First Iteration - Baseline Report/Matrix

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Abstract

The present document describes the first iteration requirement baseline for the ADS-B GS Prototyping. The baseline report/matrix, which can be found inside, is based on the selection per Prototype Provider of the different requirements derived from Project's 15.4.5a deliverables D18, D05, D06 and D07. This baseline includes the following key information:

- The allocation and compliance of the different requirements of the three ADS-B GS to be provided for project Iteration 1.
- The allocation and compliance of the different requirements of the SDPD to be provided for project Iteration 1.

The document serves as input to the subsequent project tasks which will deal with the development and verification of the prototypes. This specification will be revisited as appropriate in the course of the project work on iteration 2.

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This deliverable consists of SJU foreground.

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Executive summary

The present document describes the baseline for the first iteration of the ADS-B related Prototypes (i.e. ADS-B GS and SDPD). The selection of the requirements upon which these specifications are based are derived from the preceding deliverable D18 Ref [1] coming from Project 15.4.5a as an input. The baseline includes the following key information:

- Mandatory and Optional Requirements classification.
- Compliance of each of the partners' prototypes with Project 15.4.5a D18 requirements.
- Compliance of each of the partners' prototypes with Project 15.4.5a D05, D06 and D07 requirements.

The document serves as input to the subsequent project tasks which will deal with the development and verification of the prototypes. This specification will be revisited as appropriate in the course of the project work on iteration 2.

The Project covers different enhancements of 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

More specifically, in accordance with the set of enhancements defined in the First Iteration in Project 15.4.5a Deliverable D18 Ref [1], high level requirements are described in order to support:

- The ADS-B RAD Application.
- First ADS-B/WAM Integration steps.
- A number of alternative security enhancements.
- The DO260-B transponder standard.

This baseline will be used as a guideline to identify which of the functionalities (requirements) will be covered by each prototype provider. The requirements have been split into Mandatory or Optional, and allocated to the different elements comprising the system.

Prototype Providers will implement all mandatory requirements affecting their prototype, as well as the selected optional ones.

1 Introduction

1.1 Purpose of the document

The present document describes the baseline for the first iteration of the ADS-B related Prototypes.

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

The baseline matrix is defined at a high level (as provided by document Ref [1]) and shall be allocated to one or more of the above mentioned systems. All mandatory requirements will be covered by all prototypes while optional requirements will be covered by at least one prototype.

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

Project 15.4.5b inputs are directly taken from Project 15.4.5a (i.e. 15.4.5a Deliverables).

- SJU 15.04.05a ADS-B Ground Surveillance Specifications for first iteration D18, Ed. 00.01.00, Mar 2011 (Ref [1])
- SJU 15.04.05a Specification Baseline Document, D17, Ed. 00.01.00, Oct 2010 (Ref [2])
- SJU 15.04.05a ADS-B 1090 MHz Ext. Squitter Ground Station Specifications – Iteration 1, D05, Ed. 00.02.00, Mar 2011 (Ref [3])
- SJU 15.04.05a SDPD Specification – Iteration 1, D06, Ed. 00.01.04, Mar 2011 (Ref [4])
- SJU 15.04.05a Interface Specifications for first Iteration, D07, Ed. 00.01.00, Mar 2011 (Ref [5])

These Deliverables inter alia address:

- EUROCONTROL CASCADE Program
- Requirements Focus Group (RFG) and associated EUROCAE/RTCA standardisation activities for ADS-B Surveillance Applications (Ref [11], Ref [12])
- ADS-B Avionics equipment standardisation by EUROCAE/RTCA(Ref [8], [9] and [10])

1.4 Structure of the document

This document is organised as follows:

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

Chapter 2: General component description;

Chapter 3: ADS-B Ground System Domain Baseline Matrix; Baseline Matrix Overall Overview;

Chapter 4: Assumptions;

Chapter 5: Referenced documents; Use of copyright/classified material;

Appendix A: Traceability

1.5 Requirements Definitions – General Guidance

Requirements were developed according to the SESAR Requirements and V&V Guidelines [6].

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 [7].

In accordance with the guidelines in Ref [7], requirement identifiers follow the scheme:

REQ-15.04.05.a-D18-00xx.yyyy, where

xx	Meaning
10	ADS-B RAD Functional req.
20	ADS-B RAD 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 Components Purpose and Overview

The figure below depicts a functional context diagram of the future Ground Surveillance System, as defined in input Project 15.4.5.a, where the impacted system elements are marked in Blue.

