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 INTERFERENCE & GPS Anomalies

(Presented by the United Arab Emirates)

SUMMARY

This working paper discusses the critical issue of GNSS interference, including GPS jamming and spoofing, and its impact on civil aviation and air traffic management. It highlights the growing concern over safety and operational disruptions caused by these activities and proposes recommendations for regional collaboration and mitigation measures.

The increasing threat of GNSS interference, particularly in conflict zones, can potentially disrupt aviation operations, leading to operational disruptions and compromising safety. Unintentional interference from diverse sources further compounds this concern. The impact of GNSS interference on ATM operations and flights is profound, affecting aircraft navigation, communication, surveillance, and safety systems.

Strong spectrum management and regulations are vital to address these challenges, highlighting the collaboration between aviation and telecommunication authorities. The ICAO's GNSS Radio Frequency Interference (RFI) Mitigation Plan (Doc 9849) offers comprehensive guidance for preventing and responding to interference. Encouraging Member States to adopt and implement these measures is crucial for maintaining the reliability and safety of aviation systems.

Action by the meeting is at paragraph 6.

REFERENCES

- Assembly/41-WP/196 – GNSS Interference
- Assembly/39-WP/118 – Impact to Flight & ATM Operations from Harmful Interference to GNSS
- Doc 9849, Global Navigation Satellite System (GNSS) Manual
- Resolution A32-19
- Resolution A32-20
- Resolution A35-15
- RASG-MID safety advisory-14 (RASG 14)

1. INTRODUCTION

1.1 GNSS has been an enabler for safety, capacity, and sustainability enhancements. GNSS is the primary technology supporting performance-based navigation (PBN), enhancing airspace capacity. GNSS contributes to Sustainable Development Goals set by the United Nations, making it possible for aircraft to fly more efficient routes. GNSS has also contributed to enhancements in safety performance. GNSS is also considered the key technology in future concepts such as trajectory-based operations.

1.2 GNSS has vulnerabilities, and there has been a significant number of reports of GNSS interference, both within the MID region and elsewhere. Concerns over harmful interference have previously been raised by stakeholders within the aviation domain and are a growing concern that warrants attention and action.

1.3 The United Arab Emirates recognizes the increasing number of incidents of GNSS interference and the risk such interference may introduce to civil aviation. Traditionally, GNSS interference was generally related to GPS jamming. Still, more recently, there have been reports of GPS spoofing, where GPS signals may have been intentionally distorted, thus elevating the risk and impact on civil aviation.

2. GNSS INTERFERENCE CHALLENGES

2.1 GPS jamming is usually referred to as deliberate interference with GPS signals using radio frequency signals on the same frequency. Jamming disrupts or blocks GPS signals, rendering GPS devices and systems unable to provide accurate positioning and navigation information.

2.2 GPS spoofing is a deceptive technique where counterfeit signals are generated to mimic legitimate GPS signals. Counterfeit signals can trick GPS receivers into providing false or manipulated location information. GPS spoofing may result in users believing they are on a different trajectory than they are. This may have serious safety and security consequences, particularly when other navigation systems are impacted or unavailable.

2.3 The issue of GNSS interference, mainly jamming and spoofing, has been exacerbated in geographical areas near conflict zones and other sensitive regions. The consequences of GNSS outages are unpredictable and can significantly impact aviation operations.

2.4 Unintentional GNSS signal interference can stem from diverse sources, including VHF communications, television signals, specific radar systems, mobile satellite communications, military equipment, microwave links, GNSS repeaters, and select onboard aircraft systems.

3. GNSS INTERFERENCE EVENTS

3.1 A Learjet 45 aircraft entering the Emirates FIR via SIR VOR on the 3rd of October 2023 required navigational assistance from ATC. The pilot reported they had encountered GPS jamming before entering Emirates FIR and that they required radar vectors. Emirates ACC supported the aircraft with radar vectors and coordinated with the subsequent FIR.

3.2 Figure 1 below shows the location of GPS jamming events within Emirates FIR reported in 2023 by the national carrier.

