GREPECAS/23 —
WP/8.7
05/01/26

Fifth GREPECAS–RASG-PA Joint Meeting (GREPECAS-RASG-PA/5) and Twenty-Third Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/23)
Virtual Phase (Asynchronous, January 19 to February 17, 2026)
Face-to-face Phase (Mexico City, Mexico from March 4 to 6, 2026)

Agenda Item 8: CAR/SAM Air Navigation implementation

CONOPS ADS-B update – SAM region (2026-2036)

(Submitted by the Secretariat)

EXECUTIVE SUMMARY	
This working paper presents the status of the update of CONOPS ADS-B SAM, which is being carried out by the CONOPS ADS-B Working Group of the CNS/SUR Subgroup of the Interop WG, under the auspices of SAM/IG and Regional Project 06/901.	
Acción:	The meeting is invited to: a) Take note of the information provided in this working paper. b) Evaluate the draft of the CONOPS ADS-B SAM and consider its adoption by the NACC/CAR/SAM Regions, following the example of the current version.
Strategic Objectives 2026-2050:	• Every flight is safe and secure • Aviation is environmentally sustainable • Aviation delivers seamless, accessible, and reliable mobility for all • No country left behind • The International Civil Aviation Convention and Other Treaties, Laws and Regulations Address All Challenges • The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All
References:	• Report of the GREPECAS/20 meeting • Report of the GREPECAS/21 meeting • CONOPS ADS-B NAM/CAR/SAM • Report of the meeting SAM/IG/33

1. Introduction

1.1 GREPECAS/20 agreed that ADS-B is a surveillance system that has advantages over secondary radars and other methods such as multilateration (MLAT) and the Wide Area Multilateration System (WAM), due to its high accuracy and low infrastructure costs. Many States are already migrating to this technology and collaboration with other States is recommended to have an integrated regional system.

1.2 GREPECAS recognized, through the conclusion GREPECAS/20/03 below, the need for the Secretariat, in coordination with industry, to carry out a study on the operational priorities for the implementation of ADS-B and on aspects of the use of ADS-B in ATC Units, based on the technical guidance documentation available to the CAR/SAM Regions by GREPECAS/21. The objective of this study was to promote the coherent and harmonized implementation of ADS-B in the CAR/SAM Regions, within the framework of the Alternative Surveillance module (ASUR) of the GANP, recognizing the priorities of airspace optimization and ATS provision. services in the regions.

CONCLUSION GREPECAS/20/03	**STUDY ON OPERATIONAL PRIORITIES FOR THE IMPLEMENTATION OF ADS-B AND ASPECTS OF THE USE OF ADS-B IN ATC UNITS.**		
What: That, the Secretariat, in coordination with the industry, executes a study on the operational priorities for the implementation of ADS-B and on aspects of the use of ADS-B in ATC units, based on the technical guidance documentation available for the CAR/SAM Regions by GREPECAS/21.		**Expected impact:** ☐ Political / Global ☒ Inter-regional ☐ Economic ☐ Environmental ☒ Operational/Technical	
Why: To promote the coherent and harmonized implementation of ADS-B in the CAR/SAM Regions, within the framework of the Alternative Surveillance (ASUR) module of the GANP, recognizing the priorities of airspace optimization and the provision of ATS services in the region.			
When:	By GREPECAS/21	**Status:**	☒ Valid / ☐ Superseded / ☐ Completed
Who:	☐ States ☒ ICAO ☐ Other:	NACC/SAM Secretariat	

1.3 GREPECAS/21 meeting concluded on the need to update ADS-B CONOPS, with a view to, among other aspects, defining the operational objectives for the implementation of ADS-B in the CAR/SAM regions. In this regard, Decision GREPECAS/21/20 has been formulated below.

CONCLUSION GREPECAS 21/20	**DEVELOPMENT OF AN ACTION PLAN FOR THE ADS-B IMPLEMENTATION**		
What: That States/Territories, led by ICAO, a) review the existing Operational Concept for the ADS-B Implementation in the CAR and SAM Regions, including its operational objectives, b) support the development of model regulations for ADS-B; c) integrate all different stakeholders in the process; and d) develop an action plan incorporating activities, accountability, and milestone dates by 15 August 2024.		**Expected impact:** ☐ Political / Global ☒ Inter-regional ☒ Economic ☐ Environmental ☒ Operational/Technical	
Why: ADS-B is an enabler to several of the operational improvements foreseen in the GANP ASBUs, current many States have implemented ADS-B infrastructure as a surveillance mean. To obtain the benefits of ADS-B implementation regional agreements and priorities for the CAR and SAM States			
When:	15 August 2024	**Status:**	☒ Valid / ☐ Superseded / ☐ Completed
Who:	☒ States ☒ OACI ☒ Others: IATA		

1.4 Based on the GREPECAS guidelines, the SAM/IG, through the GT Interop, has created 3 working groups to deal with ADS-B planning and implementation:

a) ADS-B CONOPS WG;
b) Regulation WG; and

c) Implementation WG.

