Security Assessment for ADS-B Ground System - 3rd Iteration

Document information	
Project Title	Surveillance Ground System Enhancements for ADS-B (Prototype Development)
Project Number	15.04.05b
Project Manager	Thales
Deliverable Name	Security Assessment for ADS-B Ground System - 3rd Iteration
Deliverable ID	Del 23
Edition	00.01.01
Template Version	03.00.00
Task contributors	
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Abstract

SESAR WP15.4.5 is tasked with the implementation of enhancements into the ADS-B ground based surveillance system to address security limitations within ADS-B technology. The enhanced ADS-B ground system was defined to comprise enhanced ADS-B groundstations, an enhanced ARTAS Surveillance Data Processing System (SDPD) produced by EUROCONTROL and modified ASTERIX CAT 21 and 23 interfaces to carry the data validation results between the groundstations and SDPD system [1].

Candidate security and technology enhancements for incorporation within the 3rd Iteration ADS-B ground system were proposed within the WP15.4.5a Overall Baseline Specification D17 [1] and 3rd Iteration ADS-B Ground System Specification [2]. Following analysis, these options were down-selected within the WP15.4.5b 3rd Iteration Baseline Matrix/Baseline [3].

The implemented enhancements within the 3rd Iteration groundstation were limited to the incorporation of the Range through Active Interrogation (RAI) security enhancement into the ADS-B Data Validation function and associated Mode S interrogator into the ADS-B groundstation. It is judged within this report that the current RAI requirements **0040.0005** and **130.0140** within the D20 and D13 documents are presently defined to cause this enhancement to not act as a security enhancement in the case of false ADS-B plots.

Therefore, to correct this shortcoming it is proposed within this report that the RAI requirements **are** modified causing the RAI test to act as **a security enhancement** within the developed enhanced ADS-B ground system.

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Rational for rejection
N/A

Document History

Edition	Date	Status	Author	Justification
00.00.01	15/09/2014	Draft	[redacted]	First Draft
00.01.00	04/11/2014	Update		Internal review by project members
00.01.01	19/11/2014	Final		

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Executive summary

SESAR WP15.4.5 has the task for the implementation of enhancements into the ADS-B ground based surveillance system to address security and integrity limitations of ADS-B technology [1]. The enhanced ADS-B ground system was defined to comprise enhanced ADS-B groundstations, an enhanced Surveillance Data Processing System (SDPD) produced by EUROCONTROL and modified ASTERIX CAT 21 and 23 interfaces to carry the data validation results between the groundstations and SDPD system [1].

Candidate security and technology enhancements for incorporation within the 3rd Iteration ADS-B ground system were proposed within the WP15.4.5a Overall Baseline Specification D17 [1] and 3rd Iteration ADS-B Ground System Specification [2]. Following analysis, these candidate options were down-selected within the WP15.4.5b 3rd Iteration Baseline Matrix/Baseline. These comprised the Range through Active Interrogation (RAI) test and the substitution of missing ADS-B data with equivalent WAM supplied target data or data derived from a Flight Data Processing system [3].

WAM and FDP system data substitution were discarded after analysis, due to the differing error characteristics of target reports derived from systems other than ADS-B. This left the integration of the Range through Active Interrogation (**RAI**) security enhancement and required Mode S interrogator to be implemented into the ADS-B Data Validation function into the 3rd Iteration enhanced ADS-B groundstation design and processing of the RAI test result within the enhanced ARTAS SDPD system. All manufactures opted to incorporate the Mode S interrogator and RAI function into their 3rd Iteration ADS-B groundstation [3].

The RAI function was proposed with the D20 document [2], leading to a full system requirement capture within the D13 ADS-B Groundstation Specification for the 3rd Iteration [4]. Inspection of the D13 ADS-B Ground Station Specification revealed that Requirements **0040.0005** and **130.0140** had been worded to return a result of 'NOT VALIDATED' if the RAI test was not conducted. This has significant implications for the flagging of false ADS-B plots within the enhanced ADS-B groundstation.

Currently, ADS-B plots not corresponding to a real aircraft will be flagged as '**NOT VALIDATED**' and hence treated as an unenhanced ADS-B plot within the SDPD system. Therefore, false ADS-B plots would be displayed to controllers as real aircraft, having to potential to cause avoiding instructions to be issued to controlled traffic and negatively impacting on ATCO and Flight Crew workload. In this form, it is proposed that the current definition of the RAI test **does not act** as **an ADS-B security enhancement**, as false ADS-B plots would not be explicitly identified.

