International Civil Aviation Organization

WORKING PAPER

AN-Conf/14-WP/61
27/6/24

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

PLANNING FOR GNSS CONTINGENCIES

(Presented by Hungary on behalf of the European Union[1] and its Member States,
the other Member States of the European Civil Aviation Conference[2],
the European Organisation for the Safety of Air Navigation (EUROCONTROL), and Singapore)

EXECUTIVE SUMMARY

The global navigation satellite system (GNSS) is a fundamental element of communication, navigation and surveillance/air traffic management (CNS/ATM), used for aircraft navigation and surveillance, and by numerous other essential aircraft systems. It can however be compromised, especially by radio frequency interference (RFI), which has become a widespread challenge for civil aviation operations, albeit to varying degrees depending on local conditions. Therefore, some legacy systems (systems in operational use for many decades already), continue to play an important role in mitigating GNSS outages. This avoids that many airspace users lose their navigation capabilities and impose an excessive workload on air traffic services (ATS). Legacy systems which do not play a relevant role in the mitigation of GNSS outages could potentially be phased out from the aviation system. The feasibility of such phase out should be evaluated in both technical and operational contexts, starting with non-directional beacons (NDBs).

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

1. INTRODUCTION

1.1 System modernization in any domain is normally about replacing an older system with a more modern one. Aviation has not followed this premise and retained practically all systems which have ever reached widespread implementation, even if more modern systems provide significantly better performance and functionality. Retaining legacy systems means that the full benefits of new systems, including reductions in operations and maintenance costs cannot be realised, while overall system complexity is increased.

1.2 GNSS has become a fundamental element of performance-based navigation (PBN) and CNS/ATM in general, used for aircraft navigation and surveillance, and by numerous essential aircraft

[1] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Moldova, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, Türkiye, Ukraine, and the United Kingdom.

systems during all phases of flight. In many cases, applications using GNSS enable higher levels of airspace capacity and efficiency than possible otherwise.

1.3 However, airspace users have experienced GNSS outages and anomalies, caused in most cases by RFI, particularly in some unfavourable GNSS environments.

1.4 Dual-frequency, multi-constellation (DFMC) GNSS will start to become available in 2025-2028. Even though DFMC GNSS enables many operational benefits, including improved resilience to support CNS and timing applications, it can still be compromised.

1.5 Therefore, based on local conditions, there will continue to be a need for States to mitigate GNSS outages to ensure operational safety, as recommended by AN-Conf/12 Recommendations 6/8 and 6/10.

1.6 Information paper "Mitigations of GNSS vulnerabilities in Europe. Activities and examples", presented by Spain, provides further background and examples of activities which are being undertaken to safeguard GNSS-based operations at European level, and the measures taken in one European State.

1.7 The European working paper "Aviation safety and security concerns regarding interference to the global navigation satellite system (GNSS)'' AN-Conf/14-WP/63 presented under agenda item 2.2 (Timely and safe use of new technologies) is complementary to this working paper. It evaluates the safety risks of GNSS interferences and proposes recommendations to reduce their number and severity.

2. DISCUSSION

2.1 Long-term mitigation measures are laid down in Appendix C to Assembly Resolution 41-8[3], calling for an improved integration of GNSS with complementary positioning capabilities. The effective, seamless integration of such complementary capabilities would maximize the ability of aircraft to remain PBN-capable in case of a GNSS outage (typically using inertial navigation systems (INS) and distance measuring equipment (DME)) and ultimately also support other positioning applications, such as automatic dependent surveillance-broadcast (ADS-B). Some of these improvements are being developed by regional standardization organizations (RTCA, European Organisation for Civil Aviation Equipment (EUROCAE)), but more time is needed to be implemented widely.

2.2 In the short-term, large commercial air transport aircraft, which are typically equipped with INS and multi-DME navigation capabilities, might be able to revert to such capabilities to mitigate GNSS outages and remain PBN capable. Which specific aircraft might require additional support from air traffic services (ATS) during GNSS anomalies depends on a variety of factors.

2.3 Other aircraft, such as, for example, general aviation or State aircraft, may not have such redundant capabilities, and, in that case, will not be able to continue operating on PBN routes or procedures. To facilitate contingency operations by aircraft which lose their PBN capability, some States are developing a minimum operational network (MON). The navigation MON is typically supported by very high frequency (VHF) omnidirectional radio range (VOR) and instrument landing system (ILS), enabling aircraft to navigate to an aerodrome and land safely. To avoid an excessive ATS workload in affected air traffic

[3] *The Assembly:*
1. *Encourages* States to transition towards optimized, secure CNS systems based on complementary integration of suitable and independent aircraft capabilities, satellite- and ground-based infrastructure which maximize resiliency and robustness to any type of interference

sectors, States implementing a VOR MON will expect that aircraft operators are able to use the VOR MON. Consequently, aircraft minimum equipment lists (MEL) will need to ensure appropriate equipage when such MON services are provided.

2.4 In view of the above paragraphs, only those navigation systems which do not play a relevant role in mitigating GNSS-related contingencies could potentially be phased out. Phasing out of a legacy system requires more than the removal of technical standards from Annex 10 — *Aeronautical Telecommunications*. It requires the complete removal of references to such a system from all ICAO documentation, including instrument flight procedure design, operational procedures, spectrum provisions as well as training and licensing measures. The feasibility, effort and benefits of phasing out such legacy systems should be evaluated by ICAO, starting with NDBs. While the need to provide terrestrial infrastructure to cater to GNSS-related contingencies limits the ability to phase out legacy navigation infrastructure, a significant rationalization and optimization of such infrastructure is possible when implementing PBN.

2.5 Recent experience with GNSS interference, and several side effects, have highlighted that the operational impact on aircrews and air traffic controllers can vary greatly depending on the provided infrastructure, radio frequency environment, airspace structure and aircraft capability. While AN-Conf/12 recognized the need to retain some terrestrial infrastructure, it is proposed to improve how airspace users obtain information about the terrestrial infrastructure which may be available to support a particular PBN route, or PBN-enabled airspace, in case of GNSS contingency.

2.6 Similarly, to facilitate GNSS contingency planning by ATS, it is proposed to improve how ATS can obtain information about aircraft equipage and its PBN capabilities. This should be developed within the flight and flow – information for a collaborative environment (FF-ICE) concept. The objective of these improvements is to maximize the operational utility of the remaining terrestrial infrastructure in case of GNSS outages and, consequently, minimize the impact of contingency operations by multiple aircraft.

3. CONCLUSION

3.1 The Conference is invited to agree to the following recommendation:

Recommendation 3.2/x – Planning for GNSS contingencies:

That ICAO:

a) evaluate, starting with NDB, whether navigation systems which do not play a relevant role in the mitigation of GNSS outages can be completely removed from the aviation system;

b) develop recommendations for globally harmonized minimum aircraft equipage lists to ensure that provided navigation infrastructure can be used by airspace users in line with available ATS capabilities;

c) evaluate the need for improvements to ICAO provisions on the information to be used by ATS on aircraft capabilities and by airspace users on infrastructure capabilities in case of GNSS contingency;

that States:

d) take measures, commensurate with their local conditions, to ensure continuity in providing air navigation services in case of GNSS unavailability impacting multiple airspace users and to implement PBN procedures that are not based only on GNSS; and

that aircraft manufacturers:

e) improve procedures for aircrew and ability of aircraft to remain PBN-capable in case of GNSS outages or anomalies.

— END —