EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Back to Main TOC

Back to ADS TOC

Automatic Dependent Surveillance

Requirements

SUR/ET3/ST06.3220/001

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EUROPEAN AIR TRAFFIC CONTROL HARMONISATION AND INTEGRATION PROGRAMME

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Abstract

The document presents the requirements for Automatic Dependent Surveillance (ADS), including both ADS-C and ADS-B, in a gate-to-gate environment. The ADS requirements are driven by requirements defined for surveillance user functions (both ground and airborne), which include both human operators as well as automated tools.

Keywords

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DOCUMENT STATUS AND TYPE

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DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
0.1	17 May 1999	Initial document for comments on structure	
0.2	24 June 1999	Addition of requirements from ICAO Manual of ATS data link applications	All
0.3	10 August 1999	General changes.	All
0.4	13 August 1999	General changes	All
0.5	18 December 1999	Cross check with RTCA MASPs	All
0.6	31 January 2000	Version for DG/8 meeting	All

TABLE OF CONTENTS

1. INTRODUCTION

1.1 General

The document presents the requirements for Automatic Dependent Surveillance (ADS) whichare driven by requirements defined for surveillance user functions (both ground and airborne). These functions include both human operators as well as automated functions.

In the elaboration of the requirements presented here, external published requirements documents aretaken into account as much as possible,. In addition, where no such inputs are applicable, or they are inconsistent or incomplete, new requirements are elaborated.

1.2 Document Scope

This document presents the requirements for Automatic Dependent Surveillance (ADS), where the term ADS encompasses both ADS-Contract and ADS-Broadcast. It addresses all phases of flight, i.e. it includes also the relevant airport operations aspects. The document is a key deliverable of the EUROCONTROL ADS Programme and is an input for other deliverables such as the system specifications.

ADS requirements must support the requirements of surveillance users. However, it is recognised that other surveillance technologies also support surveillance and must be considered in the provision of the overall surveillance service.

Requirements which refer generally to the classical surveillance system are not repeated here, unless required for coherence in this document. The requirements presented in this document are therefore basically the enhancements of the classical system in order to exploit ADS capabilities.

The ADS requirements presented in early versions of this document should be considered as initial because:

1. The ‘driver’ surveillance user requirements are also under development.

2. The requirements correspond to the ground and airborne interface of the ADS system, whereas they may be broken down into sub-system requirements at a later stage.

3. It is expected that not all requirements will be necessary at the initial stage of implementation. Therefore, the phasing of requirements will be addressed using cost-benefit considerations in stage 1 of the ADS programme.

1.3 Document Overview

This document has the following sections:

- Chapter 2: containing document references.
- Chapter 3: containing a description of the ADS system.
- Chapter 4: containing requirements for the ADS interface characteristics.
- Chapter 5: containing ADS functional requirements.
- Chapter 6: containing ADS performance requirements.
- Chapter 7: containing other requirements, not relating to interface, functions or performance.

DEFINITIONS

The following definitions are extracted from the ADS Concept document [12].

Automatic Dependent Surveillance (ADS)

Definition: A surveillance technique in which aircraft automatically provide, via a datalink, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate.

Status: Published by ICAO.

Note: This definition covers both ADS-C and ADS-B, although it was originally intended only to describe ADS-C.

Source ICAO Manual of ATS Data Link Applications, First Edition, 1999 [1]

Automatic Dependent Surveillance-Broadcast (ADS-B)

Definition: ADS-B is a surveillance application transmitting parameters, such as position, track and ground speed, via a broadcast mode data link, and at specified intervals, for utilisation by any air and/or ground users requiring it. The aircraft originating the broadcast has no knowledge of which systems are receiving the broadcast. Any air or ground based user may choose to receive and process this information.

Status: Published by ICAO.

Source ICAO Manual of ATS Data Link Applications, First Edition, 1999 [1]

Automatic Dependent Surveillance Agreement

Definition: An ADS agreement is an ADS reporting plan which establishes the condition of ADS data reporting (i.e. data required by the ground system and frequency of ADS reports which have to be agreed to prior to provision of the ADS services).

The terms of the agreement will be exchanged between the ground system and the aircraft by means of a contract, or a series of contracts. An ADS contract would specify under what conditions ADS reports would be initiated, and what data would be contained in the reports. There are three types of contracts: Periodic, Event and Demand.

Note: An ADS agreement is relevant only to ADS-Contract (ADS-C)

Status: Proposed.

Source ICAO Manual of ATS Data Link Applications, First Edition, 1999 [1]

Automatic Dependent Surveillance-Contract (ADS-C)

Definition: ADS-C is a surveillance point-to-point application based on an ADS agreement.

