International Civil Aviation Organization

MIDANPIRG Communication, Navigation and Surveillance Sub-Group

Fourteenth Meeting (CNS SG/14)
(Abu Dhabi, UAE, 19 – 23 October 2025)

Agenda Item 6: ASBU Threads/ Elements related to CNS

Expanding PBN Implementation with DME Optimization and Development

(Presented by Saudi Arabia)

SUMMARY

Performance Based Navigation (PBN) is fundamental to modern aviation, enabling accurate and efficient aircraft flights by applying area navigation (RNAV) and required navigation performance (RNP) concepts. A key element of PBN is the reliance on ground-based navigational aids such as the DME/DME facility, which provide the positional accuracy necessary for operations in high-density airspace. This working paper investigates strengthening the PBN implementation by utilizing the DME-to-DME concept and enhancing DME signal characteristics and range. Specifically, it evaluates the benefits and advantages of replacing the directional narrow DME antennas traditionally co-located with the ILS with omnidirectional antennas. Such a configuration expands the range and uniformity of DME signals, addressing limitations in existing coverage and improving navigation reliability. The transition to omnidirectional DME antennas aims to support broader airspace utilization while maintaining compatibility with ILS operations and shifting the zero-DME location. This approach could also align with initiatives to reduce dependency on (D)VORs in remote areas or those nearing the end of their lifecycle. The results suggest that adopting omnidirectional DME antennas enhances PBN performance by improving signal redundancy, increasing the number of DME pairs, mitigating directional constraints, and enabling more seamless integration of RNAV procedures. These improvements contribute to a safer, more efficient, and harmonized air traffic management system.

Action by the meeting is in paragraph 5 of this WP.

REFERENCES

- ICAO Annex 10 Vol VI.
- Performance-Based Navigation (PBN) Manual, ICAO Doc 9613

1. INTRODUCTION

1.1 Performance-Based Navigation (PBN) is a key element of modern air traffic management, enabling aircraft to fly accurate flight paths using either satellite-based or ground-based navigation systems. PBN improves airspace capacity, reduces fuel consumption, and enhances safety.

1.2 However, the successful implementation of ground-based PBN depends significantly on having a reliable navigation infrastructure, which allows full advantage in implementing this concept correctly and effectively, such as Distance Measuring Equipment (DME). In areas with limited DME coverage, implementing ground-based PBN may be less effective, resulting in inefficiencies and operational challenges.

1.3 Performance-Based Navigation (PBN) is using performance standards rather than relying solely on fixed ground-based routes, such as VOR stations. It consists of two main components: Area Navigation (RNAV) and Required Navigation Performance (RNP). RNAV enables aircraft to fly along any desired path, while RNP ensures that the aircraft meets stringent accuracy requirements during navigation.

1.4 The DME was initially developed as a supplement to the VHF Omnidirectional Radio Range (VOR), as DME became an essential and vital part and subsystem of air navigation, and is also being integrated and associated with other Navaids systems such as the Instrument Landing System (ILS).

2. DISCUSSION

2.1 The challenge and ways to enhance Performance-Based Navigation (PBN) applications by optimizing DME networks, which are considered essential factors and elements upon which the concept of ground-based PBN depends.

2.2 It aims to strategically position and configure DME ground stations to maximize coverage supporting PBN applications while minimizing infrastructure costs. It also validates the proposed methodology through simulations, demonstrating its effectiveness in improving airspace efficiency.

2.3 Technology has continued to improve, and the latest generation of DME transceivers can exceed the current legacy operational standards, providing enhanced navigation performance in line with RNAV and RNP specifications by utilizing more DME frequencies. So, DME is considered a critical part of ground-based PBN, particularly in areas where satellite-based navigation may be unavailable or unreliable.

2.4 Distance Measuring Equipment (DME) is used in the en-route, terminal, and approach phases of flight to measure the distance between aircraft and the ground stations. In the Performance-Based Navigation (PBN) context, DME-to-DME triangulation supports Required Navigation Performance (RNP) by providing continuous and reliable distance information.

