International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)

WORKING PAPER

GREPECAS/23 — WP/5.8

Fifth GREPECAS–RASG-PA Joint Meeting (GREPECAS-RASG-PA/5) and Twenty-Third Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/23)

Virtual Phase (Asynchronous, 19 January to 17 February 2026)
In-Person Phase (Mexico City, Mexico, 4 to 6 March 2026)

Agenda Item 5: Assembly 42nd Results; Matters Concerning Air Navigation Initiatives

BRAZILIAN PLAN FOR THE IMPLEMENTATION OF A MINIMUM OPERATING NETWORK (MON) IN RESPONSE TO GNSS DISRUPTION AND THE BENEFITS OF THE PROJECT DME/DME/INERTIAL.

(Presented by Brazil)

EXECUTIVE SUMMARY

The continued growth in reliance on Global Navigation Satellite Systems (GNSS) for Performance-Based Navigation (PBN) has significantly increased civil aviation's vulnerability to radio frequency interference (RFI), such as signal jamming and spoofing. Recognizing these critical safety and operational risks, Brazil has developed and is implementing a Minimum Operational Network (MON) Plan (PCA 100-5). The Brazilian MON Plan is a comprehensive strategy, encompassing infrastructure, operational procedures, and training, designed to ensure air navigation resilience and safety against GNSS disruptions. Part of this plan is the DME/DME/Inertial Project, which aims to provide robust, complementary, and resilient navigation infrastructure, particularly for RNAV 1 operations in some high-traffic Terminal Areas (TMAs) and RNAV 5 operations in the main air flows of the continental upper airways. This paper details the strategic benefits of Brazil's DME/DME/Inertial project, including increased operational resilience and enhanced flight safety, demonstrating a tangible approach to mitigating GNSS vulnerabilities in the CAR/SAM region.

Actions:	a) Benchmarking the Potential Benefits of Brazil's MON and DME/DME/Inertial Project; and b) Encourage GREPECAS States to engage in discussions on these experiences and promote regional collaboration aimed at harmonizing criteria and developing robust, interoperable contingency plans to strengthen CNS/ATM resilience across the CAR/SAM region.
Strategic Objectives 2026-2050:	• Every flight is safe and secure • Aviation is environmentally sustainable • Aviation delivers seamless, accessible, and reliable mobility for all • No country left behind • The International Civil Aviation Convention and Other Treaties, Laws and Regulations Address All Challenges

	• The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All
References:	• ICAO 42nd Assembly Resolution A42-8C • Doc 9750, Global Air Navigation Plan (GANP) • PCA 100-5, Minimum Operational Network (MON) Implementation Plan in Response to GNSS Failure, DECEA - Brazil

1. Introduction

1.1 The global aviation community faces increasing challenges due to the growing susceptibility of GNSS signals to various forms of interference. Brazil's proposal through WP/210 (Implementation of a Minimum Operational Network – MON) at the 42nd ICAO Assembly contributed to discussions on the need for global guidelines and harmonized criteria for implementing a Minimum Operational Network (MON). The document presented Brazil's MON plan and highlighted the absence of international standards for defining strategic aerodromes, airspace volumes, and minimum ground infrastructure requirements, warning of the risks of fragmented and inefficient responses.

1.2 These concerns aligned with the considerations of Resolution A42-8/C, which recognized the importance of a holistic approach to ensure the resilience of CNS/ATM systems. The resolution emphasized complementary integration between ground, space, and onboard infrastructure, as well as the need for functions to detect, mitigate, and report interference.

1.3 As a result, Resolution A42-8/C incorporated actions reflecting the proposals of WP/210, including encouraging the definition of resilient networks and harmonization of criteria through international cooperation and Regional Planning and Implementation Groups (PIRGs). These measures aim to ensure consistency in CNS/ATM resilience, promote feasibility studies for MON, and guarantee safe and continuous operations on a global scale.

1.4 Aligned with these global recommendations, Brazil details in this study note the implementation of the MON Plan (PCA 100-5) by the Airspace Control Department (DECEA), published on May 15, 2025. This plan establishes a comprehensive national framework to ensure continuity and safety of air operations during GNSS disruptions. One of the components of this plan is the DME/DME/Inertial Project, an initiative focused on developing a resilient PBN navigation solution based on ground infrastructure in major TMAs and main upper airway flows.

2 Analysis

The MON Plan

2.1 The PCA 100-5 is a comprehensive plan that establishes the structure, procedures and responsibilities for the implementation of a Minimum Operational Network (MON). The MON aims to ensure the continuity and safety of air navigation operations in case of GNSS failure, using terrestrial navigation infrastructure and conventional procedures such as DME/DME, DME/DME/IRU, VOR/DME, ILS, SID OMNI and RADAR.

2.2 The MON structure includes procedures for all phases of flight — departure, en-route, arrival, and approach — ensuring a robust contingency environment. The Plan also provides for radar vectoring and adjustment of aircraft separation when necessary, training of air traffic controllers and pilots, and the publication of NOTAM templates to inform stakeholders about GNSS interference events.

2.3 That plan involves not only the CNS infrastructure, but also various factors, such as:

2.3.1 **National coverage with conventional aids:** A strategic network of VOR/DME, DME/DME, and ILS positioned to cover main traffic flows and critical aerodromes, ensuring all flight phases can be performed using conventional procedures;

2.3.2 **Integration with PBN and complementary infrastructure:** The DME/DME/Inertial Project supports RNAV 1 in high-traffic TMAs and RNAV 5 in continental upper airways;

2.3.3 **Criteria for strategic aerodromes and airspace:** Objective criteria for defining priority aerodromes and airspace volumes, considering connectivity, operational movement, proximity to urban centers and international flow relevance;

2.3.4 **Training and simulation:** Programs for controllers and pilots, including ATC simulator exercises to validate MON procedures and adjust radar separations;

2.3.5 **Continuous maintenance and review:** Permanent monitoring and operational readiness of the DME/VOR/ILS/RADAR infrastructure, and periodic reviews to keep the network updated and functional; and

2.3.6 **Review of Contingency Plans**: by Area Control Centers (ACC), Approach Control (APP), and the Air Navigation Management Center (CGNA).

