MONITORING AND MANAGEMENT AEROSPACE SYSTEMS

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PERFORMANCE BASED NAVIGATION AND AIRSPACE CONCEPT

Performance based navigation integration and Airspace Concept are described. Connectivity of performance based navigation and airspace concept is considered. Analysis of effectiveness of relationship between performance based navigation and airspace concept is given.

Наведено концепцію повітряного простору та принципи навігації, яка заснована на характеристиках повітряних суден. Розглянуто взаємозв'язок між принципами навігаційних характеристик повітряних суден з концепцією повітряного простору. Проаналізовано ефективність зв'язку між принципами навігаційних характеристик повітряних суден з концепцією повітряного простору.

Airspace Management, Area Navigation (RNAV), Required Navigation Performances (RNP)

Introduction

Nowadays we have encountered with such problems as:
− capacity growth problem resolving;
− fuel efficiency advancing requirements;
− increasing of environment defense requirements;
− growing demand of Area Navigation (RNAV) approaches.

Because of continuing growth of traffic and increasing of demands on airspace capacity we are pressed to find the optimum utilization of the available airspace. Together with the improved operational efficiency derived from the application of RNAV techniques, this has resulted in the development of navigation applications in various regions and for all phases of flight. Navigation Applications (NA) could potentially be expanded to the provision of guidance for ground movement. In setting out requirements for NA on specific routes or within a specific airspace, it is necessary to define requirements in a clear and concise manner. This is to ensure that both flight crew and Air Traffic Controller (ATC) are aware of the on-board RNAV system capabilities and to ensure that the performance of the RNAV system is appropriate for the specific airspace requirements.

Airspace and obstacle clearance criteria were developed on the basis of available equipment performance. Requirements specifications were based upon available capabilities and, in some implementations, it was necessary to identify the individual models of equipment that could be operated within appropriate part of airspace. Such requirements inhibiting the introduction of new RNAV system capabilities.

Performance Based Navigation (PBN) concept specifies aircraft RNAV system performance requirements in terms of accuracy, integrity, availability, continuity and functionality needed for the proposed operations in the context of a particular Airspace Concept.

There are two core input components for the application of PBN:
− Aid to Air Navigation (NAVAID) Infrastructure;
− the Navigation Specification (NS).

Applying these components in the context of the Airspace Concept to air traffic service (ATS) routes and Instrument Procedures results in a third component: the Navigation Application.

The PBN concept represents a shift from sensor-based to performance-based navigation. Performance requirements are identified in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements. These NSs are defined at a sufficient level of detail to facilitate global harmonization by providing specific implementation guidance for States and operators. Under PBN, generic navigation requirements are defined based on the operational requirements. Operators are then able to evaluate options in respect of available technologies and navigation services that could allow these requirements to be met. The chosen solution would be the most cost effective for the operator, rather than a solution being imposed as part of the operational requirements. Technologies can evolve over time without requiring the operation itself to be revisited, as long as the requisite performance is provided by the RNAV system.

Advantages of Performance Based Navigation concept

The close future work of ICAO specialists is in finding the other means for meeting the requirements of the NSs that may be evaluated and included in the applicable NSs, as appropriate.

Performance Based Navigation offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria:

− reduces need to maintain sensor-specific routes and procedures, and their associated costs;

− avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive;

− allows more efficient use of airspace (route placement, fuel efficiency, noise abatement);

− clarifies the way in which RNAV systems are used;

− facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

Within an Airspace Concept, PBN requirements referring to Navigation element will be affected by the Communication (COM), Surveillance (SUR) and Air Traffic Management (ATM) environment, as well as the Navaid infrastructure and the functional and operational capabilities needed to meet the ATM application (fig. 1).

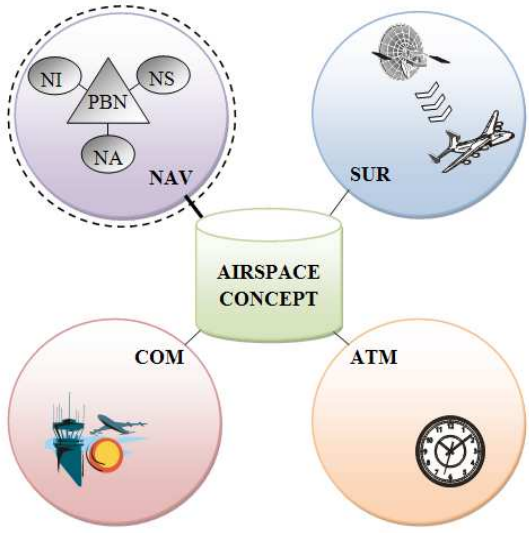

Fig. 1. Performance Based Navigation Concept

Performance Based Navigation performance requirements will also depend on what reversionary, non-RNAV means of navigation are available and hence what degree of redundancy is required to ensure an adequate continuity of function.

