International Civil Aviation Organization

EIGHTH MEETING OF SPECTRUM REVIEW WORKING GROUP (SRWG/8)

Bangkok, Thailand, 05 – 07 March 2024

Agenda Item 7: Frequency Interference in the Region

IMPROVING THE EFFICIENCY OF GNSS INTERFERENCE DETECTION AND LOCALIZATION BY ADS-B DATA

(Presented by China)

SUMMARY

This paper presents the application of Automatic Dependent Surveillance-Broadcast (ADS-B) downlink data in monitoring GNSS interference that affect aviation flights and locating the sources of interference. This technology has demonstrated impressive results in locating GNSS interference sources, resulting in a significant enhancement in the efficiency and accuracy of interference detection and localization.

1. INTRODUCTION

1.1 GNSS is one of the primary navigation systems for aviation flights. The loss of onboard GNSS signals poses a safety hazard to the use of air traffic management technologies such as ADS-B and PBN that rely on GNSS.

1.2 The GNSS signals are susceptible to the impact of harmful interference. Ongoing efforts have been directed towards the thorough identification of GNSS interference sources that pose a potential threat to air traffic in China. These efforts emphasize the utilization of cutting-edge technologies and innovative methodologies, including ADS-B Out data, to enhance the precision and efficiency of interference source detection and localization.

1.3 At present, the research of ADS-B Out data utilization shows great contribution to both the efficiency and accuracy of interference detection and localization in China.

2. DISCUSSION

2.1 According to the requirements for ADS-B position reporting in the ADS-B IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT, ADS-B relies on GNSS position information to provide surveillance capabilities.

2.2 In accordance with RTCA DO-260/ RTCA DO-260A/ RTCA DO-260B MOPS for 1090 MHz ADS-B, the ADS-B Out data includes quality factors such as Navigation Uncertain Category for Position (NUCp)， Navigation Integrity Category (NIC), Navigation Accuracy Category for Position (NACp), Surveillance Integrity Level (SIL) that indicate the integrity and accuracy of horizontal position.

2.3 Quality factors vary when the onboard GNSS signal is interfered.

2.3.1 During flight without interference, the values of quality factors are positive, which are consistent and reliable. However, the disturbance of data transmission occurred when the onboard GNSS signal is interfered, which may result in significant quality factors drop or complete cessation. The quality factors of the ADS-B Out data promptly return to normal once the flight passed the interfered zone.

2.3.2 The following figure shows a flight trajectory of ADS-B Out data when the onboard GNSS is interfered. The flight trajectory has been divided into several parts caused by interference.

