International Civil Aviation Organization

FIFTEENH MEETING OF THE ADS-B STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/15)

Bangkok, Thailand, 18 - 20 April 2016

Agenda Item 4: Review States' activities and interregional issues on implementation of ADS-B and multilateration

SAFETY CASE FOR ADS-B UNDER RADAR ENVIRONMENT

(Presented by Singapore)

SUMMARY

This paper shares with the Task Force the progress made by Singapore on the safety case for ADS-B under radar environment.

1. Introduction

1.1 Singapore planned to use the ADS-B data from Singapore and those neighbouring States sharing ADS-B data with Singapore, for air traffic control operations within the entire Singapore FIR.

1.2 As part of the safety management process, a safety case is required to assure the regulators that the use of ADS-B data for operations is sufficiently safe.

2. Challenges on the ADS-B Safety Case

2.1 When Singapore first worked on the safety case, the plan was to cater for the entire Singapore FIR, regardless whether the area is under radar or not. The main guidance documents used were the ICAO Cir326, EUROCAE ED-126 and EUROCAE ED-161.

2.2 According to ICAO Cir 326, there is no difference between the ADS-B applications in radar and non-radar environments. There is also no mention on the difference on whether the avionics should be of version 0 (i.e. RTCA DO-260), version 1(i.e. RTCA DO-260A) or version 2 (i.e. RTCA DO-260B). But there was a mention in Cir326 that States have to do their own additional assessment when using ADS-B in complex environment (which is usually radar environment).

2.3 According to EUROCAE ED-161, only version 1 and 2 avionics (i.e. RTCA DO-260A and DO-260B) are assessed to be able to support ADS-B in radar environment. There is, however, a statement that States who want to use ADS-B with version 0 avionics in radar environment will have to perform their own additional assessment. As most of the existing aircraft are equipped with version 0 avionics, Singapore has delayed the use of ADS-B within radar environment until the additional assessment is performed.

2.4 According to EUROCAE ED-126, ADS-B may be used under non-radar environment, regardless whether the ADS-B avionics are versions 0, 1 or 2. Singapore hence relied on EUROCAE ED-126 and ICAO Cir326 to complete its safety case for ADS-B application under the non-radar environment of the Singapore FIR.

2.5 Following the completion of the safety case for ADS-B application under non-radar environment, Singapore commenced ADS-B operations at parts of its non-radar area on 12 Dec 2013. Subsequently, Singapore continued to work on the safety case on ADS-B application under radar environment, which required an additional assessment.

3. Assessment on ADS-B under radar environment

Track Stability

3.1 Singapore worked with MITRE Asia Pacific Singapore (MAPS) to perform the assessment on ADS-B under radar environment. MITRE obtained three months of surveillance data from Singapore to perform the assessment. Based on statistical analysis and visual examination, it was found that the performance of the Multi-Sensor tracks or MST (which includes the fused ADS-B data) is as good as or better than the available radar tracks (known as Multi-Radar tracks or MRT).

3.2 When comparing MRT to the MST, the average distance between the positions reported by the MRT and the MST is about 0.1 NM. In instances where the distance between the positions reported by the MRT and the MST are large (>1NM), an overwhelming high percentage of these cases were due to the instabilities in the MRT.

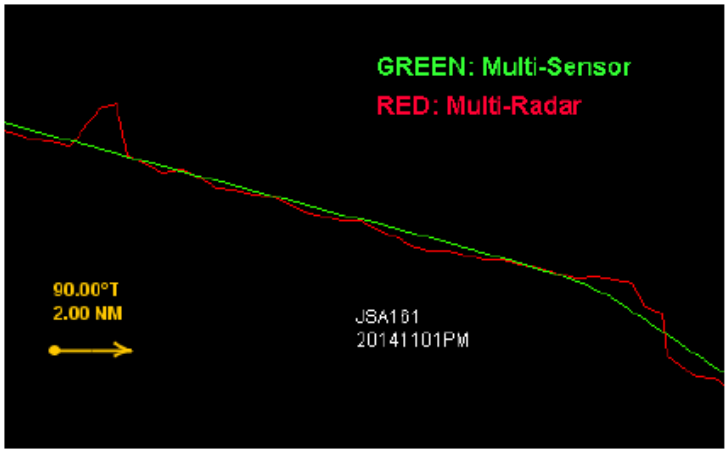

Fig 1: Difference in MST and MRT due to instability in MRT.

3.3 MST is more stable than MRT with less large jumps and abnormal sharp turns. If the current rate of MRT anomalies is operationally acceptable, the lower rate of MST anomalies should also be operationally acceptable.

	Multi-radar tracks	**Multi-sensor tracks**
Number of points	60,162,899	60,162,899
Number of two consecutive sharp turns	11,094	1,786
Number of three consecutive sharp turns	1,260	200

Table 1: Counts of sharp turns in MST compared with MRT

	Multi-radar tracks	Multi-sensor tracks
Number of points	60,162,899	60,162,899
Number of occurrence of two consecutive speed jumps	11,984	7,723

Table 2: Counts of abnormal speed changes in MST compared with MRT

3.4 The above demonstrated that the MST is 'not worse-off' than MRT

Hazard Analysis

3.5 The main hazards to be considered are the loss of ADS-B tracks and incorrect ADS-B tracks.

3.6 In the event of a sudden loss of ADS-B tracks, controllers can still rely on radars for air traffic control, which is the current mode of operation. In the event of incorrect ADS-B tracks (e.g. B787 problem), various safety nets such as split tracks or duplicate identity (the incorrect ADS-B tracks split from the radar track but carrying the same identity) alert and Route Adherent Monitoring, are available in the Air Traffic Management system to warn the controllers and controllers will then take appropriate actions.

3.7 Based on the above, the integration of ADS-B into the radar environment hardly introduces additional risks.

Other considerations

3.8 The data analysis also revealed the following:

a) 96% of the flights are equipped and tracked with ADS-B;
b) 99% of the ADS-B data has NUC of 5 and above;
c) 90% of the data has update rates faster than 3s, which is significantly better than radars.

3.9 Factors that can improve the quality of to the MST include: 1) the flights operating in a given airspace are equipped; and 2) the ADS-B data have sufficiently high NUC (i.e. NUC $\geq$ 5). These are met by points 'a' and 'b' in para 3.8. For ADS-B to effectively influence and improve track accuracy and stability, the update rate has to be sufficiently high, preferably higher than radars. This is met by point 'c' of para 3.8.

4. Safety Case

4.1 With the positive results of the assessment, the Singapore ANSP is preparing a preliminary safety case to use ADS-B under radar environment in the near future.

5. Conclusion

5.1 The meeting is invited to:

a) note the progress of Singapore on the safety case for the use of ADS-B under radar environment;

b) discuss and comment on the findings of the assessment.

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