2. Analysis

2.1 To date, the ADS-B CONOPS WG has held 12 virtual meetings with a view to discussing and validating the contributions made by the group members to update the current version of the NAM/CAR/SAM ADS-B CONOPS, first version of which was approved in April 2015 and updated in March 2022.

2.2 The proposed major changes are in **Appendix A** to this working paper. The current SAM ADS-B CONOPS version is in **Appendix B** to this working paper.

Explanatory Note: The 'APPENDIX A' to 'APPENDIX G' included in the CONOPS document (Appendix B to this Note) corresponds to internal appendices of CONOPS and should not be confused with the appendices of this Working Paper.

The proposal is that the new CONOPS ADS-B SAM have the following purposes:

a) Facilitate coordination among stakeholders involved in, or affected by, ADS-B implementation;
b) Define the operational objectives and expected benefits of ADS-B implementation in the SAM Region;
c) Describe the operational environment and conditions that allow or limit ADS-B application;
d) Present the planned improvements in the air traffic management (ATM) functionalities that will be enabled by ADS-B;
e) Provide guidance to States on the planning, procurement, and development of infrastructure necessary for ADS-B implementation;
f) Describe how ADS-B supports the optimization of air traffic services by strengthening ATS surveillance capabilities; and
g) Share essential information to promote interoperability, smooth transition of surveillance between Flight Information Regions (FIRs), data exchange between Air Navigation Service Providers (ANSPs), and harmonized aircraft equipment and ATM systems strategies.

2.3 The operational objectives of the ADS-B deployment in the SAM Region that reflect current regional needs and align with the strategic direction established by ICAO for the evolution of ATM systems globally, are to:

a) Provide surveillance coverage in continental airspace without radar and allow the application of horizontal separation minimums of 10 nautical miles (NM), based on cooperative surveillance (SSR, Mode S, MLAT and/or ADS-B).
b) Complement radar coverage in airspaces that already have radar, adding an additional layer of cooperative surveillance, based on a business case as indicated in items 2.4 and 2.5.
c) Provide surveillance capabilities in remote and oceanic airspaces.
d) Enable the implementation of new air traffic management concepts, such as:
    - Free route airspace;
    - En-trail procedures (ITP);
    - Advanced surveillance enhanced procedural separation (ASEPS), in remote/or oceanic airspace;
    - Trajectory-Based Operations (TBO);

e) Support future regional strategic initiatives for the optimization and rationalization of surveillance infrastructure.
f) Contribute to increasing the interoperability of the systems, through the harmonization of communication protocols, allowing compatibility between all systems.

2.4 The SAM ADS-B CONOPS draft indicates that States should consider, within 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 must meet the following criteria:

a) Interoperability;
b) Scalability;
c) Operational coverage; and
d) Network connectivity.

2.5 The SAM ADS-B CONOPS recommends that, for its implementation, a business case should be developed, that includes:

a) Cost-benefit evaluations;
b) Safety risk analyses;
c) Definition of operational requirements; and
d) Alignment with regional plans.

2.6 The adoption of appropriate technological solutions and the realization of a business case, as indicated in paragraphs 2.4 and 2.5, will ensure that the acquired infrastructure complies with the cooperative surveillance concept, is prepared for future upgrades, and allows data sharing with neighbouring States.

2.7 The CONOPS proposal indicates that, 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 source of surveillance, which can also support contingency scenarios, such as radar failures, as long as there is a business case to justify it.

2.8 The draft CONOPS shows that existing radars are likely to continue in service until they reach the end of their life cycle, at which point they could be replaced by ADS-B, provided the aircraft are properly equipped. ADS-B systems could be installed early in the face of the obsolescence of certain radars, providing the necessary time for them to be accepted as a replacement for radar. Based on a business case, the cost-benefit ratio and low infrastructure footprint of ADS-B are enabling factors for early deployment, if the fleet of aircraft operating in that airspace is adequately equipped.

2.9 In relation to the ADS-B separation standards, it will be necessary to carry out analyses to determine the separation standards between targets with different equipment, received from different surveillance systems, including the transition zones between these areas. Once a service provider demonstrates that the accuracy and completeness of the position provided by ADS-B is equivalent to or superior to that of secondary surveillance radar (SSR), the radar separation minima set out by ICAO in PANS-ATM (Chapter 8) or higher, may be applied.

2.10 The proposed CONOPS indicates that, in accordance with the guidance provided by ICAO for the planning and implementation of the Global Air Navigation Plan (GANP), States should use the six-step approach provided in ICAO Doc. 9883 to carry out such integrated planning/implementation, applying its fundamental principles:

a) Strong focus on desired/required outcomes;
b) Fact- and data-driven decision-making; and
c) Collaborative and justified decision-making.