Status: Proposed.

2. BIBLIOGRAPHY AND REFERENCES

This section lists references and bibliography material and gives a brief indication of the relevance of each document to ADS requirements.

Where requirements in sections 3-7 of this document refer to the following documents, this is shown using the reference number [x] in the source field of the requirement.

2.1 ICAO documents

[1] "Manual of Air Traffic Services (ATS) Data Link Applications", First edition, ICAO ADS Panel, Doc 9694-AN/955, 1999.

This document gives ICAO operational requirements for ADS-C and ADS-B (air-to-ground, not air-to-air).

[2] "Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN)", (Doc 9705).

This contains in sub-volume II, Chapter 2.2. technical provisions and requirements for the ADS application.

[3] "Procedures for Air Navigation Services (PANS) and Rules of the Air and Air Traffic Services (RAC)", (Doc. 4444 - RAC/501).

Currently contains ADS definitions and requirements related to the Transmission of ADS Reports (pages 2-10 and 2-11). Also contains requirements with respect to the need and way to indicate in flight plans if aircraft have ADS capability (Appendix 2, page A2-5; Appendix 3, page A3-12).

In the future will contain a part (Part XII) on ADS which is currently being developed by the ADSP. This part might be similar to the existing Part VI on radar.

[4] Annex 2 (Rules of the Air)

Contains ADS definitions (ADS agreement, ADS contract and Automatic Dependent Surveillance (ADS)) and a general requirement on position reports.

[5] Annex 10, Volume I (Radio Navigation Aids)

Currently contains no information on ADS. In the future it will contain general provisions and specifications on ADS in a similar way as it currently contains for radar and other radio navigation aids. The text to be included here is to be provided by the ADSP.

[6] Annex 10, Volume III (Communications Systems)

Currently contains ADS definitions *(ADS application* and *Automatic Dependent Surveillance (ADS))* and some requirements of the *ADS application* on page 4D. It refers to *Doc 9705* for the technical provisions of the *ADS application*.

[7] Annex 10, Volume IV (Surveillance Radar and Collision Avoidance Systems)

This does contains the standards and recommended practices for radar and collision avoidance systems. It does not contain ADS requirements, but it can help to develop them.

[8] Annex 11 (Air Traffic Services)

Currently contains an Automatic Dependent Surveillance (ADS) definition and a requirement/recommendation related to the automatic recording of ADS data on page 33.

[9] Automatic Dependent Surveillance (ADS) and Air Traffic Services (ATS) Data Link Applications. (Circular 256-AN/152)

[10] "Manual on Mode S Specific Services", ICAO Doc 9688-AN/952, First edition 1997.

This document contains specifications of data formats in the Mode S system, including DAP and extended squitter.

[11] "Development of appropriate recommendations on the required navigation performance (RNP) for approach, landing and departure operations", ICAO AWOP/16 WP/756, Report on Agenda Item 1, 28/06/97.

This document contains a definition of accuracy.

2.2 Non-ICAO documents

[12] "Automatic Dependent Surveillance Concept", EUROCONTROL document, SUR/ET3/ST06.2102/001, Working Draft.

This document describes the concept for ADS.

[13] "MASPS for ADS-B", RTCA, January 1998.

This document gives RTCA requirements for ADS-B (air-to-ground and air-to-air).

[14] "ODIAC Operational Requirements for ATM A/G data communications services", OPR.ET1.ST05.1000-ORD-01-00, EATCHIP, Edition 1, February 1998, prepared by ODIAC.

This document contains requirements for data link services, some of which impact on ADS requirements.

[15] "Operational Requirements for EATCHIP Phase III ATM Added Functions", Volumes 0 – 5, OPR.ET1.ST04.DEL01.0 – 5, Edition 2.0, 14 May 1998.

This document contains requirements for ground-based ATM functions. The requirements stated do not generally impact on ADS requirements.

[16] "The airborne impact of Mode S Enhanced Surveillance and Downlink Airborne Parameters", British Airways report, ESA.209.AJR.1701, Draft.

This document contains an analysis of implementing DAP on aircraft. It does not contain ADS requirements.

[17] "Study of Mediterranean and adjacent area for ADS (SMAA), Technical concept and technical requirements", SMAA/AENA-WP600-R2, July 1999, Draft issued for comment.