The development of the PBN Concept recognizes that advanced aircraft RNAV systems are achieving a predictable level of navigation performance accuracy which, together with an appropriate level of functionality, allows a more efficient use of available airspace. It also takes account of the fact that RNAV systems have developed over a 40 year period and as a result there are a large variety of implementations. Performance Based Navigation primarily identifies navigation requirements irrespective of the means by which these are met.

Benefits of Performance Based Navigation usage

Performance Based Navigation offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria. These include:

1. Reduces need to maintain sensor-specific routes and procedures, and their associated costs. For example, moving a single Very High Frequency Omnidirectional Radio Range (VOR) ground facility can impact dozens of procedures, as that VOR can be used on routes, VOR approaches, as part of missed approaches, etc. Adding new sensor specific procedures will compound this cost, and the rapid growth in available navigation systems would soon make system-specific routes and procedures unaffordable.

2. Avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive. The expansion of satellite navigation services is expected to contribute to the continued diversity of RNAV systems in different aircraft. The original Basic Global Navigation Satellite System (GNSS) equipment is evolving due to the increment of Satellite-Based Augmentation System (SBAS), Ground-Based Augmentation System (GBAS) and Ground-based Regional Augmentation System (GRAS), while the introduction of “Galileo” and modernization of “GPS” and “GLONASS” will further improve performance. The use of GNSS/inertial integration is expanding.

3. Allows more efficient use of airspace (route placement, fuel efficiency, noise abatement).

4 Clarifies the way in which RNAV systems are used.

5 Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

Designation of RNP and RNAV specifications

For oceanic, remote, en route and terminal operations RNP specification is designated as RNPX e.g. RNP 4. A RNAV specification is designated as RNAV X, e.g. RNAV 1. If two navigation specifications share the same value for X, they may be distinguished by use of a prefix. e.g. Advanced-RNP 1 and Basic- RNP 1. For both RNP and RNAV designations the expression 'X' refers to the lateral navigation accuracy in nautical miles that is expected to be achieved at least 95 percent of the flight time by the population of aircraft operating within the airspace, route or procedure (fig. 2).

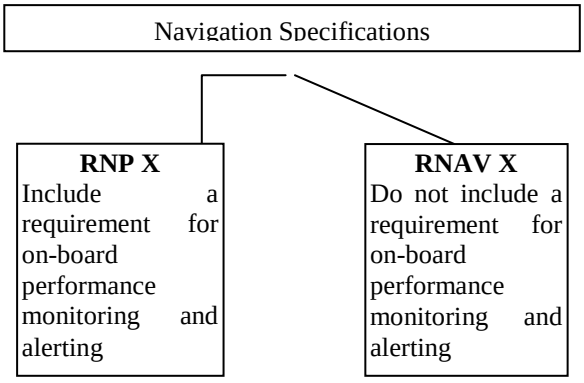

Fig. 2. Navigation Specifications designations excluding those used on Final Approach

The airspace concept

An Airspace Concept may be viewed as master plan for a particular airspace. Based on particular principles, an Airspace Concept is geared towards specific objectives. Airspace Concepts need to include a certain level of detail if changes are to be introduced within an airspace. Airspace Concepts may also describe the different roles and responsibilities, mechanisms used and the relationships between people and machines. Strategic objectives drive the general vision of the Airspace Concept. These objectives are usually identified by airspace users, air traffic management, airports as well as environmental and government policy. It is the function of the Airspace Concept and the concept of operations to respond to these requirements. The strategic objectives which most commonly drive Airspace Concepts are Safety, Capacity and the Environment.

Airspace Concepts and Navigation Applications

This cascade effect from Strategic Objectives to the Airspace Concept puts requirements on various enablers such as COM, Navigation, ATS Surveillance, ATM and Flight Operations. Navigation Functional Requirements – now within a PBN context − need to be identified.

