International Civil Aviation Organization

AN-Conf/12-WP/16
25/5/12

WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

Agenda Item 5: Efficient flight paths – through trajectory-based operations
5.1: Improved operations through enhanced airspace organization and routing

PBN FOR ENROUTE OPERATIONS

(Presented by the Secretariat)

EXECUTIVE SUMMARY

The performance-based navigation (PBN) concept specifies that aircraft area navigation system performance requirements be defined in terms of the accuracy, integrity, continuity and functionality, which are needed for proposed operations in the context of a particular airspace concept. The next edition of the *Performance-based Navigation (PBN) Manual* (Doc 9613) introduces new navigation specifications RNP 2, RNP 0.3 (principally for helicopters) and Advanced-RNP which brings with them several areas that need further development and implementation strategies. This working paper addresses the resources and strategies necessary for continued implementation and deployment within the en-route environment.

The paper only addresses navigation but does not address the communication and surveillance and air traffic management (ATM) aspects although it is understood that the combination of these must be considered for planning in the future.

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

Strategic Objectives:	This working paper relates to the Safety and Environmental Protection and Sustainable Development of Air Transport Strategic Objectives.
Financial implications:	Based on preliminary indications, the benefits of implementation are substantial for global system performance. Most navigation specifications can be met with existing on-board equipment and it is expected therefore that minimal investment is required. During any implementation a cost-benefit analysis needs to be undertaken, to determine whether PBN implementation is cost-effective.
References:	Doc 9613, *Performance-based Navigation (PBN) Manual*

1. BACKGROUND

1.1 In en-route airspace, there is a continuing demand for increased capacity and more direct routing. Airspace capacity is largely governed by the number of routes that can be defined in a portion of airspace and this is determined by the minimum route spacing available. ICAO performance-based navigation (PBN) represents a shift from sensor-based to performance-based navigation. More precise lateral navigation accuracy can go some way to enabling closer route spacing although the relationship is not linear. More predictable track-keeping during turns also helps to reduce the spacing minima on the turns. The next edition of

the *Performance-based Navigation (PBN) Manual* (Doc 9613) will introduce three new navigation specifications requiring more precise performance in en-route for both fixed-wing and helicopters operations as well as new functionality which will improve track-keeping during path transitions Radius to Fix (RF) is required for standard instrument departures/standard instrument arrivals (SIDs/STARs) utilizing the new Advanced-RNP specification as well as its en-route equivalent for ATS routes, the fixed radius transition (FRT), which may be applied as an option. It should also be noted that the new navigation specifications primarily rely on global navigation satellite system (GNSS) positioning and the advent of multi-constellation GNSS positioning over the next decade will introduce both opportunities and challenges in this regard.

1.2 This paper is one of two PBN working papers submitted to the Conference. The additional working paper, AN-Conf/12-WP/6, addresses PBN in terminal operations and is submitted under Agenda Item 2.2.

2. CHALLENGES AND OPPORTUNITIES

2.1 Implementing the new navigation specifications

2.1.1 Enabling user preferred routes (UPR) is potentially a major element in the improvement of system-wide efficiencies. The term “user preferred route” refers to a system whereby each aircraft user is free to choose the most efficient route for their aircraft given the unique parameters of each flight. Required navigation performance (RNP) in the en-route and Oceanic airspace will enable greater fuel and efficiency benefits and, particularly with more precise RNP navigation accuracies, should enable even greater increases in capacity and more direct fuel saving trajectories.

2.1.2 Route spacing in en-route environment, be it Oceanic, remote or continental airspace, is determined by the aircraft’s navigation performance, controller-pilot communications and surveillance capabilities. In terms of PBN, Oceanic and remote continental airspace is served today by two navigation specifications, RNAV 10 (formerly known as RNP 10) and RNP 4. RNAV 5, RNAV 2 and RNAV 1 serve continental en-route airspace. The new navigation specifications RNP 2 and Advanced-RNP will serve Oceanic, remote and continental airspace and can contribute to improved route spacing due to their more precise navigation accuracies.

2.1.3 The lateral navigation accuracy required within an airspace is limited by the capabilities of the various aircraft that are expected to use that airspace. RNP 2 will enable improved fuel and efficiency benefits, and these would be further enhanced by the implementation of Advanced-RNP, but all the aircraft flying in the airspace must be appropriately approved before the benefits can be realized.

2.1.4 While the navigation specifications RNP-2 and Advanced-RNP have been defined, work is ongoing to develop guidance materials, the operational approval processes and new separation minima that take advantage of RNP 2 and Advanced-RNP.

2.1.5 Availability of additional routes becomes more critical when it is realized that due to weather conditions and restricted airspace, optimum routes may cluster around a relatively narrow area. Enabling more aircraft to fly closer to an optimum trajectory through application of reduced lateral navigation accuracy values holds the promise of significant improvements in efficiency.

2.1.6 Currently there is a wide variation among different manufacturers in the way flight management systems’ (FMS) perform calculations when turning the aircraft. This can result in a significant lateral track dispersion requiring increased airspace between routes on the turn portion, limiting both route design flexibility and capacity. This can be resolved through the implementation of the FRT function.

2.2 **Improved regional coordination in the development of PBN routes**

2.2.1 One challenge faced in developing efficient PBN in the en-route environment is the fact that the routes often cross several State boundaries. This will require extensive coordination and cooperation among States, air navigation service providers and airlines.

3. CONCLUSION

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

Recommendation 5/x – Increased efficiency and airspace capacity

That the Conference, considering that performance-based navigation (PBN) is one of ICAO's highest air navigation priorities and the potential benefits achievable through creation of additional capacity with PBN:

a) urge States, to implement performance-based navigation in the en-route environment; and

b) encourage industry, to implement a fixed radius transition functionality necessary to support both fixed and free route concepts, in order that track-keeping in turns can be better managed and closer air traffic service route spacing can be achieved.

Recommendation 5/x – Improved interregional coordination in the development of performance-based navigation (PBN) routes

That the Conference, considering the challenges in developing efficient performance-based navigation in the en-route environment, and the potential benefits achievable through Recommendation 5/x on increased efficiency and airspace capacity:

a) urge States to take advantage of improved methods of coordination to achieve more optimum routes through the airspace; and

b) urge States, through the planning and implementation regional groups to improve their methods of coordination to increase implementation of en-route performance-based navigation in order to achieve more optimum routes through the airspace.

— END —