ADS-B Ground Surveillance Specifications for Second Iteration

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Abstract

The present document describes the second iteration of specifications for the ADS-B Surveillance System. The selection of the requirements upon which these specifications are based are derived from the preceding deliverable D17. The specifications address the functional ADS-B Ground Surveillance Domain without addressing any physical implementation. It includes the following key information:

➢ Scope and context of the ADS-B Surveillance System.

➢ The allocation of enhancements for project Iteration 2 (from D17).

➢ High Level specifications for the ADS-B Ground Surveillance Domain with an indication of the possible system components to which this specification is applicable.

The document serves as input to the subsequent project tasks which will further elaborate the high level specifications into detailed specifications for the ADS-B Ground

Surveillance Domain components. It will be revisited as appropriate in the course of the project work on Iteration 3.

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Executive summary

The present document describes the second iteration of specifications for the ADS-B Surveillance System. The selection of the requirements upon which these specifications are based are derived from the preceding deliverable D17 (Ref [1]). The specifications address the functional ADS-B Ground Surveillance Domain without addressing any physical implementation. It includes the following key information:

➢ Scope and context of the ADS-B Surveillance System.

➢ The allocation of enhancements for project Iteration 2 (from Ref [1])

➢ High Level specifications for the ADS-B Ground Surveillance Domain with an indication of the possible system components to which this specification is applicable.

The Project covers enhancements to the baseline by a number of drivers (applications and technological enhancements) which can be clustered as follows:

- Initial ADS-B applications

- Applications defined in SESAR projects (including future separation modes such as spacing, separation etc.)

- Integration of ADS-B with WAM

- Security and Civil-Military Interoperability

- 1090 ES MHz datalink technology enhancements

- Other enhancements

In accordance with the set of enhancements defined in Ref [1], high-level requirements are addressed in order to support:

- The ADS-B APT Application.

- ADS-B ADD (After analysis not retained for Iteration 2)

- ATSA SURF (After analysis not retained for Iteration 2)

- ASPA-Flight Deck Interval Management (FIM) (After analysis not retained for Iteration 2)

- Applications based on SESAR project deliveries (After analysis not retained for Iteration 2)

- Advanced enhancements from integration with WAM

  ➢ Enhanced ADS-B target report validation
  ➢ Enhancements from CASCADE process (to reflect any requirements stemming from the safety, performance and interoperability work on ADS-B integration with WAM) (After analysis not retained for Iteration 2)

- Advanced security enhancements

  ➢ Use of TDOA Techniques
  ➢ Multi-Ground Station target tracking (After analysis not retained for Iteration 2)
  ➢ Increased antennas sectorisation to improve the localisation performance (After analysis not retained for Iteration 2)
  ➢ Behavioural analysis of targets

- Other enhancements

  ➢ Automatic network bandwidth optimisation techniques (to adapt the data transmission content and rate according to the capacity of the network)

1 Introduction

1.1 Purpose of the document

This document describes the high level requirements for the second iteration of specifications for the ADS-B Ground Surveillance System

It is to be used as the input document for the project tasks producing the component specifications for ADS-B Ground Station, Surveillance Data Processing and Distribution systems as well as for the enhancements to the baseline interfaces.

The requirements shall be at a high level and shall be allocated to one or more of the above-mentioned components.

1.2 Intended readership

The audience of this document includes:

- Projects 15.04.05.a and b,
- Any other SJU projects that may require ADS-B Surveillance Systems for their validation activities.

1.3 Inputs from other projects

The following on-going and past activities have contributed to establishing the high level requirements for the ADS-B Ground Surveillance System:

- ➢ EUROCONTROL CASCADE Program
- ➢ Requirements Focus Group (RFG) and associated EUROCAE/RTCA standardisation activities for ADS-B Surveillance Applications (Ref [7], Ref [8],[17])
- ➢ ADS-B Avionics equipment standardisation by EUROCAE/RTCA (Ref [4],[5], [6]).

1.4 Structure of the document

Chapter 1: Purpose and scope; Requirements structure; Component purpose and high level overview

Chapter 2: General component description

Chapter 3: ADS-B Ground Surveillance Functional and Non-Functional Requirements

Chapter 4: Referenced documents

Appendix A: Traceability Matrix

Appendix B: ED-163 Requirements Analysis

1.5 Requirements Definitions – General Guidance

Requirements have been developed according to the SESAR Requirements and V&V Guidelines Ref [2].

They are broken down according to the source of the requirements, derived from the allocation which was done in Ref [1].

The layout follows the description in Ref [3].

In accordance with the guidelines in Ref [3], requirement identifiers follow the scheme:
REQ-15.04.05.a-D19-00xx.yyyy, where

xx	Meaning
12	ADS-B APT Functional req.
13	ADS-B ADD Functional req.
14-19	Reserved for SESAR applications Functional req.
22	ADS-B APT Performance req.
23	ADS-B ADD Performance req.
24-29	Reserved for SESAR applications Performance req.
30	WAM integration req.
40	Security req.
50	Civil/Military req.
60	1090ES Technology req.
00	Other

Table 1 Requirement Identifier Allocation

1.6 Functional block Purpose

The ADS-B Ground Surveillance Domain is a subset of the overall Ground Surveillance System, and adds the reception, processing and integration of ADS-B data into the surveillance data provided to the ATM System.

The ADS-B Ground Surveillance Domain consists of sets of networked ground stations plus data distribution and filtering functions, as well as tracking/fusion capabilities with other surveillance sources.

1.7 Functional block Overview

The figure below depicts a functional context diagram of the future Ground Surveillance System, where the impacted system elements are marked in blue.

Please note that the inclusion of Radar Systems and/or WAM systems depends on the operational environment and associated ADS-B applications which are to be deployed.

In case of ADS-B NRA or ADS-B APT deployment, ADS-B will be the only surveillance source.
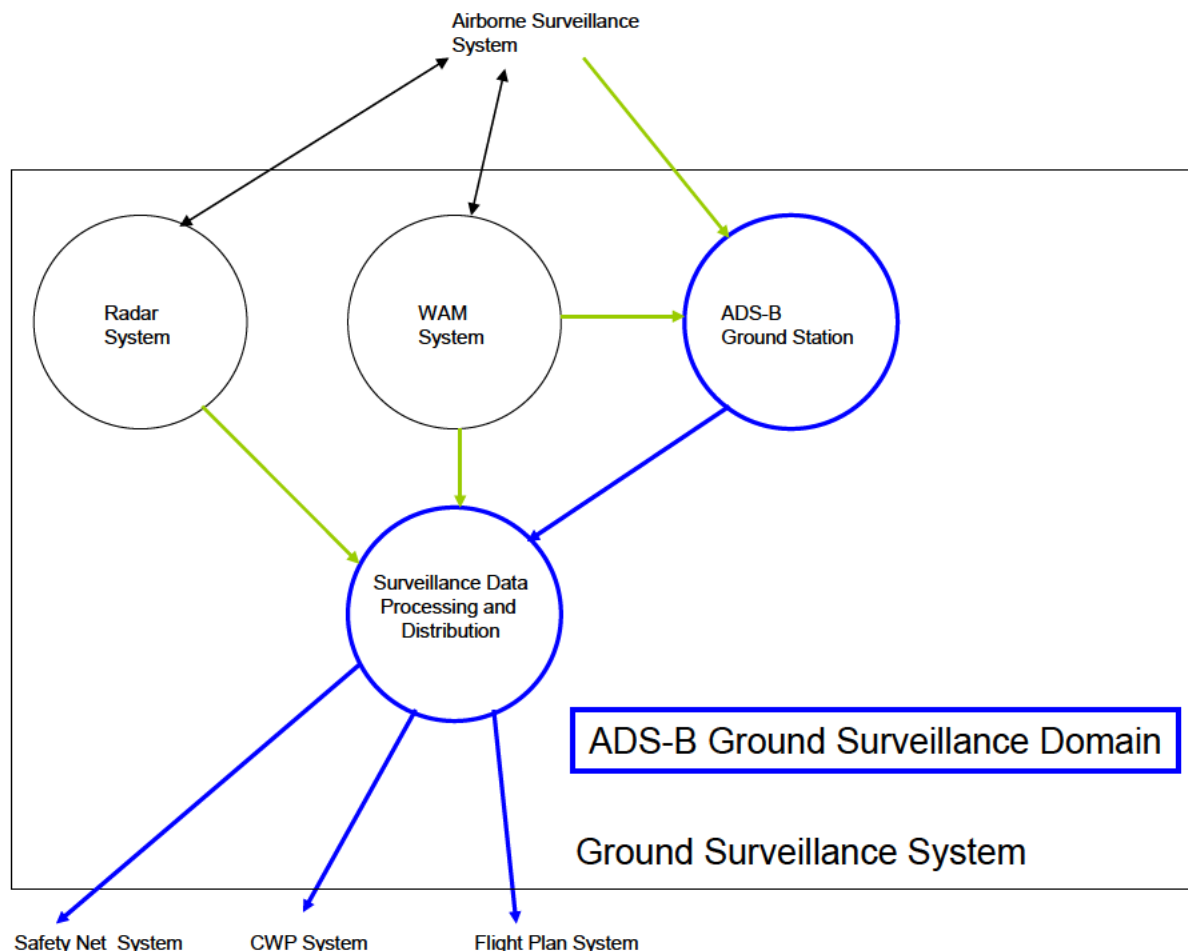
Figure 1 ADS-B Ground Surveillance Domain Context