2.5 Traditional DME systems, which are often paired with Instrument Landing Systems (ILS), typically utilize directional antennas that focus signals on specific directions to replace the markers and allow the flights to monitor their distance from the Runway during the approaches. While this can be effective for certain applications, directional antennas can create coverage gaps and limit the effectiveness and usage of DME in supporting PBN applications, particularly in less-than-ideal configurations for triangulation, such as complex airspace or areas with high terrain. All of those could be a result of a limitation in the designated operational coverage and its redundancy in specific sectors.

2.6 Enhancing PBN applications by utilizing the DME-to-DME concept, which involves improving DME signal characteristics and range while minimizing the number of VOR stations and associated costs as much as possible.

3. KEY BENEFITS OF THE IMPLEMENTATION OF THE DME-TO-DME CONCEPT:

3.1 The improvement of the DME-to-DME network will rely on two key factors:

a) Replacing the narrow directional DME antennas, which are traditionally located with the ILS, with omnidirectional antennas.

b) Expanding the number of DME ground stations and their installation, such as inside the airport, without conflicting with the system's properties or affecting the signal.

c) Capacity to manage complex, non-linear constraints and its scalability for extensive tracking areas, which contribute to finding the best solutions.

d) Determining the best performing solutions based on metrics, the process is optimized for DME-to-DME networks and connections, successfully balancing the trade-offs between coverage and cost. This results in a strategically optimized DME network that enhances PBN performance while minimizing resource expenditure.

e) Transitioning from narrow directional antennas to omnidirectional antennas will be based on the results and outputs of the simulations conducted, as well as the operational requirements. This process will align closely with the future plans and goals of airspace management.

3.2 Technically, the narrow DME equipment associated with the ILS also requires increasing the size of the amplifier in the existing systems to match the new proposal and meet all the requirements to cover the maximum possible areas in the targeted airspace.

4. CONCLUSION:

4.1 The optimized DME network significantly outperforms the traditional ground stations, such as VOR stations, in terms of supporting performance-based navigation (PBN) applications. It can deliver up to a 35% improvement in coverage at low altitudes and an 85% improvement at high altitudes. This enhancement is particularly beneficial in remote and unsighted areas, where DME coverage may be limited, as it enhances signal redundancy across multiple volumes of airspace.

4.2 The proposed solution can reduce the navigational systems infrastructure costs (ground stations) by approximately 50% by strategically placing or implementing new DME ground stations. This cost efficiency makes the methodology feasible for targeted airspaces.

4.3 Transitioning to DME omnidirectional antennas with the ILS systems can be more straightforward to install, maintain, and integrate within the existing DME networks. Furthermore, it reduces maintenance and operational costs when decommissioning certain VOR stations.

4.4 Improved DME/DME coverage enables more efficient PBN flight paths, resulting in reduced fuel consumption and lower emissions. This, in turn, facilitates more effective route planning and airspace utilization and capacity by minimizing flight times through the use of more direct routes and fewer deviations.

4.5 DME-to-DME represents the best and most feasible solution to ensure navigation performance when GNSS is unavailable due to radio frequency interference (RFI), and there has been a significant increase in the number of reported cases of GNSS RFI in many areas around the world. It should also constitute the principal option in defining and implementing the Navigation Minimum Operational Network (NAV-MON) strategy, aiming to optimize and rationalize the regional ground-based navigation infrastructure, supporting the progressive decommissioning of nonessential facilities while preserving the availability of critical navigation services. The MID NAV-MON Action group that was established by the MIDANPIRG Decision 22/20 can be tasked to explore all possible solutions and options for DME/DME coverage within the MID region, which extends the PBN applications between the FIRs.

5. ACTION BY THE MEETING:

The meeting is invited to:

a) Note the information in this Paper.
b) Invite States to share information on the progress made at national level in defining NAV MON strategy.
c) Task the MID NAV-MON Action group to analysis the DME-to-DME coverage and options for its improvement to support expansion of PBN applications and ensure the continuity of Air Navigation Services (ANS) under both normal and contingency conditions, particularly the growing risks associated with GNSS interference.

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