



WORKING PAPER

ASSEMBLY — 41ST SESSION

TECHNICAL COMMISSION

Agenda Item 31: Aviation Safety and Air Navigation Standardization

MITIGATION OF GNSS VULNERABILITIES

(Presented by Japan)

EXECUTIVE SUMMARY

ICAO Global Navigation Satellite System (GNSS) Manual (GNSS Manual: Doc9849) includes the concept of GNSS monitoring, GNSS service status notification and anomaly reporting. The Network Performance Assessment Center (NPAC) of Japan Civil Aviation Bureau (JCAB), which was established in 2020, performs GNSS monitoring and performance assessment in Fukuoka FIR, and issues a NOTAM to notify GNSS service status. NPAC reported to the ICAO about a case of GNSS anomaly that had impacted aircraft operations in the oceanic airspace in Fukuoka FIR. Japan actively contributes to ICAO discussions on the Alternative Position Navigation and Timing (APNT) strategy to maintain air navigation services to the maximum extent possible in the event of a GNSS signal outage.

Action: The Assembly is invited to:

- a) note Japan's activities of GNSS monitoring and performance assessment to mitigate GNSS vulnerabilities and to ensure the safety of air services;
- b) encourage Member States to recognize the importance of monitoring and reporting of GNSS radio frequency interference (RFI); and
- c) encourage Member States to support ICAO's activities to discuss the Alternative Position Navigation and Timing (APNT) strategy to maintain air navigation services to the maximum extent possible in the event of a GNSS signal outage.

<i>Strategic Objectives:</i>	This working paper relates to the Safety and Air Navigation Capacity and Efficiency Strategic Objectives.
<i>Financial implications:</i>	
<i>References:</i>	Annex 10 - <i>Aeronautical Telecommunications, Volume I - Radio Navigation Aids</i> Doc 9849, <i>ICAO Global Navigation Satellite System (GNSS) Manual</i>

1. INTRODUCTION

1.1 Global Navigation Satellite System (GNSS) is the core technology that has led to the development of Performance Based Navigation (PBN). It is also the basis for future improvements in navigation services, which is described in *ICAO Global Air Navigation Plan* (GANP, Doc 9750). GNSS is already the foundation of automatic dependent surveillance-broadcast (ADS-B) and automatic dependent surveillance-contract (ADS-C) which may lead to reduced separation standards.

1.2 GNSS signals from satellites are very weak at the receiver antenna, so are vulnerable to interference. *ICAO Global Navigation Satellite System (GNSS) Manual* (Doc 9849) includes the mitigation strategy to both ensure the safety and regularity of air services and discourage those who would consider disrupting aircraft operations.

1.3 The need for an alternative position, navigation and timing (APNT) strategy has been identified as a mitigation strategy.

2. DISCUSSION

2.1 Network Performance Assessment Center (NPAC) in Japan

2.1.1 Japan Civil Aviation Bureau (JCAB) established the Network Performance Assessment Center (NPAC) in 2020 for the mission of centrally monitoring, analyzing and assessing service levels of CNS as the core of CNS performance management, which is an important key to realizing performance based operation (PBO).

2.1.2 NPAC collects GNSS signals and provides the following services to users:

- a) GNSS performance prediction service for ABAS and SBAS;
- b) GNSS performance monitoring service for aircrafts that use GNSS; and
- c) GNSS performance analysis and evaluation service for users who use GNSS.

2.1.3 These services are compliant with Annex 10 — *Aeronautical Telecommunications*, Volume 1 — *Radio Navigation Aids*, Attachment D Section 10.11.12 Doc 9849, Chapter 7.

2.2 A case of GNSS signal outage in the oceanic airspace in Fukuoka flight information region (FIR)

2.2.1 NPAC detected 44 cases of the degradation of GNSS performance near the south eastern offshore of Hokkaido on multiple routes to the United States from September 22 to October 12 in 2021. NPAC assessed the impact of this event, provided the relevant information to operators and investigated the cause.

- a) Recognizing a FOM message*, which is included in ADS-C messages from aircraft, indicated value “4”, an alarm went off from ATC oceanic control system. Simultaneously, aircrafts reported that EICAS Advisory Message of ADS-B OUT had also occurred.

*The FOM value is an index related to position accuracy and 5 to 7 in normal condition.