→ = Existing standardised interfaces, **already processed** by Baseline, **not modified** by P15.4.5a

→ = Existing standardised interfaces, **already processed** by Baseline, **modified** by P15.4.5a

→ = Existing standardised interfaces, **out of scope** of P15.4.5a

In the context of this project, the following functional components are addressed:

- ADS-B Ground Station

  The term 'ADS-B Ground Station' in this document refers to a 1090ES Ground Station. The primary function of the ADS-B Ground Station is to receive 1090 MHz RF input on the Air Interface, extract data from the 1090 MHz ES messages, assemble the data into ASTERIX Category 21 ADS-B Reports and send these reports over the Ground Interface.

  This specification is not intended to dictate the physical architecture of the equipment. In alignment with the chosen baseline specifications for ADS-B Ground Stations (Ref [9]), the definition of an ADS-B Ground Station is intended to include a distributed architecture where 1090 ES reception functionality is located remotely and the report assembly for one or more sites is hosted centrally in a common server. This distributed architecture allows for the integration of WAM systems and ADS-B Ground Stations. It allows also for physical implementations where SDPD functionality is implemented in the common server of the ADS-B Ground Stations.

- Surveillance Data Processing and Distribution (SDPD)

  The baseline for the SDPD is the ARTAS multi-sensor tracking system enhancement based on the first iteration specifications. This system associates surveillance reports originating from different surveillance technologies (radar, WAM, ADS-B, and ADS-C) and fuses the

associated reports into a unique system track. The system tracks are assembled into ASTERIX CAT 62 System Track Messages and these messages are sent over the Ground Interface.

Despite the fact that an existing physical implementation of an SDPD has been chosen as the baseline, the allocation (or non-allocation) of specific requirements to the SDPD should be interpreted as a functional allocation. This specification should not prevent different physical ADS-B Ground Domain implementations. For example, ADS-B Ground Station functionality hosted in a server common to remote 1090ES reception functionality could be implemented in a physical SDPD system.

- Interfaces

  The Interfaces subject to modification by the project refer to:

  ➢ ASTERIX CAT21, Ed. 2.0h, March 2011 (ref [18])
  ➢ ASTERIX CAT 23,Ed 2.0b, March 2011 (ref [18])
  ➢ ASTERIX CAT 62, Ed 2.0c, March 2011 (ref [18])
  ➢ ASTERIX CAT 63, Ed 1.3, July 2007 (ref [13])

1.8 Acronyms and Terminology

Term	Definition
ADD	Aircraft Derived Data
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-B ADD	Aircraft Derived Data for ATC tools ("ADS-B out" application)
ADS-B APT	Enhanced ATS at the airport surface ("ADS-B out" application
ADS-B NRA	Enhanced ATS in Non Radar Areas ("ADS-B out" application)
ADS-B RAD	Enhanced ATS in Radar Areas ("ADS-B out" application)
ARTAS	ATM suRveillance Tracker And Server
ASAS	Airborne Separation Assurance System
ASEP	Airborne SEParation
ASPA	Airborne Spacing Application
ASPA-FIM	Flight-deck Interval Management ("ADS-B in" Airborne Spacing Application)
ASSUMP	Assumption
ASTERIX	All-purpose Structured EUROCONTROL Surveillance Information Exchange
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services

Term	Definition
ATSA-ITP	In-Trail Procedure in procedural airspace ("ADS-B in" ATSAW application)
ATSA-SURF	Enhanced Traffic Situational Awareness on the Airport Surface ("ADS-B in" ATSAW application)
ATSAW	Air Traffic Situation Awareness
ATX	ASTERIX
CAT	Data Category
DO	RTCA Document
ED	EUROCAE Document
ES	Extended Squitter
EUROCAE	European Organisation for Civil Aviation Equipment
FIM	Flight-deck Interval Management
GS	Ground Station
INTEROP	Interoperability
IP1	Implementation Package 1
ITP	In-Trail Procedure
Mode S	MODE Select
MOPS	Minimum Operational Performance Standards
NACp	Navigation Accuracy for Position
NRA	Non Radar Airspace
PIR	Project Initiation Report
PR	Performance Requirement
REQ	Requirement
RF	Radio Frequency
RFG	Requirement Focus Group
RTCA	Radio Technical Commission for Aeronautics
SDPD	Surveillance Data Processing and Distribution
SESAR	Single European Sky ATM Research (Programme)
SG4	Sub Group 4

Term	Definition
SJU	SESAR Joint Undertaking
SMGCS	Surface Movement Guidance and Control System
SMR	Surface Movement Radar
SPR	Safety and Performance Requirements
SPR-INTEROP	Safety, Performance and Interoperability Requirements
SSR	Secondary Surveillance Radar
TDOA	Time Difference Of Arrival
TMA	Terminal Manoeuvring Area
WAM	Wide Area Multilateration

2   General Functional block Description

2.1 Context

A high level context of the ADS-B Ground Surveillance Domain is shown in Figure 1.

The following Figure gives a more detailed overview of the component boundaries and interfaces.

