could be harmonized where these form part of a regional implementation plan.

Step 9: Regulatory Requirements for Aircraft Operators

Recognizing the additional training and procedural requirements given in Section 3.2.3 and the certification and airworthiness provisions for the manoeuvring aircraft, States should also consider the following.

i) Operator's Training Program

Guidance material will clearly detail the required and recommended training items to be included in an aircraft operator's training program. These training items will in turn form the basis of any aircraft operator's approval.

The aircraft operator's training programs must support the following knowledge objectives. Each flight crew member (pilot flying (PF) and pilot not flying (PNF)) must:

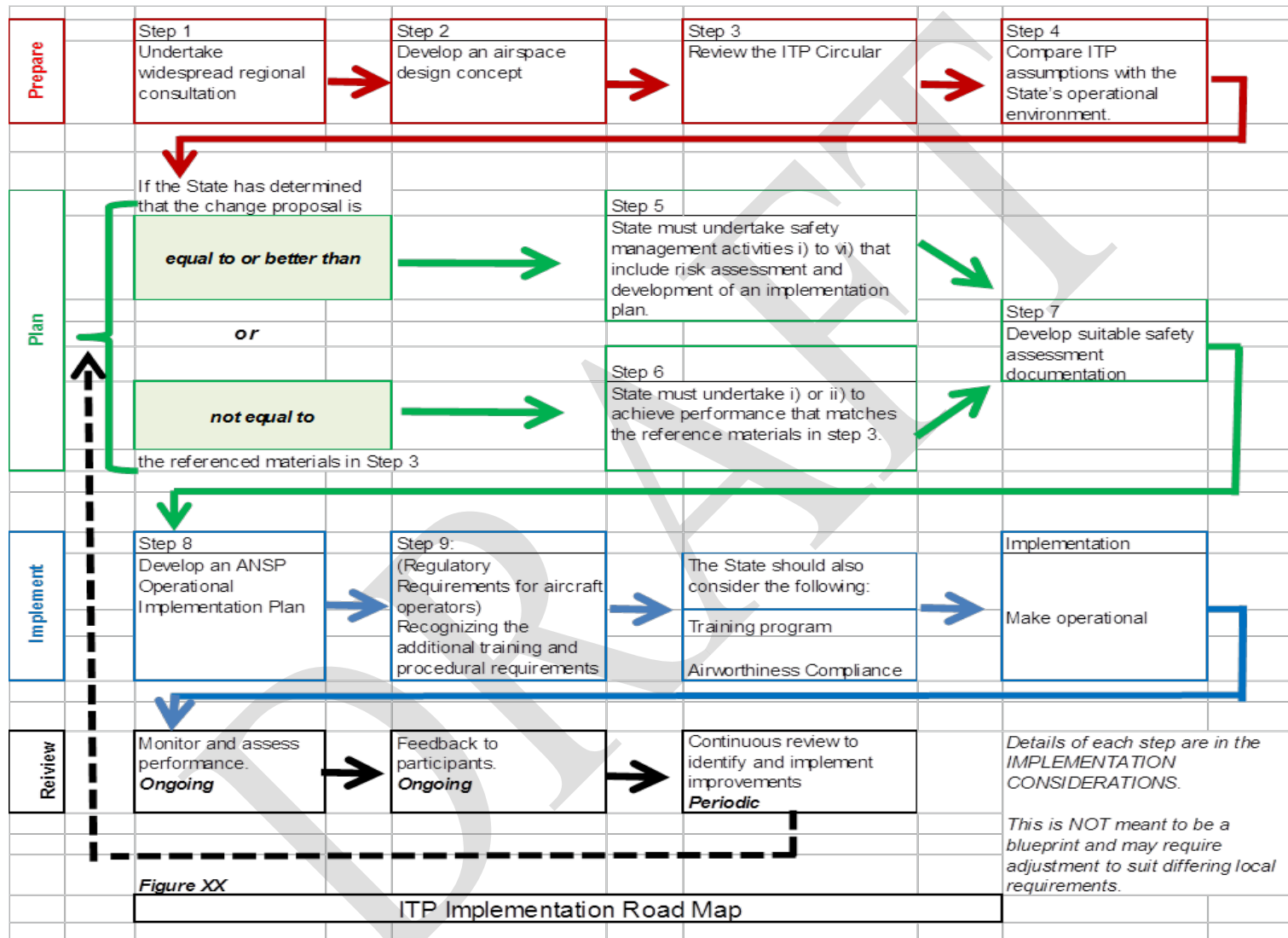
- a) understand the ADS-B ITP system, related components and operation, and failure conditions;
- b) understand the ITP initiation criteria that make an ITP climb/descent possible;
- c) understand the concept of ITP distance;
- d) know procedures for requesting an ITP clearance, and actions to take when an ITP clearance cannot be complied with;
- e) know where to reference CPDLC message sets for ITP. If ITP messages are not incorporated into the CPDLC message set, know the essential elements of an ITP request and clearance;

