International Civil Aviation Organization

ELEVENTH MEETING OF THE SOUTHEAST ASIA AND BAY OF BENGAL SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP (SEA/BOB ADS-B WG/11)

New Delhi, India 17 – 19 November 2015

Agenda Item 4: Report on ground system and avionics performance monitoring and improvement in compliance

SYSTEM SPECIFICATIONS FOR DEVELOPING AN AUTOMATIC DEPENDENT SURVEILLANCE BROADCAST (ADS-B) MONITORING SYSTEM

(Presented by Department of Civil Aviation Malaysia)

SUMMARY

This paper presents a holistic set of system specifications to monitor the ADS-B system. The first part of the work, analyses ADS-B system infrastructures/architecture/performance requirement. The second part of the work conducts a systematic review on the existing ADS-B monitoring systems. It then classifies the system's characteristic to identify gaps. Finally, it derives a set of specifications for developing an ADS-B monitoring system. It also assesses compliance of the existing ADS-B monitoring systems to the derived set of specifications using a mapping exercise. The system specifications derived in this paper may serve as a basis or minimum requirement for ANSPs or Original Equipment Manufacturers (OEMs) to develop an ADS-B monitoring system.

1. INTRODUCTION

1.1 Implementation of ADS-B Out is actively taking place in many regions. This involves voluntary efforts by the Air Navigation Service Providers (ANSPs), airline operators, regulators and manufacturers, as the global mandate is yet in place. However, some regions such as Australia have advanced in this effort.

1.2 In order to ensure that the implementations are operationally safe either towards mix-mode (radar and ADS-B) or sole operation of ADS-B in non-radar airspace, numerous safety assessment methods have already been in place by various ANSPs and researchers worldwide. According to ICAO, ADS-B shall only be used for Air Traffic Services provision, when the assessment proves that the ADS-B system's performance in a particular airspace exceeds the required level. Therefore it is compulsory to conduct the safety assessment before the system can be put operational. However, this is a one off process. The system performance may degrade over time due

to various causes. Hence periodic safety monitoring of the system is essential. This includes monitoring of ADS-B ground stations, avionics and performance level.

1.3 This paper also reviews effort from a number of ANSPs such as EUROCONTROL, Federal Aviation Administration (FAA), Airservices Australia, Hong Kong China Civil Aviation Department and Civil Aviation Authority of Singapore on developing and implementing ADS-B monitoring system. Each system's features are reviewed in detail. These systems do not take into account monitoring of the ADS-B system holistically. Neither a standardized guideline to develop the monitoring systems exists.

1.4 Based on the analysis of ADS-B system infrastructure/architecture and required performance parameters and systematic review of existing ADS Monitoring systems, a set of system specifications for developing a monitoring system for ADS-B is derived. The set of system specification takes into account a holistic view of the ADS-B system including ground station, avionics and performance. Finally, compliance of the reviewed systems to the derived specifications is assessed using a mapping exercise.

2. DISCUSSION

2.1 The proposed set of specifications is composed of five main modules; Ground Station, Equipage, Avionics, Performance Level and ATC Display. The Ground Station module has three sub-modules; namely Site Monitoring, Remote Control & Monitoring and Logistic Support Monitoring. Proposed functional elements in each module are provided in Table 1.

Table 1: Proposed set of System Specifications for developing an ADS-B Monitoring System

Proposed set of System Specifications for ADS-B Monitoring System
ADS-B Ground Station
Site Monitoring
▪ Receiver Sensitivity
▪ Antenna Cable
▪ GPS health
▪ Coverage check
▪ Probability of Detection
Remote Control & Monitoring (RCMS)
▪ CPU process operation
▪ Temperature
▪ Asterix output load
▪ Time synchronization
▪ GPS status
▪ Power status
▪ Site monitor status
Logistic Support Monitoring
▪ Records all failures, service outages and repair/return to service times
ADS-B Equipage Monitoring
▪ Update & maintain list of ADS-B equipped airframe details database
ADS-B avionics monitoring
▪ Track consistency
▪ Valid Flight ID