ADS-B Messages (1090 ES Squitters)
DO260
DO260-A
DO260-B

ADS-B
GS

ADS-B Reports
ATX CAT 21
ATX CAT 23

Surveillance Data
Processing and
Distribution

System Track Data
ATX CAT 62
ATX CAT 63

WAM Reports
ATX CAT 19
ATX CAT 20

WAM Reports
ATX CAT 19
ATX CAT 20

Radar Data
ATX CAT 01/02/34/48
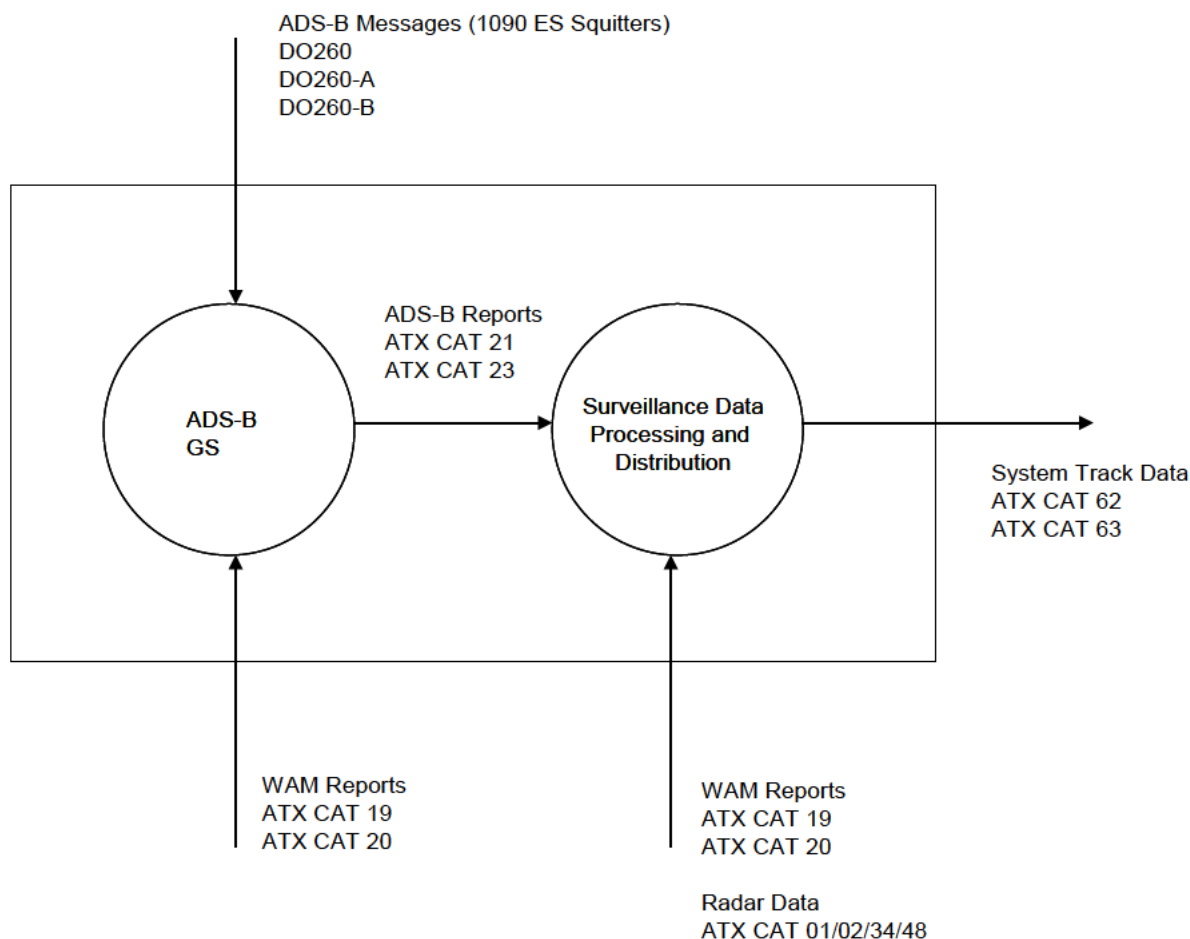
Figure 2 Component Context

2.2 Functional block Modes and States

Detailed Modes and States of the sub-components are described in the baseline documents ref [9], and [14].

This document will be used as the reference document for further detailed specifications for ADS-B Ground Stations (D09), SDPD (D10) and ASTERIX Interfaces (D11) related to Iteration 2.

Any change towards the Modes and States as a result of this document will be further detailed into those above mentioned deliverables.

2.3 Major Functional block Capabilities

The major components and capabilities are as described in Section 1.7 of this document

2.4 User Characteristics

The ADS-B Ground Surveillance System shall be capable to be integrated into a multi-sensor surveillance environment as an additional means of surveillance. This usage targets the core European airspace.

The ADS-B Ground Surveillance System shall also be able to be deployed in lower density non-core European airspace. This type of airspace could be Non-Radar Airspace (NRA) in which the ADS-B Ground Surveillance System will be the sole means of surveillance.

The ADS-B Ground Surveillance System shall also be able to be deployed at simple to complex airports (as defined in ADS-B APT) with medium traffic complexity where a conventional SMR-only solution would be sufficient for the provision of Aerodrome Control Services supported by Surveillance (SMGCS).

More information on the typical ADS-B APT user characteristics can be found in Ref [19].

The scalability and various potential physical architectures of this system will allow for a surveillance solution adaptable to the local traffic and local ATM system environment.

2.5 Operational Scenarios

The ADS-B Ground Surveillance System is foreseen to be used in a high-density traffic environment (en-route and/or TMA and/or Airport), including multiple surveillance techniques. High quality aircraft position data and other aircraft derived data will contribute to accurate Flight Plan updates and conformity monitoring.

Nevertheless due to it scalability (see User Characteristics above), such a system could also be deployed in non-core European airspace.

2.6 Functional

Due to the bottom-up approach adopted for this second iteration of specifications, a functional decomposition or analysis linking to modelling performed by X.1.7 and/or B.4.3 projects is not applicable to this document.

2.7 Service View

N/A

3 ADS-B Ground Surveillance Functional and non-Functional Requirements

3.1 General

The Project covers enhancements to the baseline by a number of drivers (applications and technological enhancements) which can be clustered as follows:

- Initial ADS-B applications

- Applications defined in SESAR projects (including future separation modes such as spacing, separation etc.)

- Integration of ADS-B with WAM

- Security and Civil-Military Interoperability

- 1090 ES MHz datalink technology enhancements

- Other enhancements

The Baseline Definition document (Project deliverable D17) has established the following enhancements to be taken into account for the second iteration:

ADS-B applications	Integration with WAM	Security and civil-military interop	1090 ES Technology	Other enhancements
ADS-B APT ADS-B ADD ATSA SURF ASPA-Flight Deck Interval Management (FIM) Applications based on SESAR project deliveries (e.g. spacing)	Enhanced ADS-B target report validation Enhancements from CASCADE process	TDOA Multi-ground station target tracking Increased antenna sectorisation to improve the localization performance Behavioural analysis of targets	Enhancements for mature new standard beyond 102A/260B, if available	Automatic network bandwidth optimisation techniques.

Table 2 Enhancements for Iteration 2

The enhancement related to automatic network bandwidth optimisation techniques was classified under 'Integration with WAM' in Ref [1]. However during the work on the Iteration 2 specifications it was felt that this enhancement is a stand-alone enhancement and is as such not linked to WAM integration.

The baselines for the requirements are the enhancements as specified for Iteration 1. This means that the baselines for Iteration 1 as specified in Ref [15] are implicitly included in the baseline of Iteration 2.

Iteration 2 will thus build on the results of Iteration 1 and relevant IP1 work (such as EUROCONTROL CASCADE Programme regarding ADS-B & WAM and the Surveillance Products & Services regarding ARTAS and ASTERIX) as well as industry standardisation (such as EUROCAE WG51 SG4).

The high level specifications in this document relate to the En-Route and Approach ATC Domain as well as to the Airport Domain.

3.2 ADS-B Applications

The following applications, of which published standards by EUROCAE/RTCA are currently available, have been taken into account:

- ADS-B APT – (ED-163/DO-321)
- ATSA-SURF – (ED-165/DO-322)
- ASPA-FIM – (ED-195)

The two ATSA applications were assessed in order to determine if the enabling "ADS-B out" requirements of those applications would have an impact on the ground surveillance segment.
The result of this assessment showed that these applications have no impact on the ground surveillance segment.
This leaves only the ADS-B APT application as standardised application to be assessed for the first iteration of specifications.