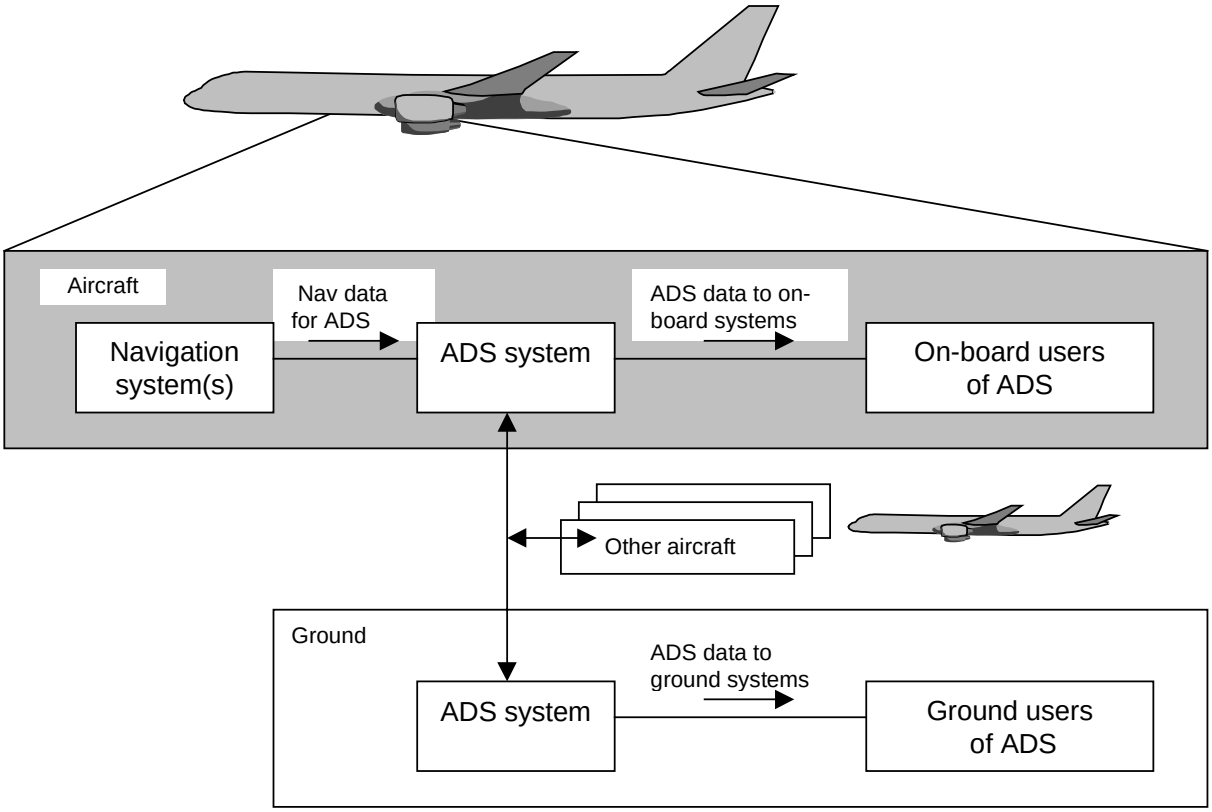
This document contains requirements for ADS extracted from ICAO and other sources.

3. BOUNDARIES OF ADS

The boundaries of the ADS system considered in this document is shown in Figure 1~~Figure 1~~.

Note that the ADS system as shown is not technology specific and encompasses ADS-Contract and ADS-Broadcast. However, it should be noted that aircraft-to-aircraft ADS data transfer can only be achieved with ADS-broadcast.

Figure 1: Boundaries of ADS system



The users of ADS data may include:

- On the ground: controllers, aircraft operators, automated tools/functions.
- On the aircraft: flight crews, automated functions/tools.