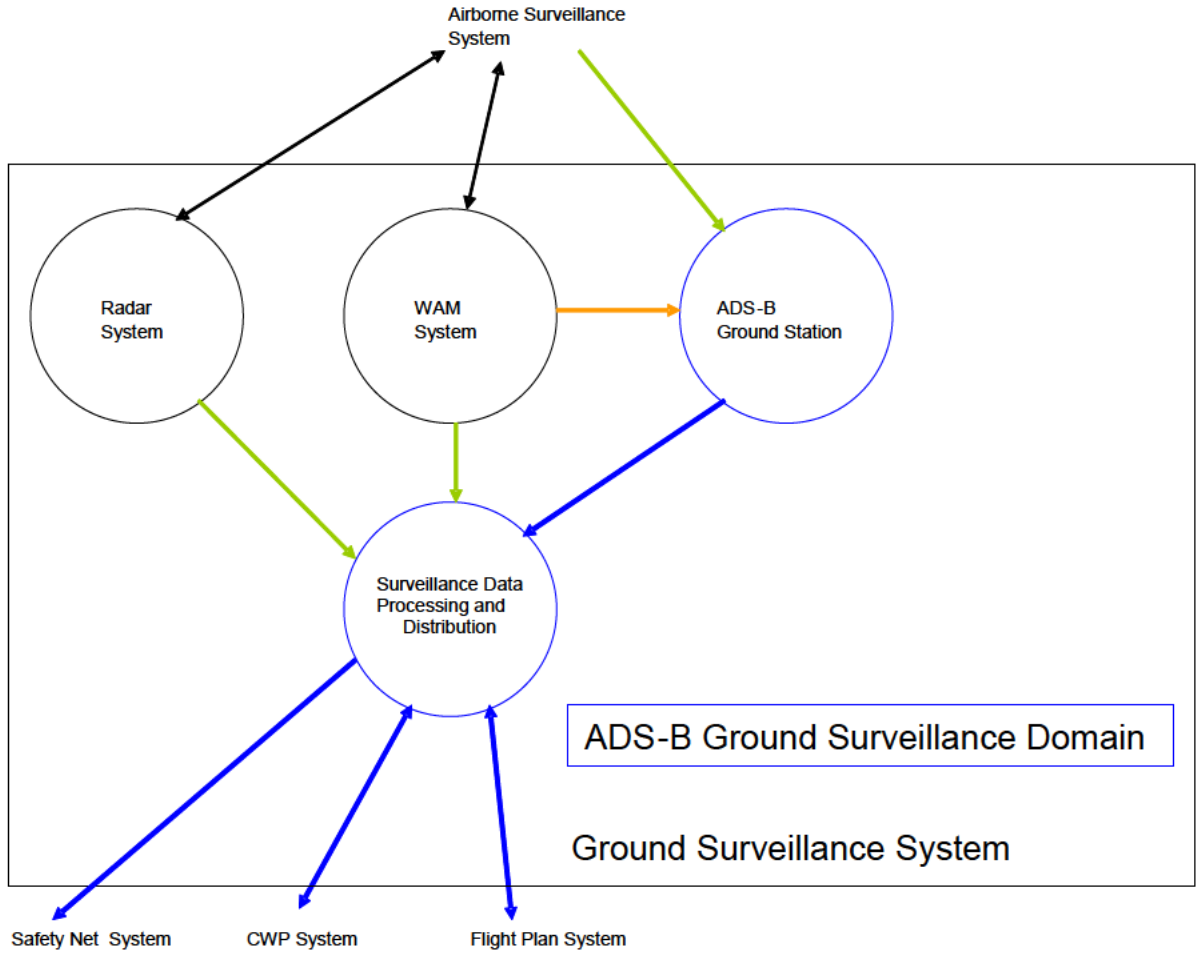

Figure 1 ADS-B Ground Surveillance Domain Context

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

= Existing standardised interfaces, **not 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.

- Surveillance Data Processing and Distribution (SDPD)

  The baseline for the SDPD is the ARTAS multi-sensor tracking system. 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.

- Interfaces

The Interfaces subject to modification by the project refer to:

- ASTERIX CAT 21, Ed. 1.8, January 2011 (Ref [14])
- ASTERIX CAT 23, Ed 1.2, March 2009 (Ref [15])
- ASTERIX CAT 62, Ed 1.10, December 2009 (Ref [16])
- ASTERIX CAT 63, Ed 1.3, July 2007 (Ref [17])

1.7 Acronyms and Terminology

Term	Definition
ACC	Accuracy
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 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
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
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSA-AIRB	Enhanced Traffic Situational Awareness during Flight Operations (“ADS-B in” ATSAW application)
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)
ATSA-VSA	Enhanced Visual Separation on Approach (“ADS-B in” ATSAW application)
ATSAW	Air Traffic Situation Awareness
ATX	ASTERIX
CAT	Data Category
DO	RTCA Document

Term	Definition
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
NM	Nautical Mile
NRA	Non Radar Airspace
OPA	Operational Performance Assessment
OPA-ASSUMP	Assumption made during the OPA
OR	Operational Requirement
OSED	Operational Services and Environment Description
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)
SG 4	Sub Group 4
SJU	SESAR Joint Undertaking

Term	Definition
SPI IR	Surveillance Performance and Interoperability Implementing Rule
SPR	Safety and Performance Requirements
SPR-INTEROP	Safety, Performance and Interoperability Requirements
SSR	Secondary Surveillance Radar
SWP	Sub Work Package
TMA	Terminal Manoeuvring Area
TOA	Time Of Arrival
Tx	Transmission
VSA	Visual Separation on Approach
WAM	Wide Area Multilateration
WG 51	Working Group 51
WP	Work Package

2 General Functional Component Description

2.1 Context

A high level context of the ADS-B Ground Surveillance Domain is shown in Section 1.6.

