International Civil Aviation Organization

AN-Conf/14-WP/118
28/6/24

WORKING PAPER

FOURTEENTH AIR NAVIGATION CONFERENCE

Montréal, Canada, 26 August to 6 September 2024

Agenda Item 2: Timely and safe use of new technologies
2.2: Addressing safety risks related to evolving aviation technologies

GLOBAL NAVIGATION SATELLITE SYSTEMS RADIO FREQUENCY INTERFERENCE IN THE SOUTH EAST ASIAN REGION

(Presented by Singapore and co-sponsored by Japan, Malaysia, Philippines, Thailand, Viet Nam and the Flight Safety Foundation)

EXECUTIVE SUMMARY

This paper presents the safety impact of global navigation satellite systems (GNSS) radio frequency interference (RFI) in South East Asia, and the need to address this issue as aviation technologies and procedures evolve.

The impact of GNSS RFI has been well recognized by ICAO and the international civil aviation community. It is however necessary to consider the impact of GNSS RFI on different regions with different operating environments, and ensure that any standards, recommendations, or guidance are developed accordingly.

Action: The Conference is invited to agree to the recommendations in paragraph 3.

1. INTRODUCTION

1.1 Global navigation satellite systems (GNSS) radio frequency interference (RFI) is a widespread issue that is intensifying, although the extent of this issue worldwide cannot yet be accurately determined due to absence of an international repository for the sharing, consolidation and visualisation of GNSS RFI reports. The impact of GNSS RFI is of concern to the aviation community given its potential impact on the safety of air navigation. ICAO had recognized this issue and agreed on several recommendations at the 12th Air Navigation Conference. Standards and Recommended Practices (SARPs) have been introduced to enhance defences such as dual-frequency, multi-constellation GNSS, which can help to reduce some vulnerabilities. There is however no technological solution currently available that can fully counter GNSS RFI, and the primary existing defence remains raising awareness and vigilance among airspace users and controllers.

1.2 The proliferation of GNSS RFI can be partially attributed to the increasing availability of, and accessibility to, low-cost devices that can be used to deliberately create interference. Additionally, GNSS RFI is increasingly being used in military defence operations. While in most cases commercial aviation is not the intended target, the interference generated does not discriminate.

1.3 Most aircraft engaged in commercial transport are equipped with internal navigation systems that act as backups to GNSS navigation. These internal systems function on inertial reference and are subject to inherent inaccuracies and drift. They require frequent updating via external reference (GNSS or ground-based infrastructure) to maintain the levels of navigation accuracy required by performance-based navigation (PBN) standards and the integrity of automatic dependent surveillance-broadcast (ADS-B) position information. Much of the existing ground-based infrastructure is being decommissioned and the associated navigation procedure withdrawn due to the ongoing cost of maintenance and the growing use of GNSS-based PBN procedures. This further reduces the available navigational redundancy in cases of GNSS RFI.

1.4 While there is growing global awareness of safety issues related to GNSS RFI, there are factors specific to each region that may exacerbate its impact and present unique challenges for operators and air traffic services (ATS) providers. In South East Asia, like in other regions with a significant volume of over-water flights, GNSS-dependent procedures have become key enablers to safely facilitate essential air connectivity with the rest of the world. In turn, this connectivity results in significant increases in traffic volume, which brings great opportunities for economic development and growth in the region.

2. DISCUSSION

2.1 The South East Asian region is particularly vulnerable to the disruption caused by GNSS RFI due to these four key issues:

2.1.1 **International over-water flights:** The South East Asian region is characterized by substantial water masses, which surpass its comparatively small land area. Consequently, almost all international flights within the region are over-water. Such flights operate out of the range of ground-based navigation aids or surveillance. There is therefore a heavy reliance on both space-based ADS-B aircraft separation and GNSS based navigation performance, especially in areas which have high volume of traffic.

2.1.2 GNSS RFI, particularly “spoofing”, may affect an aircraft’s reported position. Air traffic control (ATC) must remain vigilant to detect positional drift as manual intervention may be necessary to prevent any potential loss of separation, which significantly increases controller workload. Inaccurate aircraft position information caused by “spoofing” may also compromise aircraft automated conflict alerting systems and navigation performance. As a result, separation distances have to be significantly increased to maintain safe operations which severely restricts the traffic flow rate.

2.1.3 **Growing dependence on performance-based navigation (PBN):** ICAO has been actively encouraging States to implement PBN procedures since the adoption of Assembly Resolution A36-23 at the 36th Session of the ICAO Assembly in 2007[1]. Accordingly, South East Asian States have progressively implemented, and become reliant on, GNSS-based PBN procedures for both terminal and enroute operations. These procedures have helped to overcome several issues inherent to the region, such as terrain, adverse weather, susceptibility to natural disasters that disrupt ground-based infrastructure, limited radar coverage, and a widely dispersed population.