2.11 The proposed document recommends that ADS-B be considered under an Integrated CNS planning in the SAM Region, prioritizing the implementation of ADS-B to cover existing gaps in the ATS communications and surveillance systems in the SAM Region. Adequate coverage of both systems, especially within the boundaries of the RIS, will improve both the operational safety and the efficiency of the system.

2.12 ADS-B CONOPS WG has discussed the feasibility of establishing a common date in February 2030, so that all cross-border airspace of the SAM Region, at flight level 290 and above, is covered by ADS-B surveillance. By the same date, all aircraft operating at these levels should be equipped with a suitable transponder capable of ADS-B OUT and operating in accordance with the applicable Radio Technical Commission for Aeronautics (RTCA) Minimum Operating Performance Standards DO-260B or later, as well as on-board GNSS receivers compatible with aircraft positioning requirements. Bearing in mind that CONOPS may not be the appropriate document to set these dates, it is important that the meeting discuss this proposal and, if deemed appropriate, propose a SAM/IG conclusion on the matter.

2.13 Considering the need for a harmonized and interoperable interregional ADS-B implementation, including the NAM/CAR/SAM Regions, it would be useful for the meeting to assess the feasibility of adopting the CONOPS ADS-B SAM update attached as **Appendix B** to this working paper.

3. Suggested actions

3.1 The meeting is invited to:

a) Take note of the information provided in this working paper; and

b) Evaluate the draft of the CONOPS ADS-B SAM and consider its adoption by the NACC/CAR/SAM Regions, following the example of the current version.

MAIN CHANGES TO NAM/CAR/SAM ADS-B CONOPS (2022) IN COMPARISON WITH PREVIOUS VERSION

This Appendix summarizes the main changes and updates introduced in the new **SAM ADS-B CONOPS** draft, compared to the previous version approved in March 2022. It is intended to facilitate analysis by States and support discussion during SAM/IG/33 meeting.

AREA/SECTION	VERSION (2022)	PROPOSED VERSION (2025)	REMARKS
1. Introduction and objectives	Overview of ADS-B and its role in ATS surveillance	Extended with a strategic vision to 2035, integrating the ASBU approach and references to the GANP, seventh edition	Strengthening the strategic framework and alignment with the current GANP
2. Operational objectives	Less detail and no clear references to new applications	Detailed objectives are defined including ASEPS, TBO, ITP, FRA, interoperability and streamlining	More precise approach aligned with the current needs of the SAM Region
3. Technical justification and business case	General mentions of implementation benefits	An explicit recommendation to make a business case (cost-benefit, risks, regional alignment) is incorporated	Improvement based on lessons learned and regional experience
4. Progressive radar replacement	Not contemplated or treated with caution	It is introduced as a conditional possibility on a business case and infrastructure life cycle	It opens the way to strategic decisions in the medium and long term
5. Separation strategy	Only basic minima are mentioned	Details analysis needed for separation with multiple sources and links to PANS-ATM	Technical improvement for mixed surveillance scenarios
6. Integrated CNS planning	Mentioned superficially	Incorporation of the 6-Step Method of Doc 9883 for Joint CNS/ATM Planning	Reinforces structured and integrated planning
7. Satellite ADS-B	Mentioned in a preliminary way	Potential use is added with support for RCP240-based separation and satellite data in remote regions	Its future consideration is enabled on a technical basis

AREA/SECTION	VERSION (2022)	PROPOSED VERSION (2025)	REMARKS
8. Key Performance Indicators (KPIs)	Not considered	Incorporated as part of the use of ADS-B data for planning and management	Direct support for online performance monitoring with GANP
9. Tentative schedule	No specific dates	It is proposed to discuss in SAM/IG/33 the common February **2030 target** for ADS-B coverage in FL290+ in cross-border spaces	Item for consideration in decision SAM/IG/33

States are encouraged to analyse the proposed changes and provide specific comments on:

- The feasibility of adopting a common implementation date;
- The applicability of the 6-step approach in their national plans; and
- Training and policy needs for the effective implementation of CONOPS.- - - - - -

(Separate document)

ICAO UNITING AVIATION
A UNITED NATIONS SPECIALIZED AGENCY

South America (SAM) Office

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

(2026-2036)

March 2026

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 it 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 C. 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 D includes reference data to support national decision-making regarding ADS-B implementation. (Appendix Reference Costs for 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.