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

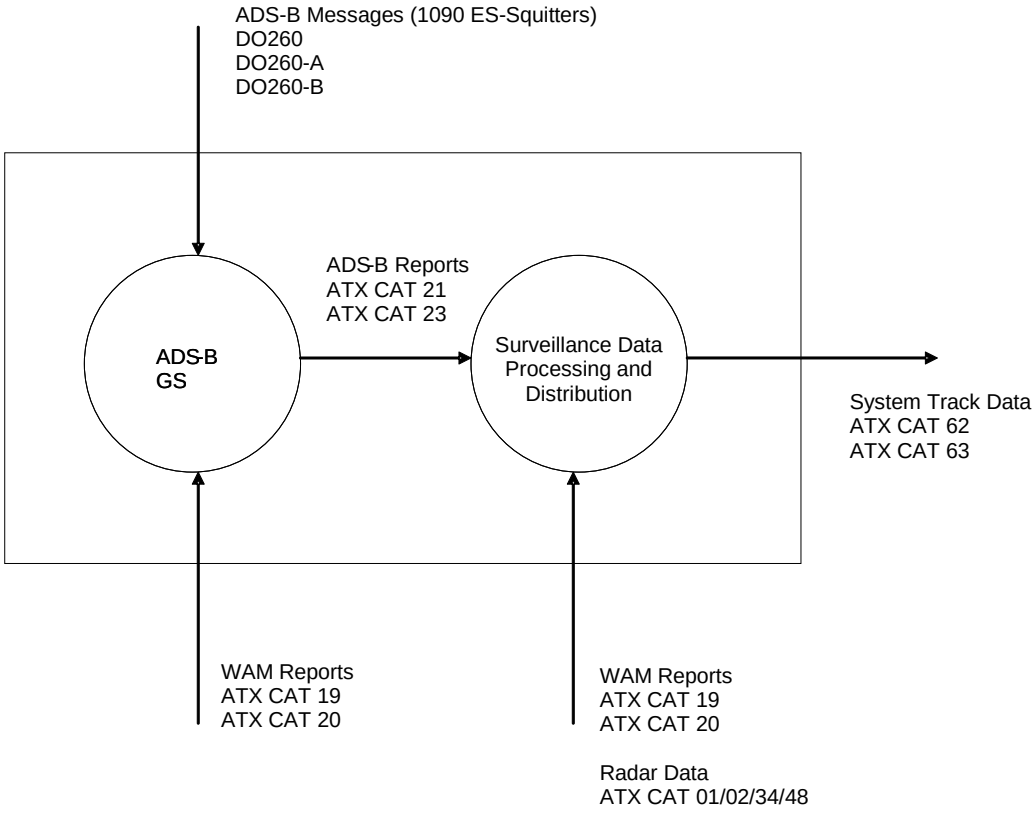

Figure 2 Component Context

2.2 Functional Component Modes and States

Detailed Modes and States of the sub-components are described in the baseline documents Ref [13] and [18].

Any change towards these Modes and States will be detailed in Project 15.4.5a deliverables Ref [3], [4] and [5]).

2.3 Major Functional Component Capabilities

The major components and capabilities are as described in section 1.6 or in document Ref [1].

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.

These user characteristics are as described in Project 15.4.5.a in document Ref [1].

2.5 Operational Scenarios

Operational scenarios as described in Project 15.4.5.a in document Ref [1] will include:

- High-density traffic environment (en-route and/or TMA) scenarios, including multiple surveillance techniques.
- Nevertheless due to the scalability of the Component (see User Characteristics above), such a system could also be deployed in non-core European airspace.

2.6 Functional

N/A

2.7 Service View

N/A

3 ADS-B Ground System Domain Baseline Matrix

3.1 Baseline Matrix

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

The Baseline Definition document (Project 15.4.5a deliverable D17) has established the following enhancements to be taken into account for the first iteration:

ADS-B applications	Integration with WAM	Security and civil-military interop	1090 ES Technology
ADS-B RAD ATSA-ITP ATSA-VSA ATSA-AIRB	Simple ADS-B target report validation	Multi sensor data fusion consistency checks Use of increased timestamp accuracy for TOA functionalities Power measurements. And range correlation Angle of arrival measurements Track consistency verification (velocity versus position change).	ED102A/DO260B

Table 2 Enhancements for Iteration 1

The baseline (as described in Ref [2]) for the enhancements will be the current ground Surveillance System Specifications, which reflect the requirements for ADS-B in Non Radar Airspace (ADS-B NRA) and (in the case of SDPD) also ADS-B in Radar Airspace (ADS-B RAD), since most of the data fusion related requirements are already included.

The baseline matrix including the requirements related with these enhancements per Prototype Provider (GS's and SDPD) is indicated below. The requirements will be as provided by document Ref [1] and shall be allocated to one or more of the above mentioned components. All mandatory requirements will be covered by all prototypes while optional requirements will be covered by at least one prototype.

This table shows which functionality will be covered per Prototype Implementer. **Note** that Interface Requirements, though addressed to one or more Prototypes, may be used also by other systems out of the Scope of Project 15.4.5b (i.e. Control and Monitoring Systems…).

IMPORTANT NOTE: The ADS-B RAD standard derives requirements assuming that there is no use of a ground Surveillance data fusion tracker system as a mosaic system is used instead (see ED-161 Ref [19], Section A.4.1.3.8). Work is foreseen by EUROCONTROL CASCADE to address the case of a Surveillance data fusion tracker system used in ADS-B RAD and the impact on the corresponding requirements.
Therefore, with respect to SESAR WP15.4.5a deliverables, there is a need to revisit the applicability of certain requirements, following the completion of this CASCADE work.

Hence, some requirements will be reworked during Iteration 2 and/or 3, so that:

- Some will be finally qualified as “not applicable”, and
- Some will be modified to be in line with the fusion tracker system philosophy (used in the SDPD).

Functionality	REQ-15.04.05.a-D18- Req. ID	GS Requirement for 1st Iteration	Mandatory / Optional	Covered by: Thales	Selex	Indra	Eurocontrol	Allocation	D05 References (GS)	D06 References (SDPD)	D07 References (INT)	Notes
RAD	0010.0001	The "Ground ADS-B Receive" function **shall** receive ADS-B messages, decode, package and time-stamp the data, and send ADS-B Surveillance Reports to the ATC Processing System, i.e., the "Ground ADS-B Processing" function.	M	Y	Y	Y	N/A	GS	0010.0010, 20, 30, 40, 50 and 60			
RAD	0010.0002	The "Ground ADS-B Receive" function shall provide the following minimum data set to the ATC Processing system: • Aircraft Horizontal Position – Latitude and Longitude; • Pressure altitude ; • Quality Indications of Horizontal Position ; • Aircraft Identity ; Emergency Indicators ; • Special Position Identification ; • Time of Applicability .	M	Y	Y	Y	Y	GS, INT	0010.0070		*see note*	Already implemented in Interfaces

		NOTE: Emergency Indicators and SPI are provided only when selected by the flight crew.										
RAD	0010.0003	When direct recognition procedures are used by the ATCO for identification, the ADS-B Ground Domain shall contain a function to ensure the aircraft identity data that is broadcast is retained and correctly associated with the position information for display,	M	Y	Y	Y	Y	GS, INT, SDPD	0010.0070	*see note*	*see note*	Already implemented in SDPD and interfaces
RAD	0010.0004	The “Ground ADS-B Receive” function shall provide in each ADS-B surveillance report a time of applicability (Interface E2) of the position information	M	Y	Y	Y	Y	GS, INT	0010.0080		*see note*	Already implemented in Interfaces
RAD	0010.0005	If the time of applicability within each ADS-B surveillance report is not applicable for all data items of that report (interface E2), the	M	Y	Y	Y	Y	GS, INT	0010.0090		*see note*	Already implemented in Interfaces

