



International Civil Aviation Organisation

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

(Doha, Qatar, 11 – 14 May 2026)

Agenda Item 3: Navigation Issues

**ENHANCING TIME SYNCHRONIZATION RESILIENCE OF ANSP SYSTEMS UNDER GNSS
RFI CONDITIONS**

(Presented by the United Arab Emirates)

SUMMARY

This paper builds on CNS SG/14-WP/7 and the outcomes of Agenda Item 3, as reflected in the CNS SG/14 meeting report, which recognised GNSS Radio Frequency Interference (RFI) as an increasing regional and global safety concern.

The ICAO 42nd Assembly further emphasised the need to strengthen CNS/ATM resilience and ensure operational continuity under degraded or denied GNSS conditions. While existing discussions have primarily focused on the impacts of positioning and navigation, this paper highlights the critical dependence of ANSP systems on precise time synchronisation, positioning it as a fundamental element of Positioning, Navigation and Timing (PNT) resilience.

The paper proposes enhancing resilience through a multi-layered timing architecture, including the deployment of anti-jamming GNSS receivers, passive timing sources, and independent synchronisation mechanisms to ensure continuity of operations.

Action by the meeting is at paragraph 3.1.

REFERENCES

- CNS SG/14-WP/7 – Mitigating GNSS and ADS-B Vulnerabilities
- CNS SG/14 Meeting Report – Agenda Item 3
- ICAO Assembly 42nd Session – Technical Commission Report
- ICAO Global Air Navigation Plan (GANP), Doc 9750
- ICAO Annex 10 – Aeronautical Telecommunications

1. INTRODUCTION

1.1 CNS SG/14-WP/7 highlighted vulnerabilities associated with GNSS-dependent surveillance systems and proposed radar data sharing as a key mitigation measure to enhance surveillance resilience in the MID Region.

1.2 The CNS SG/14 meeting report confirmed that GNSS interference is increasing both regionally and globally, with direct implications on navigation, surveillance, and communication systems, and emphasised the importance of multi-source synchronisation and Complementary PNT (C-PNT) architectures.

1.3 The ICAO 42nd Assembly further reinforced the need to strengthen CNS/ATM system resilience and ensure operational continuity in environments affected by GNSS disruption.

1.4 While these developments have largely focused on positioning and navigation resilience, time synchronisation remains a critical and cross-cutting dependency across ANSP systems that requires further attention.

1.5 This paper extends the discussion by addressing temporal integrity as a core component of PNT resilience and a prerequisite for safe and efficient ANSP operations.

2. DISCUSSION

2.1 The CNS SG/14 meeting report highlighted the increasing occurrence of GNSS Radio Frequency Interference (RFI) within the MID Region, particularly in areas affected by geopolitical developments. While the operational impact of such interference has been widely recognized in terms of positioning and navigation degradation, its implications on time synchronization remain less explicitly addressed despite being equally critical.

2.2 Modern ANSP systems operate as tightly coupled, time-dependent environments, where precise synchronization—often at sub-microsecond levels—is essential for:

- a) Surveillance: Accurate ADS-B, Wide Area Multilateration (WAM), and primary/secondary radar plot fusion.
- b) Communication: TDMA (Time Division Multiple Access) based digital communication systems (e.g., VDL Mode 2) and VoIP voice switching systems.
- c) Navigation: Maintaining GNSS-dependent navigation aids and PBN operations.
- d) System Integration: Ground-to-ground data exchange (OLDI), SWIM data distribution, and time-stamping of all ATC data recordings.

Any degradation in timing integrity, particularly in surveillance sensors, may lead to miscorrelation of tracks, reduced integrity in multi-sensor fusion, and potential loss of situational awareness.

2.3 The meeting further emphasized the adoption of multi-source synchronization and Complementary PNT (C-PNT) architectures, while the ICAO 42nd Assembly highlighted the importance of ensuring continuity of operations under degraded or denied GNSS conditions and advancing CNS/ATM resilience frameworks. These developments, together with concepts such as Minimum Operational Networks (MON) and the evolving Resilient Navigation Operational Network (NAV RON), reinforce the need for layered and diversified infrastructure. In this context, time synchronization should be explicitly recognized as a fundamental component of these resilience frameworks, as temporal integrity underpins all CNS/ATM functionalities.

2.4 Anti-jamming GNSS receivers can provide an effective first layer of protection by enhancing resistance to interference, maintaining signal lock in degraded environments, and enabling detection of anomalous RF conditions. However, such solutions do not eliminate dependency on GNSS and should therefore be complemented by additional resilience layers.

2.5 A multi-layered timing architecture is therefore required, combining GNSS-based synchronization with anti-jamming capabilities, high-stability local timing sources such as atomic clocks (Rubidium/Cesium) or holdover oscillators, and independent synchronization mechanisms including secure network-based timing (e.g., PTP - Precision Time Protocol) and cross-validation between ANSP systems. This layered approach enables graceful degradation and ensures continuity of operations even during GNSS disruption.

2.6 The regional nature of air navigation operations further amplifies the importance of timing resilience. As highlighted in the meeting, increased coordination and data sharing are essential to address GNSS RFI. Inconsistent timing across systems may propagate across FIR boundaries, affecting surveillance data exchange, coordination processes such as OLDI, and overall situational awareness. This reinforces the need to integrate timing resilience within broader regional CNS resilience initiatives, including radar sharing and NAV RON development.

2.7 In line with the ICAO 42nd Assembly direction, the focus should evolve from solely mitigating GNSS interference toward ensuring full PNT continuity. This requires ANSP systems to maintain operational capability under degraded or denied GNSS conditions, with time synchronization resilience treated as a core enabler of system integrity and continuity.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) Note the increasing impact of GNSS RFI on the time synchronization of ANSP systems;
- b) Recognize time synchronization as a critical enabler of CNS/ATM system integrity;
- c) Encourage States to assess GNSS dependency for timing across critical CNS infrastructure;
- d) Promote the implementation of multi-layered timing architectures (including local holdover capabilities and robust PTP networks) aligned with C-PNT principles;
- e) Consider incorporating timing resilience within NAV RON and regional GNSS RFI frameworks;
- f) Encourage regional collaboration and exchange of best practices on timing resilience, particularly for trans-boundary surveillance networks; and
- g) Invite ICAO to consider addressing time synchronization resilience explicitly within global PNT and CNS/ATM resilience frameworks.