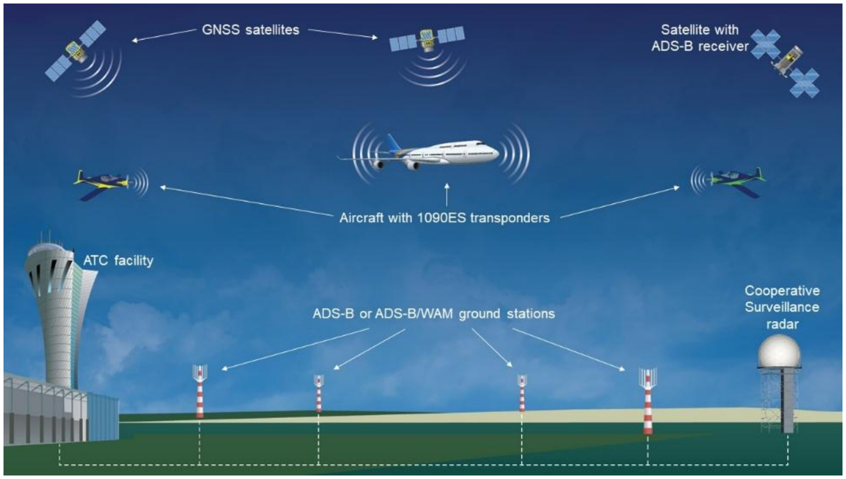
e) Provide guidance to States regarding infrastructure planning, acquisition, and development necessary for ADS-B implementation.

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 through the use of 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 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
- 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.

2.4 Operational Requirements

The following points outline key operational requirements for the use of ADS-B in mixed and non-radar surveillance environments.

These do not represent the complete set of operational requirements, which should be considered in accordance with applicable regional and international regulations.

In mixed surveillance environments (e.g., ADS-B and RADAR/WAM), RADAR/WAM data should be used to validate ADS-B data in order to mitigate the risk of ADS-B “spoofing”.

ADS-B data shall not be used for ATC separation purposes in areas without RADAR coverage until all aircraft operating in that airspace are equipped with certified ADS-B avionics and approved flight crews, ensuring the required level of operational safety.

The ADS-B surveillance service shall enhance the efficiency of ATS operations, allowing more direct routing and improved situational awareness during en-route phases. ADS-B data used for ATC shall meet the required levels of accuracy and integrity to support horizontal separation minima applied by the States.

ADS-B surveillance tracks should include the runway summary or movement information at integrated units, together with data from RADAR or other available aeronautical surveillance systems.

Data derived from non-certified aircraft or those not meeting the minimum recommended integrity levels shall not be used to form the traffic picture presented to the controller. However, such data may be stored for subsequent analysis and used to compile statistical information on reported events.

3 Description of Desired Change

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.

In accordance with conclusion SAM/IG/33-02, SAM States shall implement, no later than October 24, 2030, ADS-B 1090ES coverage and establish requirements for aircraft equipment in accordance with avionics standard DO-260B or higher, as well as pilot-controller communications in continental airspace at/above FL290, within common FIR boundaries. To achieve this implementation, States shall:

- Conduct studies on current gaps in ATS surveillance coverage and pilot/controller communications in applicable air traffic flow sectors within common FIR boundaries; and
- Carry out robust cost-benefit analyses that consider ambitions to improve capacity, efficiency, and operational safety for major air traffic flows, and formulate projects and action plans for progressive implementation.

Aircraft must also be capable of transmitting to space-based ADS-B receivers by emitting extended squitter at 1090 MHz with avionics standard DO-260B or higher. 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

When ADS-B and radar are implemented at the same site, provided that the performance requirements to qualify ADS-B for surveillance services are met, in airspaces with SSR coverage and where all aircraft are equipped with ADS-B/navigation avionics, ADS-B might be used as a complementary source of surveillance data, depending on the corresponding business case and evaluation of GNSS interference issues.

In airspaces without SSR coverage, as long as the performance requirements are met, the ADS-B will be used as the primary source of surveillance

In the long term, ADS-B is expected to progressively complement and, in certain cases, replace radar, except where a business case demonstrates the need to maintain both systems covering a specific airspace. Such business cases should take into account, among other aspects, potential impacts of GNSS radio frequency interference and outages or degradation scenarios. While ADS-B provides significant benefits in terms of cost, coverage, and flexibility, it is not proposed as an outright replacement for radar. Rather, it is considered a complementary surveillance technology, particularly valuable in areas where radar is unavailable or impractical. The gradual substitution of radar systems will only be undertaken when justified by operational, technical, and economic assessments, in alignment with the lifecycle of existing infrastructure and subject to stakeholder consultation.

Furthermore, in operational scenarios where the required surveillance performance cannot yet be ensured, mainly due to aircraft equipment, ADS-B may still provide operational value by contributing to enhanced situational awareness and timely search and rescue (SAR) support, particularly through the accurate tracking of the last known aircraft positions. In such cases, implementation should only be considered when supported by a business case that demonstrates its operational benefits.

The use of ADS-B data as a surveillance source is subject to compliance with established performance and reliability parameters. While earlier implementations referred to a single Navigation Uncertainty Category (NUC), current standards as defined in RTCA DO-260B and reflected in ICAO Annex 10, Volume IV, require the transmission of specific quality indicators: Navigation Integrity Category (NIC), Navigation Accuracy Category (NAC), and Surveillance Integrity Level (SIL). These indicators provide States and ANSPs with the necessary means to evaluate the suitability of ADS-B information for operational applications, including separation provision and complementary surveillance functions.

