ICAO UNITING AVIATION
A UNITED NATIONS SPECIALIZED AGENCY

South America (SAM) Office

THE SAM AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) OPERATIONAL CONCEPT

(2025-2035)

August 2025

Contents

1. INTRODUCTION

ATS surveillance represents an important component in the performance of the global ATM System. In areas where this service is not available, air traffic management depends on reports of aircraft positions. In this scenario, increased separations are applied to maintain the required safety levels.

In contrast, where ATS surveillance is provided, aircraft positioning is determined with greater precision, greater update frequency, and the respective airspace can be used more efficiently, accommodating a greater number of aircraft through the application of minimum reduced separation. Ground-based Cooperative ATS surveillance systems, alone or associated with non-cooperative systems, have been widely used in air traffic control.

Nonetheless, installing and maintaining RADAR infrastructure is costly. In remote areas may be challenging and even unfeasible.

This document is a strategic reference to guide actions related to the update of surveillance infrastructure in the SAM region.

The developments resulting from this ADS-B Operational Concept aim to meet the operational needs and requirements of ATM in the SAM Region, ensuring the modernization of the ATS surveillance infrastructure in line with the growing demands of operations. This modernization is essential to achieve the long-term objectives of environmental sustainability, efficiency, capacity and seamless coordination across all domains of air traffic management.

SAM States recognize ADS-B as an enabler of the global ATM concept, bringing substantial safety, efficiency, and capacity benefits; supporting its early and cost-effective implementation; and ensure that it is harmonized, compatible and interoperable with ATM operational procedures, data linkage and applications.

The ICAO Global Air Navigation Plan (GANP) provides a foundational framework for identifying essential operational requirements in Air Traffic Management (ATM), supporting the global harmonization and modernization of airspace operations. Through the Aviation System Block Upgrades (ASBU) framework, the GANP outlines a strategic roadmap for the progressive implementation of surveillance technologies.

The Surveillance Systems (ASUR) element, as outlined in the current 7th Edition of the GANP, focuses on the modernization and expansion of surveillance capabilities, with particular emphasis on remote and oceanic airspace.

a) In the current implementation phase (Block 0), ADS-B OUT and Multilateration (MLAT) are employed to complement conventional radar systems.

b) In future phases (Blocks 1 to 3), surveillance will evolve to include space-based ADS-B and vehicle-to-vehicle technologies supporting autonomous operations. By Block 3, surveillance will be performance-based, enabling the adaptive use of surveillance solutions according to the specific requirements of each airspace."

Looking ahead, the transition to Trajectory-Based Operations (TBO), along with the broader implementation of Performance-Based Navigation (PBN) and Performance-Based Communication and Surveillance (PBCS), will support more flexible and efficient routing—minimizing delays, optimizing flight trajectories, and enhancing airspace capacity. These advancements, however, are highly dependent on the deployment of modern CNS technologies to ensure accurate aircraft positioning, reliable communications, and robust surveillance, necessitating significant upgrades to current systems.

Safety analyses and testing by States will support these implementations and provide the foundation for expansion of ATS surveillance services based on ADS-B.

This concept of operations considers the use of Automatic Dependent Surveillance - Broadcast (ADS-B) data from aircraft to expand surveillance coverage to cover current gaps, mainly in remote areas, to augment current cooperative surveillance coverage and enable studies for replacement of existing cooperative surveillance assets. Prioritization criteria for ADS-B implementation to cover ATS surveillance gaps is attached as Appendix A These criteria are based on aspects such as: IFR traffic level, radar gaps, LHD index, AIDC/VHF deficiencies, etc.

Currently, some Air Traffic Service (ATS) providers rely on ground-based infrastructure to receive ADS-B data from aircraft. This concept of operations also considers the possible use of Space Based ADS-B where a business case is agreed by all stakeholders.

Note: A *business case* supports investment decisions by assessing costs, benefits, and associated risks. For informational purposes, Appendix B includes reference data to support national decision-making regarding ADS-B implementation.

The reduction of longitudinal separation between aircraft is an operational benefit that can be realized by implementing an appropriate surveillance and communication infrastructure.

1.1. Document Overview

This concept of operations consolidates the vision for the ICAO SAM Region related to the employment of ADS-B as part of the ATS Surveillance System.

The purpose of this document is to:

a) Facilitate coordination among stakeholders involved in or affected by the implementation of ADS-B.

b) Define the operational objectives and anticipated benefits of ADS-B implementation in the SAM region.

c) Describe the operational environment and the conditions that support or limit the application of ADS-B.

d) Present the expected enhancements to air traffic management (ATM) functionalities enabled by ADS-B.

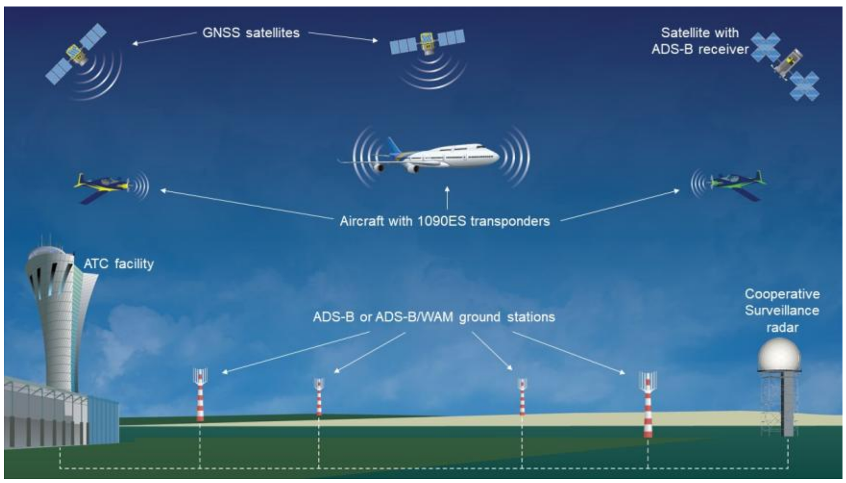
e) Provide guidance to States regarding infrastructure planning, acquisition, and development necessary for ADS-B implementation.

f) Describe how ADS-B supports the optimization of air traffic services through enhanced ATS surveillance capabilities.

g) Share essential information to promote interoperability, seamless surveillance transitions between FIRs, data-sharing among ANSPs, and harmonized fleet equipage strategies and ATM Systems.

This Concept of Operations will be reviewed and updated as necessary in response to operational or technological developments.

System Overview



ADS-B is an enabling technology for the Global ATM Operational Concept. In non-radar airspace with direct controller-pilot communication (DCPC), immediate benefits can be achieved using ADS-B OUT. In the long term, greater operational gains are expected from advanced applications based on ADS-B IN.

ADS-B OUT is considered a *dependent* and *cooperative* surveillance technology: dependent because it relies on position data from the aircraft's onboard GNSS receiver, and cooperative because this data is automatically broadcast via radio.

ADS-B provides more frequent updates and improved accuracy than SSR, facilitating operational gains in safety, efficiency, and capacity.

ADS-B-equipped aircraft transmit data that combines GNSS-derived position with other aircraft parameters. This information is simultaneously sent to other aircraft equipped with ADS-B IN and to ADS-B ground infrastructure, where it can be integrated with other cooperative surveillance sources into the air traffic management system.

The ADS-B system can be supported by ground-based receiving stations, strategically deployed to cover the airspace of interest, or by satellite-based receivers (Space-Based ADS-B) in remote or oceanic areas where ground infrastructure is impractical or cost-prohibitive.