ADS-B ADD has not been developed into a full-fledged application; nevertheless some requirements not covered directly by other ADS-B applications have been considered.

Although the ED102A/DO-260B ADS-B ES standard includes Selected Altitude and Barometric Pressure Setting, other Mode S Enhanced Surveillance data items which are currently used operationally, including heading and indicated airspeed, are either not included in the standard at all or are only broadcast if ground speed is not available.

To acquire and decode these additional Aircraft Derived Data, an active rather than passive system would be required which would be achieved using an interrogator.

The P15.4.5a Project Team has decided that the cost as well as the technical implications related to the synchronisation of the aircraft replies with the broadcast data would be too high to justify such a requirement on the ADS-B ground station.

Alternative operational solutions are available by using different surveillance technologies like WAM or for the short to medium term Mode-S radars in combination with ADS-B.

The available deliverables of SESAR Projects with a potential impact on Ground Surveillance were analysed and no substantial requirements for ADS-B Ground Surveillance could be identified.

The following table contains the projects which were analysed:

Project Number	Project Name
4.7.4a	ATSA-ITP Pioneer Trial
4.7.4b	ASAS-ASEP Oceanic Applications
4.7.5	Self Separation in Mixed Mode Environment
4.7.6	En Route Trajectory and Separation Management – ASAS Separation
9.5	ASAS-ASPA
9.6	ASAS ASEP
9.38	ASAS SSEP
10.3.2	ATC Support to ASAS sequencing and merging operations
10.3.3	ATC Support to ASAS In Trail Procedure(ITP)
10.4.4	Time Based Separation

Table 3 SESAR Projects with potential ground surveillance requirements

3.2.1 ADS-B APT Application Requirements

The following picture is taken from the ED-163 document and shows the functional architecture for the ADS-B APT application.
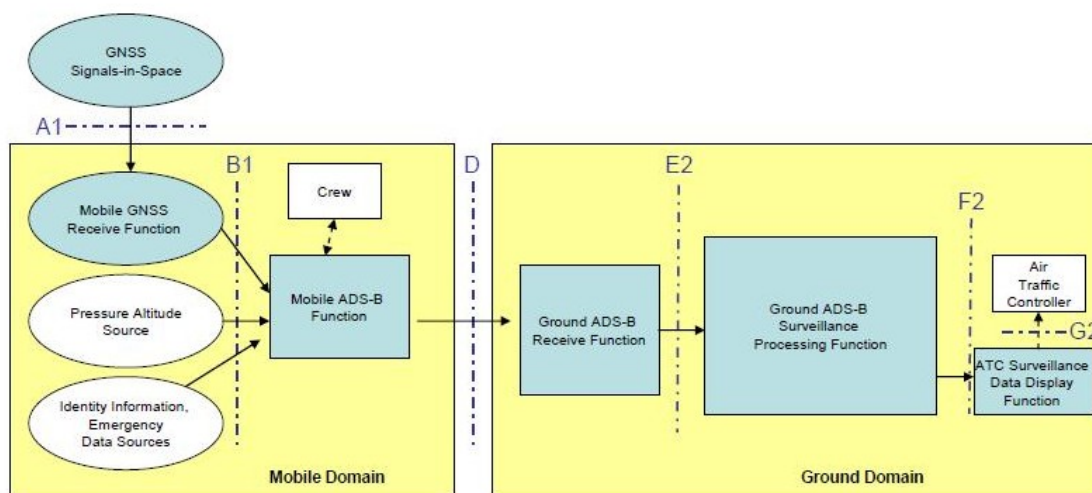

Figure 3 ADS-B APT Functional Architecture

The 'Ground Domain' in ED-163/DO-321 consists of:

- Ground ADS-B Receive Function
- Ground ADS-B Surveillance processing Function

- ATC Surveillance Data Display Function
- Air Traffic Controller

ED-163/DO-321 requirements are limited to:

- Ground ADS-B Receive Function
- Ground ADS-B Surveillance Processing Function
- ATC Surveillance Data Display Function

This document maps those requirements on the ADS-B Ground Surveillance Domain as defined in, Figure 3 according to the following Table:

ED-163/DO-321 Functional Component	P15.4.5a Functional Component
Ground ADS-B Receive Function	ADS-B Ground Station
Ground ADS-B Surveillance Processing Function	SDPD
ATC Surveillance Data Display Function	Interfaces

Table 4 Mapping of ED-163 Functions to Project 15.4.5a functions

As described in section 3.1, the baseline specifications for this iteration are the resulting specification documents related to Iteration 1.

For this reason, the ADS-B APT Ground Domain requirements as described in Ref [19] have been analysed and compared to the baseline. Only requirements not fully covered by this baseline will be described as Iteration 2 requirements.

A complete analysis of all ADS-B APT Ground Domain Requirements including references to the baseline is provided in Appendix B.

The following tables list all remaining high-level ADS-B Ground Surveillance Domain requirements for the ADS-B APT application. The requirements are allocated to one or more ADS-B Ground Surveillance Domain Components. If a requirement is allocated to a specific component, the detailed specifications and necessary quantifications will be developed in the subsequent project tasks dealing with component specifications.

[REQ]

Identifier	REQ-15.04.05.a-D19-0012.0001
Requirement	If the age of the position information is beyond a time limit, the Target **shall** be displayed with an indication (e.g. 'coasting' symbol) that the position data is stale and therefore could be unreliable.
Title	Surveillance update time out
Status	\<In Progress\>
Rationale	ED-163 Ground Domain Requirement
Category	\<Functional\>
Validation Method	
Verification Method	\<Test\>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
\<SATISFIES\>	\<ATMS Requirement\>	ED-163/SPR-11	\<Full\>
\<ALLOCATED_TO\>	\<Functional block\>	SDPD	N/A

Note 1: The value of the time limit is defined locally and a value of 4 seconds has been assumed in ED-163. (See ASSUMP. 53 below).

Note 2: See also ASSUMP. 44 on the coasting function below.

Note 3: Take also into account that stationary aircraft broadcast their position with another update rate (between 4.8 and 5.2 seconds).

ASSUMP.44 It is assumed that a coasting function exists in the Ground Domain with the following characteristics:
- When the horizontal position data received has been determined as "stale" (e.g. in the event of a loss of position data or degradation of the quality of the surveillance data), it is capable of „coasting" a Target on the Display by providing an extrapolated position using velocity information.
- This extrapolated position is presented on the Display as an identifiable Target symbol that differs from the nominal Target symbols.
- This identifiable Target symbol is removable by the controller after acknowledgement, as required by local procedures.

ASSUMP.53 A stale time limit of 4 seconds (from E2 to G2) is assumed to be applied to the age of position information

[REQ]

Identifier	REQ-15.04.05.a-D19-0012.0002
Requirement	For all mobiles on the Manoeuvring Area, the Ground Domain **should** be capable of receiving and processing the following list of ADS-B surveillance parameters: • Emitter Category • Geometric Altitude • Velocity Vector (heading/track and ground speed) • Mobile Size (length/width codes) • GPS antenna offset information
Title	ADS-B surveillance parameter forwarding
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPRec.1	<Full>
<ALLOCATED TO>	<Functional block>	SDPD	N/A
<ALLOCATED TO>	<Functional block>	Interfaces	N/A

Note: Although this requirement is practically fully covered by the baseline requirements, there could be a need to include the GPS antenna offset information in the SDPD output (ATX CAT062), such that client systems know the reference point of the aircraft with respect to the nose of the aircraft (future incursion alerting systems and/or display systems).

