International Civil Aviation Organization

Thirteenth Meeting of The Performance Based Navigation Implementation Coordination Group (PBNICG/13)

(Bangkok, Thailand, 14-16 October 2026)

Agenda Item 6: States' Minimum Operational Network (MON)

MINIMUM OPERATIONAL NETWORK (MON) IMPLEMENTATION IN AUSTRALIA

(Presented by Airservices Australia)

SUMMARY

This paper provides an overview of Australia's implementation of a Minimum Operational Network (MON) through the Navigation Rationalisation Project (NRP). The paper describes the strategic and regulatory drivers that led to the transition from a predominantly terrestrial navigation infrastructure to a Global Navigation Satellite System (GNSS)-based Performance Based Navigation (PBN) environment, the safety assurance activities undertaken to support the change, the composition of the remaining Backup Navigation Network (BNN), and the operational and stakeholder challenges encountered during implementation. The experience provides an example of how a State can modernise its navigation infrastructure while maintaining resilience and continuity of operations in the event of GNSS degradation or outage.

1. INTRODUCTION

1.1 Australia has progressively transitioned to a PBN environment based primarily on the use of GNSS technology as part of a broader national aviation modernisation strategy designed to move to a PBN operational environment.

1.2 The Australian Government's National Aviation Policy White Paper (2009) identified the need to modernise aviation navigation infrastructure while simultaneously maintaining a fit-for-purpose terrestrial backup capability to ensure continuity of operations should GNSS services become degraded or unavailable.

1.3 Following extensive consultation between government, Airservices Australia, the Civil Aviation Safety Authority (CASA), and aviation industry stakeholders, a Backup Navigation Network was developed. The BNN formed Australia's implementation of a Minimum Operational Network concept, providing sufficient terrestrial navigation capability to support normal flight operations and contingency operations during potential GNSS outages or interference.

1.4 To implement this strategy, Airservices Australia established the Navigation Rationalisation Project (NRP), which systematically reduced the number of terrestrial navigation aids (NAVAIDs) while retaining those required within the agreed Backup Navigation Network. The transition to the BNN commenced from the May 2016 AIRAC date.

2. DISCUSSION

Strategic Drivers for Navigation Rationalisation

2.1 The transition to a MON/BNN was enabled by Australia's broader implementation of PBN and increasing industry adoption of GNSS navigation capability. As GNSS became the primary means of navigation for IFR operations, maintaining the entire legacy network of terrestrial navigation aids was no longer operationally or economically justified.

2.2 The agreed purpose of the Backup Navigation Network was:
"Supporting flight completion using back up terrestrial NAVAIDs in the rare event of loss of GPS capability for GPS PBN primary means of navigation; and to allow limited ongoing operation of larger aircraft in the event of ongoing loss of GPS capability."

2.3 The project was supported by a CASA "Notice of Final Rule Making" (NFRM 1105AS), which required IFR aircraft to use GNSS as their primary means of navigation by February 2016. This regulatory mandate significantly reduced dependence on traditional terrestrial navigation aids and enabled implementation of the rationalised infrastructure model.

2.4 The NRP sought to align navigation infrastructure with PBN operational requirements while preserving resilience through retention of a strategically selected terrestrial backup NAVAID capability. The project also supported future navigation network strategies and Australia's long-term air traffic management modernisation objectives.

Safety Assessment and Assurance Activities

2.5 Recognising the significance of removing nearly half of Australia's terrestrial navigation infrastructure, Airservices conducted a safety program in accordance with the Safety Management System (SMS), covering concept, design, implementation and post-implementation phases. The safety objective was to demonstrate that the reduction in navigation aids would have a negligible impact on operational safety and that the National Airspace System would remain acceptably safe during and following transition.