2 Operational Need

The adoption of ADS-B in the SAM Region may bring short term operational and safety benefits and is fully aligned with ICAO's global initiatives to establish a harmonized, safe, and efficient air traffic management system based on interoperable technologies.

In airspaces without ATS surveillance, the implementation of ADS-B will enable the application of harmonized reduced separation minima, in accordance with the recommendations of ICAO's 14th Air Navigation Conference. The performance goals include increased safety, capacity and efficiency, contributing to reduced fuel burn and lower greenhouse gas emissions. In areas with existing radar coverage, ADS-B can provide an additional surveillance layer—extending coverage, enhancing monitoring in high-density areas, and enabling the application of new separation minima where operationally justified.

Harmonized ADS-B implementation in the SAM Region supports the standardization of a 10 NM minimum longitudinal separation in cross-border continental airspace where larger separations are still applied.

Due to its lower cost compared to radar systems, ADS-B enables States to rationally evaluate the need to maintain or decommission existing radar infrastructure, based on strategic considerations and a supporting business case that includes cost-benefit analysis and safety risks assessment.

ADS-B also supports the transition to future ATM concepts, particularly Trajectory-Based Operations (TBO) and 4D Trajectories (4DT). It is referenced in several elements of ICAO's Global Air Navigation Plan (GANP), such as:

a) ACAS-B1/1: Airborne Collision Avoidance Systems (ACAS) improvement, using ADS-B information.

b) AMET-B0/1: Meteorological observations products, using ADS-B.

c) ASUR-B0/1: Automatic Dependent Surveillance – Broadcast (ADS-B).

d) ASUR-B1/1: SB ADS-B.

e) ASUR-B2/1: Evolution of ADS-B and Mode S.

f) ASUR-B4/1: Further Evolution of ADS-B and MLAT.

2.1 ADS-B Operating Environments and Circumstances of Use

Automatic Dependent Surveillance – Broadcast (ADS-B) provides substantial operational and safety benefits, particularly in airspace where traditional surveillance infrastructure is limited, impractical, or cost-prohibitive.

To ensure effective resource allocation and early realization of benefits, it is essential to define clear deployment priorities. These are based on operational requirements, infrastructure gaps, and opportunities to improve surveillance coverage, airspace capacity, and flight efficiency.

In the SAM Region, ADS-B deployment will be prioritized in the following operational contexts:

1) **Remote or Oceanic Airspace**: Areas where radar coverage is unavailable or infeasible, and where separation based on other CNS technologies is not applied.
2) **En-route Upper Airspace**: Supporting surveillance during the cruise phase of flight, especially at FIR boundaries where surveillance gaps hinder longitudinal separation optimization and the direct routing implementation. Areas planned for infrastructure rationalization should also be considered.
3) Terminal Control Area (TMA) operations – enhancing situational awareness and traffic management during arrival, approach, and departure phases.

Additionally, ADS-B will contribute to enhance Aircraft Tracking and Search and Rescue Support to enabling continuous monitoring of aircraft to improve safety oversight and support SAR efforts by providing accurate last known position data.

2.2 Operational Objectives

The operational objectives of ADS-B deployment in the SAM Region reflect current regional needs and align with the strategic direction established by ICAO for the evolution of global ATM systems. They are as follows:

a) Provide surveillance coverage in non-radar continental airspace and enable the application of 10 NM horizontal separation minima based on cooperative surveillance (SSR, Mode S, MLAT, and/or ADS-B).
b) Complement radar coverage in existing radar airspace with an additional layer of cooperative surveillance, based on a business case.
c) provide surveillance capabilities into remote and oceanic airspace
d) Enable the implementation of new air traffic management concepts, such as:
   - Free Route airspace
   - In-Trail Procedures (ITP)
   - Advanced Surveillance-Enhanced Procedural Separation (ASEPS)—in remote/oceanic airspace.
   - Trajectory-Based Operations (TBO).

e) Support future strategic regional initiatives for optimization and rationalization of surveillance infrastructure; and

f) Contribute to increasing the interoperability of systems, through harmonization of communications protocols, allowing the compatibility among all systems.

*Note: In airspace where longitudinal separations of less than 10NM are currently applied, States involved will maintain the existing separation minima.

The full benefits of ADS-B for the SAM region will only be achieved through harmonized implementation and seamless operations, along with the continued provision of Direct Controller-Pilot Communications (DCPC) and the equipage of all aircraft with ADS-B 1090 ES avionics.

2.3. Potential Benefit of new or Modified System

The following ADS-B surveillance capabilities will contribute to improved safety, capacity, and efficiency of Air Navigation System:

Safety

- Extends surveillance coverage to areas currently not served by radar systems
- Improves or supplements existing surveillance information where needed
- Enables aircraft-to-aircraft surveillance, improving situational awareness in flight
- Improves ATC automation functions, including target accuracy and safety alerting features
- Offers a low-cost, rapidly deployable surveillance solution for contingency situations
- In long term, it may provide aircraft-to-aircraft traffic surveillance capability and provision for ATC and pilots with airport surface traffic surveillance

Capacity

- Enables radar-like separation procedures in remote or non-radar airspace
- Supports the application of common separation standards in select domains and airspace classifications
- Enables potential reductions in existing separation minima standards in all domains
- Increases resilience by complementing radar systems, ensuring service continuity in the event of radar failure, provided that all aircraft operating in the concerned airspace are equipped with the required ADS-B avionics, thereby maintaining the regular separation minima and ATC sector capacity, where operationally justified.

Efficiency

- Reduces lifecycle costs compared to cooperative surveillance radars
- Provides new information, allowing for enhanced sector & airport-derived predictions

- Provides improved information for traffic flow management, collaborative decision making, fleet management, and management by trajectory functions
- enhances traffic flow predictions at the sector and airport levels by updating the ATFM and ATC systems via extended ADS-B coverage.
- Provides a rapidly deployable, mobile surveillance sensor for contingency operations
- Provides precise surveillance and flight parameter data for specialized operating areas, including statistical data and information for development of key performance indicators.

Due to its low cost, compared to RADAR systems, ADS-B implementation will allow States to more rationally assess where it will be convenient to maintain RADAR coverage, considering the corresponding business case.

3 Description of Desired Change

ADS-B 1090 ES surveillance information (airborne and airport surface) will be widely used for air traffic control operations in upper airspace.

ADS-B 1090ES data (airborne and surface) will be broadly used in upper airspace ATC operations.

The ATC system will be upgraded to process and display ADS-B data, ensuring that controllers receive positioning information with the same levels of reliability and integrity currently associated with secondary radar systems. This includes the ability to integrate multiple sources (ADS-B, radar, MLAT) and apply data fusion techniques.

Aircraft must also be capable of transmitting to space-based ADS-B receivers by emitting extended squitter at 1090 MHz. This requirement may be met through antenna diversity (the use of an upper and lower antenna) or with a single antenna capable of transmitting both to the ground and to satellites.

3.1 Surveillance Strategy Based on Performance

In SSR-covered airspace, where aircraft are appropriately equipped and performance requirements are met, ADS-B may be used as a complementary surveillance source to enhance radar data, depending on the outcome of a business case.

In airspaces without SSR coverage, as long as the performance requirements for the minimum longitudinal separations applied are met, ADS-B will be used as the primary source of surveillance.

In the long term, it is expected that ADS-B may replace radar, except where a business case indicates the need to have both radar and ADS-B covering a specific airspace. The Business case must consider among other aspects, the GNSS radio frequency interference, GNSS outages or degradation cases.

