

**Cir 326  
AN/188**



# **Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation**

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and published under his authority

**International Civil Aviation Organization**

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to Support Air Traffic Services and Guidelines for Implementation***

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## FOREWORD

Automatic dependent surveillance — broadcast (ADS-B) and multilateration (MLAT) are additional forms of electronic surveillance that may be used to support air traffic services (ATS) in en-route and terminal area operations. While radar was previously the only form of electronic surveillance used for these operations, ADS-B and MLAT may be introduced in areas that are either not served, or are partially served, by radar. In view of their attractive costs, it is expected that ADS-B and MLAT will increasingly be used in areas where radar may not be economically viable, particularly in less demanding air traffic management (ATM) environments.

This circular provides details of a comparative assessment undertaken by the Separation and Airspace Safety Panel (SASP) that concludes that ADS-B and MLAT can be used to provide ATS surveillance, including separation, subject to certain conditions. The SASP assessment concluded that ADS-B can be used to provide a five nautical mile (5 NM) minimum, subject to certain conditions being satisfied.

For guidance to States, an implementation roadmap and answers to frequently asked questions are included in Chapter 4.

Monitoring of the deployment of State or regional implementations of ADS-B and MLAT by ICAO is anticipated.

Comments from States on this circular, particularly with respect to its application and usefulness, would be appreciated. These comments will be taken into account in the preparation of subsequent material and should be addressed to:

The Secretary General  
International Civil Aviation Organization  
999 University Street  
Montréal, Quebec, Canada H3C 5H7



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1. Appendices A to G3 inclusive are provided on the CD-ROM at the back of this circular.

# GLOSSARY

## ABBREVIATIONS/ACRONYMS

|        |                                                   |
|--------|---------------------------------------------------|
| ADS-B  | Automatic dependent surveillance — broadcast      |
| ADSBP  | ADSB processor                                    |
| ADS-C  | Automatic dependent surveillance — contract       |
| AIP    | Aeronautical information publication              |
| ANSP   | Air navigation service provider                   |
| ATC    | Air traffic control                               |
| ATM    | Air traffic management                            |
| ATS    | Air traffic services                              |
| ATSC   | Air traffic service communication                 |
| CDP    | Combined data processor                           |
| CLAM   | Cleared level adherence monitoring                |
| CNS    | Communications, navigation and surveillance       |
| CPDLC  | Controller-pilot data link communications         |
| DOP    | Dilution of precision                             |
| EPU    | Estimated position of uncertainty                 |
| ES     | Extended squitter                                 |
| FDP    | Flight data processor                             |
| FHA    | Functional hazard analysis                        |
| FMS    | Flight management system                          |
| GBAS   | Ground-based augmentation system                  |
| GNSS   | Global navigation satellite system                |
| GPS    | Global positioning system                         |
| HFOM   | Horizontal figure of merit                        |
| HPL    | Horizontal protection level                       |
| IFR    | Instrument flight rules                           |
| MLAT   | Multilateration                                   |
| MSAW   | Minimum safe altitude warning                     |
| MSSR   | Monopulse secondary surveillance radar            |
| NACp   | Navigation accuracy category for position         |
| NACv   | Navigation accuracy category for velocity         |
| NIC    | Navigation integrity category                     |
| NUC    | Navigation uncertainty category                   |
| PRM    | Precision radar monitor                           |
| PSR    | Primary surveillance radar                        |
| PSSA   | Preliminary system safety assessment              |
| RAIM   | Receiver autonomous integrity monitoring          |
| RAM    | Route adherence monitoring                        |
| Rc     | Radius of containment                             |
| RDP    | Radar data processor                              |
| REC    | Receiver                                          |
| RGCSPP | Review of the General Concept of Separation Panel |
| RMS    | Root mean square                                  |
| RU     | Receiving unit                                    |
| RVSM   | Reduced vertical separation minimum               |

|      |                                      |
|------|--------------------------------------|
| SASP | Separation and Airspace Safety Panel |
| SDP  | Surveillance data processor          |
| SID  | Standard instrument departure        |
| SIL  | Surveillance integrity limit         |
| SITA | Service provider                     |
| SPI  | Special position indicator           |
| SSA  | System safety assessment             |
| SSR  | Secondary surveillance radar         |
| STAR | Standard instrument arrival          |
| STCA | Short-term conflict alert            |
| TDOA | Time difference of arrival           |
| TMA  | Terminal control area                |
| UAT  | Universal access transceiver         |
| WAM  | Wide area multilateration            |

### EXPLANATION OF TERMS

**Accuracy.** A measure of the difference between the aircraft position reported in the ADS-B message field, or in the position field of the target report output of the MLAT system, as compared to the true position.

**Availability.** The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of time the system is available to the time the system is planned to be available. Periods of planned maintenance are discounted from the availability figures. Overall availability is composed of:

- a) the availability of functions affecting all aircraft (e.g. external positioning function, ground data acquisition function); and
- b) the availability of systems affecting only one aircraft (e.g. transponder function), expressed per flight.

