International Civil Aviation Organization

Eighth Meeting of the Performance Based Navigation Sub-Group (PBN SG/8)

(Doha, Qatar, 12 - 13 December 2023)

Agenda Item 4: PBN Planning and Implementation in the MID Region

GNSS DISRUPTION IN MID

(Presented by the secretariat)

SUMMARY

Aviation worldwide, including ICAO member States, recognizes the reliance on Performance Based Navigation (PBN) operations that require accurate and dependable space-based Positioning, Navigation and Timing (PNT) services delivered by GNSS as noted by the ICAO Assembly in the referenced Assembly Resolutions. Disruptions to GNSS result in compromised safety, inefficiency and financial losses.

Further to the increasing frequency of GNSS disruption events around the globe and in particular in MID Region, this working paper outlines the safety of flight risks related to the GNSS spoofing and jamming activities reported by various AOs and international organizations and recommends a number of mitigation measures for ANSPs and CAAs.

Action by the meeting is at paragraph 3.

REFERENCES

- Assembly Resolution A41-8, Appendix C
- ICAO Doc 9849-GNSS Manual-4th edition (unedited)-2023
- RASG-MID Safety Advisory (RSA-14) on GNSS Vulnerabilities

1. INTRODUCTION

1.1 The global navigation satellite system (commonly referred to as GNSS) is a key technology to provide communications, navigation, surveillance (CNS) and air traffic management (ATM) services worldwide. GNSS is essential for the implementation of Performance Based Navigation (PBN) and Automatic Dependent Surveillance-Broadcast (ADS-B) which are bringing substantial safety, capacity and environmental benefits to ATM. It is also used in safety-related systems and provides the time reference to synchronize systems (e.g. communication networks) and operations in ATM. However, GNSS is vulnerable to radio frequency interference (RFI) such as jamming, and cyber-attacks (e.g. spoofing). Therefore, it is essential to mitigate GNSS vulnerabilities adequately.

1.2 Modern aircraft are reliant on the signals from GNSS to feed their different systems. In recent months, however, potential spoofing activities reported by various civil air operators increased safety of flight risks to civil aviation operations due to potential loss of aircraft situational awareness and increased pilot and air traffic control (ATC) workload issues, which may have an impact on aviation safety.

1.3 This working paper outlines the safety of flight risks related to the GNSS spoofing activities reported by various AOs and international organizations in several FIRs in MID Region and recommends a number of mitigation measures for ANSPs and CAAs.

2. DISCUSSION

GPS spoofing

2.1 Since August 2023, a new variety of GPS spoofing is being reported by crews, where the signal is sufficiently strong and of sufficient integrity to feed the aircraft systems. The result is that within minutes, the IRS becomes unusable, and in many cases, all navigation capability on board is lost. Flight Crews have had to ask ATC for radar vectors. Given the types of airspace that these events are occurring in, this presents significant risk.

2.2 Spoofing is the broadcast of GNSS-like signals that cause avionics to calculate erroneous positions and provide false guidance.

2.3 The Ops Group, an organization made up of international flight operators, sounded the alarm of GPS spoofing in various locations in the MID Region. The spoofings of the GNSS system have been reported, in particular, in the following FIRs:

- Baghdad FIR (ORBI) – in particular UM688 along the Iranian border, eastern and northern Iraq close to locations like Erbil,
- Tehran FIR (OIIX) – northern Iran, Tabriz area,
- Cairo FIR – L560 near waypoint SERMA and near CVO VOR.

2.4 The effects of GNSS possible spoofing activities were observed by flight crew, including:

- Fake GPS signal (spoofed) gives the FMS the indication it is 60nm off track;
- Complete loss of navigational capability including IRS failure;
- No reliable on board navigation – ATC vectors required. One flight required ATC vectors all the way to their destination in Doha;
- Potential airspace infringements due to GNSS degradation. One operator almost entering Iranian airspace without clearance.

The recommended Actions

2.5 To address the identified issues, it is recommended to implement the following mitigation measures. These measures are to be considered for the aforementioned FIRs, and should be extended to any other area where GNSS jamming and/or possible spoofing is identified.

2.6 CAAs should:

- Ensure that contingency procedures are established in coordination with ANSPs and airspace users, and that essential conventional navigation infrastructure are retained and fully operational;
- Implement appropriate and proactive mitigating measures as a matter of high priority, including the issuance of NOTAMs, e.g. describing affected areas and related limitations (as appropriate and determined at State level).

2.7 CAAs and ANSPs should:

- Establish a process to collect information on GNSS degradations, in coordination with the relevant National Communications Authorities, and promptly notify the related outcomes to air operators and to other airspace users;

- Confirm ANSPs' readiness to provide reliable surveillance coverage that is resilient to GNSS interference, such as ground NAV aids for conventional non-satellite based navigation (Distance Measuring Equipment (DME), Very High Frequency omnidirectional range (VOR)); •
- Ensure that ANSPs' contingency plans include alternative procedures to be followed in case of large-scale GNSS jamming and/or possible spoofing events.