Although ADS-B offers significant benefits in terms of cost, coverage, and flexibility, this Concept of Operations does not propose ADS-B as an outright replacement for radar. Instead, ADS-B is presented as a complementary technology that enables surveillance in areas where radar is unavailable or impractical. The progressive substitution of radar systems will be considered only when operational, technical and economic justifications exist, in alignment with the lifecycle of existing infrastructure and subject to stakeholder consultation.

In operational scenarios where surveillance separation performance cannot yet be ensured, the use of ADS-B may still contribute to enhanced situational awareness and timely search and rescue (SAR) support, especially by enabling accurate tracking of the last known aircraft positions. Such implementation should be considered in cases where a supporting business case demonstrates its operational value.

3.2 Multi-Stakeholder Use and Data Sharing

Beyond ATS surveillance, ADS-B data can support:

- Enhanced system safety functions and traffic flow management.
- Situational awareness and SAR coordination.
- Operational monitoring by authorized entities (e.g., airline operations centers, ramp control, ATM strategic planning).
- Development and monitoring of Key Performance Indicators.

A technical review is recommended to assess the full scope of operational data contained in the ADS-B message set, as it includes not only aircraft position but also velocity, identification, intent, and integrity parameters that can support advanced ATM functionalities.

ADS-B data is inherently easier to exchange between adjacent States, as the information broadcast by the aircraft is based on standardized geographic coordinates (latitude and longitude), enabling seamless integration into regional ATM systems.

3.3 Guidance to States on the acquisition and development of infrastructure

States should consider, in their national surveillance strategy, the adoption of technological solutions compatible with the standards established by ICAO, especially those related to ADS-B Out based on DO-260B versions or higher.

The acquisition of ADS-B ground stations, compatible surveillance processors and integrated air traffic control (ATC) systems should comply with criteria of interoperability, scalability, operational coverage, and network connectivity.

It is recommended to carry out a business case, which includes cost-benefit assessments, safety risk analysis, definition of operational requirements and alignment with regional plans, ensuring that the acquired infrastructure meets the concept of cooperative surveillance and is prepared for future updates, as well as with data sharing with neighboring States.

3.4 Ensuring the provision of air traffic services supported by ADS-B

The provision of air traffic services based on ADS-B surveillance should follow a performance-based approach (PBA), preceded by the assessment of the compliance of the data transmitted by aircraft with the minimum required parameters.

To ensure operational continuity and safety, States must implement mechanisms for continuous monitoring of ADS-B performance in accordance with the applicable longitudinal separations, establish procedures for mitigating failures and ensure that controllers are properly trained to operate based on cooperative surveillance.

Integration with ATC systems and the definition of coverage areas with adequate levels of integrity and availability are essential for the reliable use of ADS-B in the provision of ATS services with reduced separation minima.

4. OPERATIONAL DESCRIPTION:

Automatic Dependent Surveillance – Broadcast (ADS-B) is a cooperative surveillance technology in which, similar to radar, aircraft automatically transmit position, velocity, and identification data to Air Traffic Services (ATS) units.

ADS-B is implemented via a 1090 MHz Mode S transponder operating on the protected aeronautical frequency band. The information broadcast includes aircraft identification, three-dimensional position, ground speed, vertical rate, and track angle. These data are typically derived from onboard GNSS receivers and are broadcast at least once per second in flight, in accordance with RTCA DO-260B standards.

In addition to position and velocity, the **quality of the position data**, as determined by onboard navigation sensors, is also transmitted, along with **track vector** information. ADS-B messages include **Figures of Merit**—such as **NIC (Navigation Integrity Category)**, **NACp (Navigation Accuracy Category for Position)** and **SIL (Surveillance Integrity Level)**, which indicate the expected quality, integrity, and reliability of the transmitted position. These parameters allow the ATC system to assess whether the surveillance data meets the performance requirements for specific separation minima and airspace classifications, as described in ICAO Doc 9871.

Like Mode S transponders, ADS-B can also transmit **emergency status information or alert conditions**, when selected by the flight crew. All messages are broadcast periodically and can be received and processed by any compliant ADS-B ground station or space-based receiver within line of sight.

While some of the transmitted information—such as position, speed, and vertical rate—can also be derived from radar systems, ADS-B is generally **more accurate under nominal conditions**, due to its dependence on GNSS. Importantly, **ADS-B accuracy is not range-dependent**, unlike radar, which degrades with distance between the aircraft and the sensor.

4.1 Surveillance

ATC will use ADS-B surveillance information in the same manner as current cooperative surveillance system information is used, for example, to assist aircraft with navigation, to separate aircraft, and to issue safety alerts and traffic advisories.

ADS-B surveillance may be used to replace radar-based surveillance or, in selected airspaces, after a corresponding business case, to enhance the quality of existing radar-based surveillance information for ATC automation system functions, for example, aircraft tracking, Minimum Safe Altitude Warnings (MSAW), Short and Medium Conflict Alert, and Mode-C Intruder Alert.

Depending on operational requirements and subject to a supporting business case, ADS-B surveillance may be used to complement or, in specific cases, replace radar-based surveillance. It can enhance the performance of ATC automation systems by improving aircraft tracking, Minimum Safe Altitude Warnings (MSAW), Short- and Medium-Term Conflict Alerts, and Mode-C Intruder Alerts. It is particularly valuable in airspace where radar coverage is unavailable or limited, enabling surveillance capabilities that would otherwise not be feasible.

4.2 ADS-B Applications

4.2.1 TMA airspace

The airspace immediately surrounding an aerodrome is considered the Terminal Control Area (TMA). This is where aircraft on approach (instrument and visual), aircraft departing and those operating in the vicinity of aerodromes are in close proximity to terrain and each other. Since this is the area of initial climb and final descent, aircraft would be crossing the levels of other aircraft.

In TMAs where the terrain restricts Secondary Surveillance Radar (SSR), ADS-B or multilateration can be used to provide surveillance. The deployment of several ADS-B antennae would be a cost-effective way to provide surveillance where it would not be possible via single SSR. The cost difference between radar and ADS-B installation makes it feasible to install several ADS-B antennae to provide overlapping coverage.

In TMA airspace, when ADS-B equals or exceeds the accuracy of SSR (see ICAO Circular 326), the minimum established radar separation in PANS-ATM (Doc 4444) sections 6.7.3.2.4; 6.7.3.2.5; 6.7.3.4.2, 6.7.3.5.1, as well as Chapter 8 may be applied without any further safety assessment requirement.

In a non-radar TMAs, ADS-B surveillance can be used to reduce separation and an increase in terminal airspace capacity. In these airspaces, an increase in airspace capacity can then allow for increases in flight schedule flexibility, increases in flight path efficiency and reductions in delays or flight disruptions.

In a non-radar airspace, ADS-B integration supports safety nets such as MSAW for aircraft flying close to terrain and reduce the occurrence of Controlled Flight into Terrain (CFIT). Where required, based on business case, in radar airspace, ADS-B would provide redundant surveillance to enhance safety.

4.2.3 En-route airspace

Where required, based on a Business Case, the rapid update of information received from aircraft through ADS-B would increase the situational awareness of the controller since it would allow for a more accurate depiction of the aircraft's current track on the controller work position, if ATM system permits. This would improve the prediction of trajectories, increasing the effectiveness of ATM system conflict detection.

The coverage range of an ADS-B receiver is line-of-sight and can be two hundred and fifty (250) nautical miles at high altitude. If sufficient ADS-B receiving stations are used, adequate coverage can be achieved despite the presence of mountainous terrain or tall structures.