This behaviour is judged to be not ideal and the author proposes that false ADS-B plots not corresponding to real aircraft should be flagged as '**VALIDATED AND INVALID**' when their position has been determined to lie within a configurable RAI range. These plots would therefore initiate a new track within the SDPD system and be correctly displayed to the controlling ATCO as suspicious [7]. If these plots were determined to be outside of the pre-configured interrogation range then the plots were set to 'NOT VALIDATED', as per the normal behaviour.

It is therefore recommended that the D20 and D13 specifications are re-issued with these changes incorporated into them, thereby causing the RAI test to act as a security enhancement within the enhanced ADS-B Groundstation.

1 Introduction

1.1 Purpose of the document

This document gives an overview of the enhanced ADS-B ground system specified within SESAR 15.4.5b and a summary of security issue present within ADS-B. It details the enhancements implemented into the ADS-B ground system 3rd prototype iterations to counter the described security issues [1] [2].

1.2 Intended readership

The audience of this document includes:

- Projects 15.04.05.a and b,
- SJU projects that may require ADS-B Surveillance Systems for their validation activities.
- SESAR ANSP's considering the implementation of ADS-B systems into their ATM system.

1.3 Inputs from other projects

Input documents in the form of system specifications, interface specifications and test specifications for the enhanced ADS-B ground system from 15.4.5a.

1.4 Structure of the document

- Executive Summary
- Chapter 1: Introduction
- Chapter 2: Safety and Security
- Chapter 3: 2nd Prototype Iteration ADS-B Security Enhancements
- Chapter 4: Assumptions
- Chapter 5: References

1.5 Functional Block Purpose

1.5.1 Enhanced ADS-B ground system overview

The enhanced ADS-B ground system comprises the following system elements, shown schematically in Figure 1 [3]:

- Enhanced ADS-B groundstation(s) [4]
- Enhanced Surveillance Data Processing and Distribution system [5]
- Modified ASTERIX Category interfaces [6];
  - ASTERIX CAT 021 ADS-B target reports and CAT 023 service messages
  - ASTERIX CAT 020 WAM target reports and CAT 019 WAM service messages
  - SDPD system track data in ASTERIX CAT 062 and service messages in CAT 063