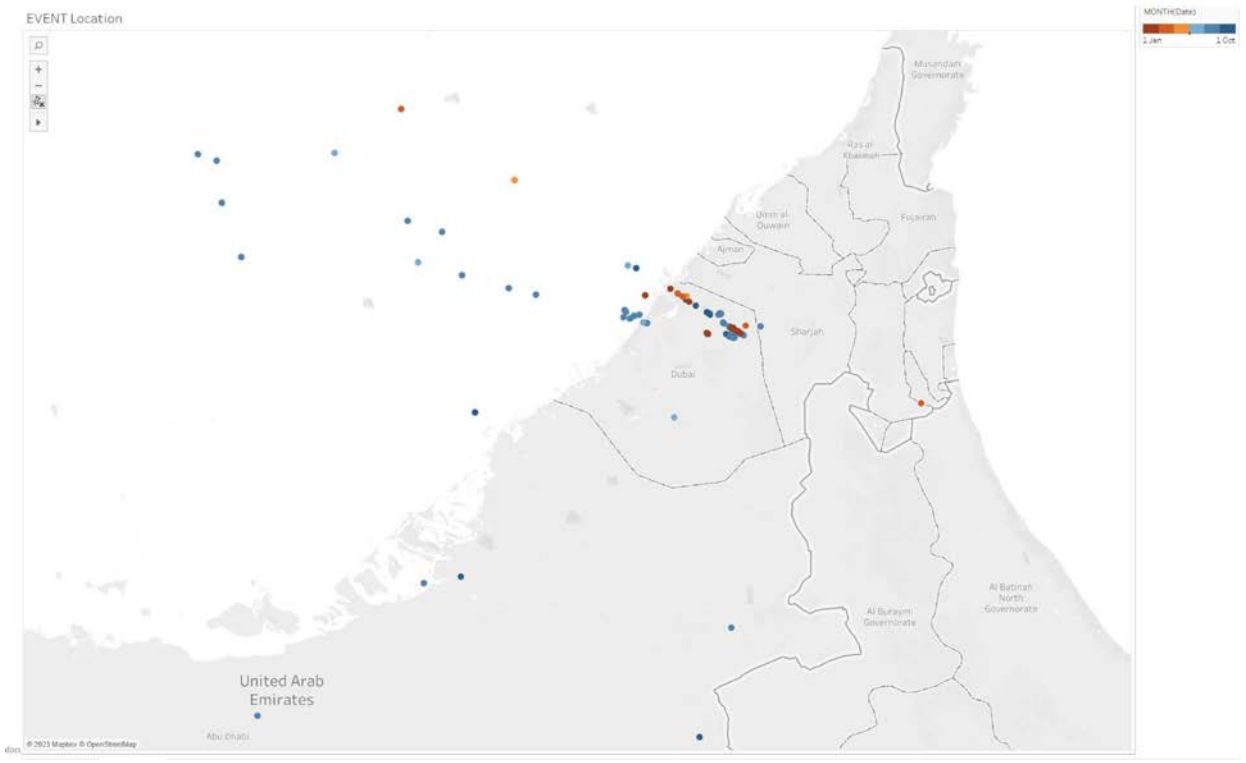

Figure 1.

3.3 Unintentional interference with GNSS signals can originate from various sources, including very high-frequency (VHF) communications, television signals, specific radar systems, mobile satellite communications, military equipment, microwave links, GNSS repeaters, and certain onboard aircraft systems.

4. IMPACT ON AIRCRAFT OPERATIONS AND AIR TRAFFIC MANAGEMENT

4.1 Automatic Dependent Surveillance-Broadcast (ADS-B) technology, which is becoming increasingly prevalent, relies on GNSS to provide real-time aircraft position and intent information to air traffic controllers and other aircraft. This technology enhances surveillance capabilities and contributes to safer and more efficient operations. Once GNSS signals are compromised, a degradation or complete interruption of ADS-B surveillance service will occur as ADS-B requires aircraft position input from GNSS.

4.2 The pivotal role of GNSS as a primary data source for aircraft navigation systems and communication, navigation, surveillance (CNS), and flight safety/control systems cannot be overstated. GNSS interference may lead to loss of waypoint navigation capabilities, impairment of area navigation (RNAV) capabilities, and inability to conduct required navigation performance (RNP) operations and RNP authorizations required (AR) approaches. Interference may also cause activation of terrain warnings and inconsistent aircraft positioning on navigation displays.

4.3 While GNSS interference poses challenges across the aviation sector, not all entities are equally impacted or equipped to detect such disturbances. Air navigation services, pivotal for ensuring the safety and efficiency of airspace operations, may not currently have the technology or equipment to identify GNSS interference directly. Some of their systems are inherently resistant to such interference due to their design or operational parameters. This ensures that while other components within the aviation framework might be susceptible, the primary systems of air navigation services remain steadfast and unaffected.

4.4 Yet, an absence of direct impact should not be misconstrued as a diminished need for vigilance. Even if the air navigation systems are not directly compromised, the broader aviation ecosystem might still be vulnerable. Proactive measures, particularly in reporting interference, ensure the overarching safety and reliability of the entire aviation operation. As technology continues to advance, there might arise a need for air navigation services to integrate

systems that can more directly detect and respond to GNSS interference. Until then, collaboration, effective communication, and strict adherence to reporting protocols remain essential.

4.5 GNSS Interference Mitigation:

4.6 Ensuring the reliability and safety of aviation systems dependent on GNSS requires a multifaceted approach.

4.7 Spectrum Management and Regulations: Collaboration between state aviation and telecom authorities is vital for effective radio frequency spectrum management. Regulations should prioritize safeguarding safety-critical aeronautical CNS systems, as outlined in ICAO's AN-Conf/12 and AN-Conf/13.

4.8 GNSS RFI Mitigation Plan: ICAO's GNSS Manual (Doc 9849) outlines a comprehensive plan to mitigate interference. This includes preventive and reactive measures, a three-step process involving threat monitoring, risk assessment, and mitigation deployment, and educating airspace users and controllers on interference recognition and response.

4.9 State Aviation Authority Regulation: States should update regulations that mandate prompt action in interference cases, with mandatory reporting to the designated regulatory authority. ANSPs should establish reporting procedures to the regulatory and civil aviation authorities to enhance infrastructure resilience against GNSS disruptions.

4.10 Dissemination of GNSS Interference Information: It's crucial to share information about civil aviation risks arising from consistent GNSS interference or spoofing in specific areas, detailing threats and potential consequences.

4.11 Long-Term Technological Solutions: Traditional navigation aids temporarily relieve GNSS loss, but long-term, sustainable solutions are imperative, especially with the transition to performance-based navigation. The aviation industry must prioritize advanced technological solutions for effective GNSS interference mitigation.

5. CONCLUSION

5.1 GNSS has delivered significant safety and efficiency benefits and is an indispensable element of flight and ATM operations. GNSS is also a key enabler for future enhancements within the aviation domain. GNSS interference may not only introduce risks to current aircraft and ATM operations but also hinder future developments

6. ACTIONS BY THE MEETING

6.1 The meeting is invited to:

a) address this emerging risk with high priority by establishing an action group (AG) to coordinate and propose measures to mitigate this risk. The AG should comprise all relevant stakeholders, including ICAO, IATA, States, ANSPs, manufacturers, military authorities, and other relevant stakeholders; and

b) encourage ANSPs to carry out awareness campaigns to enhance awareness of GNSS interference, including risks and mitigations.

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