Parameter	Meaning	Value / Category	Confidence level / probability
NIC (Navigation Integrity Category)	Position integrity (based on **HPL – Horizontal Protection Level**)	Ezample: NIC=7 → HPL ≤ 0.2 NM; NIC=9 → HPL ≤ 75 m	The position is within the HPL with **≥ 99.999% probability**
NACp (Navigation Accuracy Category – position)	Horizontal position accuracy (based on **EPU – Estimated Position Uncertainty**)	Example: NACp=8 → error ≤ 0.1 NM (≈185 m); NACp=10 → error ≤ 30 m	Error not exceeded with **95% confidence**

NACv (Navigation Accuracy Category – velocity)	Reported velocity accuracy	NACv=1 → error ≤ 10 m/s NACv=2 → error ≤ 3 m/s	Error not exceeded with **95% confidence**
SIL (Surveillance Integrity Level)	Surveillance integrity level (probability of failure)	SIL=1 → $< 10^{-3}$ / vuelo-hora; SIL=2 → $< 10^{-5}$ / vuelo-hora; SIL=3 → $< 10^{-7}$ / vuelo-hora	Residual error probability
NUC (Navigation Uncertainty Category – histórico)	Single indicator used in the initial DO-260 (combined integrity and accuracy)	**NUCp (position)** replaced by **NIC/NAC** in **DO-260A/B**	Obsolete – no longer used

ATS Scenario	Target separation	Suggested ADS-B thresholds	System performance (typical)	Notes
En-route (ACC, upper airspace)	**5 NM**	**NIC ≥ 7** (HPL ≤ 0.2 NM) • **NACp ≥ 8** (≤ 0.1 NM) • **SIL ≥ 2** ($\leq 10^{-5}$/h)	**Update rate ≤ 5s • End-to-end latency ≤ 3 s • Availability ≥ 0.999**	Comparable to conventional SSR. Suitable where good coverage and continuity are ensured.
TMA / APP (terminal vectoring)	**3 NM**	**NIC ≥ 8–9** (HPL ≤ 0.1 NM / 75 m) • **NACp ≥ 9–10** (≤	**Update rate ≤ 2s • End-to-end latency ≤ 2 s •**	Requires a mature network (low loss, controlled jitter) and local operational validation.

		0.05 NM / 30 m) • **SIL ≥ 2 (ideal 3)**	**Continuity ≥ 0.999**	
Final approach on the same runway (successive IFR operations)	**2.5 NM** *(on final)*	**NIC ≥ 9** (HPL ≤ 75 m) • **NACp ≥ 10** (≤ 30 m) • **SIL = 3** ($\leq 10^{-7}$/h)	**Update rate ≤ 1s • End-to-end latency ≤ 1.5 s • High track stability**	To be used when the network and processing demonstrate very low latency and high stability. Applicable to IMC conditions with an approved safety case.
Remote / non-radar areas	**5 NM** *(typical objective)*	**NIC ≥ 7 • NACp ≥ 8 • SIL ≥ 2**	**Rate** ≤ 5 s • **Latencia e2e** ≤ 3s	If surveillance-based separation cannot be achieved, ADS-B may support situational awareness and SAR.
Mixed-sensor airspace (SSR + ADS-B)	**3–5 NM** *(design-dependent)*	Adjust to the **most limiting sensor**; if ADS-B is the governing sensor, refer to previous rows	Ensure **coherent data fusion**, performance monitoring, and alerting	Establish clear **sensor voting / fallback** rules and controlled degradation mechanisms.

3.2 Multi-Stakeholder Use and Data Sharing

Beyond air traffic services (ATS) surveillance, ADS-B data provides opportunities to support multiple operational domains and stakeholders. The potential applications include:

- **Enhanced safety functions and traffic flow management**;

- **Improved situational awareness and coordination of search and rescue (SAR) operations**;
- **Operational monitoring by authorized entities** (e.g., airline operations centers, ramp control, and strategic ATM planning);
- **Development and monitoring of Key Performance Indicators (KPIs)** to assess system performance.

A comprehensive technical review is recommended to evaluate the full scope of operational data contained in the ADS-B message set. This review should consider not only position information but also velocity, identification, intent, and integrity parameters that can support advanced ATM functionalities.

In addition, ADS-B data is inherently easier to exchange between adjacent States, as the broadcast is based on standardized geographic coordinates (latitude and longitude), thus facilitating seamless integration into regional ATM systems and promoting interoperability.

Starting with DO-260B compliant avionics and reflected in ASTERIX Cat.021 Edition 2.6, ADS-B messages may include meteorological parameters such as wind speed and direction, air temperature, turbulence, and related data. This capability provides additional operational value, supporting trajectory-based operations, situational awareness, and integration into regional ATM and MET systems.

