International Civil Aviation Organization

MIDANPIRG Communication, Navigation and Surveillance Sub-Group (CNS SG/15)

(Doha, Qatar, 11 – 14 May 2026)

Agenda Item 3: Navigation issues

MITIGATING GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) VULNERABILITIES

(Presented by Sultanate of Oman)

Summary

This paper builds on CNS SG/14-WP/9 presented by the Sultanate of Oman and follows up on the outcomes of Agenda Item 3, as reflected in the CNS SG/14 meeting report. It highlights the critical importance to recognize the GNSS Vulnerabilities at the international, regional, and national levels. Furthermore, this Working Paper underscores the need to review and update ICAO MID Doc. 011 "Guidance on GNSS implementation in the MID Region and RASG-MID RSA-14 "Guidance Material Related to GNSS Vulnerabilities". Additionally, this paper presents the recent activities taken by the Sultanate of Oman regarding GNSS Vulnerabilities.

Action by the meeting is at paragraph 3.

REFERENCES

- ICAO MID CNS SG/14 – WP/9
- ICAO Annex 10, V I
- Doc 9849 "Global Navigation Satellite System (GNSS) Manual"
- Report of MIDANPIRG/22 & RASG-MID/12 (Doha, Qatar, 4 – 8 May 2025)
- RASG-MID SAFETY ADVISORY – 14 (RSA-14)
- 42nd session of ICAO assembly and resolution 42-8/C
- AN-CONF/14 Report
- Recommended Actions from 2nd ICAO Radio Navigation Symposium (7-9 April 2025, India)
- Recommendations from the ICAO EUR/MID Radio Navigation Symposium (6 to 8 February 2024)
- Joint ICAO EUR/NAT-MID Workshop on GNSS RFI, 18-20 November 2025, Doha, Qatar

1. INTRODUCTION

1.1 GNSS supports positioning, navigation and timing (PNT) applications. GNSS is the foundation of Performance Based Navigation (PBN), Automatic Dependent Surveillance – Broadcast (ADS-B) and Automatic Dependent Surveillance – Contract (ADS-C). GNSS also provides a common time reference used to synchronize systems, avionics, communication networks and operations, and supports a wide range of non-aviation applications.

1.2 GNSS signals from satellites are very weak at the receiver antenna, and so GNSS signals are vulnerable to radio frequency interference. ICAO Global Navigation Satellite System (GNSS) Manual (Doc 9849) includes the mitigation strategy.

1.3 The increasing frequency and geographic spread of GNSS RFI, particularly in the MID Region experiencing geopolitical instability, has introduced a significant threat to the reliability and integrity of satellite-based services.

2. DISCUSSION

2.1 Dependence on GNSS is increasing, as GNSS is used for an ever-expanding range of safety, security, business and policy critical applications. GNSS functionality is being embedded into many parts of critical infrastructures. Aviation is now dependent on uninterrupted access to GNSS positioning, navigation and timing (PNT) services. Aviation relies heavily on GNSS for area navigation and precision approach. Aircraft avionics such as the Flight Management Systems (FMS) require GNSS timing for a large number of onboard functions including Terrain Avoidance Warning System (TAWS). Onboard avionics are highly integrated into commercial aircraft and are very dependent on GNSS timing data. At the same time, GNSS vulnerabilities are being exposed and threats to denial of GNSS services are increasing.

2.2 GNSS Vulnerability has been identified as a safety issue and one of the main challenges impeding the implementation of PBN in the MID Region.

2.3 With the increasing dependence on GNSS, it is important that GNSS vulnerabilities be properly addressed.

2.4 There are several types of threat that can interfere with a GNSS receiver's ability to receive and process GNSS signals, giving rise to inaccurate readings, or no reading at all, such as radio frequency interference, space weather induced ionospheric interference, solar storm, jamming and spoofing. The disruption of GNSS, either performance degradation in terms of accuracy, availability and integrity or a complete shutdown of the system, has a big consequence in critical infrastructure.