[REQ]

Identifier	REQ-15.04.05.a-D19-0012.0003
Requirement	The Ground Domain **shall** have the capacity to acquire and maintain all Mobiles in the Manoeuvring Area.
Title	Surface squitter decoding
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.8	<Full>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0012.0004
Requirement	For all Mobiles on the Manoeuvring Area, the Ground Domain **shall** be capable of receiving, processing and displaying to the controller the following list of ADS-B surveillance parameters: ☐ Horizontal Position ☐ Identity Information ☐ Pressure Altitude (for airborne aircraft) ☐ Discrete Emergency Code(s) (not required for vehicles) - as a minimum: general emergency, communications failure, unlawful interference. *Note 1: With the exception of horizontal position, when one of the surveillance parameters are unavailable, the other available parameters are still displayed.* *Note 2: See also SPR.16 for the other data to be displayed to the controller.* *Note 3: Identity Information may include Mode A Code if required by the implementing ANSP.*
Title	Surface squitter minimal information
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.10	<Full>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0001
Requirement	The update interval for ADS-B position reports for Mobiles on the airport surface Manoeuvring Area **shall** be 1 second at a probability of at least 90% (at interface E2, Figure 3).
Title	Position Report Update Interval
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.22	<Full>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0002
Requirement	The update interval for ADS-B emergency mode items for aircraft on the airport surface Manoeuvring Area **shall** be 2 seconds at a probability of at least 90% (at interface E2, Figure 3).
Title	Emergency Mode Items Update Interval

Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.23	<Full>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0003
Requirement	The update interval for non-changing ADS-B items for Mobiles on the airport surface Manoeuvring Area **shall** be 20 seconds at a probability of at least 90% (at interface E2, Figure 3).
Title	Non-changing ADS-B Items Update Interval
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.24	<Full>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

Note: The non-changing items of relevance to this requirement are emitter category and (if available) aircraft length/width codes and GNSS antenna offset.

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0004
Requirement	The update interval for changing Identity Information on the airport surface Manoeuvring Area **shall** be 20 seconds at a probability of at least 90% (at interface E2, Figure 3).
Title	Identity Information Update Interval
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.25	<Full>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0005
Requirement	The probability of the Ground Domain system integrity failure **shall** be 1.00E-03 or less per hour.
Title	Integrity Failure Probability
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	

Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.20	<Full>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0022.0006
Requirement	The probability of the Ground Domain system continuity failure **shall** be 1.00E-03 or less per hour.
Title	Continuity Failure Probability
Status	<In Progress>
Rationale	ED-163 Ground Domain Requirement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	ED-163/SPR.21	<Full>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

3.3 Integration of ADS-B with WAM

3.3.1 Enhanced ADS-B target report validation

The vast majority of currently deployed ADS-B 1090 ES systems are integral part of a WAM system. Such integration offers not only the advantage of infrastructure sharing between the two surveillance systems but also the potential for substantial improvement of the 1090ES detection capability (and hence performance robustness of ADS-B reception) by taking into account multilateration derived data during the squitter decoding process. This is related mainly with target acquisition, handling of duplicate Mode S addresses, protection against spoofing, as well as integrity and continuity enhancements.

The first iteration of specifications contained a requirement for a simple validation of received ADS-B positions with an independent surveillance source (WAM). This first step provided protection against spoofing and integrity enhancements.

The aim of the proposed enhancements for Iteration 2 is to improve the technical solution developed in Iteration 1 concerning the integration of WAM Data, in order to perform Integrity Checks on ADS-B reports.

In this iteration, a larger subset of items derived from WAM reports will be used in order to perform more reliable and more precise integrity checks.

First of all, the correlation between WAM reports and ADS-B reports will be improved solving the main open issue coming from iteration one about the management of duplicate ICAO addresses. In this iteration, a solution to this problem will be investigated.

Furthermore, new Integrity checks, involving not only position data, but also other sets of typical WAM information (altitude information, Mode 3/A, Callsign, etc…) will be investigated.

The results of these checks will be provided in output by means of a dedicated field in ASTERIX Cat. 021. This technical solution foresees the following formats in input and in output:

- 1090 MHz messages (ADS-B Message) as input

- ASTERIX Cat. 020 (WAM Data) as input

- ASTERIX Cat. 021 (ADS-B Report) as output

In addition to the functionalities already developed in Iteration 1, the ADS-B ground surveillance system foresees the following functionalities:

- The system will be able to receive and integrate the WAM data (ASTERIX Cat. 020) and to correctly correlate them with ADS-B reports by managing the case of duplicate ICAO addresses in WAM reports

- The system will be able to perform new integrity checks in order to provide other subsystems with more precise information about the integrity of the ADS-B data set

The following tables list all identified high-level ADS-B Ground Surveillance Domain requirements for the enhanced ADS-B report target validation functionality. The requirements are allocated to one or more ADS-B Ground Surveillance Domain Components. If a requirement is allocated to a specific component, the detailed specifications will be developed in the subsequent project tasks dealing with component specifications.

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0001
Requirement	The ADS-B Ground Surveillance Domain processes and decodes received WAM data in ASTERIX CAT020. In addition to data specified in Iteration 1, the following minimum data item **should** be decoded: - Measured Height - Mode-S MB Data - Calculated Track Velocity
Title	WAM Decoding
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0002
Requirement	The ADS-B Ground Surveillance Domain **should** be able to manage the case of WAM reports with duplicated Mode S addresses during the phase of correlation of ADS-B reports with WAM reports.
Title	Duplicate Addresses Management
Status	<In Progress>
Rationale	Open issue from IT1
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance

| <SATISFIES> | <ATMS Requirement> | SJU PIR Review P15.4.5.a 23/03/2010 | <Partial> |
| <ALLOCATED TO> | <Functional block> | ADS-B GS | N/A |

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0003
Requirement	The ADS-B Ground Surveillance Domain **should** be able to check the integrity of the barometric altitude reported in ADS-B reports through the WAM data.
Title	ADS-B/WAM Altitude Data Comparison
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0004
Requirement	If REQ-15.04.05.a-D19-0030.0003 is implemented, the ADS-B Ground Surveillance Domain **shall** be able to report the validation result in the ASTERIX CAT021 ADS-B report.
Title	ADS-B/WAM Altitude Consistency Reporting
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0005
Requirement	If REQ-15.04.05.a-D19-0030.0004 is implemented, the SDPD **shall** be able to use the validation result.
Title	ADS-B/WAM Altitude Consistency Use
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0006

Requirement	If REQ-15.04.05.a-D19-0030.0005 is implemented, the validation result **shall** be reported to the end user of the surveillance data.
Title	ADS-B/WAM Altitude Consistency Forwarding
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0007

Requirement	The ADS-B Ground Surveillance Domain **should** be able to perform a cross check between data in ADS-B report received through 1090ES and Mode S enhanced data in WAM reports.
	
	Note: Candidate Mode-S data to be compared are:
	
	    -Aircraft-Id (BDS 2,0)
	    -ACAS Resolution Advisor (BDS 3,0)
	    -Selected Altitude (BDS 4,0)
	    -Track and Turn Report (BDS 5,0)
	    -Heading and Speed Report (BDS 6,0)
	
	For some of these items proper time windows should be configured allowing acceptable differences between data receptions in two information sources.

