



**WORKING PAPER**

**THIRTEENTH AIR NAVIGATION CONFERENCE**

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**COMMITTEE A**

**Agenda Item 3: Enhancing the global air navigation system**

**3.5: Other ATM issues**

**PROGRESSING GLOBAL ATS SURVEILLANCE BENEFITS THROUGH SPACE-BASED  
ADS-B**

(Presented by the Civil Air Navigation Services Organisation (CANSO))

**EXECUTIVE SUMMARY**

This paper presents an update on the development, testing and possible benefits of space-based automatic dependent surveillance — broadcast (ADS-B) as a global air traffic services (ATS) surveillance technology

**Action:** The Conference is invited to:

- a) recognise that the process to introduce ATS surveillance in airspace with direct controller-pilot communication is well understood and documented;
- b) note the ongoing activities of several CANSO member air navigation services providers (ANSPs) to validate that space-based automatic dependent surveillance-broadcast (ADS-B) will meet existing ATS surveillance performance standards;
- c) recognise the significant potential safety and operational benefits of introducing ATS surveillance services into areas where they have not previously been available;
- d) note that significant progress is being made by ICAO and its Separation of airspace and Safety Panel (SASP) to introduce new performance-based standards for the use of ATS surveillance with controller-pilot data link communications (CPDLC) and HF as COM communication; and
- e) request ICAO to provide full support to further embedding this ATS surveillance source capability into existing Standards and Recommended Practices (SARPs), the Global Air Navigation Plan (GANP, Doc 9750) and guidance materials as another alternative means of surveillance from which to choose.

**1. INTRODUCTION**

1.1 Continuing growth of air traffic calls for continuous improvement in air traffic management (ATM), commensurate with evolving technology and aircraft equipment investments. In areas where ATS surveillance services are not provided, air navigation service providers need to maintain a safe, orderly and expeditious flow of air traffic. This requires the use of efficient and safe air traffic control separation standards. The availability of ATS surveillance has enabled ANSPs to introduce more fuel- and cost-efficient profiles while reducing safety risks.

1.2 Space-based automatic dependent surveillance-broadcast (ADS-B) expands on the existing and well-documented ADS-B technology, by deploying ADS-B receivers in space via satellites to overcome line of sight limitations of traditional ground installation air traffic services (ATS) systems.

## **2. USING SPACE-BASED ADS-B AS AN ATS SURVEILLANCE TECHNOLOGY**

2.1 ATS surveillance services have historically been made possible through the installation of ground-based infrastructure. They are generally restricted by line of sight and are limited in oceanic and remote areas. Similarly, radar surveillance in remote areas and mountainous or harsh terrain could not always be supported through physical unavailability or the cost of communication links to relay surveillance data. Although terrestrial ADS-B sites have helped overcome some of these limitations by using satellite communication links, the provision of ATS surveillance services in those areas is often still limited to the periphery of the ground-based site.

2.2 In 2007, ICAO formally acknowledged that radar-like systems had been developed and it incorporated updated references to “ATS surveillance” rather than “radar”. ICAO notes that a comparable ground-based system is one that has been demonstrated, by comparative assessment or other methodology, to have a level of safety and performance equal to or better than monopulse secondary surveillance radar (SSR). ICAO also provides guidance and examples as to how ADS-B is determined to meet the definition of “ATS surveillance system”.

### **2.3 What are air navigation services providers (ANSPs) doing with space-based ADS-B?**

2.3.1 Numerous air navigation service providers recognise the benefits expected from space-based ADS-B surveillance. Eleven ANSPs (all CANSO members) are in the process of integrating and demonstrating that space-based ADS-B meets ATS surveillance requirements as defined by ICAO and set forth in requirements such as the EUROCAE ED-129B and the EUROCONTROL Draft GEN-SUR. Over twenty two other ANSPs are considering implementation in the next three years.

2.3.2 One such system, the space-based ADS-B constellation, is more than 50 per cent complete with over forty satellites in orbit, enabling continued extensive testing to determine system performance using measured data from the space-based ADS-B receivers and comparative assessment by the end user, modelling, ground based reference transmitters and flight tests undertaken by NAV CANADA and the Federal Aviation Administration (FAA).

2.3.3 Overall initial results and refined modelling show that, with a complete constellation, a better than 8s UI (update interval) will be achievable at a latency from aircraft to the ANSP automation platform of less than two seconds at 96 per cent probability, consistent with ATS surveillance requirements

2.3.4 Generally speaking, a full satellite constellation for ATS surveillance will also allow for an independent position validation using methods such as a time difference of arrival (TDOA). This will allow for an independent position check (IPC) field to be provided to ANSPs allowing for an independent verification of aircraft position from the global navigation satellite system (GNSS), possibly mitigating many known types of errors in navigation sources to surveillance systems and significantly augmenting the core surveillance service in areas currently covered by terrestrial ADS-B receivers.