The data obtained from adjacent FIRs could be shared across borders as long as there are compatible data formats. Compatibility considerations for ADS-B data sharing include availability of different data fields if different ADS-B version(s) are supported; interoperability of different ASTERIX CAT021 editions; and handling of ADS-B data received from different ground stations in regions where coverage overlaps. Regional architecture for exchanging ADS-B data between ANSPs is attached as Appendix C.

In a procedural environment, it is difficult for a controller to know if an aircraft is in an abnormal situation. In many cases, this only becomes clear after position reports have been omitted or an emergency (or urgency) report was sent by the pilot. In a surveillance area however, emergency reports are received instantaneously. This allows controllers and emergency professionals to see the aircraft's flight path and accurately locate its last position. A situation that significantly increases the likelihood of a favorable outcome.

In non-radar airspace, cockpit workload can be reduced through the implementation of ATS surveillance solutions. ADS-B is generally considered a more cost-effective option compared to other surveillance technologies. Accurate position reporting in procedural environments imposes a considerable workload on pilots, who must regularly transmit their position to ATC. By automating this task, ADS-B reduces communication requirements and allows pilots to focus on the core tasks of aviating, navigating, and communicating in a more efficient manner.

4.2.3.1 Upper airspace

In procedural (non-surveillance) upper airspace, ADS-B could provide surveillance coverage and reduce the required separation, to that defined by ICAO PANS-ATM (Doc 4444) 8.7.3 provided:

- Identification of ADS-B equipped aircraft is established and maintained.
- The accuracy and integrity measures of ADS-B messages are adequate to support the separation minima.
- There is no requirement for detection of aircraft not transmitting ADS-B.
- There is no requirement for determination of aircraft position independent of the aircraft navigation system.

4.2.3.2 Lower en-route airspace

The speed, rate of climb and descent and general maneuverability vary widely for aircraft in the lower airspace below FL 245. Commercial aircraft, general aviation and military operators all share the lower airspace. ATS Surveillance, including ADS-B, can increase situational awareness for controllers.

In long term, for aircraft with ADS-B IN, improved situational awareness would also be extended to the cockpit.

4.2.4 Oceanic and Remote airspace

The objective of using ATS surveillance based on ADS-B in oceanic and remote airspace is to enable a more efficient horizontal and vertical flight profile through the possibility of approving flight level change requests and direct routing using a reduced separation standard. Flight crews request flight level changes to improve flight efficiency and safety by optimizing fuel burn, accessing better wind conditions and by avoiding turbulence. In procedural oceanic and remote airspace, only ADS-B-IN equipped aircraft can use In-Trail-Procedures (ITP) to execute flight level change maneuvers. ITP allows ATC to approve these flight level change requests between properly equipped aircraft using reduced separation minima during the maneuver.

4.3 Proposed environment

In the short term, ADS-B can complement existing radar systems to improve surveillance performance and fill coverage gaps. Its high update rate and positional accuracy make it a reliable surveillance source, which can also support contingency scenarios such as radar outages or GNSS degradation, provided a supporting business case exists.

Existing Radars will most likely continue in service until reaching the end of their life cycle, at which time they could be replaced by ADS-B, assuming suitable aircraft equipage. ADS-B systems could be installed in anticipation of certain radars becoming obsolete to give sufficient lead-time for their acceptance as radar replacement. Based on a business case, the cost-to-benefit ratio and small footprint of ADS-B infrastructure is an enabling factor for early deployment if the fleet of aircraft operating in the airspace are suitably equipped.

Terrestrial ADS-B coverage can vary depending on altitude and terrain. A range of two hundred and fifty (250) Nautical Miles is possible at high altitudes. This range is reduced at lower altitudes and in mountainous terrain. Modeling tools can predict the expected coverage in advance of deployment. The availability of additional infrastructure such as power, communications and security should also be considered when choosing a site.

5. SYSTEM DESCRIPTION:

5.1. Surveillance Services System

The Surveillance Services system's functions (Aircraft, Data Link Processor, Broadcast Server, ATC Automation, and Traffic Flow Management Automation) provide the ADS-B services that support ADS-B applications. The ADS-B surveillance service is supported by Aircraft/Vehicle, Data Link Processor, and ATC Automation functions.

5.2 Functional Description

The purpose of each function of the Surveillance Services System, how they interoperate with each other, and how the Surveillance Services System fits into the Region are described below.

5.2.1 Aircraft

The Aircraft is the source of ADS-B information. The Aircraft gathers information including position data from a GNSS, crew input, barometric altitude, vertical speed, and aircraft identification data. The Aircraft processes the gathered information and determines the associated integrity and accuracy indicators. The Aircraft encodes and broadcasts the information in an ADS-B message. The ATC ADS-B system will monitor information transmitted by the aircraft. The quality of the data will be evaluated to ensure compliance with the mandated performance measurements and standards.

5.2.2 Broadcast Server

The Broadcast Server is a key component of the ADS-B ground station subsystem responsible for receiving, validating, and distributing ADS-B messages collected from aircraft. After demodulation and decoding of the 1090 MHz signal, the server aggregates the data and formats it according to the required output protocols (e.g., ASTERIX CAT021) for downstream systems.

This component typically performs the following functions:

- Filtering and Validation: Ensures that only compliant ADS-B messages (e.g., DO-260B or higher) are forwarded, applying quality checks and integrity filters.
- Decoding and Timestamping: Processes raw ADS-B messages and applies precise timestamps using synchronized clock sources (e.g., GPS or NTP).

Broadcasting to multiple clients: Redistributes the processed data to a variety of consumers such as:

- Data Link Processors (DLP),
- Air Traffic Management (ATM) systems,
- National or regional surveillance data networks,
- Storage systems or recording tools for post-analysis.

Protocol Support: May support multiple output formats or protocols (e.g., TCP, UDP multicast, SNMP traps) and is often configurable to broadcast based on security or performance requirements.

In a regional context, the Broadcast Server may also serve as the interface point with the national DCN (Data Communication Network) or with regional hubs, allowing for ADS-B data exchange with neighboring ANSPs through secure VPNs or NNI links.

Furthermore, the continuous collection and structured dissemination of surveillance data through the Broadcast Server provides a reliable basis for generating Key Performance Indicators (KPIs) referenced in the ICAO Global Air Navigation Plan (GANP), particularly in relation to performance-based surveillance, situational awareness, and regional interoperability objectives.

5.2.3 Data Link Processor

The Data Link Processor receives ADS-B Messages broadcast by Aircraft over the 1090 MHZ Extended Squitter (1090ES) data link, formats them into ADS-B reports, and sends the reports to an ATC automation system. The Data Link Processor (DLP) generates status reports, containing information on alarms and events in the DLP subsystems and sends them to the ATC automation system. The DLP will also generate internal test target messages and send the resulting ADS-B reports to the ATC automation system.

5.2.4 ATC Automation

ATC automation receives ADS-B reports in both an ADS-B-only environment as well as mixed surveillance (e.g., radar, ADS-B, and Wide Area Multilateration, WAM). ATC automation performs MSAW and Conflict Alerts processing using the ADS-B data (and radar/WAM data if in a mixed surveillance environment). In mixed surveillance environments, radar/WAM data may be used to "validate" ADS-B data to mitigate ADS-B "spoofing" risk. ATC automation may be able to improve tracking and safety feature functions using the high accuracy and greater update rate of ADS-B reports.

5.2.5 Air Traffic Flow Management (ATFM) Automation

ATFM automation should receive ADS-B reports as part of the surveillance data passed from an en route and/or terminal ATC Automation system. As the coverage areas increase, ATFM decision support tools may incorporate the data to produce more accurate demand projections, operational response strategies, (such as ATFM Measures) for periods of excess demand relative to capacity and weather. Additionally, the resultant aggregate demand data provided to the ATM community may reflect the increased accuracy and support better informed collaborative decision-making through traffic management.