2.4 The plan also considers a reduction in airspace capacity and efficiency, especially in areas where DME/DME coverage is limited.

2.5 In this moment, DECEA is consolidating the analyses submitted by the five Regional Centers, based on the criteria and conditions established in the Plan, ensuring the consistent application of guidelines across the national territory.

2.6 In parallel, inspection flights are being conducted to assess DME/DME coverage in selected Terminal Areas, considering the strategy for implementing RNAV 1 procedures (SID and STAR) with DME/DME/Inertial sensors.

2.7 To ensure resilience, the Plan must be continuously updated, incorporating contingency measures against interference and periodic reviews to keep pace with technological advancements and the adoption of new systems.

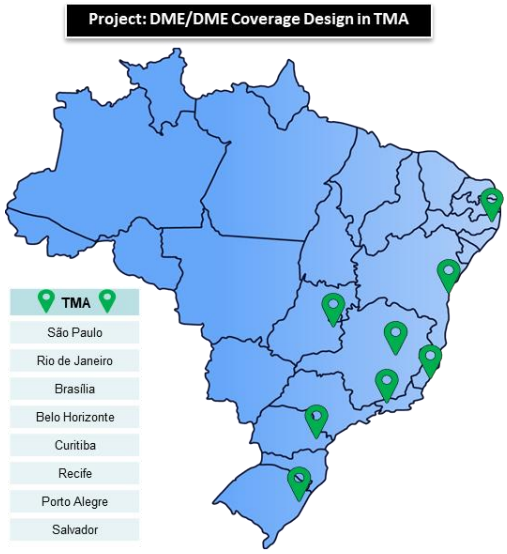
The DME/DME/Inertial Project

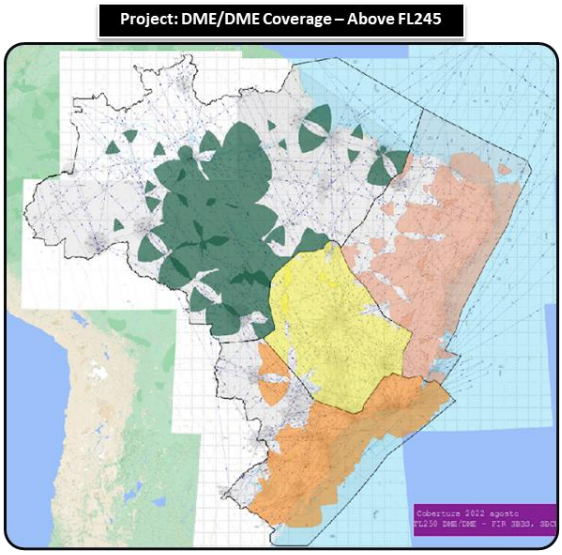
2.8 Based on ICAO's ASBU Block "NAVS-B0/4 – Navigation Minimal Operating Networks (Nav. MON)" and EUROCONTROL best practices, Brazil's DME/DME/Inertial Project aimed to strategically expand the ground-based infrastructure to complement GNSS.

2.9 Due to logistical challenges and the continental dimensions of Brazilian territory, the operational strategy was designed to leverage onboard inertial systems to fill gaps in DME/DME coverage. Consequently, DME/DME coverage was recently expanded with the installation of 52 standalone DME stations.

2.10 The project's scope was to support RNAV 1 procedures (SID/STAR) in high-traffic terminal areas (TMA) and RNAV 5 operations across most upper continental airways.

2.11 In this strategy, the map on the left shows the terminal areas covered by the project, representing the country's busiest regions: São Paulo, Rio de Janeiro, Brasília, Belo Horizonte, Curitiba, Recife, Porto Alegre, and Salvador. The map on the right illustrates the forecasted DME/DME coverage above FL245 after full implementation, designed to serve the main air traffic flows. The darker areas indicate coverage gaps.





3 Conclusions

3.1 The implementation of Brazil's MON Plan demonstrates a strong commitment to operational resilience against GNSS vulnerabilities, integrating ground infrastructure, conventional procedures, and complementary systems such as DME/DME/Inertial. This approach reinforces the need for coordinated strategies to ensure the continuity of air operations in interference scenarios, in line with ICAO guidelines for integration between ground, space, and onboard systems. The Brazilian experience shows that robust national solutions are essential but insufficient without a joint effort to standardize criteria and practices at the regional level.

3.2 In this context, regional harmonization plays a key role in avoiding fragmented responses and ensuring consistency in defining strategic aerodromes, airspace volumes, and minimum infrastructure requirements. Collaboration among States, through regional groups such as GREPECAS, is crucial to promote synergies, share experiences, and establish resilient networks that meet CAR/SAM needs. This integration will not only enhance safety and operational efficiency but also enable continuous evolution of solutions to address emerging threats, consolidating a safer, resilient and more interoperable air navigation environment for the entire region.

4 Suggested actions

4.1 The Meeting is invited to:

a) Benchmarking the Potential Benefits of Brazil's MON and DME/DME/Inertial Project; and

b) Encourage GREPECAS States to engage in discussions on these experiences and promote regional collaboration aimed at harmonizing criteria and developing robust, interoperable contingency plans to strengthen CNS/ATM resilience across the CAR/SAM region.

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