		"Ground ADS-B Receive" function shall provide separate times of applicability for the specific data items that differ,										
RAD	0010.0006	The "Ground ADS-B Surveillance Processing" function shall time-register the asynchronously received ADS-B position updates from ADS-B-equipped aircraft	M	Y	Y	Y	Y	GS, INT, SDPD	0010.0080	*see note*	*see note*	Already implemented in SDPD and interfaces
RAD	0010.0007	The "ADS-B to Radar Association" function shall enable the switching between ADS-B and radar surveillance sources (e.g., as a backup during a failure) without requiring the ATCO to perform a • Re-verification of altitude data, and • Re-identification of aircraft identity,	M	N/A	N/A	N/A	Y	SDPD		*see note*		Already implemented in SDPD
RAD	0020.0001	The likelihood of an ADS-B Ground Domain system integrity failure shall be 2E-05 or less per hour.	M	Y	Y	Y	Y	GS, SDPD	0010.0100	0010.0005		Requirement applicable for the whole Domain, not for single components
RAD	0020.0002	The likelihood of a "Ground ADS-B Receive" function continuity failure shall be 1E-05 or less per hour.	M	Y	Y	Y	N/A	GS	0010.0110			

RAD	0020.0003	The 95% latency for ADS-B surveillance reports (measured between points D and E2 – output of the “Ground ADS-B Receive” function) shall be no greater than 0.5 seconds, excluding communication latency to the ATC processing system. Note: It is assumed that all latency on the “Ground ADS-B Receive” function is compensated.	M	Y	Y	Y	N/A	GS	0010.0120			
RAD	0020.0004	The time of applicability conveyed in the ADS-B surveillance report shall have an absolute accuracy relative to UTC of ±0.1 seconds or less.	M	Y	Y	Y	Y	GS, INT	0010.0130		*see note*	Already implemented in Interfaces
RAD	0020.0005	The ADS-B Ground Domain shall not introduce any additional horizontal position error greater than that which might otherwise be introduced by a linear extrapolation using the instantaneous velocity for the target. Note: Linear extrapolation assumes uniform motion is continued along the latest velocity estimate to the	M	N/A	N/A	N/A	Y	SDPD		*see note*		Already implemented in SDPD

		time of synchronization. Consequently, additional errors will be introduced into the extrapolated position by uncertainties in the velocity estimate and aircraft accelerations that occur during the extrapolation period.										
RAD	0020.0006	The ADS-B Ground Domain (including data link) shall not degrade altitude resolution to worse than 100 feet.	M	N/A	N/A	N/A	Y	SDPD		*see note*		Already implemented in SDPD
RAD	0020.0007	The ADS-B Ground Domain shall have capacity to handle the reports from the maximum load of aircraft in the environment as described in the OSED without degradation.	M	Y	Y	Y	Y	GS, SDPD	0010.0140	*see note*		Already implemented in SDPD. Not related with interfaces but with the infrastructure.
RAD	0020.0008	The probability that the ADS-B Ground Domain detects a loss of ADS-B position, and provides an indication of such to the existing ATC Processing System shall be at least 99.99%. Notes: 1. Alternatively, the requirement might be fulfilled by the existing ATC Processing System,	M	N/A	N/A	N/A	Y	SDPD		*see note*		Partly compliant. To be revisited in following iterations.

		i.e., beyond interface F2*. 2. This requirement, taken together with ASSUMP 44, will ensure that the appropriate safety objectives are met.										
RAD	0020.0009	The probability that the ADS-B Ground Domain detects a loss of ADS-B-reported altitude, and provides an indication of such to the existing ATC Processing System shall be at least 99%. Notes: 1. Alternatively, the requirement might be fulfilled by the existing ATC Processing System, i.e., beyond interface F2*. 2. This requirement, taken together with ASSUMP 46, will ensure that the appropriate safety objectives are met.	M	N/A	N/A	N/A	Y	SDPD		*see note*		Partly compliant. To be revisited in following iterations.

RAD	0020.0010	The probability that the "ADS-B to Radar Association" function detects an inconsistency between an ADS-B and radar-reported emergency code, and provides an indication of such to the existing ATC Processing System shall be at least 99%. Note: This requirement, taken together with ASSUMP 37, will ensure that the appropriate safety objectives are met.	M	N/A	N/A	N/A	Y	INT, SDPD		0010.0010	0070.0001	Partly compliant. To be revisited in following iterations.
RAD	0020.0011	The probability that the "ADS-B to Radar Association" function detects an inconsistency between ADS-B and SSR aircraft identity data (i.e., Mode A or aircraft identification), and provides an indication of such to the existing ATC Processing System shall be at least 99%. Note: This requirement, taken together with ASSUMP 38, will ensure that the appropriate safety objectives are met.	M	N/A	N/A	N/A	N/A	INT, SDPD		*see note*	*see note*	Requirement not addressed now, because is dependent of the fusion update of ED161. To be revisited in Iteration 2.