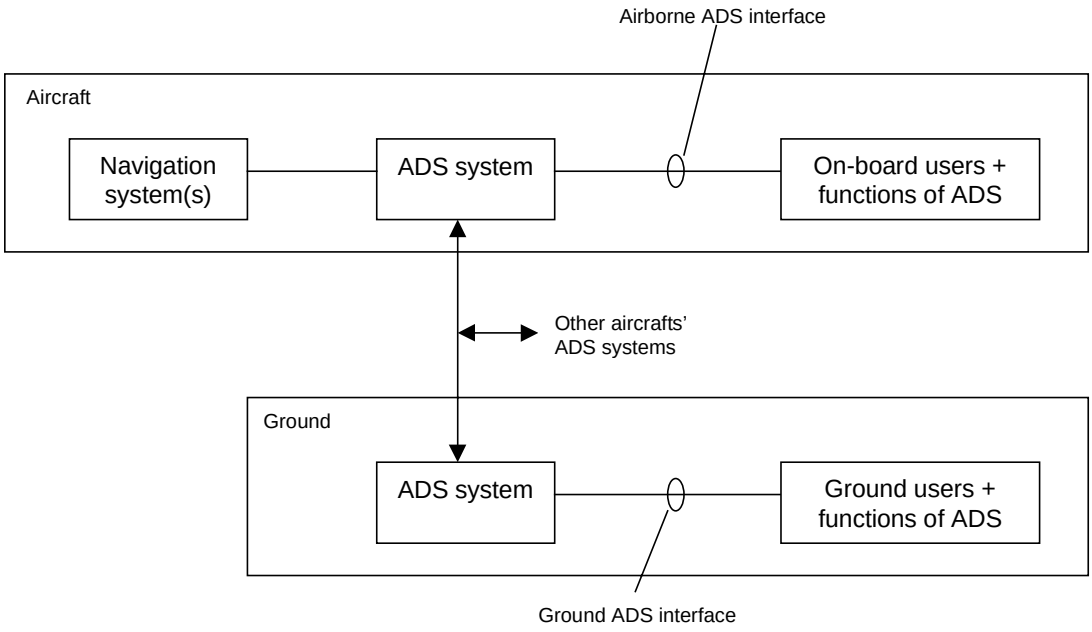
4. INTERFACE REQUIREMENTS

4.1Introduction

This section describes the ADS interface requirements, addressing both the ground and airborne parts of the system.

The requirements are described at the ground and airborne interfaces which are illustrated in Figure 2Figure 2.

Figure 22: Ground and Airborne ADS interfaces



4.1.1 Quantisation

When the full resolution of ADS data cannot be accommodated within the message, a common quantisation algorithm shall be used to ensure consistent performance across different implementations.

4.1.2 Standardisation

The output of the ADS system shall be standardised e.g. based on the extension of ASTERIX or other commonly agreed format.

The ADS interface standard will be seamlessly applicable from gate-to-gate.

The standard shall foresee items for future use.

4.2 Data Item requirements

The data items which shall be provided in the case of ADS-C are as detailed in [1] and [2]. These data will not be repeated here.

The data items which shall be provided in the case of ADS-B are as follows:

4.2.1 Time

The reports which will be provided by the ADS system shall include the time of applicability (validity) of the position measurement.

The time shall be expressed in hours/minutes/seconds.

4.2.2 Identification

The ADS reports shall include the following identification information:

- Call Sign
- Address
- Category

4.2.2.1 Call Sign

The ADS shall be able to transmit the aircraft call sign of up to 7 alphanumeric characters.

The aircraft/vehicles which do not receive ATS services ~~and military aircraft~~ are not required to provide a call sign.

4.2.2.2 Address

The ADS reports shall include the 24-bit unique technical address.

In the case of military aircraft, the following shall apply: The 24-bit address is not required to be linked *permanently* with one particular airframe. This means that the military will allocate a 24-bit address (from their allocated block) to a military aircraft before take-off. Unlike civilian aircraft, military aircraft may be allocated different codes on each sortie.

However, no two military aircraft shall use the same 24-bit address at the same time. The code shall not be changed in flight.

The same rules concerning downlinking of 24-bit address code shall apply to the military as apply to civilian aircraft.

4.2.2.3 Emitter Category

The emitter category shall refer to the characteristics of the aircraft or vehicle and will be one of the following:

1. Light aircraft – 7000 kg (15500 lbs) or less
2. Reserved
3. Medium aircraft – more than 7000 kg (15500 lb) but less than 136000 kg (300000 lbs)
4. Reserved
5. Heavy aircraft – 136000 kg (300000 lbs) or more
6. High performance (larger than 5g acceleration capability
7. Reserved
8. Reserved
9. Reserved
10. Rotorcraft
11. Glider/Sailplane
12. Lighter-than-air
13. Unmanned aerial vehicle
14. Space/transatmospheric vehicle
15. Ultralight/Handglider/paraglider
16. Parachutist/skydiver
17. Reserved
18. Reserved
19. Reserved
20. Surface vehicle – emergency vehicle
21. Surface vehicle – service vehicle
22. Fixed ground or tethered obstruction
23. Reserved

24. Reserved

The military aircraft shall have the capability of deselecting this data item.

4.2.3 Three-dimensional Position

The ADS reports shall include the three-dimensional position of the aircraft or vehicle.

The position reports shall be transmitted in a form that can be translated without loss of accuracy and integrity to latitude, longitude, geometric altitude and barometric altitude.

All geometric position elements shall be referenced to WGS-84 system.

4.2.3.1 Latitude and Longitude

The horizontal latitude and longitude positions shall be reported as a geometric position.