2.3.5 The ICAO Surveillance Panel (SP) is considering the performance of space-based ADS-B as ATS surveillance, together with primary surveillance radar (PSR), secondary surveillance radar (SSR), multilateration and ground-based ADS-B.

## 2.4 Possible use cases of global ATS surveillance capability

2.4.1 Throughout the past decades, the introduction or expansion of ATS surveillance coverage has enabled safety and efficiency improvements. ANSPs are accustomed to create a business case to introduce new ATS surveillance capability and technology. The concept of operations for using space-based ADS-B as ATS surveillance can be considered in various ways by ANSPs.

2.4.2 The first space-based ADS-B surveillance system is expected to be fully operational at the end of this year (2018). It can be foreseen that the availability of global ATS surveillance will have a significant impact on future planning for the global aviation system and the Global Air Navigation Plan (GANP, Doc 9750) as well as the aviation system block upgrades (ASBUs). Numerous existing ASBU modules could provide even more benefits or be accelerated, coupled with the availability of global and continuous ATS surveillance.

2.4.3 ADS-B as sole ATS surveillance source: In areas where there is currently no ATS surveillance coverage, ADS-B as ATS surveillance could instantly enable significant safety, operational and infrastructure efficiency gains. This could be done by:

- Coupling ATS surveillance through space-based ADS-B with existing VHF as COM communications. This would not require a change in separation standards but follow a traditional comparative analysis and safety case approach.
- Using ATS surveillance in remote or oceanic airspace using controller-pilot data link communications (CPDLC) or future direct controller-pilot communication through satellite. Separation standards in development by ICAO are expected to allow for more flexibility using ATS surveillance and CPDLC over satellite as COM. The ICAO SASP is currently in the advanced development of new standards to reduce longitudinal and lateral procedural separation standards of 15 NM or less for publication in the PANS-ATM in 2020.
- This scenario could also be appropriate for ANSPs wishing to provide increased situational awareness, provision of automated safety nets and increased safety at flight information region (FIR) boundaries – even if separation standards are not reduced. The data can also be used beyond the geographical boundaries of an ANSP to provide arrival or air traffic flow management (ATFM) purposes (e.g. the ability to monitor and track out of area traffic for an ACC).
- Space-based ADS-B may be able to provide contingency coverage when for example there is radome damage due to adverse weather leading to a short-notice coverage gap, or create even essential coverage during modernisation of ground based ATS surveillance assets).

## 2.5 To fill gaps in existing ATS surveillance coverage or augment ATS surveillance coverage.

2.5.1 In areas where ATS surveillance already exists through single or multiple layers the introduction of a unique independent layer of ATS surveillance using space-based ADS-B could provide value by removing coverage gaps and allowing for greater availability and predictability of ATS surveillance data while allowing for infrastructure rationalisation and limiting costly overlap through traditional means. Space-based ADS-B surveillance can be included as one of the options for an ANSP's surveillance architecture.

## 2.6 **Impact of global ATS surveillance on safety and efficiency in air traffic management**

2.6.1 *Safety improvements.* In the safety realm, at present, the most current and progressive oceanic ATC systems remain limited in how aircraft updates are received and processed for the purpose of position determination. ATC situation display "targets" represent estimated extrapolations and therefore are not representative of the actual aircraft position. ATS surveillance will bring not only the potential for operator efficiency gains, but also the capability for the ATM system to immediately detect and track both intended and unintended aircraft trajectory profile changes in real time.

2.6.2 Air traffic controllers (ATCOs), provided with increased ATS surveillance or improved situational awareness will be better equipped to detect aircraft deviations from clearances and unsafe proximity between aircraft and between aircraft and terrain. The availability of ATS surveillance also allows ATCOs to provide more options and support to aircraft in contingency situations, such as encountering severe weather or emergency descent.

2.6.3 The 15th meeting of the ICAO North Atlantic Safety Oversight Group (NAT-SOG) estimated the impact of ADS-B surveillance on the vertical collision risk in the NAT. Analysis over a twelve month period showed that with strategic lateral offset procedure (SLOP), selected flight level vs. cleared flight level (SFL-CFL) conformance checking using ATS surveillance would have potentially prevented eighteen vertical deviations from occurring in that twelve month period, reducing the collision risk estimate by 35 per cent. The safety benefit increases to a 77 per cent reduction in the collision risk when the remaining vertical deviation times could be limited to five minutes.