2.5 To bring attention to the critical issue of GNSS interference, and to foster discussions on the management of GNSS vulnerabilities and potential mitigation measures against GNSS RFI, ICAO convened the ICAO EUR/MID Regional Navigation Symposium from 6 to 8 February 2024 in Antalya, Turkey. One important outcome of this symposium is the list of recommendations regarding Stakeholders' continued efforts towards ensuring safe, reliable, and resilient air navigation. Additionally, Joint ICAO EUR/NAT-MID Workshop on GNSS RFI has been convened from 18 to 20 November 2025 in Doha, Qatar. Furthermore, ICAO APAC Radio Navigation Symposium has been held in New Delhi, India from 7 to 9 April 2025 which concluded a list of important recommendations.

2.6 At the regional level, ICAO MID Regional Office has endorsed the following decisions/conclusions during the last MIDANPIRG 22/RASG 12 (Doha, Qatar, 4 – 8 May 2025), as follows:

i. PIRG/RASG DECISION 3: That, the amended RASG-MID Safety Advisory 14 (RSA-14) is endorsed.

ii. PIRG/RASG CONCLUSION 2: CONSOLIDATED REGIONAL APPROACH TO GNSS RFI MANAGEMENT.

2.7 At the regional level, ICAO MID Regional Office has published ICAO MIDANPIRG Doc. 011 titled "GUIDANCE ON GNSS IMPLEMENTATION IN THE MID REGION", edition December, 2018. This guidance includes some mitigation strategies to GNSS vulnerabilities in Part III: GNSS Vulnerabilities.

2.8 Recommendation: revise and update ICAO MID Doc. 011 "GUIDANCE ON GNSS IMPLEMENTATION IN THE MID REGION" to consider the following:

i. Latest amendment of ICAO Annex 10, Volume I;

ii. Assembly Resolution 42-8/C;

iii. AN-Conf/14 recommendation 2.2/2;

iv. Latest revision of RASG-MID Safety Advisory 14 (RSA-14);

v. Recommendations from the ICAO EUR/MID Radio Navigation Symposium (6 to 8 February 2024);

vi. Recommended actions and lessons learned emanate from the 2nd ICAO Radio Navigation Symposium (7-9 April 2025, New Delhi, India); and

vii. Latest update to Global Air Navigation Plan.

2.9 Furthermore, at the regional level, ICAO MID Regional Office has published RASG-MID RSA-14 titled "Guidance Material Related to GNSS Vulnerabilities", Second Edition – October 2024. This guidance includes risk assessment methodology at **Appendix B** as long as some mitigation strategies to GNSS vulnerabilities.

2.10 Recommendation: revise and update RASG-MID RSA-14 "Guidance Material Related to GNSS Vulnerabilities" to consider the recent updates at the global and regional levels in general and Appendix C "GNSS Anomaly for the Period January 2015- June 2018" in particular.

2.11 ICAO MID CNS SG/14 meeting agreed on the Oman proposal to explore the need to review the ICAO MID Doc. 011 to incorporate the latest developments from ICAO Annex 10, the RASG-MID Safety Advisory 14 (RSA-14), and the 2024 EUR/MID Radio Navigation Symposium recommendations.

2.12 At the national level, the following actions have been taken:

- Civil Aviation Authority of Oman has published Civil Aviation Safety Bulleting No. 2024-01 on 13th August 2024 regarding GNSS Outage and alternatives leading to Navigation-Surveillance Degradation. This Safety Bulletin is applicable to all stakeholders to be aware of the potential safety and capacity impacts of GNSS interference, jamming, and spoofing. Furthermore, this safety bulleting provides guidance, information and recommendation to the relevant stakeholders. The Safety Bulletin is available on the link: https://www.caa.gov.om/upload/files/CASB%202024-01%20GNSS%20Jamming%20or%20Spoofing%20Issue%202%20Rev.0%20130824%20(2).pdf.
- Ensure that Instrument Landing Systems (ILS), Distance Measuring Equipment (DME) stations and Very High Frequency Omnidirectional Range (VOR) stations are made available and kept operational as required;
- Continue to collect and analysis of GNSS RFI reports from Airlines and Air Traffic service provider.
- Issuance of NOTAM A0249/26 regarding GNSS RFI

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information mentioned in this working paper;
b) agree on the need to update the following documents and to discuss the appropriate mechanism for their revision and maintenance, as appropriate:
i) ICAO MID Doc. 011 “Guidance on GNSS implementation in the MID region”, as highlighted in 2.8.
ii) RASG-MID RSA-14 “Guidance Material Related to GNSS Vulnerabilities”, as highlighted in 2.10.