4.2.3.2 Altitude

Both barometric and geometric altitude shall be reported, if available.

The barometric altitude shall be reported with reference to standard temperature and pressure.

The barometric altitude shall be derived from the same source as the pressure altitude which is reported by Mode C and Mode S, in the case of aircraft carrying both transponder and ADS functionality.

It is noted that the geometric altitude is the minimum altitude from a plane tangent to the earth's ellipsoid, defined by WGS-84.

The altitude shall be provided within a range of -1000 ft to 100000 ft.

For aircraft and vehicles operating on the airport surface, it is not required to report the altitude, provided that it is indicated (by the emitter category) that the aircraft or vehicle is on the surface [13].

For fixed or tethered objects, the altitude of the highest point shall be reported.

4.2.4 Velocity

The ADS system shall be capable of reporting the following information:

- Ground Speed

- Track Angle
- Airspeed
- Heading
- Vertical rate

The geometric velocity information shall be referenced to WGS-84.

4.2.4.1 Ground Speed

The ADS system shall be capable of reporting the aircraft/vehicle derived ground speed.

The range of the ground speed shall be up to a max. of 4000 knots.

4.2.4.2 Track Angle

The ADS system shall be capable of reporting the aircraft derived track angle.

4.2.4.3 Airspeed

The ADS system shall be capable of reporting the aircraft derived airspeed as a choice of the following:

- Mach
- IAS
- Mach and IAS

4.2.4.4 Heading

The ADS system shall be capable of reporting the aircraft heading.

4.2.4.5 Vertical Rate

The altitude rate shall include a designation as climbing or descending.

The altitude rate shall be reported within a range of up to 32000 ft/min.

The barometric altitude rate is the current rate of change of barometric altitude. The geometric altitude rate of the state vector is measured along the line from the origin of the WGS-84 reference system to the current position of the aircraft or vehicle.

For vertical errors (95%) less than 15 m, the geometric altitude rate shall be reported.

For vertical errors (95%) higher than 15 m, the barometric altitude or inertially augmented barometric altitude rate shall be reported [13].

4.2.5 Track Rate

The ADS shall be capable of providing the track angle rate.

~~4.2.6Figure of merit~~

~~ADS-C reports shall include a Figure of Merit (FOM), according to ICAO provisions [1].~~

~~4.2.7~~4.2.6 Estimated position uncertainty

The ADS system shall be capable of providing the estimated position uncertainty.

~~4.2.8~~4.2.7 Status

The ADS system shall be capable of supporting an indication of emergency or priority status [13].

The following types of status shall be included:

1. No emergency/Not reported
2. General emergency
3. Lifeguard/medical
4. No communications
5. Unlawful interference
6. State~~Spare~~

~~i.~~7. Spare

~~4.2.9~~4.2.8 Trajectory Intent data

The ADS system shall be capable of transmitting four dimensional trajectory intent data.

The trajectory intent data shall consist of a string of four dimensional points that describe the predicted trajectory of the aircraft along with the point type and turn radius associated with the flight path transition.

~~4.2.9.1~~4.2.8.1 *Transmission characteristics*

This data shall be transmitted under the following events:

a. whenever an active flight plan change occurs

b. when a lateral waypoint is sequenced

c. whenever there has been a significant change to the predicted trajectory caused by tactical operations or unforecasted environmental conditions

d. when a defined period has elapsed since the last transmission

~~4.2.9.2~~4.2.8.2 *Non-compliance and non-availability indication*

The ADS reports shall include a non-compliance indication for the intent data.

The ADS reports shall include a non-availability indication for the intent data.

~~4.2.9.3~~4.2.8.3 *Trajectory intent data items*

The trajectory intent points shall be according to ARINC 702A. They shall include the following items:

- Latitude
- Longitude
- Altitude
- Time to go (to the intended point)
- Point type
- Turn direction
- Turn radius

~~4.2.10~~4.2.9 Meteorological information

The ADS system shall be capable of providing the following meteorological data:

- Wind direction
- Wind speed
- Temperature

- Turbulence

~~4.2.11~~4.2.10 Other data items

The ADS system shall be expandable in order to support additional data items which will be considered necessary in the future

4.3 Transmission characteristics

4.3.1 Modes of operation

The ADS system has~~shall provide for the~~the following types of modes of operation~~n:~~

i. Broadcast

~~ii.~~ii. Point-to-point

4.3.2 Transmission characteristics

The ~~following~~ transmission characteristics which shall be provided in the case of ADS-C are as detailed in [1] and [2]. These will not be repeated here~~:~~

- ~~On-demand~~
- ~~Periodic~~
- ~~Event driven~~
- ~~Emergency~~

~~*4.3.2.1Event types*~~

~~The following event types shall be at least foreseen for the aircraft derived data:~~

- ~~Vertical Rate change~~
- ~~Waypoint change~~
- ~~Lateral deviation change~~
- ~~Level change~~
- ~~Level change deviation~~
- ~~Airspeed change~~
- ~~Ground speed change~~

- Heading change
- Extended projected profile change
- FOM field change
- Track angle change

For the above types of events, the provisions of ICAO, as described in shall be fulfilled.