Title	ADS-B/WAM Mode S Enhanced Data Comparison
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0008
Requirement	If REQ-15.04.05.a-D19-0030.0007 is implemented, the ADS-B Ground Surveillance Domain **shall** be able to report the validation result in the ASTERIX CAT021 ADS-B report.
Title	ADS-B/WAM Mode S Enhanced Data Consistency Reporting
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance

<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0009
Requirement	If REQ-15.04.05.a-D19-0030.0008 is implemented, the SDPD **shall** be able to use the validation result in order to determine whether the ADS-B report shall be used.
Title	ADS-B/WAM Mode S Enhanced Data Consistency Use
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0010
Requirement	If REQ-15.04.05.a-D19-0030.0009 is implemented, the validation result **shall** be reported to the end user of the surveillance data.
Title	ADS-B/WAM Mode S Enhanced Data Consistency Forwarding
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0011
Requirement	The ADS-B Ground Surveillance Domain **should** be able to check the integrity of the velocity reported in ADS-B reports through the WAM data.
Title	ADS-B/WAM Velocity Data Comparison
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0012

Requirement	If REQ-15.04.05.a-D19-0030.0011 is implemented, the ADS-B Ground Surveillance Domain **shall** be able to report the validation result in the ASTERIX CAT021 ADS-B report.
Title	ADS-B/WAM Velocity Data Consistency Reporting
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0013
Requirement	If REQ-15.04.05.a-D19-0030.0012 is implemented, the SDPD **shall** be able to use the validation result.
Title	ADS-B/WAM Velocity Data Consistency Use
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0030.0014
Requirement	If REQ-15.04.05.a-D19-0030.0013 is implemented, the validation result **shall** be reported to the end user of the surveillance data.
Title	ADS-B/WAM Velocity Data Consistency Forwarding
Status	<In Progress>
Rationale	ADS-B/WAM Shared infrastructure opportunity
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	SJU PIR Review P15.4.5.a 23/03/2010	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

3.4 Security

All security enhancements proposed for Iteration 2 were revisited.

Multi-ground station target tracking refers to a proposal to combine the information from multiple ground stations into a single target report. The P15.4.5a project team decided that the complexity of

bringing the data from multiple sources into the same time domain made the proposed solution to be very close to existing SDPD functionality. It was decided that physical implementations without a dedicated SDPD box can still implement SDPD functionality inside the physical ADS-B GS systems.

Increased antenna sectorisation to improve the localisation performance was considered as a technology dependent implementation option of the Angle of Arrival measurement security enhancement already included in Iteration 1.

3.4.1 Application of TDOA Techniques

The TDOA technique will allow to the Ground Station to verify the integrity of position extracted from the ADS-B position message taking as reference the hyperbole reconstructed inside the Ground Station by the TDOA technique. The hyperbole is elaborated taking as input the Time of Arrival of the same Position message at various Ground Station or receiver functions. Therefore for this enhancement the following two possible configurations for the ADS – B Ground Station System are foreseen

- Multiple Ground Stations with overlapping coverage connected to a central processing system.
- A single Ground Station with multiple receiver functions.

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0040
Requirement	The ADS-B Ground Surveillance Domain **should** be able to calculate for each received ADS-B position message the relative TDOA.
Title	TDOA Calculation
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0042
Requirement	The ADS-B Ground Surveillance Domain **should** be able to process the TDOA in order to validate the position information extracted from the position message.
Title	TDOA Processing
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0044
Requirement	The ADS-B Ground Surveillance Domain **should** be able to report the validation result in the ASTERIX CAT021 ADS-B report.
Title	TDOA Techniques reporting
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0046
Requirement	The SDPD **should** be able to use the validation result.
Title	TDOA Techniques Use
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0048
Requirement	The validation result **should** be reported to the end user of the surveillance data
Title	TDOA Techniques Forwarding
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

3.4.2 Behavioural analysis of targets

For each ADS-B emitter category a set of credible values for data items and rates of change could be configured. The received data items could then be verified against these ranges. In this way, unrealistic values emitted by spoofed aircraft could be detected.

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0080
Requirement	The ADS-B Ground Surveillance system **should** validate the track consistency evaluating track behaviour (values and changes of specific a/c attributes to be verified). *Note: Those specific attributes are: velocity, acceleration, heading, altitude, and vertical rate.*
Title	Track behaviour validation
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0082
Requirement	The ADS-B Ground Surveillance system **should** have a set of configurable ranges for each attribute behaviour to be verified based on "ADS-B Emitter Category SET" Code Definitions. *Note: Those specific attributes are: velocity, vertical rate, altitude, acceleration, and heading.*
Title	Configurable acceptable data value ranges
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0084
Requirement	Based on received "ADS-B Emitter Category SET" Code Definitions, the ADS-B Ground Surveillance system **should** verify the track behaviour against predefined valid configurable attribute ranges for each item independently. *Note: Those specific attributes are: velocity, vertical rate, altitude, acceleration, and heading.*
Title	Verification Process
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED TO>	<Functional block>	ADS-B GS	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0086
Requirement	The ADS-B Ground Surveillance system **should** issue the corresponding ATX Cat 021 report with the BAR bits set to adequate values based on the overall result of Track Consistency verification function. *Note: Track Consistency verification includes:* 1. *velocity versus position change (Iteration 1), and* 2. *track consistency evaluating track behaviour (velocity, vertical rate, altitude, acceleration, and heading) (Iteration 2)*
Title	Verification Process
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0088
Requirement	The SDPD **should** be able to use the validation result.
Title	BAR Use
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0040.0090
Requirement	The validation result **should** be reported to the end user of the surveillance data
Title	BAR Forwarding
Status	<In Progress>
Rationale	Possible security enhancement
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	NATO C3 Agency Technical Note 1407	<Partial>
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

3.5 Civil Military Interoperability

The ADS-B Surveillance System shall be interoperable with the military aircraft ADS-B In/Out solution defined in 9.24. The project will follow the outcome of Project 9.24, but for Iteration 2, no tangible requirements for the ADS-B Ground Surveillance Domain have been identified.

3.6 Other Enhancements

3.6.1 Automatic network bandwidth optimization techniques

The main aim of this self-adjustable functionality is getting the optimal data send rate and data content to comply with the required system performance.

This functionality is meant to be used as a performance enhancement, especially applicable in low bandwidth networks, where saturation of the network and possible data losses/delays can appear:

The Ground System Domain (referenced at high level to ADS-B GS, ADS-B Central Server and/or SDPD) would adapt its data transmission in case of network overload, reducing its data transmission rate, using geographical areas of responsibility defined in a multi ground station system.

Definitions:

1. A network is considered to be *overloaded* when the required data rate is higher than the data transmission physical limit through the media over a configurable period of time.
2. Hence, *threshold parameters* can be defined for the transition to and from various levels of degraded modes.
3. An *area of responsibility* for a GS is defined as a geographical zone covered exclusively by that GS at a given time.
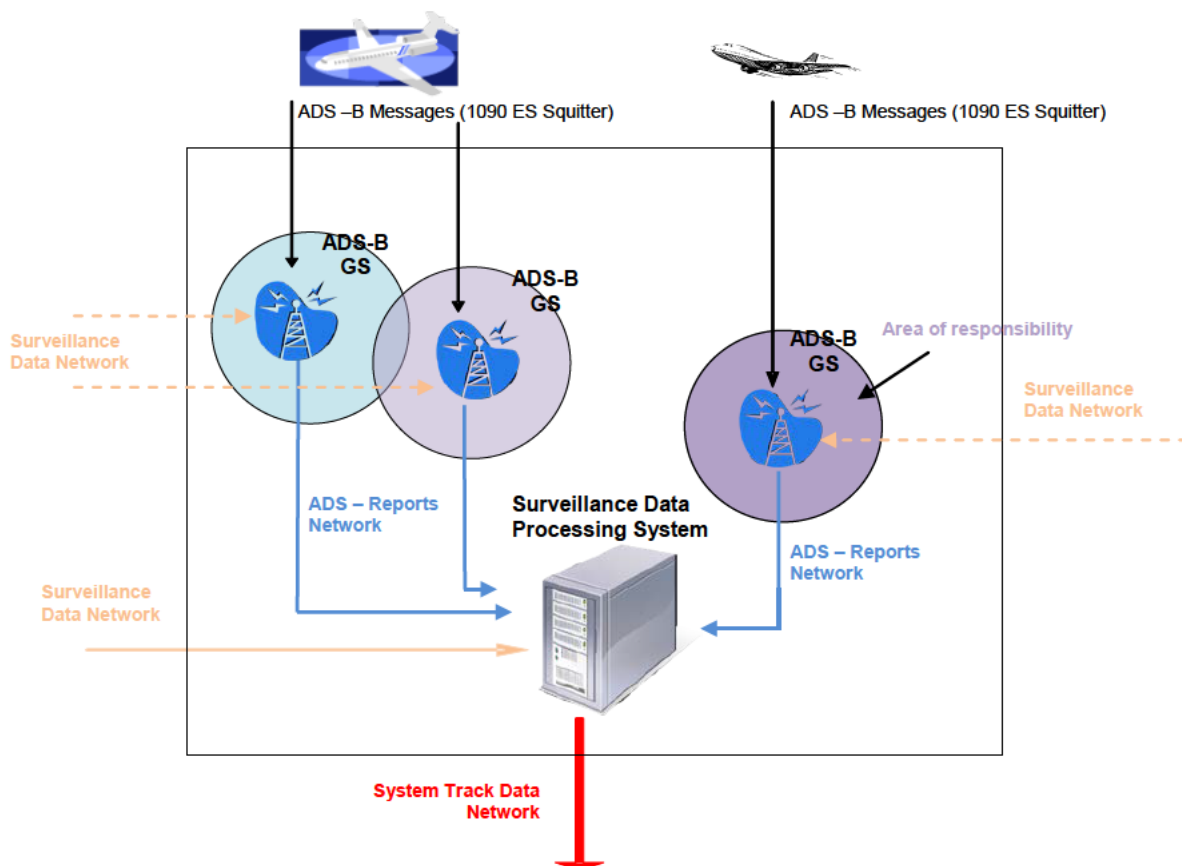
Figure 4 Networks and Areas of Responsibility Overview

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0030
Requirement	The ADS-B Ground Surveillance Domain **should** have the capability to monitor the load of the network.
Title	Network load calculation
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0032
Requirement	The ADS-B Ground Surveillance Domain **should** have the capability to detect the overload of the network.
Title	Network overload calculation
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0034
Requirement	The ADS-B Ground Surveillance Domain **should** have the capability to automatically reduce the load of the network in case of a detected overload, switching to the next level down of degraded data mode.
Title	Automatic switch-over status to degraded mode
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0036
Requirement	The ADS-B Ground Surveillance Domain **should** have the capability to automatically switch back to the next level up of degraded mode or to the normal mode related to the load of the network in the case the detected network load has improved and passed a threshold over a configurable period of time.
Title	Automatic switch-over status to normal mode
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0038
Requirement	The ADS-B Ground Surveillance Domain **should** have degraded data mode that could imply: • omission of optional items (several subsets could be configured); • reduced data update rate; • geographical filtering
Title	Degraded data mode actions
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0040
Requirement	The ADS-B Ground Surveillance Domain **should** have a configurable adaptation strategy (including parameters and switching decisions).
Title	Configurable adaptation strategy
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A

[REQ]

Identifier	REQ-15.04.05.a-D19-0000.0042
Requirement	The ADS-B Ground Surveillance Domain **should** have means to indicate to external users the currently used mode level (normal, or level of degradation).
Title	Bandwidth mode status signal
Status	<In Progress>
Rationale	Potential performance improvement
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<ALLOCATED_TO>	<Functional block>	ADS-B GS	N/A
<ALLOCATED_TO>	<Functional block>	SDPD	N/A
<ALLOCATED_TO>	<Functional block>	Interfaces	N/A

3.7 Functional block Internal Data Requirements

This specification does not prescribe any particular internal component architecture.

3.8 Design and Construction Constraints

No design or construction constraints have been identified.

3.9 Functional block Interface Requirements

The ADS-B Ground Surveillance System uses the EUROCONTROL ASTERIX Surveillance Standard for all message exchange with other ground ATM system components as well as for internal communication between ADS-B Ground Station and Surveillance Data Processing components.

For the reception of airborne data the ADS-B Ground Surveillance System uses the ED-102A/DO-260B standard, but shall also be compatible with ED-102/DO-260 and DO-260A standards.

4   References

[1]   SJU 15.04.05a Specification Baseline Document, D17, Ed. 00.01.00, Oct 2010

[2]   SESAR Requirements and V&V Guidelines Latest version

[3]   SESAR Toolbox User Manual Latest version

[4]   EUROCAE/RTCA MOPS for 1090 MHz ADS-B, ED-102/DO-260, Sept. 2000

[5]   RTCA MOPS for 1090ES ADS-B and TIS-B, DO-260A, Dec. 2006 (includes Changes 1 and 2)

[6]   EUROCAE/RTCA MOPS for 1090ES ADS-B and TIS-B, ED-102A/DO-260B, Dec. 2009

[7]   EUROCAE/RTCA SPIR Document for ADS-B NRA Application, ED-126/DO-303, Dec. 2006

[8]   EUROCAE/RTCA SPIR Document for ADS-B RAD Application, ED-161/DO-318, Sept. 2009

[9]   EUROCAE ED129: Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground
Station, June 2010

[10] EUROCONTROL ASTERIX Standards CAT 21, Ed 1.8, Jan 2011,

[11] EUROCONTROL ASTERIX Standards CAT 23, Ed 1.2, March 2009

[12] EUROCONTROL ASTERIX Standards CAT 62, ED 1.10, December 2009

[13] EUROCONTROL ASTERIX Standards CAT 63, Ed 1.3, July 2007

[14] EUROCONTROL ARTAS V8, System/Segment Specifications, Doc. 46 127 300 – 305

[15] SJU 15.04.05a ADS-B Surveillance System Spec. for It 1,D18, Ed. 00.02.00, March 2011

[16] SJU 15.04.05a ADS-B Ground Station Spec. for It 1, D05, March 2011

[17] SJU 15.04.05a 1090 SDPD URs for It1, D06, Ed 00.01.04, March 2011

[18] SJU 15.04.05a Interface Spec. for It.1 , D07, Ed 00.01.00, March 2011

[19] EUROCAE/RTCA SPIR Document for ADS-B APT Application, ED-163/DO-321, Nov. 2010

[20]   CRISTAL RAD HD Air Derived Data (ADD) Study, CRSTL3/RPT/02 Issue 1, Jan. 2010

4.1 Use of copyright / patent material /classified material

No copyright/patent material is included in this specification.

Appendix A Traceability

The project intends to import all requirements defined in this document as well as the lower level derived requirements as specified in Deliverables D9, D10 and D11, into a requirements management tool (like DOORS).

Such a tool will then generate an overall traceability matrix which could be included in this document at a later stage.

Appendix B Analysis of ADS-B APT Ground Domain Requirements

The following table contains all ADS-B APT Ground Domain Requirements as extracted from ED-163.

For each requirement an analysis is provided in order to judge if this requirement is an additional requirement for the ADS-B Ground Surveillance System with respect to the Iteration 1 baseline.

Each Ed-163 requirement is classified as one of the following 4 states:

- Not Applicable
- Already fully covered
- Not yet fully covered
- New

If a requirement is already fully covered by one or more baseline requirements, those requirements are referenced.