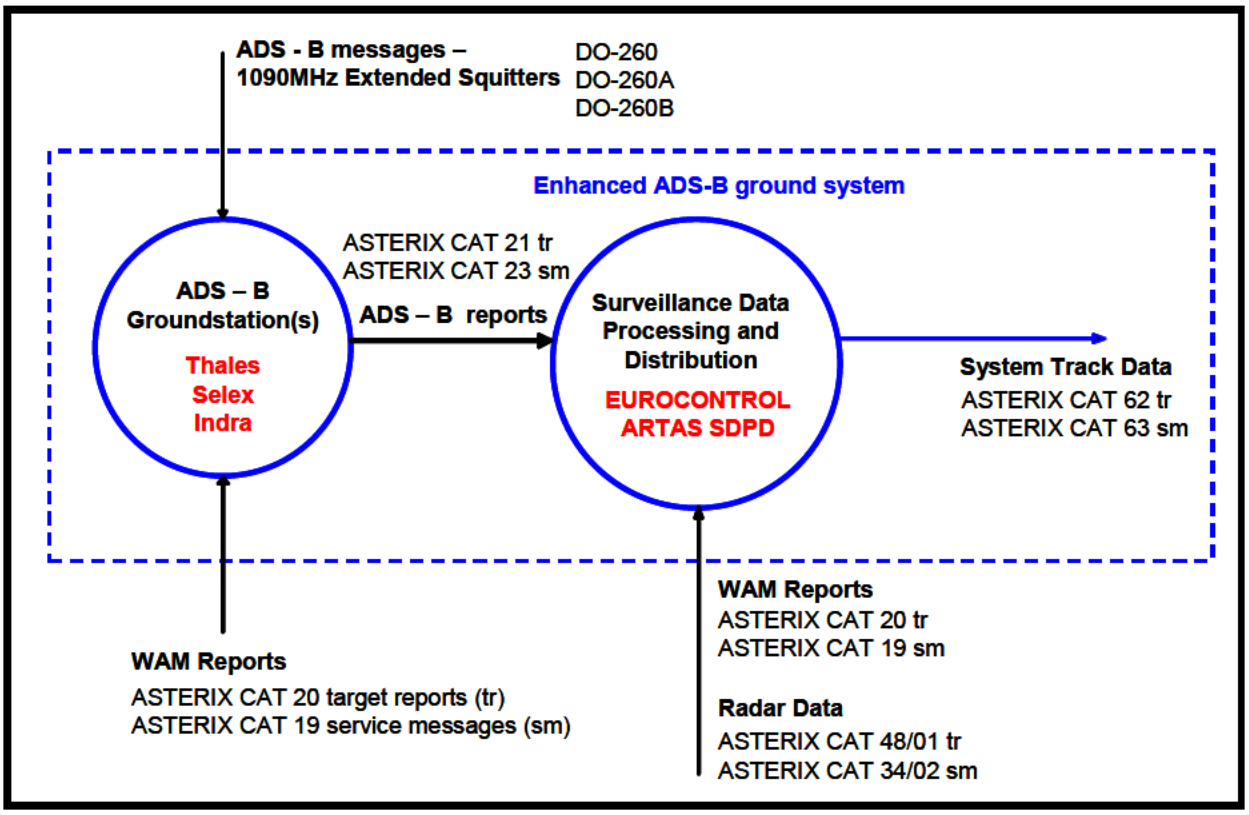

Figure 1. Enhanced ADS-B ground system schematic

1.6 Functional block Overview

1.6.1 Enhanced ADS-B groundstation overview

The primary functions of the 1090 ADS-B groundstation (GS) are shown schematically in Figure 2 and comprise [4]:

- Receive 1090 MHz RF input on the **Air Interface**
- Extract message payload data from 1090MHz Extended Squitter ADS-B messages
- Timestamp the decoded ADS-B messages using the UTC Time Sync function. Timestamp data derived from either NTP signals delivered on the Ground Interface or GNSS (GPS) signals sourced on the Air Interface
- Assemble the ADS-B message data into ASTERIX Category 021 target reports
- Dispatch the ASTERIX CAT 021 ADS-B target reports and ASTERIX CAT 023 service messages to client systems over the **Ground Interface**
- Interacts with the Remote Control and Monitoring system through the **Management Interface**, using SNMP messaging protocols
- Determines the internal status of the groundstation equipment through BITE

Figure 2. 3rd prototype iteration Enhanced ADS-B Groundstation functional diagram[1]

[1] The partitioning shown is for the purpose of describing the high level behaviour of the Ground Station and is not intended to convey an implementation requirement or the physical architecture of the equipment

New physical and logical functionality for integration into the 3rd Prototype Iteration Groundstation was proposed for integration ADS-B 1090 MHz Ext. Squitter Ground Station Specification - Iteration 3 [4] and defined within WP15.4.5b Baseline Matrix/Report [3]:

- Integration of a 1030MHz interrogator into the enhanced 1090 Groundstation, complete with timestamp information from the GNSS source
- Implementation of a scheduling function into the ADS-B Data Validation to enable the selective integration using ICAO Annex 10 Uplink Format UF5 to extract the Aircraft Identification field from BDS (2,0) within the Mode S transponder
- Ability to decode the resulting Downlink Format DF5 Mode S replies and timestamp the reception time using GNSS signals
- Use timestamp information from the interrogation and reply to determine the 'round-trip' delay from enhanced ADS-B groundstation to aircraft.
- Validate the ADS-B reported position information using the Round Trip Delay algorithm implemented into the 3rd Iteration ADS-B Data Validation function.
- Extend the C&M function into the Interrogator within the 3rd It Groundstation.

1.6.2 SDPD system overview

The Surveillance Data Processing & Distribution system (SDPD) receives aircraft data from individual surveillance sensors, including ADS-B 1090 MHz Extended Squitter Ground Station, and serves fused surveillance track updates to client systems such as Controller Working Positions (CWP). Aircraft data updates contains measured or reported 2-D horizontal position, reported altimeter altitude, velocity, status and other information extracted from aircraft on-board systems and received by ground based surveillance sensors [4].

The primary function of the SDPD is to present an accurate and complete air situation picture in ASTERIX Category 062 to its client systems. The CAT 062 picture is composed of input surveillance target report data received in ASTERIX Categories 048/001 (radar), 020 (WAM) and 021 (ADS-B) target messages and fused into a composite air picture [4].

The SDPD uses the input service messages in ASTERIX Categories 034/002 (radar), 019 (WAM) and 023 (ADS-B) to determine the validity of the separate surveillance system supplied target data stream and hence to discard or include each particular surveillance target data stream.