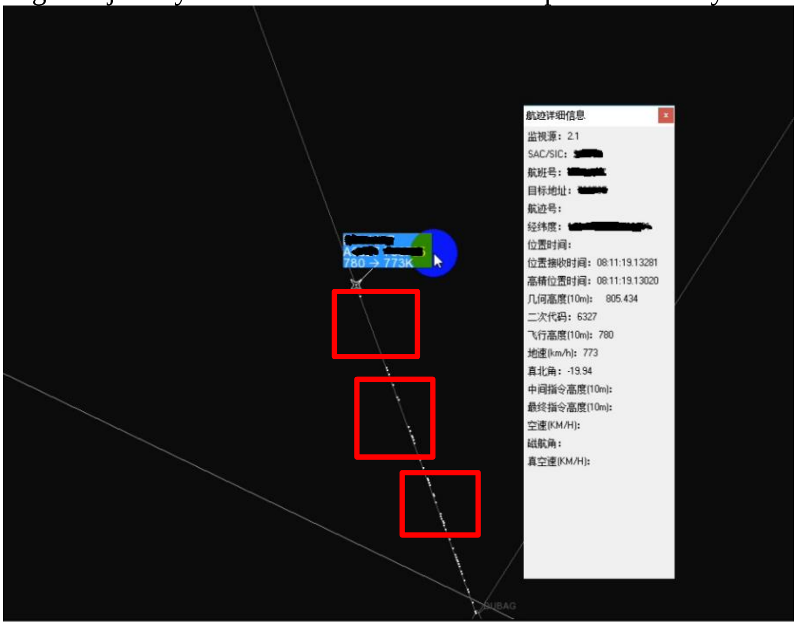

Figure 1 Partial ADS-B trajectory of an aircraft

2.3.3 Taking quality factor NUCp as an example， according to the frames of ADS-B Out data (UTC 08:11:00-08:11:17), the data frame shows normal ADS-B tracks clearly with a consistent NUCp value 7 before UTC 08:11:01. However, during the subsequent interference period (UTC 08:11:02-08:11:17), the ADS-B track's NUCp value abruptly dropped to 0 (UTC 08:11:02-08:11:03) followed by a complete halt in data transmission (UTC 08:11:03-08:11:17). After UTC 08:11:17, the ADS-B data promptly resumed its normal transmission, with the NUCp value returning to value 7.

Table 1 ADS-B data frames for the specified time period (UTC 08:11:00-08:11:17)

Lat	Lon	Nucp	flightlevel	Groundspeed	trackangle	time
34.*****	113.****	7	256	213.9792	-19.9622	08:11:00
34.*****	113.****	7	256	213.9792	-19.9622	08:11:00
34.*****	113.****	7	256	213.9792	-19.9622	08:11:01
34.*****	113.****	7	256	213.9792	-19.9622	08:11:01
34.*****	113.****	7	256	214.6775	-20.0391	08:11:02
34.*****	113.****	0	256	214.6575	-20.0391	08:11:02
34.*****	113.****	0	256	214.6575	-20.0391	08:11:03
34.*****	113.****	7	256	214.4314	-19.9127	08:11:17

2.4 ADS-B data exhibiting these specific characteristics is extracted to accurately determine the precise start and end times, along with the corresponding longitude and latitude, of each aircraft's GNSS signal loss. To some extent, those extracted data above shows possible relationships with the interference occurred in the same area. To further determine the accuracy of interference, massive ADS-B data analysis is required.

2.5 By using the heatmap technology and big data analysis, the spatial extent and frequency of GNSS interference on a geographic map are depicted in Fig2 which provides a comprehensive understanding of the affected areas. The red, green, and blue color-coding scheme is used to visually represent and differentiate the intensity of airborne GNSS interference frequencies within a fixed area. The red coverage indicates areas where interferences happened frequently, while the green coverage shows less frequency of the interference occurrences, only a few interferences supposed to be found in the blue coverage.

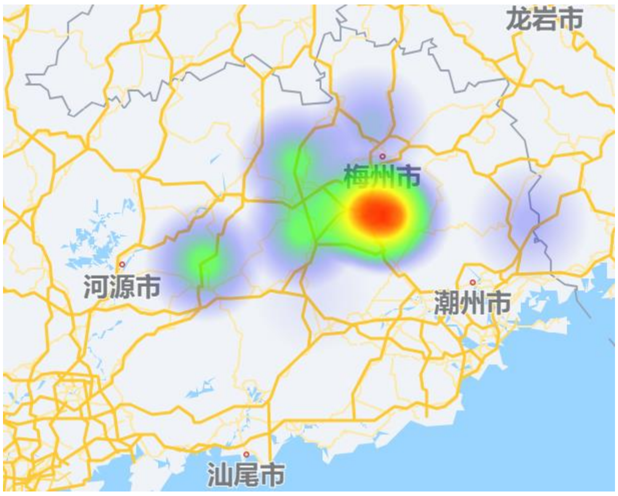

Figure 2 GNSS interference schematic heatmap

2.6 Compared with the traditional interference detection and localization method, the utilization of this new technology shows contribution to narrow down the scope of investigation area by taking the more accurate location and time information into consideration. This technology has been applied in GNSS signal protective monitoring and interference detection in China, and achieved positive results.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matter as appropriate

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