



ICAO

International Civil Aviation Organization

**Twenty Ninth Meeting of the Communications/
Navigation and Surveillance Sub-group (CNS SG/29)
of APANPIRG**

Bangkok, Thailand, 16-20 June 2025

Agenda Item 7: Navigation

7.2 GNSS Interference and Mitigating Measures

RECOMMENDATIONS OF RADIO NAVIGATION SYMPOSIUM

(Presented by the Secretariat)

SUMMARY

The paper presents the recommendations emanated from the ICAO APAC Radio Navigation Symposium, and update on relevant ICAO actions related to GNSS RFI.

1. INTRODUCTION

1.1 The 2nd ICAO Radio Navigation Symposium was held in New Delhi, India, from 07-09 April 2025. The theme of the Symposium was GNSS RFI: Collectively Bridging Gaps and Shaping the Path Forward.

1.2 The Symposium evaluated the efficiency and effectiveness of current mitigation measures and received updates from States and other stakeholders regarding the impact of GNSS RFI on civil aviation operations. The objective was to identify potential gaps; technological, procedural, or human-centric, that could be addressed to further enhance safety and resilience.

2. DISCUSSION

ICAO APAC Radio Navigation Symposium Recommendations

2.1 The meeting may wish to recall that ICAO in collaboration with ITU and IMO has recently issued a joint statement on the protection of the radio navigation satellite service from harmful interference.

2.2 The ICAO/ITU/IMO statement called for five (5) key actions and urgently called on their respective Member States to:

- a) protect the GNSS from transmissions that can adversely cause harmful interference degrading, interrupting or misleading signals used for civilian and humanitarian purposes;
- b) reinforce resilience of the systems which rely on GNSS for navigation, positioning and timing (PNT) in relation to this type of interference;

- c) retain sufficient conventional navigation infrastructure for contingency support in case of GNSS outages and misleading signals, and develop mitigation techniques for loss of services;
- d) increase collaboration between radio regulatory, civil aviation, maritime, defense and enforcement authorities; and
- e) report cases of harmful interference affecting GNSS to the appropriate telecommunication, aeronautical and maritime authorities, and to the ITU Radiocommunications Bureau, to enable the monitoring of the situation.

2.3 The Symposium reaffirmed the significance of the ICAO/ITU/IMO Joint Statement and outlined a set of recommended actions and best practices as at **Appendix A** to this paper.

Reporting GNSS RFI occurrences to ITU through ICAO

2.4 As part of ICAO's engagement with ITU, the existing GNSS RFI reporting procedure between the two agencies has been reviewed to explore potential enhancements. A new account for ICAO will be created on ITU's online tool, the Satellite Interference Reporting and Resolution System (SIRRS), to facilitate reporting and improve the tracking of cases where analysis determines a significant impact on air navigation with an international scope. In such cases, ICAO will promptly transmit the results to ITU.

2.5 Additionally, the system facilitates keeping ICAO informed about the progress in applying the procedure outlined in Article 15, Section VI, of the Radio Regulations for cases of harmful interference to GNSS identified by ICAO. ICAO will also be notified as soon as the interference incident is deemed resolved.

GNSS RFI- related NOTAM

2.6 The 14th Air Navigation Conference (AN-CONF/14) acknowledged the absence of a standardized NOTAM Q-code for GNSS interference events and subsequently requested ICAO to develop additional NOTAM codes to enhance consistency and operational efficiency.

2.7 GNSS RFI-related NOTAMs contain varying Q-Codes and inconsistent significations. IATA reported that eighteen (18) different Q-Codes are used worldwide, rendering filtering mechanisms ineffective. Furthermore, it has been noted that different text is used for the Item E like "GPS Unreliable," "GPS Jamming," "GPS signal interference," "GNSS interference,". This diversity creates challenges for operators attempting to identify and search in NOTAMs for information about GNSS interference events.