5.3 Modes of Operation

The Surveillance Services system is a system of systems, making the definition of modes of operation more complicated than those of a single system providing a single function. Applications are enabled by specific Surveillance Services.

5.3.1 Normal Operations (All Services Available).

Under normal operating conditions, with all CNS/ATM services fully operational (including radar, ADS-B, WAM, and communication systems), ADS-B serves as a complementary and strategic surveillance source, offering high update rates, low latency, and precise position information.

Its integration into ATC automation systems strengthens situational awareness, enhances conflict detection and alerting, and supports trajectory-based operations (TBO). Even in the presence of overlapping radar coverage, ADS-B can improve redundancy and act as a validation source for cooperative targets, enabling improved safety margins.

In this context, ADS-B is not intended to replace existing surveillance systems but to enhance surveillance infrastructure as part of a multi-sensor environment, aligned with the ASBU B1-SUR module of the ICAO Global Air Navigation Plan (GANP). The use of ADS-B in normal operations contributes to the generation of key performance indicators (KPIs) related to safety, efficiency, and capacity, thus supporting strategic planning and continuous performance improvement at the regional and national levels.

5.3.2 Loss of Transmit Capability

A failure or degradation in the aircraft's transmit capability will result in the loss of ADS-B data being sent to the Data Link Processor and other surveillance systems. As a consequence, the affected aircraft will no longer be visible via ADS-B to Air Traffic Control or other ADS-B IN equipped aircraft.

This loss of information can impact situational awareness and the ability to apply surveillance-based separation to that specific aircraft. However, ADS-B services involving other properly functioning aircraft will remain unaffected. The system should include procedures to detect such failures and trigger appropriate fallback mechanisms, such as reversion to radar-based tracking or procedural separation, where applicable.

5.3.3 Degradation or Loss of ADS-B Surveillance Source

Degradation or loss of the ADS-B system would result in the inability to receive ADS-B messages from aircraft, affecting the continuity of surveillance data flow to the ATC automation system. This interruption could prevent the generation of real-time tracks, safety alerts, and situational awareness updates. The impact will depend on the affected airspace and whether redundant surveillance sources (e.g., radar, WAM) or neighboring ADS-B stations can compensate for the loss.

Due to the criticality of aircraft surveillance data, a backup plan must be in place. In areas covered by other surveillance sources, including radar and WAM systems, data from the other system would be used as backup surveillance in the ATC/ATFM Automation system when this occurs. In non-radar areas, controllers would revert to procedural separation. The degradation or loss of the ADS-B surveillance source, GNSS, could result in regional loss of ADS-B services. This would result in the loss of the Aircraft ability to transmit ADS-B state vector information.

5.3.3 ATC Automation

Each ATC Automation system should have system-specific backup strategies that will apply regardless of the source of surveillance data.

6. ASSUMPTIONS, CONSTRAINTS, AND DEPENDENCIES

6.1 Organizational Impacts

6.1.1 Staffing

The introduction of ADS-B applications may require adjustments to current ATC facility staffing schemes to optimize facility operations. Technical support personnel adjustments may need to be made to support and maintain local and remotely deployed ADS-B equipment, in addition to the maintenance responsibilities for existing infrastructure equipment. An adequate number of field support facilities and personnel will be required to install and maintain, ADS-B equipment. Training requirements guidance for Air Traffic Controllers, CNS technicians and Supervisors, and Inspectors is attached as appendix D, based on Circular 326, Doc 4444, and TRAINAIR Plus materials.

6.1.2 Safety Management System (SMS)

The Surveillance Services **s**ystem should conform to ICAO SMS processes. See Appendix J for representative hazards and commensurate risk assessments.

6.1.4 Regulation and Policy

Rules may be required, and procedures will be necessary to support ADS-B enabled spacing and separation operations. Any changes to flight rules may require public comment and resolution.

Other actions, such as airspace redesigns, may be necessary to realize full operational benefits.

6.1.5 Publication/Notices

Changes to current publications will be required to reflect operational and compliance changes. Development of new operational, procedural, and training documentation is required. Notices announcing changes to operational, procedural, and compliance requirements will need to be developed and distributed. Examples of documentation that may be affected include, but are not limited to:

- International Agreements
- Aeronautical Information Publication (AIP), AIC and NOTAM
- Letters of Agreement (LOA)
- ATC Facilities Standard Procedures

6.2 Operational Impacts

6.2.1 ATC Automation

For ATC surveillance application, DLPs will provide ADS-B reports and status reports to ATC automation systems. ADS-B reports received by automation will include not only aircraft position/altitude and Mode 3A codes, but also additional surveillance related parameters such as, but not limited to, velocity, aircraft flight identification, and accuracy/integrity measures of ADS-B position reports. When ADS-B accuracy/integrity measures are inadequate for the service being provided, then either the corresponding ADS-B data should not be displayed to the controller, or the controller should be notified that the displayed data cannot be used. ADS-B ground stations will provide surveillance reports to automation at a higher update rate than radar. ADS-B reports may also be used by automation to improve aircraft tracking accuracy and safety functions such as CA and MSAW.

Because of the additional surveillance provided by ADS-B, ATS providers may desire to implement the use of fusion on ATC automation platforms. This capability fuses any available surveillance source (e.g., ADS-B, Radar, WAM) and displays a single tracked target to ATC. This allows automation to provide ATC with a faster synchronous display update and, when ADS-B surveillance is part of the fused target, a more accurate target position will be displayed to the controller.

6.2.2 ATFM Automation

For ATFM automation, ADS-B reports may be incorporated as elements of the already established provision of surveillance from en route and terminal ATC Automation systems. There are no anticipated significant operational impacts. The resolution of any asynchronous reporting/timing issues should be resolved within the ATC Automation systems prior to exchange with ATFM. The use of the improved surveillance by ATFM systems, processes and personnel will be as described above. Diagrams that describe how ADS-B strengthens national or regional ATFM systems is attached as Appendix E.

6.2.3 Radar-based Surveillance Systems

A communication interface method with existing primary and secondary radars or WAM systems will be required to provide sensor measurements.

6.2.4 Service Provider and User Procedures

The introduction of ADS-B may require ATC standard operating procedures changes to optimize potential operational efficiency gains.

6.2.5 ADS-B Separation Standards

Analysis may be required to determine separation standards between mixed equipage targets received from different surveillance systems including the transition boundaries between these surveillance areas. Once a service provider shows that ADS-B positioning accuracy and integrity is equivalent to or better than secondary surveillance radar, then ICAO radar separation minima (PANS-ATM, Chapter 8) can be utilized. The goal is a common, standardized separation minimum for service providers.

6.3 Service Provider and User Impacts

The equipage decision will vary for different users and consideration must be given on the effect ADS-B implementation and operations will have on those that do or do not equip. Each state will define and enforce avionics and navigation equipment standards through corresponding State publications, etc. but must be within the minimum standards specified by ICAO.

Each state will issue a publication that prescribe minimum performance standards for navigation equipment used by the civil aviation community. ICAO issues standards and recommended practices for international civil aviation. The development of minimum performance standards for military users may be the responsibility of the separate department services. These military standards must conform to civil airspace required navigation performance requirements, prevent violation of civil air traffic clearances, and ensure safe separation of military and civil air traffic.