The event driven transmission shall be possible also in the case of broadcast mode of operation.

In the case of ADS-B, the following types of transmission characteristics shall be provided:

- Periodic
- Event driven

4.4 Data items and transmission characteristics required from ground ADS interface

Req 1 Source -

The following types of data shall be available from the ground ADS interface:

- Aircraft identity.
- Aircraft 4-D position data.
- State vector information.
- Intent data.
- Meteorological data.

The following tables shows the data items defined in the ADS Concept [12] for different phases of flight.

	MAS/Continental High-Density		
	Taxi, Departure and Arrival	**TMA**	**En-route**
Potential role of ADS for ground	Aircraft identity Time Intent data (periodic/low rate and once per change point, extended projected profile once in departure and then once per FIR)		
	Position (periodic/high rate) Air and ground vector (periodic/high rate)	Position (periodic/high rate) Air and ground vector (periodic/high rate) Meteo data (low rate in general and high rate for bad weather)	Position (periodic/medium rate) Air and ground vector (medium rate) Meteo data (low rate in general and high rate for bad weather)

	MAS/Continental Low-Density		
	Taxi, Departure and Arrival	**TMA**	**En-route**
Potential role of ADS for ground	Aircraft identity Time Intent data (periodic/low rate and once per change point, extended projected profile once in departure and then once per FIR)		
	Position (periodic/high rate) Ground vector (periodic/high rate)	Position (periodic/high rate) Ground vector (periodic/high rate) Meteo data (low rate in general and high rate for bad weather)	Position (periodic/medium rate) Ground vector (periodic/low rate) Meteo data (low rate in general and high rate for bad weather)

	Non-continental[1]
	En-route
Potential role of ADS for ground	Aircraft Identity Time Position (periodic/low rate) Ground vector (periodic/low rate) Intent data (periodic low rate and once per change point, extended projected profile once per FIR) Meteo data (low rate in general and high rate for bad weather)

[1] This is an airspace where radar infrastructure does nt exist or is not practicable.

	Free-Flight
Potential role of ADS for ground	Aircraft Identity Time Position (periodic/high rate) Ground vector (periodic/high rate) Intent data (once per change point) Meteo data (low rate in general and high rate for bad weather)

The detail of data items in this Section shall be refined in later versions of this document.

4.5 Data items and transmission characteristics required from airborne ADS interface

~~Req 2 Source -~~

The following types of data shall be available from the airborne ADS interface:

- Aircraft identity.
- Aircraft 4-D position data.
- State vector information.
- Intent data.

The following table shows the data items defined in the ADS Concept [12] for different phases of flight.

	MAS/Continental High-Density		
	Taxi, Departure and Arrival	**TMA**	**En-route**
Potential role of ADS for aircraft	Aircraft identity Time Intent data (periodic/low rate and once per change point)		
	Position (periodic/high rate) Ground vector (periodic/high rate)	Position (periodic/high rate) Ground vector (periodic/high rate)	Position (periodic/high rate) Ground vector(periodic/medium rate)

	MAS/Continental Low-Density		
	Taxi, Departure and Arrival	**TMA**	**En-route**
Potential role of ADS for aircraft	Aircraft identity Time Intent data (periodic/low rate and once per change point)		
	Position (periodic/high rate) Ground vector (periodic/high rate)	Position (periodic/high rate) Ground vector (periodic/high rate)	Position (periodic/medium rate) Ground vector (periodic/medium rate)

	Non-continental
	En-route
Potential role of ADS for aircraft	Aircraft Identity Time Position (periodic/medium rate) Ground vector (periodic/medium rate) Intent data (periodic low rate and once per change point)

	Free-Flight
Potential role of ADS for aircraft	Aircraft Identity Time Position (periodic/high rate) Ground vector (periodic/high rate) Intent data (periodic low rate and once per change point)

The detail of data items shall be refined in later versions of this document.

5. FUNCTIONAL REQUIREMENTS

5.1 General

This section describes requirements on functional processing of ADS data, including its distribution.