- f) understand all display symbology for the installed ITP equipment;
- g) understand minimum climb/descent rates required in a fixed Mach environment;
- h) understand the need to verify that the ITP initiation criteria are still met once the clearance is received;
- i) know the contingency procedures to follow in the event that the ITP manoeuvre must be discontinued, once climb/descent has been initiated;
- j) know that when an RA occurs with a concurrent ITP clearance; follow the climb or decent in the RA command.

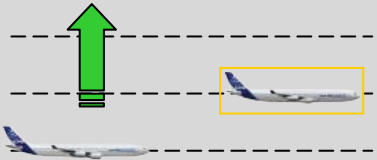
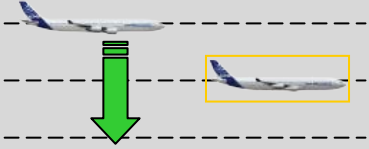
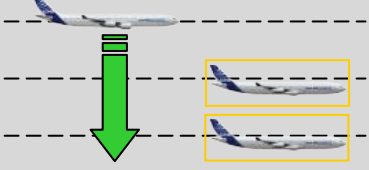
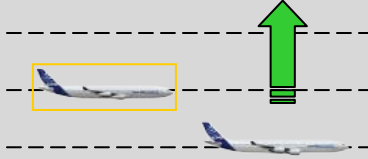
Note.- Operator specific SOP for flight crew conduct of ITP is recommended. These may be developed by the operator, or suggested by the OEM.

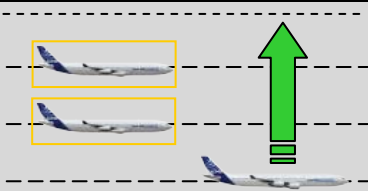
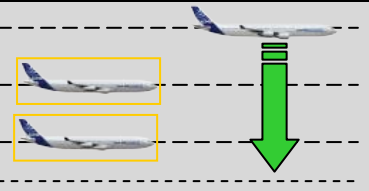
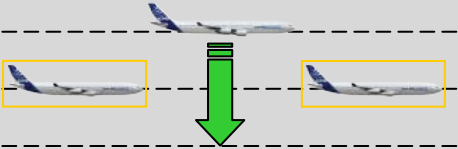
ii) Airworthiness Compliance

The State must promulgate the acceptable means of compliance with regard to the airworthiness requirements. ADS-B ITP implementations may be hosted on various avionics platforms.