These navigation functionalities are formalized in a navigation specification which, together with a NAVAID Infrastructure, supports a particular navigation application. As part of an Airspace Concept, navigation applications also have a relationship to Communication, ATS Surveillance, ATM, ATC tools and Flight operations.

Airspace concepts by area of operation

Oceanic and Remote continental Airspace Concepts are currently served by two navigation applications, RNAV 10 and RNP 4 (fig. 3).

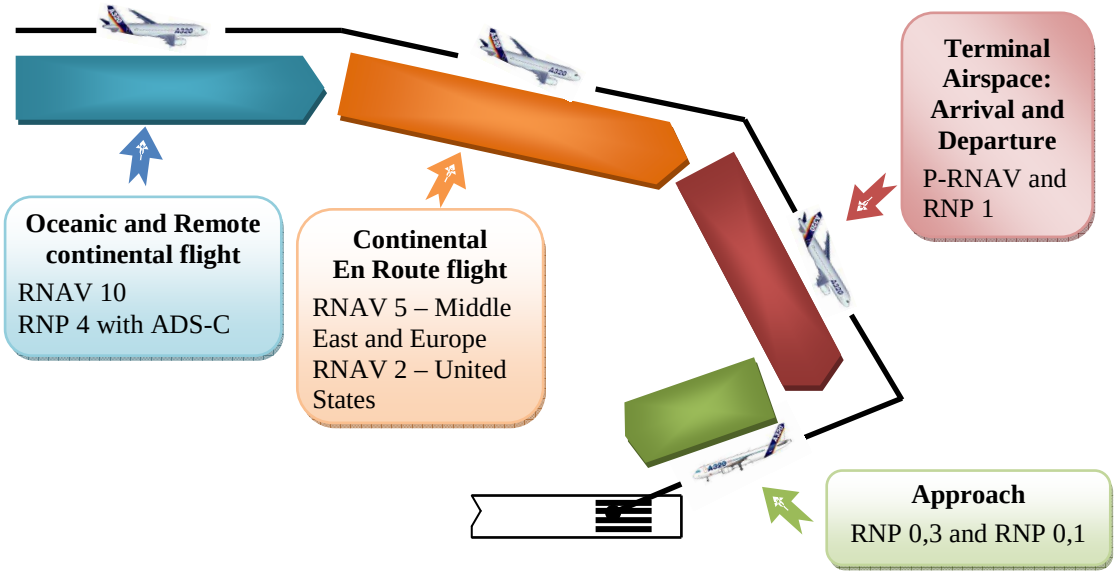

Fig. 3. Airspace concepts by area of operation

Both these navigation applications rely primarily on GNSS to support the navigation element of the Airspace Concept. In the case of the RNAV 10 application, no form of ATS Surveillance service is required. In the case of the RNP 4 application, Automatic Dependence Surveillance Contract (ADS-C) is used.

Continental En Route Airspace Concepts are currently supported by RNAV applications. RNAV 5 is used in the Middle East and European region. In the United States, an RNAV 2 application supports an En Route continental Airspace Concept.

At present, Continental RNAV applications support Airspace Concepts which include radar surveillance and direct controller pilot communication.

Existing Terminal Airspace Concepts, which include Arrival and Departure, are supported by RNAV applications. These are currently used in the European Region and the United States. The European Terminal Airspace RNAV application is known as P-RNAV (Precision RNAV). RNP-1 has been developed primarily for application in non-radar, low-density terminal airspace. In future, more RNP applications are expected to be developed for both en-route and terminal airspace.

Approach concepts cover all segments of the instrument approach i.e. initial, intermediate, final and missed approach. They will increasingly call for RNP specifications requiring a navigation accuracy of 0.3 NM to 0.1 NM or lower.

Typically, three sorts of RNP applications are characteristic of this phase of flight: new procedures to runways never served by an instrument procedure, procedures either replacing or serving as backup to existing instrument procedures based on different technologies, and those developed to enhance airport access in demanding environments.

Conclusion

ICAO Major plan solving global problems providing with Airspace concepts by area of operation (Oceanic and Remote continental Airspace Concepts, Continental En Route, Terminal Airspace: Arrival and Departure, Approach) based on implemented PBN till 2016 and all instrument landing system (ILS*)* equipped runways should have general or at least reserve Approach Procedure With Vertical Guidance chart.

The main aim for PBN implementation is to reduce collisions between terrain and aircraft under controlled flight. Also PBN implementation provides with airspace usage increasing efficiency, capacity and aerodromes access extension, solving environment pollution problems.

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