The EUROCONTROL ARTAS product was selected as the SDPD element within the enhanced ADS-B system and is designed around four main functions [4];

- The TRACKER processes the input surveillance information (from the surveillance sensors) and maintains the Track Data Base,
- The SERVER performs the Track Information Service i.e. the management of all requests from Users and the transmission of the relevant sets of track data to these Users. It will also execute the so-called inter-ARTAS cooperation functions.
- The SYSTEM MANAGER performs the functions related to the supervision and management of the ARTAS Unit,
- The RECORDING function will record selected data related to the operational use of ARTAS.

A functional block diagram of the ARTAS SDPD system is shown in Figure 4 [4]:

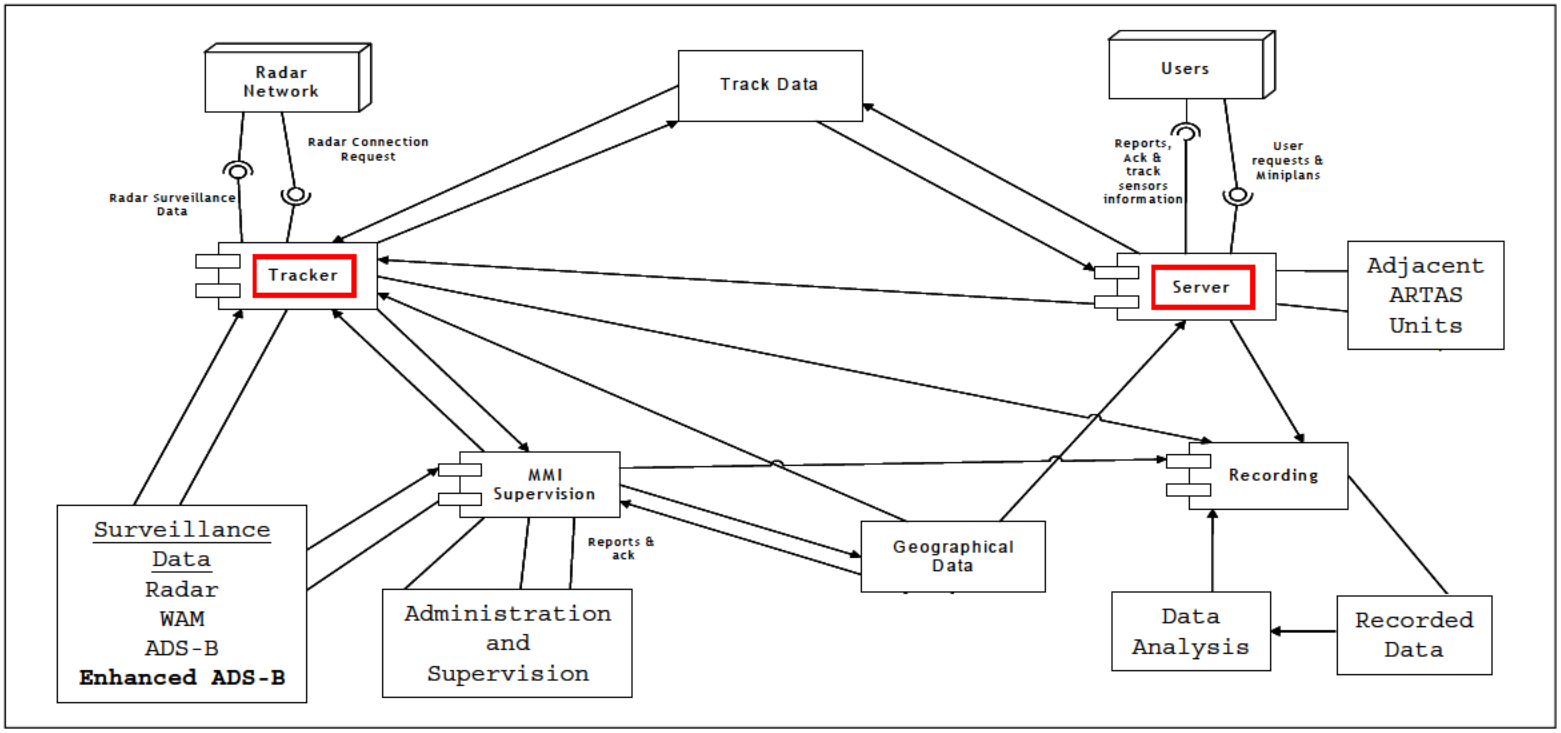

Figure 3. ARTAS functional overview

WP15.4.5b security enhancements are implemented the TRACKER function [7]. The new functionality examines the status of the ADS-B data validation test flags reported within the modified ASTERIX CAT 21 ADS-B target reports [8]. It associates the report into an existing track, if the Aircraft Identification, Mode S address, etc match and the security enhancement validation flags are set as VALID and VALIDATED or PARTIALLY VALIDATED and VALIDATED.