2.8 Two (2) Q-codes and recommended Item E text have been identified by ICAO navigation systems panel (NSP) as follow and will be incorporated in relevant ICAO documents. Furthermore, guidance on how pilots should interpret NOTAM is being developed

- i) the code (LF) should be associated with an interference event affecting the GNSS service and assign the NOTAM code "GA" or "GW" in cases where interference is confirmed to be jamming or when a State is unable to distinguish between jamming and spoofing or remains uncertain given that both often occur simultaneously.

- ii) new code related to spoofing should be created and associate it with the GNSS services- Notam code "GA" or "GW", as Spoofing can lead to more severe

consequences; therefore, it is essential to have a specific Q-code dedicated to spoofing;

iii) recommended NOTAM Text for Jamming “*GNSS may be unreliable within.*”
And for spoofing “*GNSS may be misleading within.*”

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the draft set of recommendations of the ICAO APAC Radio Navigation Symposium;
- b) take necessary follow-up actions; and
- c) discuss any relevant matter as appropriate

Outcome of the ICAO APAC Radio Navigation Symposium

New Delhi - India

7-9 April 2025

The ICAO APAC Radio Navigation Symposium reviewed existing Global Navigation Satellite System (GNSS) Radio Frequency Interference (RFI) mitigation strategies with the objective to identify gaps and offer insights into actions required to address the evolving challenges posed by GNSS RFI in terms of technological, procedural, and human-centric aspects of mitigation.

The Symposium reaffirmed the significance of the ICAO/ITU/IMO Joint Statement on the Protection of Radio Navigation Satellite Service (RNSS) from Harmful Interference and outlined a set of recommended actions and best practices to achieve the following objectives:

Objective 1: Minimize RFI occurrence through effective regulatory measures and enforcement.

1.1 States should:

1.1.1 ensure sufficient aviation representation in delegations of States to ITU WRC-27 preparatory meetings, to progress future improvements to ITU Resolution 676 and to ensure that future WRC updates of Radio Regulations do not adversely impact GNSS;

1.1.2 improve coordination with the military by facilitating the sharing of information on RFI testing and any relevant activities such as Counter-UAS operations;

1.1.3 possess the necessary technical capabilities to detect GNSS RFI, conduct Radio Frequency (RF) measurements, and geolocate the source of the RFI; and

1.1.4 utilise the ITU RR15 escalation procedure to ensure proper resolution for incidents of RFI with cross-border impact that cannot be solved nationally or internationally through routine procedures; States may also submit reports to the respective ICAO Regional Office, which can then forward those reports to the ITU Satellite Interference Reporting and Resolution System (SIRRS) for further action.

1.2 **Spectrum authorities** of States need to step up enforcement against GNSS jamming transmitters (GPS Jammers) while educating the general public about their illegality, without unintentionally exposing system vulnerabilities. Law enforcement should monitor and take action against online marketplaces selling such devices. Additionally, making jammer ownership illegal will help authorities to confiscate them more effectively and strengthen regulatory control; and

1.3 All stakeholders need to contribute to the development of further ICAO guidance to strengthen the link between operator reports, air navigation services provider (ANSP) confirmation,

and spectrum regulator engagement. The coordination and reporting processes must be efficient and simplified to ensure timely and effective management.

Objective 2: Support Air Crews in Operational Risk Reduction and Management

2.1 **ICAO should** consider the necessity of standardized radiotelephony phraseologies for specific scenarios. Establishing clear, standardized communications in these situations could greatly benefit both pilots and air traffic controllers, ensuring accurate and efficient responses;

2.2. Airlines and aircraft manufacturers should:

2.2.1 Integrate GNSS RFI factors into fuel and alternate planning to ensure contingency measures are in place for potential navigation disruptions, including refining dispatch decisions based on aircraft equipment and ensuring the aircraft's capabilities match the expected interference conditions;

2.2.2 ensure pilots maintain proficiency in conventional navigation methods, supporting operational resilience in GNSS-degraded environments. This includes:

2.2.2.1 providing training to ensure pilots can operate effectively using conventional procedures, enabling them to fly without reliance on GNSS when necessary.