3.4 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.

3.5 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:

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 complement, or in specific airspaces replace, radar-based surveillance, provided a supporting business case demonstrates operational, technical, and safety suitability. It can enhance ATC automation system performance by improving aircraft tracking, Minimum Safe Altitude Warnings (MSAW), Short- and Medium-Term Conflict Alerts, and Mode-C Intruder Alerts. ADS-B 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 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 E.

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. 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; and
- 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 through the use of 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.

Ground based 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.

Space-based ADS-B, on the other hand, provides global surveillance capability, including coverage over oceanic, remote, and mountainous areas where terrestrial ADS-B or radar coverage is not feasible. The combination of ground and space-based ADS-B allows for seamless surveillance continuity from gate-to-gate, enhancing safety and efficiency.

Operational implementation should consider data integration and fusion mechanisms between ground and space-based ADS-B data sources, ensuring consistency, synchronization, and compliance with surveillance performance standards defined in Annex 10, Volume IV and relevant ICAO guidance material.

5. SYSTEM 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 as primary source 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.

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, 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 (DLP) 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 Traffic Management Initiatives (TMIs)) 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.

5.3.2.1Loss 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.

5.3.2.3 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.

6.1.3 Safety Management System (SMS)

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

6.1.4 Regulation and Policy

Rules and procedures will be required to support ADS-B–enabled spacing and separation operations. States may need to update existing regulations or develop specific operational requirements to ensure the safe and harmonized use of ADS-B within their airspace. Any amendments to flight rules or operational approvals may require consultation and publication processes.

Additional measures, such as airspace restructuring or procedural adaptation, may be necessary to achieve the full operational benefits of ADS-B implementation.

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, Data Link Processors (DLP) 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. These reports may also be used by automation systems to enhance tracking accuracy and safety functions such as Conflict Alert (CA) and Minimum Safe Altitude Warning (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 enroute 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 improved surveillance by ATFM systems, processes and personnel will be as described above.

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, and in consultation with Airspace Users.

Each state will issue a publication that prescribes 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 has been used for several decades, it is not expected simulated or special training for users and service providers. However, 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

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), supported by the application of User Preferred Routings (UPR), Strategic Direct Routing (SDR), and Free Route Airspace (FRA), constitutes a key initiative to enhance operational efficiency. These measures contribute to optimizing flight trajectories and vertical profiles, resulting in reduced flight time, improved airspace utilization, and lower fuel consumption and CO_2 emissions.

In certain portions of the SAM Region, FRTO initiatives have faced challenges due to deficiencies in ATS surveillance and VHF coverage, particularly near FIR boundaries. The integrated planning of ADS-B and VHF coverage in these boundary areas—complementing existing infrastructure—will support the implementation of Cross-Border SDR and enable a gradual evolution toward Cross-Border FRA operations.

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 projects will prioritize covering existing gaps in ATS Surveillance in SAM Region, and it will include also, at least, coverage of the gaps in Direct Controller Pilot Communication. Adequate

Surveillance and Communication coverage, mainly in the FIRs boundaries, will allow an improvement of safety and efficiency.

The expanded use of ADS-B will meet the specific strategies and demands of States while also contributing to increasing the safety of operations, since the other required enablers, such as communication and ATC systems, are also considered in the integrated planning.

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.

7.5.1. 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.

7.5.2. 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.

7.5.3. 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.

To support these enhancements, the inclusion of operational flow diagrams and system interface models is recommended. These visual representations should illustrate how ADS-B data is integrated into AIDC and ATFM, highlighting improvements in data exchange, coordination, and decision-making processes.

7.5.4. 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.

This information should serve as a guideline, recognizing that actual costs and benefits will vary according to local infrastructure, and implementation models adopted by each State.

7.5.5. 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.

7.5.6. Training Requirements

Minimum training 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.

7.5.7. 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- 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 B – 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 C

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

TBD

APPENDIX D

Reference Costs for ADS-B Implementation

Financial assumptions (parameterized)

Parameter	Value	Status	Notes
Reporting base currency	USD	Output	All comparisons are expressed in USD.
Exchange rate COP → USD	4000	Editable	Initial assumption. Adjust according to criteria/date.
Exchange rate BRL → USD	0.2	Editable	Placeholder in case costs in BRL arise.
Exchange rate ARS → USD	0.001	Editable	Placeholder in case costs in ARS arise.
FX assumption date		Editable	To be completed for traceability purposes.