If the validation flags are set to INVALID and VALIDATED, then the SDPD initiates A new ADS-B track and sets status bits in the ASTERIX CAT 62 output accordingly, dependant on the failed test [9]. The display system can therefore be configured to flag these potentially false ADS-B plots to the ATCO using appropriate symbology.

If the security enhancement tests are not performed then the enhancement flags are set to NOT VALIDATED and the target report is treated as an unenhanced plot [7].

1.7 Glossary of terms

Not Applicable

1.8 Acronyms and Terminology

Term	Definition
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-B RAD	Enhanced ATS in Radar Areas ("ADS-B out" application)
ARTAS	ATM suRveillance Tracker And Server
ASTERIX	All-purpose Structured EUROCONTROL Surveillance Information Exchange
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
BITE	Built-in Test System
CAT	Data Category
CONOPS	Concept of Operations
CWP	Controller Working Position
ED	EUROCAE Document
ES	Extended Squitter
EUROCAE	European Organisation for Civil Aviation Equipment
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GS	Ground Station
ICAO	International Civil Aviation Organization
INTEROP	Interoperability
Mode S	Mode Select
MOPS	Minimum Operational Performance Standards
RF	Radio Frequency
RTCA	Radio Technical Commission for Aeronautics
SDPD	Surveillance Data Processing and Distribution
SESAR	Single European Sky ATM Research (Programme)
SJU	SESAR Joint Undertaking
SSR	Secondary Surveillance Radar
TDOA	Time Difference Of Arrival
TMA	Terminal Manoeuvring Area
WAM	Wide Area Multilateration

Table 1. Acronyms and Terminology

2 Safety & Security

Safety aspects of the 3rd Prototype Iteration enhanced ADS-B ground system are covered within the D22 Safety Assessment report [10]. This report focuses on the security enhancements implemented into the 3rd Iteration Prototype ADS-B ground surveillance system, in-addition to the baseline established within the 1st and 2nd Iterations.

2.1 ADS-B security issues

Security concerns within ADS-B were defined within the Overall System Specification for WP15.4.5 [1]. It defined spoofing, or the broadcast of ghosts tracks and their operational impact on the delivered ATC service or ADS-B airborne applications as the one of the main security concerns within a dependant broadcast technology such as ADS-B.

The operational impact of the broadcast and subsequent reception within ADS-B groundstations of false ADS-B reports are:

- Denial of Service through the reception of false ADS-B messages in addition to those broadcast by real aircraft. The presence of the false ADS-B signals acts to degrade the detection performance of the ADS-B groundstation. This reduction could lead to a loss of separation between aircraft due to missing updates on aircraft and a loss of confidence by the ATC Controller in the provide ADS-B technical service, leading to its withdrawal from use.
- Denial of Service through the presence of excessive numbers of false ADS-B plots on the ATC Controller workstation display, causing a loss of situational awareness of real aircraft and hence requiring the withdrawal from use of the ADS-B technical service.
- The source of the false ADS-B signals can be deliberate false transmissions from either ground based or airborne transmissions or from airborne ADS-B equipment in a malfunctioning state.

2.2 WP15.4.5 Security Enhancements

2.2.1 Enhanced ADS-B groundstation Data Validation tests

Security enhancements implemented within the enhanced ADS-B groundstation were implemented into the new ADS-B Data Validation function and organised into two areas [1]:

1. Internal ADS-B target report validation tests within the ADS-B groundstation, for the enhancement of the ADS-B service in situations when the ADS-B ground surveillance system was deployed in a stand-alone manner.
2. Multi-sensor ADS-B target report validation tests between the dependant cooperative ADS-B aircraft information (i.e. horizontal position, identification, height, etc.) and the equivalent reference data items derived from an independent cooperative surveillance source i.e. WAM or Mode S data.

Given the convergence between ADS-B and WAM technologies witnessed in recent ATM equipment development and EUROCAE WG51 SG4 activities to generate a composite ADS-B-WAM specification, the SJU expressed a desire for integration between these complementary technologies within WP15.4.5. Therefore, the source for reference data for the multi-sensor check was chosen to be WAM [1].