~~Req 4 Source -~~

High-level requirements defined by ICAO shall be taken into account in the development of the ADS system.

~~Req 5 Source [1], part VII, page VII-2-1~~

ADS data and messages shall be:

a) delivered at a rate appropriate to the service

b) generated and transmitted in a time-ordered sequence; and

c) delivered in the order sent.

5.2 Data Distribution

~~Req 6 Source -~~

ADS data shall be distributed to the relevant users both on the ground and in the air.

Note: The potential users of ADS data include human operators and automated functions.

The transmission characteristics of the processed ADS data shall reflect the corresponding capabilities of the ADS-C and ADS-B applications.

5.3 Adaptability

~~Req 7 Source -~~

It shall be possible to adapt the characteristics of the ADS service, e.g. in varying operational environments such as phase of flight, type of airspace or the other available surveillance infrastructure.

5.4 Seamless Operation

~~Req 8 Source -~~

The ADS service shall ensure a seamless operation in a mixed and varying environments including:

- various surveillance data sources;
- different airspace types;
- different phases of flight (taxi, TMA and en-route);
- borders between different ground ATM units.

5.5 Integration of ADS with other Surveillance data

~~5.5~~5.5.1 Surveillance Data Fusion

~~Req 9 Source -~~

ADS data, and other available surveillance data (if any), shall be used for tracking.

Note: The role of ADS data for tracking will depend on the alternative surveillance sources available and other factors.

~~Req 10 Source -~~

ADS data shall be fused with data from other surveillance sources if available.

~~5.6~~5.5.2 Surveillance Environment Assessment

~~Req 11 Source -~~

ADS data shall be compared with data from other surveillance sources, if available, to ensure integrity of ADS.

~~5.7~~5.6 Expandability

~~Req 12 Source -~~

The ADS system shall be expandable, in order to accommodate changes in e.g. message type, structure, content, length and transmission characteristics.

6. PERFORMANCE REQUIREMENTS

6.1 Introduction

This section describes the performance requirements applicable to ADS.

In the case of the ground Surveillance system including ADS, the performance will, in general, be at least equal to the Surveillance Standard [ ]. The requirements of the Surveillance Standard will be provided in the relevant Sections below..

6.2 Timestamp

~~Req 13 Source [1], part VII, page VII-2-1~~

ADS data timestamps shall be accurate to within <TBD> of UTC.

Note: The ICAO Manual of ATS data link applications gives a requirement of 1s, but this needs to be discussed.

6.3 Integrity

Definition: The probability that errors will be mis-detected. This may be when a correct message is indicated as containing one or more errors, or when a message containing one or more errors is indicated as being correct. (Reference: [1], Table I-3-A.1)

~~Req 14 Source [1] , part I, Table I-3-A.1~~

The integrity of ADS data shall be 10^{-7}.

Note: Integrity is generally measured in terms of the probability that errors will be mis-detected. This may be when a correct message is indicated as containing one or more errors, or when a message containing one or more errors is indicated as being correct[2].

6.4 Reliability

Definition: The probability that the system will deliver a particular message without errors. (Reference: [1])

~~Req 15 Source [1], part I, Table I-3-A.1~~

The reliability of ADS data shall be 99.996%.

[2] RTCA integrity definition for ADS-B (from RTCA ADS-B MASPS): the probability of an undetected error in a report received by an application, given that the ADS-B system is supplied with correct source data.

Note: The difference between reliability and integrity is that integrity includes errors due to the ADS data source while reliability does not, and reliability takes into account message loss/duplication as errors, while integrity does not.

6.5 Availability

Definition: The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of the time the system is available to the time the system is planned to be available. (Reference: [1])

~~Req 16 Source [1] , part I, Table I-3-A.1~~

The availability of the ADS system shall be 99.996%.

Note: Availability is used to define requirements on continuous system operation over a long period of time (e.g. max downtime of n minutes per year). Downtime due to maintenance is not included. Availability is different from continuity, as discussed below.

6.6 Continuity

Definition: The probability of a system to perform its required function without unscheduled interruptions during the intended period of operations. (Reference: [1])

~~Req 17 Source [1] , part I, Table I-3-A.1~~

The continuity of the ADS system shall be 99.996%.

Note: Continuity is used to define continuous system operation over a short period of time (e.g. hour of flight in the RTCA ADS-B MASPS). Continuity is different from availability [3].

Note: Continuity is normally associated with safety critical manoeuvres – e.g. an aircraft should not start a CAT III ILS approach unless confident that the ILS will still be there by the time it lands.