RAD	0020.0012	The probability that the "ADS-B to Radar Association" function detects an inconsistency between ADS-B and SSR aircraft pressure altitude data, and provides an indication of such to the existing ATC Processing System shall be at least 99%. Note: This requirement, taken together with ASSUMP 48 will ensure that the appropriate safety objectives are met.	M	N/A	N/A	N/A	N/A	INT, SDPD		*see note*	*see note*	Requirement not addressed now, because is dependent of the fusion update of ED161. To be revisited in Iteration 2.
RAD	0020.0013	The probability that the ADS-B Ground Domain detects duplicate ADS-B Aircraft Identities (i.e., discrete Mode A or aircraft identification) within the same sector), and provides an indication of such to the existing ATC Processing System shall be at least 99%. Notes: 1. Alternatively, the requirement might be fulfilled by the existing ATC Processing System, i.e., beyond interface F2*. 2. This requirement, taken together with ASSUMP 39, will ensure that the appropriate safety objectives are met.	M	Y	Y	Y	Y	GS, INT, SDPD	0010.0150	*see note*	*see note*	SDPD Partial compliance (for mode A), to be completed in future iterations. Requirement to be revisited after Fusion PSC is updated

RAD	0020.0014	The probability that the "ADS-B to Radar Association" function detects a large ADS-B position error, and provides an indication of such to the existing ATC Processing System shall be at least 99%, where a large error is at least 40% of the separation minima for the ADS-B-RAD environment. Notes: 1. This requirement, taken together with ASSUMP 43, will ensure that the appropriate safety objectives are met. 2. This requirement is conditional on the sustained corruption of the horizontal position information itself or its quality indicators. Very conservative assumptions have been made on the nature of the resulting horizontal position errors (and their probability distribution) as well as the detection capability of the "ADS-B to Radar Association" function (see Appendix C-1.1 for a detailed discussion). Local safety assessments should take this into due account.	M	N/A	N/A	N/A	Y	INT, SDPD		*see note*	*see note*	Partly compliant. To be revisited in following iterations.

		3. It is assumed that corresponding ADS-B horizontal position errors greater than 10 NM are always detected,										
RAD	0020.0015	The probability that the "ADS-B to Radar Association" function detects a significant ADS-B horizontal position error, and provides an indication of such to the existing ATC Processing System, shall be at least 90%, where a significant error is at least equal to the NIC boundary but less than 40% of the separation minima for the ADS-B-RAD environment.	M	N/A	N/A	N/A	Y	INT, SDPD		*see note*	*see note*	Partly compliant. To be revisited in following iterations.

		Note 1: This requirement, taken together with ASSUMP 43, will ensure that the appropriate safety objectives are met. Note 2: This requirement is closely linked to SPR 46 (refer also to Note 2 thereof).										
RAD	0020.0016	The probability that the "ADS-B to Radar Association" function detects an error of more than 500 ft between ADS-B and SSR pressure altitudes shall be at least 99%.	M	N/A	N/A	N/A	Y	INT, SDPD		*see note*	*see note*	Partly compliant. To be revisited in following iterations.

RAD	0020.0017	The probability of providing a Surveillance Report containing newly received ADS-B Position data of sufficient quality associated with any aircraft in En Route airspace within 8 seconds shall be 97%. Notes: 1. Additional requirements are subject to local implementation. Other considerations may apply (see OSA: §C.5.1.5 - “Loss of track information”). 2. Data continuity for a single aircraft is inherently encompassed by this requirement for position update, i.e. in terms of the number of consecutive misses of receiving a position update ultimately leading to a track drop. The required position update probability takes account of normal environmental factors that are experienced during this flight phase, such as coverage variations in received signals (including received satellite signals), that affect the production and receipt of ADS-B	M	Y	Y	Y	Y	GS, SDPD	0010.0160	*see note*		Already implemented in SDPD

		positions of sufficient quality on a single aircraft basis. Multiple aircraft data continuity is addressed in ASSUMP 24.										
RAD	0020.0018	The time interval between a change of Mode A code provided by the ADS-B aircraft domain and an ADS-B surveillance report containing the new Mode A code at interface E2 shall be no longer than 8 seconds (95%) En Route.	M	Y	Y	Y	N/A	GS	0010.0170			
RAD	0020.0019	The time interval between a change of emergency and SPI information provided by the ADS-B aircraft domain and an ADS-B surveillance report	M	Y	Y	Y	N/A	GS	0010.0180			

		containing the new emergency and SPI information at interface E2 shall be no longer than 8 seconds (95%) En Route.										
RAD	0020.0020	For En Route aircraft, if the position accuracy quality indicator (NACp) is not received within 24 seconds of a position message, then the ADS-B Ground Domain shall determine the position accuracy requirement has been met using a NIC encoding that corresponds to 926 meters (or less) as a substitute for the NACp requirement. Note: Alternatively, the requirement might be fulfilled by the existing ATC Processing System, i.e., beyond interface F2*.	M	N/A	N/A	N/A	Y	INT, SDPD		*see note*	*see note*	Already implemented in interfaces.

RAD	0020.0021	The probability of providing a Surveillance Report containing newly received ADS-B Position data of sufficient quality associated with any aircraft in TMA airspace within 5 seconds shall be 97%. Notes: 1. Additional requirements are subject to local implementation. Other considerations may apply (see OSA: C.5.1.5 - “Loss of track information”). 2. Data continuity for a single aircraft is inherently encompassed by the requirements for position update, i.e. in terms of the number of consecutive misses of receiving a position update ultimately leading to a track drop. The required position update probability takes account of normal environmental factors that are experienced during this flight phase, such as coverage variations in received signals (including received satellite signals), that affect the production and receipt of ADS-B positions of sufficient quality on a single aircraft	M	Y	Y	Y	Y	GS, SDPD	0010.0190	*see note*		Already implemented in SDPD.

		basis. Multiple aircraft data continuity is addressed in ASSUMP 24.										
RAD	0020.0022	The time interval between a change of Mode A code provided by the ADS-B aircraft domain and an ADS-B surveillance report containing the new Mode A code at point E2 shall be no longer than 5 seconds (95%) TMA.	M	Y	Y	Y	N/A	GS	0010.0200			
RAD	0020.0023	The time interval between a change of emergency and SPI information provided by the ADS-B aircraft domain and an ADS-B surveillance report containing the new	M	Y	Y	Y	N/A	GS	0010.0210			

		emergency and SPI information at point E2 shall be no longer than 5 seconds (95%) TMA.										
RAD	0020.0024	For TMA, if the position accuracy quality indicator (NACp) is not received within 15 seconds of a position message, then the ADS-B Ground Domain shall determine the position accuracy requirement has been met using a NIC encoding that corresponds to 513 meters (or less) as a substitute for the NACp requirement. Note: Alternatively, the requirement might be fulfilled by the existing ATC Processing System, i.e., beyond interface F2*.	M	N/A	N/A	N/A	Y	INT, SDPD		*see note*	*see note*	Already implemented in interfaces.
Integration of ADS-B with WAM	0030.0001	The ADS-B Ground Surveillance Domain should be capable to receive output from a WAM system in ASTERIX CAT 020 version 1.7.	O	Y	Y	N	N/A	GS	0030.0010, 15 and 20		0030.0001	