- b) Comparing ADS-C with ADS-B information acquired by the GNSS performance monitoring service and understanding the affected areas on GPS and ADS-B. As a result of that, we found that the outbreaks were concentrated in a specific area of NOPAC (R220) (Figures 1 and 2).

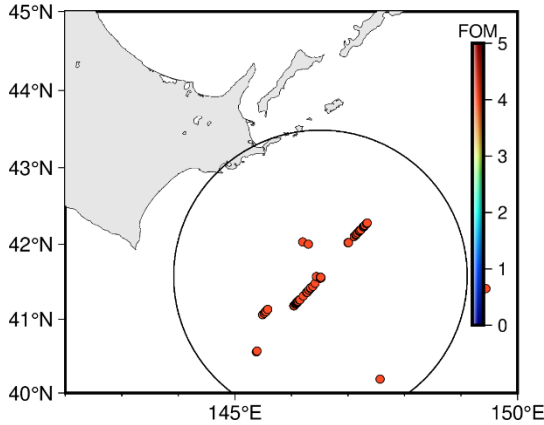


Figure1. ADS-C degradation areas

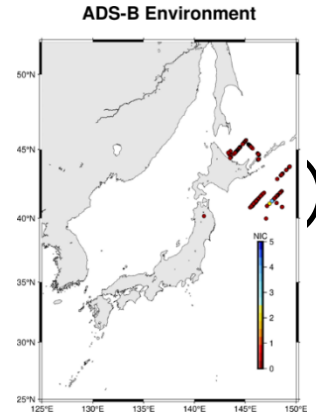


Figure 2. ADS-B degradation areas

- c) Confirming that GPS health status and satellite placement from the GNSS performance monitor was in good condition.
- d) Confirming that there were no magnetic storms and radio bursts by space weather information.
- e) Requesting relevant authorities for cooperation. In consequence, the Regional Bureau of Telecommunications confirmed there is no noise found on land and a Japan Coast Guard helicopter found GPS reception problems.
- f) Asking the Flight Inspector to check the GPS signal but GPS reception problems were not confirmed as that problem had been already converged at that time.
- g) After above actions, NPAC issued the following NOTAM from October 14 to November 30.

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 GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM RADIUS
 CENTERED ON 415457.90N 1465133.04E (WaypointName) ON THE FUKUOKA FIR.
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Note. — Issuing NOTAM of GPS performance degradation is an effective way to indicate “position coordinate of center location or Waypoint” and “distance from center location” for pilots so that ND screen can display the affected areas. Therefore, it can not only provide visual recognition of that affected areas in which GNSS or ADS-B may not working normally to pilots in advance but also contribute to preventing unnecessary actions, misoperations and enhancing safety.

2.2.2 Taking this event into consideration, JCAB will focus on grasping the situation and solving the problem immediately as well as providing helpful information as follows:

- a) obtaining information from the operator as soon as possible when encountering GNSS signal outage;
- b) collecting various data in real time and sharing the information with relevant authorities and organizations;
- c) determining the scope and extent of the impact and working to resolve the problem as soon as possible;
- d) considering rapid issuance of procedures from the reporting of radio frequency interference (RFI) s to the issuance of NOTAM; and
- e) providing NOTAM in an operationally effective manner.

2.3 **ICAO discussions on the APNT strategy**

2.3.1 GNSS enables PBN and provides navigation guidance for all phases of flight, from en-route through to precision approach. The need for an APNT strategy with the goal of maintaining services to the maximum extent possible in the event of a GNSS signal outage have been identified.

2.3.2 Furthermore, GNSS provides a precise time reference that is used to synchronize ground systems, onboard equipment, communication networks and operations. It is expected that having a system-wide time reference will become more critical in the future operational context (e.g. 4D trajectory-based operations). An alternative time source to GNSS is required to reduce the potential for interruption.

2.3.3 Japan actively contributes to ICAO discussions on the APNT strategy.

3. **CONCLUSION**

3.1 The Network Performance Assessment Center (NPAC) of JCAB, which was established in 2020, performs GNSS monitoring and performance assessment in Fukuoka FIR, and issues a NOTAM to notify GNSS service status to ensure the safety of air services.

3.2 It is important to have a mechanism of monitoring and reporting of GNSS RFI for relevant airspace users and air traffic controllers to be promptly and appropriately informed and to mitigate the impact on aircraft operations.

3.3 Japan actively contributes to ICAO discussions on the APNT strategy to maintain air navigation services to the maximum extent possible in the event of a GNSS signal outage.