CBA Summary (USD)

Country	CAPEX (USD)	OPEX (USD)	Total (USD)	No. of items
Colombia	302,320.00	29,142.50	331,462.50	10
Guyana	139,451.00	0.00	139,451.00	1

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuer	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPE	Numeric cost
				Argentina						
Cost Type	Component	Approcimate Cost	Manufacturer or Key Details	Argentina						
ADS-B Equiment	Receiver	U$s 189.000	INVAP SE	Argentina					CAPEX	189,000.00
	Antenna			Argentina						
	GPS			Argentina						
	Local Server			Argentina						
	Redundant power supply			Argentina						
	Cabinet			Argentina						
	Electrical protection			Argentina						
	Others			Argentina						
Installation	Labor			Argentina					CAPEX	
	Cranes			Argentina						
	Support infraestructure			Argentina						
	Civil works			Argentina						
	Site or tower preparation			Argentina						
Transport and logistics	Equipment shipment to site			Argentina						
	Customs costs (if imported)			Argentina						
Licenses / Certifications	Aeronautical permits			Argentina						
	frecuencies			Argentina						
	Spectrum, etc.			Argentina						
Technical training	Courses for maintenance technicians	The Modernization Program contract includes training for ATSEP personnel. Additionally, the contract for the acquisition of the ManageAir system provides training for ATCO personnel.	INVAP	Argentina					OPEX	

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuen	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPEX	Numeric cost
	Courses for operators		INDRA	Argentina					OPEX	
Connectivity / Data network	MPLS	The manufacturer's technical solution includes the required connections. One of the five planned stations requires a satellite link due to the absence of nearby fiber-optic infrastructure, as the site is located in a mountainous area at 4,283 m AMSL.		Argentina					OPEX	
	VSAT			Argentina					OPEX	
	LTE			Argentina					OPEX	
	FO			Argentina					OPEX	
Integration with the Automated Center				Argentina						
1. Implementation Costs				Brazil						
				Brazil						
Cost Type	Part (Included)	Approcimate Cost	Manufacturer or Key Details	Brazil						
ADS-B Equiment	Central Processing Station Equipment	17370000	THALES/SUTECH	Brazil					CAPEX	17,370,000.00
	ADS-B Station Equipment		THALES/SUTECH	Brazil						
	Site Monitoring Equipment		THALES/SUTECH	Brazil						
	Remote Control and Supervision Systems Equipment		THALES/SUTECH	Brazil						
Technical Services	66 ADS-B Stations	6520000	THALES/SUTECH	Brazil					CAPEX	6,520,000.00
	5 Central Processing Stations		THALES/SUTECH	Brazil						

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuen	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPE	Numeric cost
	1 Technical Management		THALES/SUTECH	Brazil						
Electrical, electronic and materials infrastructure	Central Processing Station Equipment	1250000	THALES/SUTECH	Brazil						1,250,000.00
	ADS-B Station + Monitoring Site		THALES/SUTECH	Brazil						
	Remote Control System		THALES/SUTECH	Brazil						
Technical documentation	Central Processing Station Equipment	847000	THALES/SUTECH	Brazil						847,000.00
	ADS-B Station		THALES/SUTECH	Brazil						
	Monitoring Site		THALES/SUTECH	Brazil						
	Documentation library		THALES/SUTECH	Brazil						
Operational and maintenance training	Courses for maintenance technicians	400000	THALES/SUTECH	Brazil					OPEX	400,000.00
	Courses for operators		THALES/SUTECH	Brazil					OPEX	
Assited operation	Assited operation	168200	THALES/SUTECH	Brazil						168,200.00
Integration with the Automated Center	Integration with Automated Center	_	THALES/SUTECH (INCLUIDO)	Brazil						
				Brazil						
		227272.7273		Brazil						227,272.73
1. Implementation Costs				Guyana						
				Guyana						
Cost Type	Part	Approcimate Cost	Manufacturer or Key Details	Guyana						
ADS-B Equiment	Receiver	US$71391 (cost per 1 GS)	INTELCAN. Model S7120. 2-PSU,2-RXU, 2-MPU, 1-SMU	Guyana	228242				CAPEX	71,391.00

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuen	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPEX	Numeric cost
	Antenna			Guyana						
	GPS			Guyana						
	Local Server			Guyana						
	Redundant power supply			Guyana						
	Cabinet			Guyana						
	Electrical protection			Guyana						
	Others (UPS)	US$7400	Triplite	Guyana		USD	1	7,400.00		7,400.00
Installation	Labor	US$139451	No towers were required; existing telecom towers were used	Guyana		USD	1	139,451.00	CAPEX	139,451.00
	Cranes			Guyana						
	Support infraestructure			Guyana						
	Civil works			Guyana						
	Site or tower preparation			Guyana						
Transport and logistics	Equipment shipment to site	US10000	From Canada to site in Guyana	Guyana						10,000.00
	Customs costs (if imported)	N/A Duty-Free		Guyana						
Licenses / Certifications	Aeronautical	No costs in Guyana		Guyana						
	Frequencies			Guyana						
	Spectrum, etc.			Guyana						
Technical training	Courses for maintenance technicians	US$19000. 8 paticipants, 5 dias	INTELCAN	Guyana					OPEX	19,000.00
	Courses for operators			Guyana					OPEX	