2.1.4 However, the growing dependency on PBN procedures is premised on an expectation of the availability and integrity of GNSS signals. GNSS RFI has been shown to not only render such

[1] ICAO Doc 9902, *Assembly Resolutions in Force* (as of 28 September 2007), *“The Assembly:* 1. *Urges* all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance-Based Navigation Manual* (Doc 9613);”

procedures unavailable in the immediate vicinity of the interference but has also led to aircraft experiencing a sustained loss of required navigation performance (RNP) capability for the remainder of the flight.

2.1.5 **Decommissioning of ground-based infrastructure:** Many States have begun the process of decommissioning ground-based infrastructure and the associated navigation procedures. The ongoing resource burden required to maintain such infrastructure, and the growing dependence on GNSS-based navigation, are significant incentives that drive such decommissioning. As a result, the main navigation contingency in the case of GNSS RFI is weakening.

2.1.6 The concept of strategically placed networks of ground-based infrastructure designed to provide a backup navigation system in case of GNSS RFI, called a minimum operational network (MON), has been discussed by several regions including the Asia Pacific[2]. However, there is currently no unified standard or supporting guidance for the establishment of such networks. MONs would also need to be supported by the retention of associated navigation procedures (standard instrument departure (SIDs), standard instrument arrival (STARs) and approach control (APPs)), many of which have already been removed in favour of PBN.

2.1.7 **Lack of harmonized reporting for GNSS RFI encounters**. While individual States have implemented domestic standards for the reporting of GNSS RFI encounters, these reports are rarely shared internationally. The information contained within these reports also varies and may not be aligned with ICAO's guidance[3]. This hinders the primary existing defence against GNSS RFI, which relies on raising awareness and vigilance among airspace users and controllers.

2.1.8 The absence of an international repository for the sharing and consolidation of such reports further exacerbates the issue. By harmonizing the requirement for States and international organizations to report to ICAO, GNSS RFI reports can be consolidated into a single repository, providing a reliable source of information. This information can be shared through regional aviation safety groups (RASGs) to raise awareness within the region and discuss for appropriate mitigation actions. Additionally, the development of a dashboard to visualise the information contained within this repository would further enhance GNSS RFI awareness of airspace users and controllers.

2.1.9 It is worth noting that International Air Transport Association (IATA) has contributed a significant amount of data and analysis on the issue of GNSS RFI[4].

3. CONCLUSION

3.1 Given the urgency of the situation and the absence of an immediate technological solution, it is proposed that the Conference consider and agree to the recommendations presented in Paragraph 3. It is essential for all stakeholders to work collaboratively to address this pressing issue and ensure the continued safety and efficiency of air travel.

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[2] Asia/Pacific Seamless ANS Plan, Version 3.0, Appendix C: Seamless ANS Principles, "Navigation Aids, 17. The continued rationalisation of terrestrial navigation aids to satellite-based procedures, while retaining a minimum network necessary to maintain safety of aircraft operations."

[3] ICAO *Global Navigation Satellite System (GNSS) Manual* (Doc 9849), Appendix F, GNSS Radio Frequency Interference Mitigation Plan

[4] Eighth Meeting of the Spectrum Review Working Group (SRWG/8) WP/12, GNSS Radio Frequency Interference: IATA Analysis

3.2 The Conference is invited to agree to the following recommendations:

Recommendation 2.2/x – Enhancing GNSS RFI awareness and contingency planning

That ICAO:

a) develops an international global navigation satellite system (GNSS) radio frequency interference (RFI) report repository, with States and international organizations for the consolidation of GNSS RFI to and to develop a hotspot dashboard that facilitates enhanced awareness of GNSS RFI;

b) share reports of GNSS RFI though regional aviation safety groups (RASGs) to raise awareness within the region and discuss for appropriate mitigation actions; and

c) develops Standards and technical guidance, as necessary, as well as a mechanism for the establishment and maintenance of regional minimum operational networks (MON) for inclusion in regional air navigation plans for implementation status to be monitored through planning and implementation regional groups (PIRGs);

that States:

d) recognize the impact of GNSS RFI on commercial aircraft;

e) adopt the GNSS RFI reporting template as stated in ICAO Doc 9849, Appendix F;

f) collect and share reports of GNSS RFI occurring within their territory so that they may improve the awareness of other airspace users;

g) review any existing plans for the decommissioning of ground-based infrastructure and associated navigation procedures in view of establishing a regional MON to provide contingency in the case of GNSS RFI; and

h) consider restricting, prohibiting, or regulating the production, distribution, sale, and use of devices that can be used to interfere with GNSS signals[5].

— END —

[5] A41-WP/653, Report on Agenda Item 31, "*The Assembly:* 5. *Urges* States to apply necessary measures to avoid the commercialization/proliferation and the use of illegal transmitters such as jammers and the misuse of test and maintenance equipment which may impact CNS systems;"