6.3.1 User and Service Provider Training

Since ADS-B out will be part of the ATS surveillance, which it has been used for several decades, it is not expected simulated or special training for users and service providers. However, a theoretical instruction will be required to understand the new technology's capabilities, characteristics, and limitations. This will include, but not be limited to:

- Rules governing areas and conditions allowing an ADS-B application.
- Rules governing certified equipment levels and personnel qualifications.
- Rules and procedures for separation applications.

7. ADS-B IMPLEMENTATION

The ADS-B implementation, as any new technological solutions, will be based on a positive business case, maximizing existing aircraft capabilities, when operationally justified. The ADS-B implementation and related infrastructure should consider, among other aspects:

- Measurable safety and/or operational improvements as agreed by stakeholders.
- Follow an inclusive airline consultation process prior to investments being made.
- Be supported by coordinated cost-benefit analysis.
- Follow ICAO user charges principles.

ADS-B implementation schedule as of the date of approval of this document is attached as Appendix F

At the final stage of ADS-B implementation, in the end-of-life cycle of the already installed radars, ADS-B should not be implemented as a redundant surveillance capability, and, provided there is a positive business case, it should replace radar, or be used in non-radar airspace to improve ATS surveillance. Exceptions should be evaluated where there is a strong operational requirement (complexity and/or volume of traffic, for example) to keep both radar and ADS-B. Transition timelines need to be determined in consultation with airspace users.

Mandating ADS-B OUT avionics equipage should be considered only for airspace where ADS-B is planned to be the only surveillance capability. Once ADS-B ground stations become operational, ANSPs should, and based on end of radar cycle of life, in consultation with airlines, publicly and transparently establish a timeline to decommission other surveillance infrastructure.

The rationalization of radar infrastructure is a possible and emerging trend following the successful implementation of ADS-B in certain airspace. According to the Global Air Navigation Plan (GANP), module ASUR-B4/1, "cooperative surveillance is expected to become the primary means of surveillance and will typically be provided by ADS-B and MLAT systems, while rotating radars will be decommissioned at the end of their service life, where appropriate."

The required performance for airborne and ground-based ADS-B systems must align with the longitudinal separation minima applied or planned for the airspace in question. This alignment should be supported by projected gains in capacity and efficiency, validated through a positive business case and a corresponding safety assessment. The operational use of ADS-B by States—and the separation minima applied or introduced—should be guided by ICAO Circular 326, *Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation* and supported by an evaluation of existing onboard capabilities.

Note: ICAO Circular 326 provides guidance on ADS-B implementation, covering, among other aspects, separation standards, the need for an airspace concept, performance requirements, and safety assessment criteria.

ADS-B implementation should be part of an integrated planning, including, at least, communication, navigation, and ATM systems/procedures to implement concrete airspace user benefits such as enhanced air traffic flow management, optimized aircraft separation, Improved Operations through Enhanced en-route Trajectories - FRTO (e.g., User Preferred Routings – UPR, Strategic Direct Routing – SDR and Free Route Airspace – FRA). In this sense, in accordance with guidance provided by ICAO for planning/implementation of the Global Air Navigation Plan, States should use the Six Steps Method, provided in the ICAO Doc. 9883 to perform the mentioned integrated planning/implementation, applying its main principles:

- Strong focus on desired/required results.
- Reliance on facts and data for decision making; and
- Collaborative justified decision-making

7.1 ADS-B as enabler for ATM and Safety projects

7.1.1 Optimization of Longitudinal Separation Minima

Currently in several SAM region FIRs boundaries, the longitudinal separation minima applied by ACCs is 80 NM or 10 minutes. Some initiatives in SAM Region were taken to reduce such separation to 40NM, evolving to 20NM, in a non-radar environment, with application of GNSS distance and VHF communication, as provided in the ICAO Doc. 4444. However, there is still reluctancy on using this separation minima due to the lack of ATS Surveillance.

ADS-B should be used to cover the existing gaps in the boundaries of the CAR/SAM FIRs to boost the reduction of longitudinal separation minima to 20 NM, evolving gradually to 10 NM, as recommended by 14th ICAO Air Navigation Conference. Special attention should be given by State for a possible need to cover gaps in VHF Communication to fulfil all requirements for such implementation.

7.1.2 Improved Operations through Enhanced en-route Trajectories - FRTO

The implementation of Improved Operations through Enhanced en-route Trajectories (FRTO), by the application of User Preferred Routings (UPR), Strategic Direct Routing (SDR) and Free Route Airspace (FRA), is one of the main initiatives to increase performance in the efficiency through the reduction of flight time and distance, improvement of vertical flight profile, focusing on fuel savings and CO_2 emissions.

Some FRTO initiatives in portions of the SAM Region were not possible due to deficiencies in the ATS Surveillance and VHF coverage, mainly in the boundaries of FIRs. An integrated planning of ADS-B and VFH coverage in the FIR boundaries to complement the existing infrastructure may boost the implementation of the Cross Border SDR, gradually evolving to the Cross Border FRA.

7.1.3 OPFL - Target-to-target separations using Space-based ADS-B data

With the advent of Space-based ADS-B data in oceanic and remote continental areas, there are projected Capacity, Efficiency and Environmental advantages in SB ADS-B derived separation minima.

A "radar-like" target-to-target separation minima that capitalizes on the increased frequency of position information updates but makes use of datalink communications capability (for circumstances where VHF communications do not exist) will offer increased flexibility and free aircraft form needing to adhere to specific tracks. The horizontal separation applying ADS-B and communications system satisfying RCP 240 may be 15 NM, in accordance with ICAO Doc. 4444.

Implementation of the target-to-target separation minima will provide alleviation track adherence requirements associated with procedural separation minima. And offer a consequent increase in access to optimal flight levels.

The availability of the flexibility offered by target-to-target separation will increase airspace efficiency, resulting in reduced fuel burn and consequently reduced greenhouse gas emissions.

7.1.4 Reduction of Large Height Deviation (LHD) and implementation of AIDC

The meeting of the GREPECAS Twenty-Third Scrutiny Working Group Meeting (GTE/23 informed that LHDs with Code "E" (error/failure of coordination between ATC facilities) were the most frequent in 2022, with 685 of 711 events (96%). The high number of "E" codes is being demonstrated since the beginning of the GTE work, after the RVSM implementation, which urges the need for better coordination between adjacent air traffic units, which could be achieved through awareness-raising and coordination training among controllers.

One of the main tools to improve the coordination between adjacent ATS facilities is the implementation of AIDC, and due to the amount of Code E LHD, its implementation is considered a high priority in SAM Region.

The implementation of AIDC is dependent of an adequate ATS Surveillance in the boundaries of FIRs, including a suitable overlap. In this sense, the implementation of ADS-B in the FIRs limits to cover the actual gaps in the ATS Surveillance coverage is one the requirements for an adequate implementation of AIDC.

It is important to note that even without an AIDC implementation, a suitable ATS surveillance and VHF coverage is by themselves essential mechanism to mitigate errors in the coordination between ATS facilities. Functional diagrams that describe how ADS-B strengthens AIDC exchanges, especially in border FIRs where high levels of LHD (Large Height Deviation) have been reported is attached as Appendix G.