Ed 163 Requirement	ED163 Source	Analysis	Status
SPR.8. The Ground Domain **shall** have the capacity to acquire and maintain all Mobiles in the Manoeuvring Area.	PR.17	This requirement translates to the capability to decode and process surface position squitters	New
SPR.9. The Ground Domain **shall** provide surveillance information satisfying all the performance requirements within the applicable Manoeuvring Area.	PR.16	Not a single GS requirement but rather a local implementation requirement; Number of stations, redundancy etc.	Not Applicable
SPR.10. For all Mobiles on the Manoeuvring Area, the Ground Domain **shall** be capable of receiving, processing and displaying to the controller the following list of ADS-B surveillance parameters: ☐ Horizontal Position ☐ Identity Information ☐ Pressure Altitude (for airborne aircraft) ☐ Discrete Emergency Code(s) (not required for vehicles) - as a minimum: general emergency, communications failure, unlawful interference. *Note 1: With the exception of horizontal position, when one of the surveillance parameters are unavailable, the other available parameters are still displayed – see ASSUMP.47.* *Note 2: See also SPR.16 for the other data to be displayed to the controller* *Note 3: Identity Information may include Mode A Code if required by the implementing ANSP.*	OR.2 PR.1 PR.2 PR.3 PR.4 OR.13 OR.7 OR.4	This requirement translates to the capability to decode and process surface position squitters	New
SPR.11. If the age of the position information is beyond a time limit, the Target **shall** be displayed with an	PR.13	This is a requirement on the SDPD which could not be traced back to an existing SSS requirement.	Not yet fully covered

indication (e.g. „coasting" symbol) that the position data is stale and therefore could be unreliable. *Note 1: The value of the time limit is defined locally and a value of 4s has been assumed for the analysis (see ASSUMP.48)* *Note 2: See below associated ASSUMP.44 on the coasting function*		SDPD should also take the different update rate for stationary aircraft into account.	
SPR.12. The Ground Domain **shall** time stamp the position information as appropriate to the particular data link to within 0.1s.	PR.8	Covered by Baseline Requirement REQ-15.04.05.a-D18-0020.0004 – tracing back to ED-161/SPR-36	Already fully Covered
SPR.13. The Ground Domain **shall** be capable of receiving and processing Surveillance Data Quality Indicators (NACp, NIC, NUCp, SIL and SDA).	PR.5	Covered by Baseline Requirements REQ-15.04.05.a-D05-0020.0090 (SDA), REQ-15.04.05.a-D05-0020.0180 (NACp) REQ-15.04.05.a-D05-0020.0160 (NIC) – tracing back to REQ-15.04.05.a-D18-0060.0061 – tracing back to ED102A/DO260B ED129 (NUCp)	Already fully covered
SPR.14. The Ground Domain **shall** exclude ADS-B reports when the quality of the position information is unacceptable for ADS-B-APT purposes. *Note: ADS-B reports are not used if the quality of the position information is found to be unacceptable, as determine from the values of the quality indicators or from the results of ground monitoring of the position source.*	PR.15	SDPD Requirement Covered by Baseline Requirement ARTAS-SSS-T-RTA-051	Already fully covered
SPR.15. The Ground Domain **shall** be capable of associating ADS-B data items	PR.6 PR.7	Covered by Baseline Requirement REQ-15.04.05.a-D05-0010.0030 – tracing back to	Already fully covered

delivered in multiple ADS-B messages for the same Mobile. *Note: this shall be done using the Mobiles 24-bit address.*	OR.11	REQ-15.04.05.a-D18-0010.0001 – tracing back to ED-161/SPR-26	
SPR.16. For all Mobiles on the Manoeuvring Area, the following list of other information **shall** be displayed to the controller: ☐Ground Movement/Direction Indicator (e.g. heading indicator, history dots and ground velocity data); ☐Map information, showing at least at least runway and taxiway boundaries. *Note: The Ground Domain may determine velocity information from tracking of positions or from ADS-B reported velocity. See further information in Appendix B.VI.*	OR.2 OR.3	This is a display function requirement, outside the scope of P15.4.5, covered by ATX CAT 062 data items	Not applicable
SPR.17. The Ground Domain **shall** display Mobiles" positions that are time synchronized and with a constant refresh cycle.	OR.5	This is a fundamental SDPD requirement implemented in ARTAS, although it is not so easy to find a hard reference.	Already fully covered
SPR.18. The Ground Domain **shall** inform the controller through the use of symbols or by other means when the surveillance data is unavailable or its quality is insufficient for the ADS-B-APT application.	OR.8	This is a display function requirement, outside the scope of P15.4.5.	Not applicable
SPR.19. Means to distinguish airborne aircraft from Mobiles on the ground **shall** be provided to the controller.	OR.6	This is a display function requirement, covered by ATX CAT 062 data items	Not applicable
SPRec.1 For all Mobiles on the Manoeuvring Area, the Ground Domain **should** be capable of receiving and processing the following list of ADS-B surveillance parameters: ☐ Emitter Category ☐ Geometric Altitude	PRec.1 - PRec.5	Covered by Baseline SDPD Requirements: ED-129 (Emitter category, Geometric Altitude, Velocity Vector) REQ-15.04.05.a-D05-0020.0140 (Mobile Size) – tracing back to REQ-15.04.05.a-D18-0060.0061 – tracing back	Not yet fully covered

☐ Velocity vector (heading/track and ground speed) ☐ Mobile size (length/width codes) ☐ GPS antenna offset information		to ED102A/DO260B REQ-15.04.05.a-D05-0020.0060 (GPS Antenna Offset) - tracing back to REQ-15.04.05.a-D18-0060.0061 – tracing back to ED102A/DO260B There may be an interface requirement (CAT062) to pass the antenna offset to the display function in order to position the aircraft symbol on a map	
SPR.20. The likelihood of the Ground Domain system integrity failure **shall** be 1.00E-03 or less per hour.	SR.2	New performance requirement linked to ADS-B APT	New
SPR.21. The likelihood of the Ground Domain system continuity failure **shall** be 1.00E-03 or less per hour.	SR.3 OR.17	New performance requirement linked to ADS-B APT	New
SPR.22. The update interval for ADS-B position reports for Mobiles on the airport surface Manoeuvring Area **shall** be 1 second at a probability of at least 90% (at interface E2). *Note: Special considerations may be made for stationary Targets where the ADS-B broadcast period may be changed by some data links to reduce unnecessary radio frequency (RF) interference (see Appendix B.III).)*	PR.9 OR.9	Interface E2 is between ADS-B GS and SDPD The lower update rate for stationary targets needs to be recognized by the SDPD for suppression of coasting activation	New
SPR.23. The update interval for ADS-B emergency mode items for aircraft on the airport surface Manoeuvring Area **shall** be 2 second at a probability of at least 90% (at interface E2).	PR.10 OR.9	New performance requirement linked to ADS-B APT	New
SPR.24. The update interval for non-changing ADS-B items for Mobiles on the airport surface Manoeuvring Area **shall** be 20 second at a probability of at least 90% (at interface E2).	PR.11	This requirement should be easily covered, but seems different from existing requirements.	New

Note: The non-changing items of relevance to this requirement are emitter category and (if available) aircraft length/width codes, GNSS antenna offset.			
SPR.25. The update interval for changing Identity Information on the airport surface Manoeuvring Area **shall** be 20 second at a probability of at least 90% (at interface E2).	PR.12	This requirement should be easily covered, but seems different from existing requirements.	New

Table 5 ED-163 Ground Domain Requirements Analysis

- END OF DOCUMENT -