Results of each of the implemented ADS-B data validation tests are reported in the modified ASTERIX CAT 21 data item I021/40 Target Report Descriptor data field [6], [8]. The results returns the values:

- **Validated and valid** if the test passed
- **Validated and partially valid** if the high priority items within the test passed i.e. only Mode S DAPS comparison between WAM and ADS-B data items failed
- **Validated and invalid** if the test failed i.e. did not match the conformance limits for the internal tests or exceeded the metric threshold in the comparison test between WAM and ADS-B data items
- **Not validated** if the test was disabled in the ADS-B groundstation.

Security enhancements implemented into the 1st and 2nd Iteration prototype groundstation are described within the 2nd Iteration Security Report [11]and formed the baseline for the 3rd Iteration prototype development.

2.2.2 Enhanced ARTAS functionality

Enhanced ADS-B target reports containing the validation test results where input into the enhanced prototype ARTAS for consideration in the tracking process [5]. The results were processed within the Tracker using the following rules [7]:

- If all **ADS-B validation test flags** reported in the enhanced ASTERIX CAT 21 target report data item I21/40 are set to **validated and valid** or **validated and partially valid** and the ADS-B target report characteristics matched to an existing track (i.e. Mode S address, position, etc) then the ARTAS tracker updates the existing track with the ADS-B target report. The validation test result are set to **valid** within ASTERIX CAT 62 data item I62/80 Track Status for each performed security enhancement test [9].
- If any of the **ADS-B validation result flags** are set to **validated and not valid** within the ADS-B target report, the ARTAS tracker initiates a new track and flags it as **invalid** within the appropriate ASTERIX CAT 62 data item I062/80 Track Status validation result data field [9].
- If an existing track is set to **invalid** and the tracker receives a matching ADS-B target report with a **validated and valid** or **validated and partially valid** result within it then the ARTAS tracker updates the existing track to a **valid** status and does not initiate a new track .
- If all validation tests are disabled within the ADS-B groundstation, effectively setting the ADS-B output to an un-enhanced state, the ARTAS tracker associates the ADS-B target report into a matching track, otherwise it initiates a new track if the track initiation rules are satisfied.

Security enhancements implemented into the 1st and 2nd Iteration prototype ARTAS are described within the 2nd Iteration Security Report and formed the baseline for the 3rd Iteration prototype development [11].

2.2.3 3rd Iteration Security Enhancement selection

Document D20, ADS-B Surveillance System Specification for Third Iteration defined a set of security enhancements proposed for consideration for implementation within the enhanced ADS-B groundstation and ARTAS [2]:

Iteration	Multi-sensor check: Integration with WAM	ADS-B Groundstation internal validation test
3	ADS-B Target report data update by WAM system	• ADS-B Report validation using FDPS or other relevant inputs • Range through Active Interrogation (RAI)

Table 2. Overall System Specification security enhancements for consideration

The proposed enhancement set was analysed within the 3rd Iteration Baseline Matrix Report, with FDPS validation of ADS-B data and the substitution of missing ADS-B target report position information by WAM data not chosen for implementation, due to the differing characteristics of target data derived from an FDP system or WAM system compared to ADS-B data [3].

Therefore, only the Range through Active Interrogation security enhancement was retained within the Iteration 3 prototype design. Table 3 shows that all groundstation manufacturers selected it for integration into their prototype groundstation design [3]:

Item No.	Security Enhancement	Thales ADS-B GS	Selex ADS-B GS	Indra ADS-B GS	EUROCONTRL SDPD
3rd Prototype Iteration					
10	Aircraft Range measurement validation from Active Interrogation	Y	Y	Y	Y

Table 3. RAI test implementation by groundstation manufacturer and EUROCONTROL

2.3 RAI validation test description

2.3.1 Enhanced ADS-B Groundstation operation

The Range through Active Interrogation or RAI ADS-B groundstation internal validation test is designed to verify that an aircraft broadcasting ADS-B messages lies on the circumference of circle which corresponds to its reported position within the decoded messages. It can be deployed in multi-sensor or standalone ADS-B environments, as it is internal to the groundstation [4].

The RAI measurement process is shown schematically within Figure 4:

Figure 4. RAI measurement process within the RAI test

The RAI validation test use the Mode S address from decoded ADS-B messages to selectively interrogate individual aircraft within the interrogation range of the interrogator, using an ICAO Annex 10 format Uplink Format UF5 Aircraft Identity interrogation. The ADS-B groundstation timestamps the transmission time of the interrogation, termed Time of Interrogation or **TOI**.