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuen	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPEX	Numeric cost
Connectivity / Data network	MPLS			Guyana					OPEX	
	VSAT	US$4000/month for 4 sites	DIGICEL Guyana	Guyana					OPEX	4,000.00
	LTE			Guyana					OPEX	
	FO	US$955/month per site	GTT	Guyana					OPEX	955.00
Integration with the Automated Center			Included in installation cost	Guyana						
1. Implementations Costs				Uruguay						
				Uruguay						
Cost Type	Part	Approcimate Cost	Manufacturer or Key Details	Uruguay						
ADS-B Equiment	Receiver	150000	INDRA	Uruguay					CAPEX	150,000.00
	Antenna			Uruguay						
	GPS			Uruguay						
	Local Server			Uruguay						
	Redundant power supply			Uruguay						
	Cabinet			Uruguay						
	Electrical protection			Uruguay						
	Others			Uruguay						
Instalation	Labor			Uruguay					CAPEX	
	Cranes			Uruguay						
	Support infraestructure			Uruguay						
	Civil works			Uruguay						
	Site or tower preparation			Uruguay						
Transport and logistics	Equipment shipment to site			Uruguay						
	Customs costs (if imported)			Uruguay						

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fuer	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPE	Numeric cost
Licenses / Certifications	Aeronautical			Uruguay						
	frecuencies			Uruguay						
	Spectrum, etc.			Uruguay						
Technical training	Courses for maintenance technicians			Uruguay					OPEX	
	Courses for operators			Uruguay					OPEX	
Connectivity / Data network	MPLS	Existing contract integrated with other services	ANTEL - State telecommunications provider	Uruguay					OPEX	
	VSAT		No se utiliza	Uruguay					OPEX	
	LTE		No se utiliza	Uruguay					OPEX	
	FO	Integrated with other existing services	Airport internal network	Uruguay					OPEX	
Integration with the Automated Center	Integration with Automated Center		INDRA	Uruguay						
1. Implementation Costs				Colombia						
Cost Type/Category	**Part/Component**	**Approcimate Cost**	**Manufacturer or Key Details**	**Colombia**						
ADS-B Equiment	Redundant ADS-B Station + CNMS	COP 570.970.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	142,742.50	CAPEX	570,970,000.00
ADS-B Equiment	Data fusion system (>=30 ADS-B)	COP 274.530.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	68,632.50	CAPEX	274,530,000.00
ADS-B Equiment	Network devices (switches/routers)	COP 6.550.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	1,637.50	CAPEX	6,550,000.00

Cost type / Category	Part / Component	Approximate cost	Manufacturer / Key details	Country	Notas / Fue	Currency	Exchange rate to USD	Cost in USD	CAPEX / OPE	Numeric cost
ADS-B Equiment	Lightning protection, obstruction lights, grounding, mast	COP 6.590.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	1,647.50	CAPEX	6,590,000.00
ADS-B Equiment	TWR display position	COP 83.280.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	20,820.00	CAPEX	83,280,000.00
Installation / Services	Installation + SAT	COP 126.700.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	31,675.00	CAPEX	126,700,000.00
Installation / Services	FAT tests	COP 59.910.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	14,977.50	CAPEX	59,910,000.00
Installation / Services	Warranty (3 years)	COP 39.350.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	9,837.50	CAPEX	39,350,000.00
Installation / Services	OJT training	COP 41.400.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	10,350.00	CAPEX	41,400,000.00
Connectivity	ADS-B data communication link	COP 116.570.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	29,142.50	OPEX	116,570,000.00
Total	TOTAL (equipment + services), excl. VAT	COP 1.325.850.000	Aerocivil Providencia Contract/Form 7	Colombia		COP	4000	331,462.50		1,325,850,000.00

APPENDIX E

Regional architecture for exchanging ADS-B data between ANSPs

TBD

APPENDIX F: 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)

Likelihood	Severity				
	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	unlikely	insignificant	3D

						received.			
Incorrect Data broadcast by an aircraft due to data corruption	Incorrect data due to data corruption on 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	remote	minor	2D

						affected.			
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	improbable	moderate	3D

						information.			
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	inadequate operational procedures for managing and controlling ADS-	remote	minor	3C	Maximize the reuse of proven operational procedures to handle ADS-B control	unlikely	minor	2D

	operational procedures will introduce a hazard to the system	B areas increases the probability of a breakdown				areas. Ensure sufficient procedures are developed and tested for the transition between ADS-B and Procedural control			
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 procedural control.	improbable		3D	Increase in the level of security and security response at ground installations			

incorrect altitude data transmitted by aircraft	Aircraft transmitting wrong altitude because or 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	remote	moderate	3C	scheduled checks on site monitoring equipment done at frequent intervals and data collection and analysis	remote	moderate	3C

		separation							
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

— — — — — — — — — — —

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 B

— — — — — — — — — — —

o

— FIN —