7.2 ADS-B concept of operations by Block – GANP

Block	Description
Baseline	Aircraft surveillance is accomplished through the use of non-cooperative and cooperative surveillance radar. Non cooperative surveillance radar derives aircraft position based on radar echo returns. Cooperative surveillance radar is used to transmit and receive aircraft data for barometric altitude, identification code. However, non-cooperative and cooperative surveillance radars cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions, and have a heavy reliance on mechanical components with large maintenance requirements.
Block 0	Surveillance is provided supported by new technologies such as ADS-B OUT and wide area multilateration (MLAT) systems. These capabilities will be used in various ATM services, e.g., traffic information, search and rescue, and separation provision. ADS-B OUT and MLAT systems complement existing cooperative surveillance radar and may be deployed independently or together. Depending on local airspace needs, ADS-B or MLAT may replace cooperative radar.
Block 1	ADS-B surveillance is provided using receivers on spacecraft, allowing improved options for surveillance in oceanic and remotes areas.
Block 2	The evolution of ADS-B and transponder avionics provides new aircraft/atmospheric information to support ANSP and vehicle-to-vehicle applications. New community and internet-based surveillance system to track airborne vehicles at low altitudes and/or high altitudes. Performance-based surveillance framework is provided for ANSP services. Within this timeframe, vehicle identities/positions/velocities may be shared using the internet. Automated dependent surveillance broadcast vehicle-to-vehicle potentially is provided in a different spectrum in lower airspace for small RPA operations.
Block 3	All aircraft identities/positions/velocities are provided/shared by the operator using an aviation network. A performance-based surveillance framework allows ANSPs to determine the most effective blend of surveillance methods. Cooperative surveillance is expected to be the principal means of surveillance and is typically provided by ADS-B and MLAT systems; rotating radars will be replaced at end-of-life where appropriate. New passive non-cooperative surveillance techniques available to provide such services at lower cost.

7.3 Integrated CNS Planning in SAM Region

The ADS-B implementation will prioritize covering existing gaps in the Communication and ATS Surveillance in SAM Region. An adequate coverage, mainly in the FIRs boundaries, will allow an improvement of safety and efficiency.

7.4 Link with international environmental commitments

An integrated planning, including ADS-B as one of main enablers to achieve flight efficiency, will allow States to complement other aviation in-sector emissions reductions efforts such as technological innovations and sustainable aviation fuels to meet the ICAO aspirational goal of carbon neutral growth. States should use environmental indicators of GANP and flight efficiency in reducing emissions through optimized routes and smaller separation.

7.5 Proposed Regional Implementation and Prioritization Framework for ADS-B Surveillance

In alignment with the regional strategic objectives for enhanced surveillance and seamless air traffic services, the following structured framework is proposed to guide the phased implementation and prioritization of ADS-B (Automatic Dependent Surveillance–Broadcast) capabilities across CAR/SAM FIRs.

1. FIR-Specific Implementation Timeline

To support the regional goal of achieving ADS-B coverage above FL290 by the year 2030, States should adopt a phased deployment plan tailored to each FIR. Prioritization shall be based on the following operational criteria:

- High IFR traffic density areas.
- Border regions with insufficient radar coverage.
- FIRs with documented Large Height Deviation (LHD) occurrences.

FIRs of immediate interest include those covering the Amazon basin, Andean corridors, and Eastern Caribbean airspace.

2. Inter-FIR Data Exchange Architecture

To enable effective surveillance continuity across FIR boundaries, States should adopt a standardized, secure, and interoperable data exchange framework, including:

- Use of ASTERIX Category 021 for message encoding.
- Secure FTP or mirrored data repositories for data sharing.
- Compatibility with regional SWIM platforms where available.

3. Operational Integration with ATFM and AIDC

The integration of ADS-B surveillance into existing ATM systems shall enhance:

- Cross-border AIDC coordination processes, reducing LHD risk and improving transfer predictability.
- Air Traffic Flow Management (ATFM) systems through real-time trajectory updates.

Operational flow diagrams and interface models are recommended to illustrate these enhancements.

4. Economic Assessment Reference

To assist in cost-benefit analysis and investment planning, a regional reference table should be developed, including:

- Estimated acquisition and installation costs per ADS-B ground station.
- Integration costs for ATC/ATM systems.
- Projected operational benefits, such as fuel savings and capacity optimization.

5. Regional Prioritization Indicators

A harmonized list of prioritization indicators is proposed to assist States in identifying critical deployment areas. These include:

- Volume of IFR movements.
- Existing SSR or radar coverage gaps.
- VHF communication coverage deficiencies.
- Reported AIDC coordination limitations.
- Historical LHD rates per FIR.

6. Training and Certification Requirements

Minimum training and certification standards should be established for:

- Air traffic controllers applying ADS-B-based separation minima.
- CNS personnel responsible for the operation and maintenance of ADS-B systems.
- Supervisors overseeing ADS-B procedural application.

Training programs should be aligned with ICAO provisions, including Doc 4444 (PANS-ATM), Circular 326, Doc 10012, and TRAINAIR Plus modules.

7. Environmental and Efficiency Benefits

ADS-B implementation is expected to contribute significantly to environmental sustainability goals as defined in the GANP and under ICAO's CORSIA framework. Notable benefits include:

- Reduced fuel burn through optimized routing and reduced separation.
- Lower CO_2 emissions due to enhanced surveillance accuracy and flight efficiency.

This framework supports the region's transition toward performance-based surveillance, enabling harmonized implementation, increased safety, and environmental sustainability.

APPENDIX A

Prioritization criteria for ADS-B implementation to cover ATS surveillance gaps

TBD

APPENDIX B

Reference Costs for ADS-B Implementation

TBD

APPENDIX C

Regional architecture for exchanging ADS-B data between ANSPs

TBD

APPENDIX D

Training requirements guidance for Air Traffic Controllers, CNS technicians and Supervisors

TBD

APPENDIX E

Diagrams that describe how ADS-B strengthens national or regional ATFM systems

TBD

APPENDIX F

ADS-B implementation schedule

APPENDIX G

Functional diagrams that describe how ADS-B strengthens AIDC exchanges, especially in border FIRs where high levels of LHD (Large Height Deviation)

TBD

APPENDIX H

References

[1] APANPIRG ADS-B Study, Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689), Second Edition, 2017

[2] Space Based ADS-B Surveillance in Oceanic Airspace Concept of Operations Draft 0.2 dated February 1, 2012.

[3] ICAO Document 9854 “Global Air Traffic Management Operational Concept:” First Edition 2005

[4] DOC 4444, “Procedures for Air Navigation Services, Air Traffic Management”, ICAO, Tenth six edition 2016

[5] Annex 2 to the Convention on International Civil Aviation, “Rules of the Air”, ICAO, July 2005

[6] Annex 4 to the Convention on International Civil Aviation, “Aeronautical Charts”, ICAO, July 2009.

[7] Annex 11 to the Convention on International Civil Aviation, “Air traffic Services”, ICAO, Fourteenth Edition, July 2016.