2.2.2.2 encouraging position cross-checking using VOR radials for situational awareness; and

2.2.2.3 ensuring a full IRS alignment before departure if the aircraft experienced GNSS RFI during the previous flight, as indicated in the aircraft journey log;

2.2.3 clarify and streamline RFI reporting, potentially through EFB integration, to facilitate timely incident reporting;

2.2.4 ensure pilots understand space weather advisories, providing clear guidance on how to interpret and respond to relevant information; and

2.3 The symposium acknowledged IATA's initiative in providing the Turbulence Aware platform to support airline information sharing and encouraged the development of similar initiatives for RFI information exchange.

Objective 3: Ensure effective support to flight crews while maintaining safety

3.1 In line with ICAO provisions, States should:

3.1.1 ensure ATC readiness to provide radar vectors when requested, navigational assistance, and clock checks, and clearly define circumstances under which ATC may refuse vectoring;

3.1.2 prioritize suitable staffing levels, sector workload planning, and continuous monitoring of compliance with clearances to ensure effective air traffic management;

3.1.3 ensure comprehensive ATCO training and awareness programs focusing on response to abnormal situations and clearance deviations, equipping controllers with the necessary skills to handle unexpected events effectively;

3.1.5 enhance pilot awareness by providing near real-time GNSS RFI “Weather” updates via Electronic Flight Bag (EFB), aeronautical terminal information service (ATIS), or other channels, to support informed decision-making.

Objective 4: Ensure suitable CNS capabilities are available as required

4.1 States should:

4.1.1 ensure timely and effective communication regarding RFI incidents, warning could be issued via NOTAM, AIP (Aeronautical Information Publication), and/or ATIS as appropriate;

4.1.2 ensure ATSEP personnel receive training/awareness program on GNSS RFI detection, mitigation, and reporting. Simulation exercises and collaborative awareness programs could be implemented to enhance response capabilities and operational resilience;

4.1.3 establish a resilient operational network (RON) by ensuring availability of sufficient navigation infrastructure to support continuous Performance-Based Navigation (PBN) operations and by facilitating positional awareness through maintenance of a VOR/DME Network for reliable cross-checking;

4.1.5 implement GNSS jamming and spoofing monitoring using ADS-B Out (ground based or space-based) or wide area multilateration (WAM).

Objective 5: Strengthen capabilities to maintain PBN and optimize operational efficiency by leveraging current technology

5.1 Aircraft and avionics manufacturers should:

5.1.1 avoid cross-contamination of aircraft/avionics sensors due to GNSS RFI;

5.1.2 augment GNSS time with precision time sources to improve resilience and mitigate disruptions;

5.1.3 enhance GNSS robustness with rapidly deployable Multi-Mode Receivers (MMR) and strategic system upgrades; and

5.1.4 enable advanced RNP operations using DME through improvements to multi-DME navigation and clarifying the DME interrogator scanning and selection criteria.

5.2 States should:

5.2.1 implement spoofing monitors in surveillance trackers while conducting a comprehensive ADS-B to SSR/WAM comparison; and

5.2.2 optimise DME transponder network planning and coverage.

6: Achieve Robust Positioning, Navigation, and Timing (PNT) through long-term C-PNT development

6.1 States should:

6.1.1 conduct a comprehensive cyber risk assessment for all CNS/ATM systems, particularly space-based systems, and implement adequate mitigation measures; and

6.1.2 enhance GNSS resilience and improve cybersecurity defenses through standardization and implementation of advanced technical improvements such as authentication mechanisms, improved antennas (CRPA) for robust interference mitigation and enhanced signal reception, RFI detection systems and downlink enhancements to identify and counter RFI in real time and ensure secure and reliable data transmission across GNSS networks.

6.2 ICAO should:

6.2.1 enhance L-Band spectrum utilization through standardization of enhanced DME (eDME) and assess other candidate PNT solutions;

6.2.2 establish a balanced CNS evolution roadmap, whereas ground, air, and space capabilities should work collaboratively within a unified framework that prioritizes spectrum efficiency as the fundamental driver; and

6.2.3 emphasize the core objective of the Integrated CNS, transforming common mode weaknesses into strengths through smart integration while maintaining independence across ground, air, and space systems.