6.7 Coverage

Definition: The operational geographic area (or volume) within which the system provides a service.

The ADS system shall enable Surveillance coverage over the complete ECAC area from gate-to-gate.

[3] RTCA continuity definition for ADS-B (from RTCA ADS-B MASPS): The probability that the ADS-B System, for a given ADS-B Message Generation Function and in-range ADS-B Report Generation Processing Function, is unavailable during an operation, presuming that the System was available at the start of that operation. The allocation of this requirement to ADS-B System Functions should take into account the use of redundant/diverse implementations and known or potential failure conditions such as equipment outages and prolonged interference in the ADS-B broadcast channel.

6.8 Latency

Definition: The elapsed time between a system input and the corresponding system output.

Note: ICAO ADSP uses the term transfer delay for ADS-C and the term latency for ADS-B, defining transfer delay as the elapsed period from the time at which the originating user initiates the triggering event until the time the transmitted information has been received by the intended recipient.

6.9 Surveillance Data Refresh Rate

Definition: The rate at which new surveillance information is supplied to the user.

Note: The required surveillance data refresh rate is usually associated with a probability of achieving the update rate (for example, it could be specified as '99% probability of an update every 10s').

Note: For ADS data, the surveillance refresh rate is related to the

- Transmission Rate (TR), i.e. the nominal rate at which reports are transmitted by the source ADS station.
- Successful Reception Probability (also known as message success rate [MSR]), i.e. the probability of successful reception of a report by an ADS data acquisition unit. The MSR is a reliability measure.
- Effective Update Period (EUP): Elapsed time between successive ADS report updates (from the same source ADS station) at the output of the destination ADS data acquisition unit.

6.10 Capacity

Definition: ADS system capacity is a combination of channel capacity over a geographic area over a number of channels (if appropriate).

The ADS-B system shall be capable of operating for the traffic densities which are expected in ECAC by the year 2015. These are indicated in the Figure below.

6.11 Accuracy

Definition: The degree of conformance between estimated or measured position (and other relevant parameters such as velocity and time) of a platform and its true position (or velocity or time). (Reference: [11]).

Note: Accuracy requirements may be specified for each element of the data transmitted. For example, position accuracy, velocity accuracy, next waypoint accuracy and timestamp accuracy.

In the case of ground Surveillance including ADS, the accuracy figures will, in all cases, be better than the ones of the Surveillance Standard for classical Surveillance [ ]. The following Figure provides the requirements of the Standard for major TMA and en-route (dual SSR coverage). In the case of integration of ADS in these areas, these level of performance shall be the baseline even if, in the future, e.g. one of the SSRs will phase out.

Major TMA				
Accuracy		***Type of motion***		
Elements	***Parameters***	***Uniform motion***	***Uniform speed change***	***Standard turn***
Position	*Along trajectory position RMS errors*	*50 m*	*125 m*	*70 m*
	Across trajectory position RMS errors	*50 m*	*50 m*	*70 m*
Ground speed	*Ground speed RMS error*	*0.6 m/s*	*13 m/s*	*3 m/s*
Course	*Course RMS error*	*0.5 °*	*1 °*	*4.5 °*

En-route				
Accuracy		***Type of motion***		
Elements	***Parameters***	***Uniform motion***	***Uniform speed change***	***Standard turn***
Position	*Along trajectory position RMS errors*	*120 m*	*285 m*	*180 m*
	Across trajectory position RMS errors	*120 m*	*145 m*	*180 m*
Ground speed	*Ground speed RMS error*	*1.5 m/s*	*20 m/s*	*5 m/s*
Course	*Course RMS error*	*0.5 °*	*1.1 °*	*3 °*

6.12 End-to-end transfer delay

Definition: The period elapsed from the time at which the originating user initiates the triggering event until the time the transmitted information has been received by the intended recipients. (Reference: [1])

~~Req 18 Source [1] , part I, Table I-3-A.2~~

The mean end-to-end transfer delay of ADS data shall be not more than <TBD> s.

The 95% end-to-end transfer delay of the ADS system shall be not more than <TBD> s.

The 99.996% end-to-end transfer delay of the ADS system shall be not more than <TBD> s.

Note: The ICAO Manual of data link applications gives classes of transfer delay from A to J. It is necessary to decide which of these shall apply to the ADS system.

7. OTHER REQUIREMENTS

7.1 Security

The system shall prevent unauthorised access, in order to protect flight safety, as well as commercial and military interests.

7.2 Regulatory requirements

The ADS system shall operate in an internationally allocated aeronautical telecommunication band.

7.3 Environmental issues

The ADS system shall be capable for all-weather operations.