*For radar and MLAT.* The availability of ground components and data transmission equipment will affect the service for all aircraft. The availability of an individual aircraft SSR transponder function will affect the service for that aircraft.

*For ADS-B.* In addition to the availability of ground receiving and data transmission systems, the availability, in the region, of navigation sources (including satellite constellations) of sufficient quality will affect many aircraft.

**Continuity.** The probability of a system performing its required function without unscheduled interruption, assuming that the system is available when the procedure is initiated. Overall, continuity is composed of the continuity of:

- a) functions affecting all aircraft (e.g. satellite function, ground data acquisition function), expressed in number of disruptions per year; and
- b) systems affecting only one aircraft (e.g. transponding functions), expressed per flight hour.

*For radar and MLAT.* The continuity of ground radar and data transmission equipment will affect the service for all aircraft. The continuity of an individual aircraft SSR transponder function will affect the service for that aircraft.

*For ADS-B.* In addition to the continuity of ground receiving and data transmission systems, the continuity, in the region, of navigation sources (including satellite constellations) of sufficient quality will affect many aircraft.

**Cooperative independent surveillance.** Surveillance which uses the SSR transponder replies from an aircraft, but position is determined purely by the ground system.



**Dilution of precision (DOP).** This is a ratio between the accuracy of the measurement of the received signal and the accuracy of the output due to the geometry between the aircraft and the ground receiving station.

*Note.— Given that aircraft move the geometry, the DOP is always changing.*

**Estimated position uncertainty (EPU).** The measure of the accuracy of a position estimate.

**Horizontal position accuracy.** This is essentially the horizontal position measurement error distribution. For radar, accuracy is usually defined as a bias (offset) and noise. It is assumed that the noise is of Gaussian distribution and the RMS value is quoted. Horizontal position accuracy is normally expressed in terms of range and azimuth dimensions. However, the azimuth error distribution is of prime concern. The overall errors are considered to have the following component errors:

- a) core errors (usually expressed as a standard deviation  $\sigma$ );
- b) tail errors; and
- c) systematic bias.

For ADS-B, accuracy is usually defined as noise. It is assumed that the noise is of Gaussian distribution and the RMS value is quoted. Horizontal position accuracy is usually defined as the radius of a circle centred on the target's reported position such that the probability of the target's actual position being inside the circle is 90 per cent.

For MLAT, accuracy is a function of the geometry between the aircraft and contributing ground stations, independent of on-board systems.

**Navigation uncertainty category (NUC).** A codified parameter used to report the maximum position error which might not be detected with a predefined probability. NUC originates in a position-determining system and is transmitted by aircraft complying with DO-260/ED-102 or ICAO Annex 10, Amendment 77.

**Navigation uncertainty category — position (NUC-P).** Uncertainty categories for the position information. Provides a measure of the accuracy of the position information.

**Reliability.** The probability that the system will deliver a particular message or other data without one or more errors. It is assumed that if the rate of errors is deemed unacceptable by the users, appropriate alternative separation will be provided.

**Surveillance integrity limit (SIL).** SIL defines the probability of the integrity containment radius used in the NIC parameter being exceeded, without detection. SIL is the probability that the position error is greater than NIC and is undetected. NIC and SIL are transmitted by aircraft complying with DO-260A.

**Vertical accuracy.** This is essentially the vertical position measurement error distribution. For radar, ADS-B and MLAT, encoders on the aircraft provide the altitude, and the encoded data are transmitted to the radar, ADS-B or MLAT ground station. Therefore, vertical accuracy at ATC processing depends on altimeter accuracy — and the transmission errors resolution. In addition MLAT can provide a measure of the aircraft's geometric altitude, independent of on-board systems.

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# PUBLICATIONS

(referred to in this circular)

## ICAO PUBLICATION

### Annexes

Annex 10 — *Aeronautical Telecommunications, Volume III — Communication Systems*

### Procedures for Air Navigation Services (PANS)

ATM — *Air Traffic Management* (PANS-ATM, Doc 4444)

### Manuals

*Global Navigation Satellite System (GNSS) Manual* (Doc 9849)

*Manual on Airspace Planning Methodology for the Determination of Separation Minima* (Doc 9689)

*Safety Management Manual (SMM)* (Doc 9859)

## OTHER PUBLICATIONS

### EUROCAE

*Minimum Operational Performance Specification for Mode S Multilateration Systems for Use in A-SMGCS*, ED-117

*Safety, Performance and Interoperability Requirements Document for ADS-B-NRA Application*, Doc ED-126

*Guidelines for Test and Validation Related to Airport CDM Interoperability*, Doc ED-146

### EUROCONTROL COMPARATIVE ASSESSMENT — SSR TO MLAT

*Guidance Material on Comparison of Surveillance Technologies (GMST)*

### RTCA

*Minimum Aviation System Performance Standards for Automatic Dependent Surveillance — Broadcast (ADS-B)*, RTCA DO-242A

*Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using the Global Positioning System*, RTCA DO-208

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