Integration of ADS-B with WAM	0030.0002	If REQ-15.04.05.a-D18-0030.0001 is implemented, the ADS-B Ground Surveillance Domain should process and decode received WAM data in ASTERIX CAT020 version 1.7. The following minimum set of data item should be decoded: • Aircraft Horizontal Position – Latitude and Longitude • Pressure altitude • Aircraft Identity (Mode 3A, Mode-S Address, Aircraft-Id) and Emergency Indicators • Time of Applicability	O	Y	Y	N	N/A	GS	0030.0030			
Integration of ADS-B with WAM	0030.0003	The ADS-B Ground Surveillance Domain should be capable to receive WAM system status messages in ASTERIX CAT 019 version 1.2.	O	Y	Y	N	N/A	GS	0030.0035, 40, 50, 60 and 70			
Integration of ADS-B with WAM	0030.0004	If REQ-15.04.05.a-D18-0030.0003 is implemented, ADS-B Ground Surveillance Domain should process and decode received WAM data in ASTERIX CAT019 version 1.2. The following minimum set of data item should be	O	Y	Y	N	N/A	GS	0030.0080			

		decoded: • Time of Applicability • System Status										
Integration of ADS-B with WAM	0030.0005	If REQ-15.04.05.a-D18-0030.0004 is implemented, the ADS-B Ground Surveillance Domain shall use the WAM System Status received by ASTERIX CAT019 as a criterion for the enabling of the ADS-B validity check.	O	Y	Y	N	N/A	GS	0030.0090, 100, 102, and 104			
Integration of ADS-B with WAM	0030.0006	If REQ-15.04.05.a-D18-0030.0002 is implemented, the ADS-B Ground Surveillance Domain should correlate ADS-B reports received through 1090ES with reports received from a WAM System in ASTERIX CAT020 version 1.7.	O	Y	Y	N	N/A	GS	0030.0110, 120 and 130			
Integration of ADS-B with WAM	0030.0007	If REQ-15.04.05.a-D18-0030.0006 is implemented, the ADS-B Ground Surveillance Domain shall verify the validity of ADS-B reports by comparing ADS-B position data with position	O	Y	Y	N	N/A	GS	0030.0140, 150 and 155			

		data of correlated WAM reports.										
Integration of ADS-B with WAM	0030.0008	If REQ-15.04.05.a-D18-0030.0007 is implemented, the validation result (positive/negative) shall be reported in the CAT021 ADS-B report	O	Y	Y	N	Y	GS, INT	0030.0140 and 150		0020.0004	
Integration of ADS-B with WAM	0030.0009	If REQ-15.04.05.a-D18-0030.0008 is implemented, the validation result (positive/negative) should be used by the SDPD to determine if the ADS-B report shall be used.	O	N/A	N/A	N/A	Y	SDPD		0030.0010 and 15		Partly compliant. To be revisited in following iterations.
Integration of ADS-B with WAM	0030.0010	If REQ-15.04.05.a-D18-0030.0009 is implemented, the validation result (positive/negative) should be reported to the end user of the surveillance data	O	N/A	N/A	N/A	Y	INT, SDPD		0030.0020	0080.0003	
Angle of arrival measurement	0040.0001	The ADS-B Ground Surveillance Domain should have the capability to determine the direction of arrival of the received ES.	O	N	N	Y	N/A	GS	0060.0015 and 18			

Angle of arrival measurement	0040.0002	If REQ-15.04.05.a-D18-0040.0001 is implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3), the ADS-B Ground Surveillance Domain should measure the direction of arrival of it	O	N	N	Y	N/A	GS	0060.0010			
Angle of arrival measurement	0040.0003	If REQ-15.04.05.a-D18-0040.0002 is implemented, the ADS-B Ground Surveillance Domain shall register a real direction of arrival of each of the received ES.	O	N	N	Y	N/A	GS	0060.0020 and 30			
Angle of arrival measurement	0040.0004	If REQ-15.04.05.a-D18-0040.0002 is implemented, the ADS-B Ground Surveillance Domain shall calculate the direction of arrival of each of the received position ES using the reported position and the known GS position.	O	N	N	Y	N/A	GS	0060.0040			
Angle of arrival measurement	0040.0005	If REQ-15.04.05.a-D18-0040.0004 is implemented, the ADS-B Ground Surveillance Domain shall compare the real direction of arrival with the calculated direction of arrival using the reported position.	O	N	N	Y	N/A	GS	0060.0050 and 60			

Angle of arrival measurement	0040.0006	If REQ-15.04.05.a-D18-0040.0005 is implemented and if "n" consecutive position updates defined as "not matching" have been received, then the ADS-B Ground Surveillance Domain shall mark the message as "direction of arrival Failure".	O	N	N	Y	N/A	GS	0060.0070, 72, 74 and 76			
Angle of arrival measurement	0040.0007	If REQ-15.04.05.a-D18-0040.0006 is implemented, the ADS-B Ground Surveillance Domain shall report “direction of arrival failures” in ADS-B reports created out of marked messages.	O	N	N	Y	Y	GS, INT	600.070		0020.0001 and 0020.0003	
Angle of arrival measurement	0040.0008	If REQ-15.04.05.a-D18-0040.0007 is implemented, the angle of arrival validation result (positive/negative) should be used by the SDPD to determine if the ADS-B report shall be used.	O	N/A	N/A	N/A	Y	SDPD		0060.0010 and 0015		Partly compliant. To be revisited in following iterations.
Angle of arrival measurement	0040.0009	If REQ-15.04.05.a-D18-0040.0008 is implemented, the angle of arrival validation result (positive/negative) should be reported to the end user of the surveillance data	O	N/A	N/A	N/A	Y	INT, SDPD		0060.0020	0080.0002	Partly compliant. To be revisited in following iterations.