2.6.4 A 2016 report by the Flight Safety Foundation (FSF) focused on the cumulative impact on the global aviation safety net. It concluded that there is an extensive range of immediate, mid-term and longer-term safety and efficiency benefits. Examples include: improved cross-flight information boundary error detection, improved and earlier detection of off-track errors, enhanced safety alerting through danger area infringement warning (DAIW), short-term conflict alert (STCA), minimum safe altitude warning (MSAW), route adherence monitoring (RAM), cleared level adherence monitoring (CLAM) and predicted level mismatch (PLM).

2.6.5 The FSF also refers to the introduction of ADS-B across Australia. A study of before and after the introduction, illustrated a substantial advancement that ADS-B has made in increasing weather deviation flexibility. This while assuring ATC situational awareness (SA) and enhancing the level of safety due to having an accurate, reliable and continuous traffic picture. Significant safety benefits have also been realised at the FIR boundary between Australia and Indonesia where shared ADS-B based surveillance has allowed early operational error detection based on ATC situational awareness and the implementation of surveillance-based automated safety nets. Australia and Papua New Guinea are expecting to enable these benefits on their border soon.

2.6.6 *Efficiency improvements.* In the efficiency realm, the application of ATS surveillance separation standards, rather than procedural standards, enables ATCOs to permit aircraft to operate at, or more closely to, their optimum flight profiles. Resulting in predictability, and fuel / greenhouse gas emissions savings. Additionally, ATS surveillance provides the necessary information to support better inter-unit and regional flow management coordination.

2.6.7 An RTCA industry group formed as the Enhanced Surveillance Task Group (ESTG) reported in 2017 to the NextGen Advisory Committee that "Enhanced surveillance capabilities will contribute to reducing the separation distances and may increase the overall safety, efficiency, fuel-savings, and reduce emissions for aircraft operating in U.S. controlled oceanic airspace."

2.6.8 The ICAO North Atlantic Economic Financial and Forecast Group (NAT EFFG) concluded that based on the current NAT Space-Based ADS-B concept of operations (CONOPS) for the NAT Region, the net present value of reduced oceanic separation standards in the NAT, increased climbs and variable Mach via the SB ADS-B enhancement (in the order of 15/15 Nautical Mile NM), represents a positive business case over the time span 2019-2033

2.6.9 In addition to the oceanic business case, the implementation of space-based ADS-B at various CANSO members is expected to result in avoided costs of replacing and maintaining radars and ground-based ADS-B that could eventually be decommissioned.

## 2.7 **Other considerations for global ATS surveillance**

2.7.1 It is expected that space-based ADS-B, will form a key part of many airline solutions to meet the ICAO Global Aeronautical Distress Safety System (GADSS) and Autonomous Distress Tracking (ADT) requirements for the 2018 and 2021 mandate

2.7.2 Global ATS surveillance availability will also enable the creation of a global surveillance “blanket” and, with this, an ability to support search and rescue (SAR) services globally in retaining position data, allowing for a global approach to air traffic flow management (ATFM), cross-border safety/harmonisation, spectrum analysis, risk analysis, efficiency analysis, search and rescue, collaborative decision making via the development of future applications using the rich ADS-B environment data to better predict weather related issues such as turbulence.

## 3. **CONCLUSION**

3.1 The development of space-based ADS-B technology, its deployment, testing and integration with ANSPs is well on its way. At the end of the first quarter of 2018, thirty three ANSPs are in the process of implementing space-based ADS-B systems or considering such introduction in the next three years.

3.2 The use of ATS surveillance within VHF coverage is well documented as a means to improve airspace safety and efficiency and it is widely expected that space-based ADS-B will be considered as ATS surveillance and will meet industry ATS surveillance standards such as EUROCAE and EUROCONTROLS “Generic Surveillance Safety and Performance Requirement” (GEN SUR SPR)

3.3 There is sufficient study and analysis material available demonstrating significant safety and operational benefits that introducing ATS surveillance can bring to oceanic and remote airspace. Significant progress is being made on the development of new performance-based separation standards using ATS surveillance together with communications as CPDLC and HF as COM.

3.4 CANSO invites the Conference to note the promising testing results of space based ADS-B as a global ATS surveillance capability and the significant benefits the introduction of such capability can bring to help deliver this industry’s main safety and efficiency goals

3.5 CANSO invites the Conference to support the expeditious approval of the enhanced separation standards by ICAO using global ATS surveillance in conjunction with CPDLC or HF as communication and encourages ICAO to support its members at a regional level to implement this capability and maximise its potential benefits.

3.6 CANSO invites the Conference to ensure, when appropriate, space-based ADS-B is included in ICAO documentation as an ATS surveillance system platform and reflected as such in near, medium and long-term ICAO priorities, strategy and documentation such as the Global Air Navigation Plan (GANP), Standards and Recommended Practices (SARPs) and guidance material.

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