2. EXAMPLES OF ITP GEOMETRIES AND CPDLC MESSAGES

	ITP CLIMB	ITP DESCENT
ITP BEHIND manoeuvres	 <u>FLIGHT CREW request:</u> DM9: REQUEST CLIMB TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid] <u>ATC clearance:</u> UM169: ITP BEHIND [acid] UM20: CLIMB TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]	 <u>FLIGHT CREW :</u> DM10: REQUEST DESCENT TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid] <u>ATC clearance:</u> UM169: ITP BEHIND [acid] UM23: DESCEND TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]
	 <u>FLIGHT CREW request:</u> DM9: REQUEST CLIMB TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid1] AND [ITP Distance] NM BEHIND [acid2] <u>ATC clearance:</u> UM169: ITP BEHIND [acid1] AND BEHIND [acid2] UM20: CLIMB TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]	 <u>FLIGHT CREW :</u> DM10: REQUEST DESCENT TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid1] AND [ITP Distance] NM BEHIND [acid2] <u>ATC clearance:</u> UM169: ITP BEHIND [acid1] AND BEHIND [acid2] UM23: DESCEND TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]
ITP AHEAD OF manoeuvres	 <u>FLIGHT CREW request:</u> DM9: REQUEST CLIMB TO [altitude] DM67: ITP [ITP Distance] NM AHEAD OF [acid] <u>ATC clearance:</u> UM169: ITP AHEAD OF [acid] UM20: CLIMB TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]	 <u>FLIGHT CREW request:</u> DM10: REQUEST DESCENT TO [altitude] DM67: ITP [ITP Distance] NM AHEAD OF [acid] <u>ATC clearance:</u> UM169: ITP AHEAD OF [acid] UM23: DESCEND TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]

	ITP CLIMB	ITP DESCENT
ITP AHEAD OF manoeuvres	 <u>FLIGHT CREW request:</u> DM9: REQUEST CLIMB TO [altitude] DM67: ITP [ITP Distance] NM AHEAD OF [acid1] AND [ITP Distance] NM AHEAD OF [acid2] <u>ATC clearance:</u> UM169: ITP AHEAD OF [acid1] AND AHEAD OF [acid2] UM20: CLIMB TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]	 <u>FLIGHT CREW request:</u> DM10: REQUEST DESCENT TO [altitude] DM67: ITP [ITP Distance] NM AHEAD OF [acid1] and [ITP Distance] NM AHEAD OF [acid2] <u>ATC clearance:</u> UM169: ITP AHEAD OF [acid2] AND AHEAD OF [acid2] UM23: DESCEND TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]
ITP combined BEHIND and AHEAD OF manoeuvres	 <u>FLIGHT CREW request:</u> DM9: REQUEST CLIMB TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid1] AND [ITP Distance] NM AHEAD OF [acid2] <u>ATC clearance:</u> UM169: ITP BEHIND [acid1] AND AHEAD OF [acid2] UM20: CLIMB TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]	 <u>FLIGHT CREW request:</u> DM10: REQUEST DESCENT TO [altitude] DM67: ITP [ITP Distance] NM BEHIND [acid1] AND [ITP Distance] NM AHEAD OF [acid2] <u>ATC clearance:</u> UM169: ITP BEHIND [acid1] AND AHEAD OF [acid2] UM23: DESCEND TO AND MAINTAIN [altitude] UM129: REPORT LEVEL [altitude]
	<u>ITP aircraft</u> 	<u>Reference aircraft</u> 
	<u>UM20 and UM23 may be substituted with:</u> UM#26: CLIMB TO REACH [altitude] BY [time] UM#27: CLIMB TO REACH [altitude] BY [position] UM#28: DESCEND TO REACH [altitude] BY [time] UM#29: DESCEND TO REACH [altitude] BY [position]	<u>The following elements may be added after UM20 and UM23:</u> UM#46: CROSS [position] AT [altitude] UM#47: CROSS [position] AT OR ABOVE [altitude] UM#48: CROSS [position] AT OR BELOW [altitude]
	<u>Air traffic controller response when unable to approve ITP request:</u> UM0: UNABLE <u>and then optionally in a separate uplink:</u> UM169: SEND NEW ITP REQUEST IF ABLE [altitude(s)]	

— END —