Proposed set of System Specifications for ADS-B Monitoring System
▪ Presence of NAC/NIC/NUC values
▪ Presence of geometric altitude
▪ Presence and correctness of velocity vector
▪ Correctness of 24 bit code
▪ Avionics configuration & connections
ADS-B performance monitoring
▪ Validity of NIC/NUC values
▪ Accuracy of ADS-B horizontal position (based on a reference sensor)
▪ Deviation between geometric and barometric height
▪ Compare ADS-B reports from two/more separate stations
▪ Monitor spread of the ADS-B position data
▪ Message interval rate
ATC Display monitoring
▪ Split track- ADS-B reported position might be off
▪ Coupling Failure-Wrong aircraft ID

2.2 Compliance Analysis

Table 2 tabulates the compliance analysis of the various ANSPs monitoring systems in section 2.1, to the set of proposed system specifications in section 6.

Table 2: Compliance Analysis

Performance Indicators	AirServices Australia	Federal Aviation Authority	EUROCONTROL	Civil Aviation Authority of Singapore (CAAS)	Civil Aviation Department Hong Kong (CAD HK)
ADS-B Ground Station					
Site Monitoring					
▪ Receiver Sensitivity	✓	✓			
▪ Antenna Cable	✓	✓			
▪ GPS health	✓	✓			
▪ Coverage check				✓	
▪ Probability of Detection				✓	
Remote Control & Monitoring (RCMS)					
▪ CPU process operation	✓	✓			
▪ Temperature	✓	✓			
▪ Asterix output load	✓	✓			
▪ Time synchronization	✓	✓			
▪ GPS status	✓	✓			

Performance Indicators	AirServices Australia	Federal Aviation Authority	EUROCONTROL	Civil Aviation Authority of Singapore (CAAS)	Civil Aviation Department Hong Kong (CAD HK)
▪ Power status	✓	✓			
▪ Site monitor status					
Logistic Support Monitoring					
▪ Records all failures, service outages and repair/return to service times	✓	✓			
ADS-B Equipage Monitoring					
▪ Update & maintain list of ADS-B equipped airframe details database	✓		✓		
ADS-B avionics monitoring					
▪ Track consistency	✓				
▪ Valid Flight ID	✓				✓
▪ Presence of NAC/NIC/NUC values	✓				
▪ Presence of geometric altitude	✓				
▪ Presence and correctness of velocity vector	✓				
▪ Correctness of 24 bit code	✓				
▪ Avionics configuration & connections					✓
ADS-B performance monitoring					
▪ Validity of NIC/NUC values				✓	✓
▪ Accuracy of ADS-B horizontal position (based on a reference sensor)			✓	✓	✓

Performance Indicators	AirServices Australia	Federal Aviation Authority	EUROCONTROL	Civil Aviation Authority of Singapore (CAAS)	Civil Aviation Department Hong Kong (CAD HK)
▪ Deviation between geometric and barometric height				✓	
▪ Compare ADS-B reports from two/more separate stations				✓	
▪ Monitor spread of the ADS-B position data				✓	
▪ Message interval rate					
ATC Display					
▪ Split track- ADS-B reported position might be off				✓	
▪ Coupling Failure- Wrong aircraft ID				✓	

2.3 The set of system specifications for an ADS-B monitoring system derived in this paper covers monitoring of every part of the ADS-B system including avionics, ground station and also performance level. In other words, it is looking at the system's holistic view to ensure safety. Therefore the author suggests that the holistic set of system specifications derived in this paper in Table 1, to be used as a basis in ICAO's guideline document to develop and implement ADS-B monitoring system. The mapping in Table 2 shows that, Airservices Australia's approach is the most compliant with the derived set of indicators. Federal Aviation Administration (FAA), Hong Kong China Civil Aviation Department and Civil Aviation Authority of Singapore have still to improve their current monitoring approach to ensure ADS-B safety for ATC operations.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) discuss any relevant matters as appropriate; and

c) Further, it is recommended that the holistic set of system specifications derived in this paper in Table 1, to be used as a basis in ICAO's guideline document to develop and implement an ADS-B monitoring system.

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