2.6 The safety program included:

- Development of a dedicated BNN Safety Plan;
- Concept and Design Safety Assessment Reports;
- Implementation Safety Assessment Reports;
- Hazard Identification (HAZID) workshops;
- Operational risk assessments;
- Human factors assessments;
- Environmental assessments;
- Training Needs Analyses (TNAs);
- Transition planning activities; and
- Planned post-implementation review processes.

2.7 Implementation safety activities involved operational specialists from air traffic control, technical services, engineering, maintenance, procedure design and safety teams. Flight-thread analysis and sector-specific assessments were conducted to understand the practical impacts of decommissioning individual and multiple navigation aids.

2.8 Key hazards identified during the implementation phase included:

- Loss of a BNN NAVAID during a GNSS outage;
- Multiple BNN NAVAIDs becoming unavailable simultaneously;
- Incorrect implementation of the BNN design;
- Navigation aid misidentification;
- Inadequate operational training;
- Reduced ability to manage GNSS outage scenarios;
- Controller error;
- Flight planning and automation system impacts;
- Increased traffic complexity in adjacent areas;
- Regional airport emergency diversion constraints;
- Airspace design implications; and
- Loss of separation arising from navigation capability changes.

2.9 Mitigation measures included comprehensive stakeholder communication, controller engagement, operational training, revised charts and procedures, development of GNSS replacement waypoints, GNSS outage notification arrangements, transition planning, contingency procedures, and safety monitoring arrangements. Following implementation assessment, all residual risks were assessed as Class D under the Airservices SMS and considered manageable to As Low As Reasonably Practicable (ALARP) levels.

Overview of Australia's current Minimum Operational Network/Backup Navigation Network

2.10 The BNN was developed through extensive consultation among Airservices Australia, CASA and aviation industry stakeholders. Rather than preserving navigation aids for historical reasons, the retained network was selected specifically to support contingency operations in a GNSS-dominant navigation environment.

2.11 The selection of navigation aids for retention within the BNN was informed by conduct of a fault-tree analysis, undertaken by engineering, operational and safety specialists. The assessment was based on the premise that a widespread GNSS outage would constitute a contingency operation rather than a continuation of normal traffic levels, with the primary objective being the safe completion of flights already airborne either to their destination or a suitable alternate.

2.12 When conducting the fault-tree analysis, individual navigation aid retention was assessed against its contribution to the ability to provide for the safe completion of flight in the event of a GNSS outage. Considerations included:

- Fleet navigational capability;
- Prioritising aids at aerodromes commonly serviced by air transport or regional/charter;
- At controlled aerodrome, retention of at least one of VOR and/or NDB, plus ILS where installed; and

- The capability of nearby aerodromes to adequately serve as an alternate, considering:
  - Whether the alternate aerodrome was licensed or not;
  - The distance of the alternate from the primary destination aerodrome; and
  - Aerodrome infrastructure, i.e. lighting, runway length, pavement strength etc.

The resulting network design and selection criteria were subsequently validated through extensive consultation with government, industry and operational stakeholders.

2.13 Prior to implementation of the NRP, Australia's terrestrial navigation network consisted of 407 navigation aids comprising:

- 256 NDBs;
- 85 VORs; and
- 66 DMEs.

2.14 The resulting Backup Navigation Network retained 214 navigation aids comprising:

- 112 NDBs;
- 48 VORs; and
- 54 DMEs.

2.15 A total of 193 navigation aids were identified for decommissioning, including:

- 144 NDBs;
- 37 VORs; and
- 12 DMEs.

2.16 The retained network continues to be maintained and monitored in accordance with CASA Part 171 requirements, ensuring the availability of terrestrial navigation capability necessary to support instrument approaches and degraded navigation operations. The BNN currently fulfills Australia’s Minimum Operational Network requirement while supporting PBN as the primary navigation method.