The interrogation range of the groundstation is smaller than the reception range of Mode S replies/ADS-B messages, due to increased sensitivity of the groundstation receiver (-91dBm) compared to the transponder receiver (-72dBm), even though the groundstation broadcasts more power (250W-1.5kW) and has a high gain antenna (>6dBi) than the equivalent elements within the Mode S transponder (125-500W, 0-3dBi respectively). Therefore, the range for which targets are eligible for the RAI test must be configurable within the enhanced ADS-B groundstation for reliable operation of the RAI test.

The Mode S transponder, upon successful reception and decoding of the UF5 interrogation, broadcasts a Downlink Format DF5 reply, containing the Aircraft Identification set by the flight crew for the flight in-question. The enhanced ADS-B groundstation receives this DF5 reply, decodes it and timestamps the Time of Reception or **TOR** for each aircraft [4].

The RAI algorithm determines the round trip delay RTD using TOI, TOR and the fixed delay turnaround delay within the Mode S transponder and applies the following formula to calculate the range of the aircraft:

$$Aircraft\ Range = c * \frac{TOR - TOI}{2}$$

where c is speed of light.

The RAI test determines if the interrogated aircraft has a measured range which lies on the surface of a sphere within a user definable threshold of the measured range, as shown in Figure 4. The RAI test returns different results dependant on if the RAI measurement process returned a valid or invalid result:

- If the aircraft is valid the RAI test returns a **VALID and VALIDATED** result, reported within the RAI field in the fifth extension of ASTERIX CAT 21 data item I21/40 Target Report Descriptor in the ADS-B target report [8].
- If the measured range exceeds the user threshold then the RAI test returns an **INVALID and VALIDATED** result within the RAI field in the I21/40 data item.

If the test is not performed because the aircraft is excessive range for valid interrogation by the enhanced ADS-B groundstation then the RAI bit in I21/40 is set to **NOT VALIDATED** in the output ADS-B target report.

2.3.2 Enhanced SDPD operation

The SDPD uses the result of the RAI test to either associate the ADS-B target report into existing tracks if the result is **validated and valid** and set the validation test flags in ASTERIX CAT 62 service track message field in data item CAT 062/80 Track Status data field, in the Seventh Extension titled RTD result (bit 2) [10] [7].

It initiates a new track if the validation result is set to **validated and invalid** and set the appropriate validation test result in the I62/80. If the test is not performed i.e. **not validated** then ARTAS either associates it with an existing suitable track or initiates a new track, as per the standard process

The setting of the CAT 62/80 data item could be used to flag the plot on the ATC CWP display or filter it from display, dependant on configuration of the CWP. It should be noted that the ability to exclude plots from output of ARTAS is not implemented into the enhanced ARTAS prototype developed within WP15.4.5b but could be within a fully developed mature ARTAS product [7].

2.4 RAI validation as Security Enhancement

2.4.1 Aircraft equipped with a Mode S transponder

The Ranging through Active Integration acts to validate the reported range of aircraft carrying Mode S transponders through comparison of the measured aircraft range with the aircraft position reported in the ADS-B message and derived from the aircraft GNSS source. In this case, the test acts to increase the integrity of the received ADS-B messages through comparison with a measured parameter, in the same manner as for the comparison with WAM measured aircraft position data within the WAM integration test described in the Second Iteration Security Report [11].

The RAI test result is reported within CAT 62 data item 80 and hence be displayed through appropriate symbology to the ATCO, increasing confidence in the presented ADS-B information and acting as an enhancement compared to the unenhanced version of ADS-B data.

If the reported position was in error from the actual aircraft position, through a low integrity navigational source for instance, this test would highlight this error, through the setting of the **VALIDATED and INVALID** flag. The ANSP could decide to suppress this type of report from display through the RAI flag set in the CAT62 target report or to show it and used appropriate symbology to denote the failed test. This handling of cases where the reported and actual position of the aircraft and the highlighting to the ATCO is judged to increase the integrity of the provided ADS-B service compared to unenhanced ADS-B, where the ATCO would be unaware of the actual aircraft position difference [2].

Therefore, in the case of real aircraft carrying a Mode S transponder the **RAI** test **is** judged as a **security enhancement**, as it increases the ATCO confidence of the validity of the presented ADS-B plot.