Position versus velocity check	0040.0050	The ADS-B Ground Surveillance Domain should validate ADS-B report consistency by evaluating the ADS-B received target velocity against the ADS-B received target position change.	O	Y	N	N	Y	GS, SDPD, INT	0070.0010, 15, 20, 22, 24 ,26, 30 and 40	0070.0010, 15 and 0020 *See note*	0020.0001, 0020.0005, 0030.0004 and 0080.0004. *see note*	Partly compliant. To be revisited in following iterations.
Power measurement and range correlation	0040.0040	The ADS-B Ground Surveillance Domain should have the capability to measure the power of the received ES	O	N	N	Y	N/A	GS	0050.0005, 10 and 30		0030.0003	
Power measurement and range correlation	0040.0041	The ADS-B Ground Surveillance Domain should be capable to detect the equipment class of the transmitting aircraft.	O	N	N	N	N/A	GS	See note			Not feasible
Power measurement and range correlation	0040.0042	Once a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3), the ADS-B Ground Surveillance Domain should estimate the transmission power of it.	O	N	N	Y	N/A	GS	0050.0040			
Power measurement and range correlation	0040.0043	If REQ-15.04.05.a-D18-0040.0042 is implemented, the ADS-B Ground Surveillance Domain shall calculate the distance of the target from the ADS-B receiver using the reported	O	N	N	Y	N/A	GS	0050.0040			

		position and altitude										
Power measurement and range correlation	0040.0044	If REQ-15.04.05.a-D18-0040.0042 is implemented, the ADS-B Ground Surveillance Domain shall determine the approximate distance of each of the received ES using the measured power and equipment class. (see ED129 appendix F)	O	N	N	Y	N/A	GS	0050.0040			
Power measurement and range correlation	0040.0045	If REQ-15.04.05.a-D18-0040.0042 is implemented, the ADS-B Ground Surveillance Domain shall compare the distance obtained from the received position data with the distance calculated using measured power increments.	O	N	N	Y	N/A	GS	0050.0080			
Power measurement and range correlation	0040.0046	If REQ-15.04.05.a-D18-0040.0045 is implemented and if "n" consecutive position updates for which the difference between the approximate distance and the reported distance is greater than "x" Nm have been received in "t" seconds, then the ADS-B Ground Surveillance	O	N	N	Y	N/A	GS	0050.0100, 104, 106 and 108			

		Domain shall mark the message as "Power/Distance inconsistency".										
Power measurement and range correlation	0040.0047	If REQ-15.04.05.a-D18-0040.0046 is implemented, the ADS-B Ground Surveillance Domain shall report “Power/Range inconsistency” in ADS-B reports created out of marked messages.	O	N	N	Y	Y	GS, INT	0050.0100		0020.0001 and 0002	
Power measurement and range correlation	0040.0048	If REQ-15.04.05.a-D18-0040.0047 is implemented, the power/range validation result (positive/negative) should be used by the SDPD to determine if the ADS-B report shall be used.	O	N/A	N/A	N/A	Y	SDPD		0050.0010 and 15		Partly compliant. To be revisited in following iterations.
Power measurement and range correlation	0040.0049	If REQ-15.04.05.a-D18-0040.0048 is implemented, the power/range validation result (positive/negative) should be reported to the end user of the surveillance data	O	N/A	N/A	N/A	Y	INT, SDPD		0050.0020	0080.0001	

Multi-sensor data fusion consistency checks	0040.0010	In short, the "ADS-B to Radar Association" is an essential operational requirement to support the display in the mixed ADS-B and radar environment. This top-down operational requirement has been further substantiated by the safety assessment. As the function had already been identified for operational needs, it was also considered for its safety benefits in the OSA. Clearly, because the function inherently compares the positions and identities of different surveillance sources for the same aircraft, it also offers some useful safety benefits in a multi-sensor environment, in particular to detect inconsistencies between ADS-B and radar information. Hence, the "ADS-B to Radar Association" function is included in the barriers of the OSA event trees and provides useful gains towards achieving the safety targets.	M	N/A	N/A	N/A	N/A	SDPD				Too GENERIC Requirement

Multi-sensor data fusion consistency checks	0040.0011	If an automation system does not currently have a bias compensation function, one should be implemented and must also be considered in determining requirements for ADS-B, as it is an additional error component (residual bias).	M	N/A	N/A	N/A	Y	SDPD				
Multi-sensor data fusion consistency checks	0040.0012	It is assumed that the ATC processing system has a multisensory registration function to detect and compensate for systematic biases between radar and ADS-B.	M	N/A	N/A	N/A	Y	SDPD				
Multi-sensor data fusion consistency checks	0040.0013	It is recommended the ATC processing system performs a multi-sensor registration function to detect and compensate for systematic biases between radar and ADS-B such that the residual biases are limited to a maximum of 0.05 degrees (azimuth) and 40 meters (range) (see SSE analysis results discussed in §D.5 and §D.6).	M	N/A	N/A	N/A	Y	SDPD				