GNSS Testing Activities and Need for an Enhanced Civil/Military Coordination

2.8 While further investigations of the reported GPS spoofing cannot confirm military activities as causes of the outages with certainty, this nonetheless remains probable for cases near zones of conflict. Therefore, it is appropriate to reiterate that States should use caution when conducting civil and military GNSS and other testing activities which could contribute to operational impact on aviation CNS systems. Airspace users should be informed accordingly. Many States have already put in place efficient civil-military processes to coordinate testing activities, in particular in the context of military exercises. Considering the potential negative impact of GNSS testing on the safety of flights, States are strongly encouraged to further enhance civil-military coordination related to GNSS and associated testing.

GNSS RFI Mitigation Plan

2.9 ICAO has developed a GNSS RFI mitigation plan as a part of the GNSS Manual (ICAO Doc 9849). The mitigation plan describes a list of preventive and reactive measures aimed at mitigating the interference risk as far as practicable. The framework recommended by the mitigation plan includes a continuous three-step process of 1) monitoring threats; 2) assessing risks; and 3) deploying mitigation measures. The plan also explains the need to inform AUs in the event of GNSS outages and the necessity to train flight crew and air traffic controllers to be able to recognize interference events and to react appropriately.

RASG-MID Safety Advisory – 14

2.10 The meeting may wish to recall that the Seventeenth Meeting of the Middle East Air Navigation Planning and Implementation Regional Group and Seventh Meeting of the Regional Aviation Safety Group-Middle East MIDANPIRG/17 & RASG-MID/7 held in Cairo, Egypt, 15 – 18 April 2019, endorsed through RASG-MID CONCLUSION 7/1 the RASG-MID Safety Advisory (RSA-14) on GNSS Vulnerabilities.

2.11 The RASG-MID Safety Advisory (RSA-14) on GNSS Vulnerabilities is available at https://www.icao.int/MID/Documents/2017/RASG-MID6/RSA%2014-GNSS%20Vulnerabilities.pdf

2.12 The meeting will recall also that the SARPs have been recently updated to add requirements for DFMC SBAS, new core constellations and additional core constellation signal. In addition, the latest updates on the DOC 9849, GNSS Manual, in particular Chapter 5 GNSS Vulnerability with the significant material added to address recent developments and thinking with respect to jamming and spoofing and the Appendix F GNSS RFI Mitigation Plans addressing current, significant issues with jamming and spoofing concerns.

2.13 To ensure that the guidance materials remain accurate, relevant, and aligned with the latest developments, it is necessary that the RASG-MID Safety Advisory (RSA-14) on GNSS Vulnerabilities be updated to reflect recent developments and changes that have occurred in Annex 10 Volume 1 and GNSS Manual DOC 9849.

2.14 The meeting may wish to recall that MIDANPIRG/18 through DECISION 18/40 established GNSS Guidance Ad-Hoc Action Group tasked to review and prepare a revised version of the Guidance on GNSS Implementation in the MID Region. Therefore, it is proposed that the Ad-Hoc Action Group provides updates to the RASG-MID Safety Advisory (RSA-14) to reflect recent developments and changes to maintain its effectiveness and reliability.

GNSS interference NOTAM terminology

2.15 The meeting may wish to recall that the MIDANPIRG/20 endorsed through MIDANPIRG Conclusion 20/18 a NOTAM TEMPLATE FOR GNSS INTERFERENCE. Based on the recent new entry of GNSS Spoofing, the NOTAM Template should be updated to reflect the spoofing activities and its effect on safety of flight operations - for instance, ″GNSS MAY BE MISLEADING WITHIN″ for spoofing events.

2.16 Therefore, MIDANPIRG AIM SG should be invited to consider updating the NOTAM Template for GNSS Interference based on the recent new entry of GNSS Spoofing.

ICAO EUR/MID Radio Navigation Symposium

2.17 Under the theme ”***Towards Safe, Reliable and Resilient Air Navigation***” and with the aim to provide recent updates on GNSS constellations and augmentation systems, identify and address emerging challenges including GNSS vulnerabilities and discuss GNSS vulnerabilities management plan, in particular possible GNSS jamming/spoofing monitoring solutions, the ICAO EUR/MID Radio Navigation Symposium for EUR/NAT and MID Regions is planned to be held in Antalya, Turkiye, from 6 to 8 February 2024. The Symposium will be organized jointly by the ICAO EUR/NAT and MID Regional Offices. Therefore, MID States are strongly encouraged to participate actively in this Symposium.

3. ACTION BY THE MEETING

3.1. The meeting is invited to:

a) encourage Member States to implement the recommended actions to reduce and mitigate GNSS identified issues;
b) agree on the proposal for the GNSS Guidance Ad-Hoc Action Group to update the RASG-MID Safety Advisory (RSA-14) to reflect recent developments and changes to maintain its effectiveness and reliability;
c) request the AIM SG to update the NOTAM template for GNSS interference; and
d) encourage Member States to participate actively in the ICAO EUR/MID Radio Navigation Symposium.

– END –