2.4.2 False ADS-B messages

False ADS-B messages, broadcast from either a ground based or airborne transmitter are assessed to currently register a state of **NOT VALIDATED** within the RAI test. The behaviour of the ADS-B groundstation within the RAI test is defined within D20 [2] and D13 ADS-B Ground Station Specification of the 3rd Iteration [12]. Requirement **0040.0005** and **0130.0140** within D13 states:

REQ-15.04.05.a-D20- Req. ID	D20 Requirement	REQ-15.04.05.a-D13- Req. ID	GS Requirement for 3rd Iteration
0040.0005	If REQ-15.04.05.a-D20-0040.0003 and REQ-15.04.05.a-D20-0040.0004 are implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3) and the associated RTD applicability is elapsed, the ADS-B position report shall be marked as NOT VALIDATED.	**0130.0140**	The 1090 GS shall mark as "**NOT VALIDATED**" any ADS-B target position update for which the validity of the associated RTD has expired, or if there is no associated RTD.

Table 4. RTD validation test requirement extracted from the D20 and D13 ADS-B GS Specification

Therefore, as presently specified if the ADS-B target does not have an associated RTD value due to the test not completely for any reason then the RTD test result will be set to **NOT VALIDATED**. In the case of false ADS-B messages, the ADS-B target report would therefore be a candidate for combination into an existing track, falsely setting the status of the track.

In this case it is assessed that the RAI test **will not act** as a ADS-B **security enhancement** in the case of identification of transmission of false ADS-B messages, due to the lack of RTD measurement to undertake the RAI test under the current wording of the specification.

It this proposed within this document to reword requirement **0130.0140** replacing '**NOT VALIDATED**' with '**VALIDATED and INVALID**' if the RTD value is missing, for targets within the configured RAI Range volume. Under this wording, a false ADS-B target report would be correctly set to a '**VALIDATED and INVALID**' state within the output ASTERIX CAT 21 I21/40 Target Status field and hence would initiate a new track in ARTAS, flagged as a false ADS-B track. This changes are reflected in the new wording of 0040.0005 and 130.0140 given in Table 5:

REQ-15.04.05.a-D20- Req. ID	D20 Requirement	REQ-15.04.05.a-D13- Req. ID	GS Requirement for 3rd Iteration
0040.0005	If REQ-15.04.05.a-D20-0040.0003 and REQ-15.04.05.a-D20-0040.0004 are implemented, each time a valid position message, located within the configured RAI Range, is received for a target in "target data maintenance" mode (see ED-129 chapter 3) and the associated RTD applicability is elapsed, the ADS-B position report shall be marked as **VALIDATED and INVALID**. If the same target is located outside the configured RAI Range, the related target report shall be marked as **NOT VALIDATED**.	**0130.0140**	The 1090 GS shall mark as **NOT VALIDATED** any ADS-B target position update for which the validity of the associated RTD has expired, or if there is no associated RTD, if the target is located within the RAI Range. If the target is located within the RAI Range volume, it shall be marked as **VALIDATED AND INVALID** if no RAI test result is returned

Table 5. Proposed modified RAI Requirements from D20 and D13 documents

It is recommended that the D13 and D20 specifications are re-issued with these changes incorporated into them, ensuring that the RAI test acts as a security enhancement within the enhanced ADS-B Groundstation.

3 Assumptions

None

4 References

[1] SJU 15.04.05a ADS-B Specification Baseline Document, **D17**

[2] SJU 15.04.05a ADS-B Surveillance System Spec. for Third Iteration, **D20**

[3] SJU 15.04.05b 3rd Prototype Iteration – Baseline Report/Matrix, **D17**

[4] SJU 15.04.05a ADS-B 1090MHz Ext. Squitter Ground Station Specification–Iteration 3, **D13**

[5] SJU 15.04.05a SDPD Specification – Iteration 3, **D14**

[6] SJU 15.04.05a Interface Specifications for Third Iteration, **D15**

[7] ARTAS_SCN_V8B1_SJU_WP15_4_5b_iteration_2&3_V1.3 05.12.2013

[8] EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE, Part 12: Category 021 ADS-B Reports, Edition 2.81

[9] EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE, Part 9: Category 062 SDPS Track Messages, Edition 2.75

[10] SJU 15.04.05b 3rd Prototype Iteration – Safety Assessment Report, **D22**

[11] SJU 15.04.05b Security Assessment for 15.04.05b 2nd Prototype Iteration, **D16**

[12] SJU ADS-B 1090 MHz Ext. Squitter Ground Station Specification - Iteration 3

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