Multi-sensor data fusion consistency checks	0040.0014	In addition to providing enhanced tracker accuracy, sensor fusion can provide a supplementary means of integrity monitoring for En Route airspace that enhances the position integrity available from radar and/or ADS-B measurement data. This is achieved by monitoring radar and ADS-B position measurements versus the best available aircraft position estimate, to discriminate against large position errors.	M	N/A	N/A	N/A	Y	SDPD				
Multi-sensor data fusion consistency checks	0040.0015	In a multi-sensor environment, in addition to the above functionality, another mitigation means for spoofing could be implemented i.e. the validity check of the ADS-B message to detect incompatible positions w.r.t. the Independent Surveillance sensors, such as SSR Mode-S and/or WAM or the system track.	M	N/A	N/A	N/A	Y	SDPD		0010.0015 and 20		
Time of Arrival versus Distance Validation	0040.0030	The ADS-B Ground Surveillance Domain should be capable to determine the distance of a target from an ADS-B receiver by using the	O	N	Y	N	N/A	GS	0040.0010, 20, 25 50,60, 65, 70, 80, 90 and 100		0030.0002	

		received horizontal position data, the received altitude data and the static receiver position.										
Time of Arrival versus Distance Validation	0040.0031	The ADS-B Ground Surveillance Domain should have a function elaborating the consistency of TOA versus calculated distance from an ADS-B receiver for multiple ADS-B receivers having received the same position squitter.	O	N	Y	N	N/A	GS	0040.0110, 120, 124, 128, 130, 140, 150 and 160			
Time of Arrival versus Distance Validation	0040.0032	If "n" consecutive position updates for which the TOA/distance consistency check yields inconsistent, then the ADS-B Ground Surveillance Domain shall mark the message as "inconsistent TOA/distance".	O	N/A	Y	N/A	N/A	GS	*see note*			Requirement previously allocated to SDPD
Time of Arrival versus Distance Validation	0040.0033	The ADS-B Ground Surveillance Domain shall report “inconsistent TOA/distance” in ADS-B reports created out of marked messages.	O	N/A	Y	N/A	Y	GS, INT			0020.0001 and 0020.0006	
Time of Arrival versus Distance Validation	0040.0034	The TOA/distance consistency check result (positive/negative) should be used by the SDPD to determine if the ADS-B report shall be used.	O	N/A	N/A	N/A	Y	SDPD		0040.0010 and 15		Partly compliant. To be revisited in following iterations.

Time of Arrival versus Distance Validation	0040.0035	If REQ-15.04.05.a-D18-0040.0034 is implemented, the TOA/distance consistency check result (positive/negative) should be reported to the end user of the surveillance data	O	N/A	N/A	N/A	Y	INT, SDPD		0040.0020	0080.0005	
ED102A/ DO260B Compatibility	0060.0060	The ADS–B Surveillance System shall be capable to receive the message over 1090 ES in accordance with the introduced changes in the DO-260B standard.	M	Y	Y	Y	N/A	GS	0010.0010			
ED102A/ DO260B Compatibility	0060.0061	The ADS–B Surveillance System shall be capable to decode the ADS-B message, in order to extract the available information, in accordance with the introduced changes in the DO-260B standard.	M	Y	Y	Y	N/A	GS	0020.0010, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220 and 230			
ED102A/ DO260B Compatibility	0060.0062	The ADS–B Surveillance System should be able to filter ADS-B messages based on their announced DO-260, DO-260A or DO-260B standard version.	M	Y	Y	Y	N/A	GS	0010.0010			

ED102A/ DO260B Compatibility	0060.0063	The ADS-B System ground surveillance domain shall be able to transform the introduced DO-260B changes into Standard ASTERIX Category 21 data items.	M	Y	Y	Y	Y	GS, INT	0020.240		0010.0001, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,13,14,15,16 and 17	
ED102A/ DO260B Compatibility	0060.0064	The ADS-B Ground Surveillance shall be able to output the DO-260B changes via Standard ASTERIX Category 21 data reports.	M	Y	Y	Y	Y	GS, INT, SDPD	0010.0060	0020.0010	0010.0001, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,13,14,15,16 and 17	-

Table 3 Baseline Matrix for Iteration 1

3.2 Design and Construction Constraints: Baseline Matrix Overall Overview

Due to the different functionalities and enhancements proposed for the Component, an Overall Baseline Matrix addressing the implementation for the different sub-systems as a whole is deemed as necessary.

The following table addresses the different implementations which will be covered per Partner contributor in the Project.

Additionally this table allows to easily check if all the requirements are currently covered by the Project.

		Covered by				
Functionality	**Mandatory / Optional**	**Thales**	**Selex**	**Indra**	**Eurocontrol**	**Overall fulfillment**
RAD	M	Y	Y	Y	Y	**Y**
Integration of ADS-B with WAM	O	Y	Y	N	Y	**Y**
Angle of arrival measurement	O	N	N	Y	Y	**Y**
Position versus velocity check	O	Y	N	N	Y	**Y**
Power measurement and range correlation	O	N	N	Y	Y	**Y**
Multi-sensor data fusion consistency checks	M	N/A	N/A	N/A	Y	**Y**
Time of Arrival versus Distance Validation	O	N	Y	N	Y	**Y**
ED102A/DO260B Compatibility	M	Y	Y	Y	Y	**Y**

Table 4 Baseline Matrix: Overall Overview for Iteration 1

As shown in the table, **all requirements are covered by at least one Prototype provider.**

4 Assumptions

N/A

5 References

[1] SJU 15.04.05a ADS-B Ground Surveillance Specifications for first iteration, D18, Ed. 00.01.00, Mar. 2011

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

[3] SJU 15.04.05a ADS-B 1090 MHz Ext. Squitter Ground Station Specifications – Iteration 1, D05, Ed. 00.02.00, Mar. 2011

[4] SJU 15.04.05a SDPD Specification – Iteration 1, D06, Ed. 00.01.04, Mar. 2011

[5] SJU 15.04.05a Interface Specifications for first Iteration, D07, Ed. 00.01.00, Mar. 2011

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

[7] SESAR Toolbox User Manual Latest version

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

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

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

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

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

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

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

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

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

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

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

[19] EUROCAE ED161: Safety, Performance and Interoperability Requirements Document for ADS-B-RAD Application, September 2009

5.1 Use of copyright / patent material / classified material

No copyright/patent/classified material is included in this report.

Appendix A Traceability

The objective of this Deliverable is to serve as a quick guideline of the baseline to be taken by the different Prototypes.

Hence, the use of a traceability Matrix is not necessary, as no requirements are defined but options to be implemented.

Traceability will be provided in the following tasks of this Project (i.e. Tailoring of the Test Specifications and Verification activities).

-**END OF DOCUMENT -**