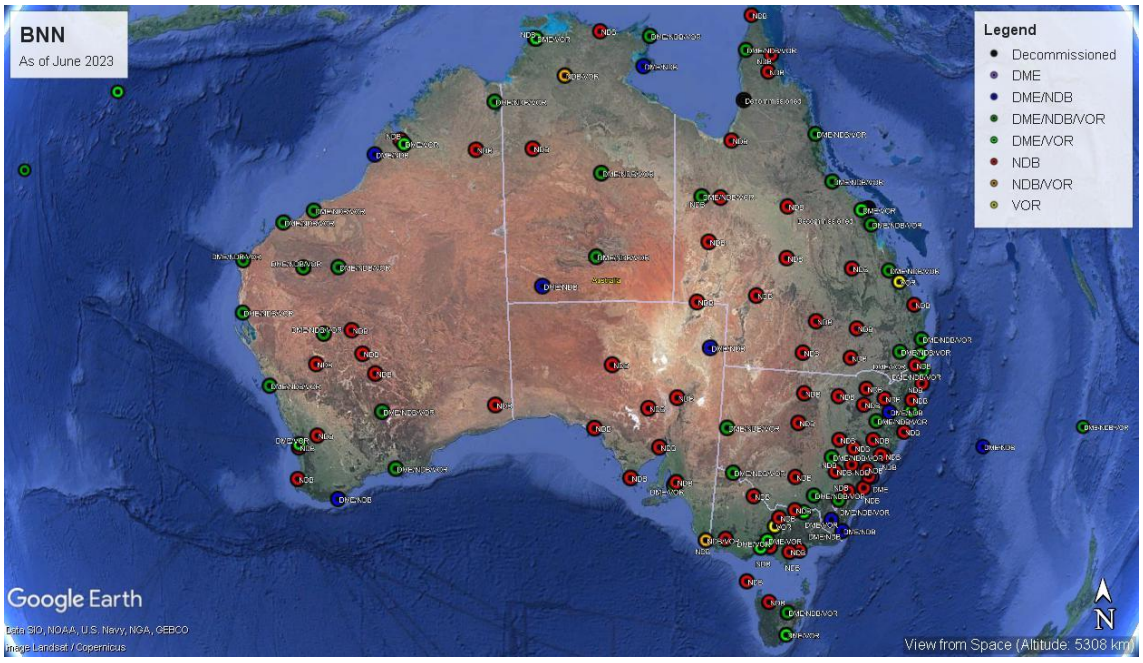


Figure 1. The composition and distribution of the BNN as of June 2023

Implementation Challenges and Lessons Learned

2.17 One of the most significant challenges involved changing long-standing perceptions regarding the role of terrestrial navigation aids. Historically, these facilities formed the primary means of navigation. Under the new operating model they became a contingency capability, requiring both pilots and controllers to understand the different operational assumptions underpinning the BNN concept.

2.18 Substantial stakeholder engagement was required to ensure operational readiness. Consultation activities involved airlines, private operators, flying schools, aerodrome operators, Defence, local communities, private navigation aid owners and aviation representative bodies. Information was disseminated through airline and regional industry meetings/conferences, dedicated aviation safety forums and pilot information nights.

2.19 The project also required procedural and technical changes, including:

- redesign of instrument procedures;
- withdrawal of procedures dependent on decommissioned NAVAIDs;
- creation of replacement GNSS waypoints;
- revision of charts and aeronautical publications;
- updates to ATC systems;
- review of ATC lateral separation diagrams; and
- amendment of local operational instructions and agreements.

2.20 Maintaining confidence in the ability to manage a widespread GNSS outage was another important consideration. Safety assessments therefore focused heavily on ensuring that the retained BNN provided sufficient capability, that remaining NAVAIDs achieved acceptable levels of availability, and that contingency procedures remained understood and executable by pilots and controllers.

2.21 A key lesson learned was the importance of integrating regulatory change, operational procedures, stakeholder communication, safety assurance and implementation planning into a single coordinated program. The safety assessment review concluded that transition to the BNN was achieved safely noting that identified controls were implemented and maintained.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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