[8] Annex 15 to the Convention on International Civil Aviation, “Aeronautical Information Services”, ICAO, Fifteenth Edition, July 2016

[9] ICAO Cir 326, “Assessment of ADS-B and Multilateration Surveillance to Support Air traffic Services and Guidelines for implementation”, ICAO, 2012

APPENDIX I – Definitions and Glossary

ACAS	(ICAO) Airborne Collision Avoidance System
ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance – Contract
ANS	Air Navigation Services
ANSP	Air Navigation Services Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATS	Air Traffic Service
CPDLC	Controller Pilot Data Link Communications
CRM	Collision Risk Model
CSP	Communication Service Provider
CTA	Control Area
DCPC	Direct Controller Pilot Communication
Doc 4444	(ICAO) Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)
FIR FL (number)	Flight Information Region Flight Level
GNSS	Global Navigation Satellite System
HF	High Frequency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IGA	International General Aviation
MNPS	Minimum Navigation Performance Specifications
MTCD	Medium Term Conflict Detection

NAT	(ICAO) North Atlantic (Region)
NM	Nautical Miles
OCA	Oceanic Control Area
PBN	Performance Based Navigation
RCP	Required Communication Performance
RNPC	Required Navigation Performance Capability
RVSM	Reduced Vertical Separation Minima
SAR	Search and Rescue
SATCOM	Satellite Communications
SATVOICE	Satellite Voice Communications
SMS	Safety Management System
TCAS	Traffic Collision Avoidance System
VHF	Very High Frequency

APPENDIX J: Hazard and Risk Evaluation of ADS-B Application:

Table Att-1. Severity table (basic)

Level	*Descriptor*	*Severity description (customize according to the nature of the product or the service provider's operations)*
1	Insignificant	No significance to aircraft-related operational safety
2	Minor	Degrades or affects normal aircraft operational procedures or performance
3	Moderate	Partial loss of significant/major aircraft systems or results in abnormal application of flight operations procedures
4	Major	Complete failure of significant/major aircraft systems or results in emergency application of flight operations procedures
5	Catastrophic	Loss of aircraft or lives

Table Att-3. Likelihood table

Level	*Descriptor*	*Likelihood description*
A	Certain/frequent	Is expected to occur in most circumstances
B	Likely/occasional	Will probably occur at some time
C	Possible/remote	Might occur at some time
D	Unlikely/improbable	Could occur at some time
E	Exceptional	May occur only in exceptional circumstances

Table Att-4. Risk index matrix (severity × likelihood)

	Severity				
Likelihood	*1. Insignificant*	*2. Minor*	*3. Moderate*	*4. Major*	*5. Catastrophic*
A. Certain/frequent	Moderate (1A)	Moderate (2A)	High (3A)	Extreme (4A)	Extreme (5A)
B. Likely/occasional	Low (1B)	Moderate (2B)	Moderate (3B)	High (4B)	Extreme (5B)
C. Possible/remote	Low (1C)	Low (2C)	Moderate (3C)	Moderate (4C)	High (5C)
D. Unlikely/improbable	Negligible (1D)	Low (2D)	Low (3D)	Moderate (4D)	Moderate (5D)
E. Exceptional	Negligible (1E)	Negligible (2E)	Low (3E)	Low (4E)	Moderate (5E)

(Adapted from Doc 9859)

Operational Activity	Identified Hazards and Risks	Description of Risk	Initial Risk Assessment			Further Mitigation factors	Revised Risk Assessment		
			Likelihood	Consequence	Risk Level		Likelihood	Consequence	Risk Level
ADS-B Operational Trial	Failure of Ground Station	Loss of ADS-B positional data to the controller. Increase in workload due to transitioning to procedural control and reassess traffic.	unlikely	Insignificant	3D	Revert to procedural control and apply appropriate separation standard for affected aircraft. A site monitoring system shall provide a degree of on-line integrity monitoring. Warnings would be provided to ATC if site monitoring is not received.	unlikely	insignificant	3D
Incorrect Data broadcast by an aircraft due to data corruption	Incorrect data due to data corruption broadcast by the aircraft ADS-B transponder. The GNSS on the aircraft still operating correctly.	Significant error in the displayed position of the aircraft that could lead to a breakdown in separation without the controller being aware.	remote	moderate	3D	controller observation of history trail and look for track jump	remote	minor	2D

Corruption of Data by the ground station	Incorrect data displayed to the controller due to data corruption at the ADS-B ground station	Error in the reported position of the aircraft therefore could lead to a breakdown in separation without the controller being aware. This may affect all data.	Improbable		3D	Controller observation of history trail and look for track jump. Ensure only tested and proven ADS-B ground station are used in the operational trials. Ensure Route adherence monitoring is implemented for ADS-B tracks.			
Loss of position accuracy of reported position	The accuracy performance of the navigational equipment in the aircraft has deteriorated to the level that it is not acceptable to support the specified separation standard	Loss of ADS-B positional data to the controller. Increase in workload due to transitioning back to procedural control and reassess traffic	remote	moderate	3D	Ensure the ATM system will detect degradation in accuracy performance below a specified threshold and provide appropriate visual notification to the Unit concerned (NUC value). Revert to procedural control for the affected aircraft. Site monitoring is used to validate that it is only one aircraft affected.	remote	minor	2D
Incorrect processing of ADS-B Data by the ATM system	Data reaching the ATM system processed in such a way as to give a false indication of position, altitude, or trajectory	Possible error in the displayed position of the aircraft therefore could lead to a breakdown in separation	remote	moderate	3C	Conduct comprehensive testing of the ADS-B processing and displaying functionality of the ATM. Test should include the conduct flight tests and compare results to commissioned radar information.	improbable	moderate	3D

Failure of GNSS satellites	Loss of ADS-B tracks at the ATS unit	Loss of ADS-B data and Nuc drops causes an increase in workload and procedural control in re-established.	unlikely	moderate		site monitoring installed to provide a degree of on-line monitoring and warning to ATC if site monitoring			
Inadequate ATS Training	Introduction of ADS-B function to an ATS unit without adequate training introduces a new hazard.	Insufficient training in MHI, new procedures and transition from ADS-B control to procedural control and may increase the probability of breakdown in separation.	possible	moderate	3C	prove comprehensive training that covers all operational aspects including contingencies	unlikely	moderate	3D
Inadequate Operational Procedures	Introduction of new ADS-B function is new to ATS, and adequate operational procedures will introduce a hazard to the system	inadequate operational procedures for managing and controlling ADS-B areas increases the probability of a breakdown	remote	minor	3C	Maximize the reuse of proven operational procedures to handle ADS-B control areas. Ensure sufficient procedures are developed and tested for the transition between ADS-B and Procedural control	unlikely	minor	2D
RF Jamming	Radio Frequency Jamming of ADS-B due to deliberate or non-deliberate actions	Loss of ADS-B positional data to the ATS unit result in in an increase in workload due to transitioning to	improbable		3D	Increase in the level of security and security response at ground installations			

		procedural control.							
incorrect altitude data transmitted by aircraft	Aircraft transmitting wrong altitude because of faulty barometer or wrong geometric levels on display	Could lead to a loss of separation between aircraft or CFIT	unlikely	major	4D	obtain verbal verification of altitude when ADS-B target is observed	improbable	major	4D
Incorrect 24-bit code	incorrect 24-bit code filed on the flight plan leading to mismatch or no match ADS-B target to filed FPL	wrong call sign affixed to aircraft track leading to increase workload for controller to rationalize the proper callsign	remote	minor	2C	work by plight plan monitoring group to identify how often this occurs and put measures to reduce the incidents with operator	improbable	minor	2D
Failure of communication link between the ground station and ATS unit	loss of ADS-B position at the ATS unit due to the loss of data from ground station	increase in controller workload transitioning to procedural control and possible loss of separation between aircraft	unlikely	moderate	3D	ensure redundancy of communication lines and power and reliability of technical support for the ground installation	unlikely	moderate	3D

Failure of site monitor	site monitor relays information on the suitability of data received from ADS-B returns	erroneous data could be reaching the ATM system and be undetected by the controller leading to loss of separation	remote	moderate	3C	scheduled checks on site monitoring equipment done at frequent intervals and data collection and analysis	remote	moderate	3C
Mixed operating environment	controller having different tracks to work with ADS-B, Flight Plan and SSR tracks	increase in controller workload transitioning different separation standards and possible loss of separation between aircraft	possible	moderate	3C	adequate initial training in procedures and regular refresher training to ensure controller competence	unlikely	moderate	3D

— — — — — — — — — — —