REPUBLIC OF CYPRUS
**MINISTRY OF COMMUNICATIONS AND WORKS**

CHARTING, OBSTACLES AND PROCEDURES UNIT

**DEPARTMENT OF CIVIL AVIATION**
NICOSIA 1429

# IMPLEMENTATION OF PERFORMANCE BASED NAVIGATION (PBN)

## ROADMAP FOR CYPRUS 2013 – 2020

## VERSION 1.0 – FEBRUARY 2013

**MINISTRY OF TRANSPORT AND WORKS – DEPARTMENT OF CIVIL AVIATION CYPRUS – CHARTING, OBSTACLES AND PROCEDURES UNIT**

## Table of Contents

**EXECUTIVE SUMMARY**

The implementation of Performance Based Navigation is presently the global aviation's community highest Air Navigation Priority. In view of the need for detailed navigation planning, it was deemed advisable to call for preparation of a national PBN Implementation Plan by each State.

The PBN Implementation plan in Cyprus will be delivered in three major phases with target implementation dates of 2014, 2017 and 2020. It provides guidance and direction to stakeholders, addresses the planned evolution of navigation, as one of the key systems supporting air traffic management, and describes the RNAV and RNP navigation applications that should be implemented in the three major phases in Cyprus.

The dependence on PBN will progress along with the implementation phases. The plan calls for major investment from all stakeholders, thus the benefits - safety, efficiency, and environment - must be clearly identified, understood and agreed by everyone involved along with the assurance that these benefits will be delivered.

The need to implement PBN derives from the following:

- Strategic Objectives (safety, accessibility)
- Airspace Concept
- ICAO Assembly resolution 37-11
- Aircraft Operator requests
- Policy Directives(noise, environment)
- ATM operational requirements

Implementation involves many different stakeholders including:

- Executives
- Regulators
- Aircraft Operators
- Aerodrome Operators
- Manufacturers
- Air Navigation Service Providers (provision of radio navigation signals)
- Air Traffic Service Providers
- Airspace/flight procedures designers
- AIS Service Providers

All stakeholders must ensure that sufficient trained and qualified personnel are available to support the implementation of PBN.

**INTRODUCTION**

The PBN concept specifies aircraft RNAV and RNP 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. 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 navigation specifications 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. As part of the future work of the ICAO, it is anticipated that other means for meeting the requirements of the Navigation Specifications will be evaluated and may be included in the applicable Navigation Specifications, as appropriate.
PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria:

a. Reduces need to maintain sensor-specific routes and procedures, and their associated costs.
b. Avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive.
c. Allows more efficient use of airspace (route placement, fuel efficiency, noise abatement).
d. Clarifies the way in which RNAV and RNP systems are used.
e. Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.
f. Safety improvements through greater adherence to a safe flight trajectory e.g. use of Continuous Descend Operations (CDO) which is the key component of the ICAO strategy to address Controlled Flight Into Terrain (CFIT) accidents.

Within an Airspace Concept, PBN requirements will be affected by the communication, surveillance and ATM environment, as well as the Navaid infrastructure and the functional and operational capabilities needed to meet the ATM application. PBN performances requirements will also depend on what reversionary, non-RNAV means of navigation are available and hence what degree or redundancy is required to ensure an adequate continuity of function.

The development of the Performance-Based Navigation 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. PBN primarily identifies navigation requirements irrespective of the means by which these are met.

*ICAO Assembly Resolution A37-11*

The implementation of RNP APCH procedures with vertical guidance (APV) was primarily encouraged by ICAO Assembly Resolution 36-23 which urges the States to implement APV procedures to all instrument runway ends by 2016, either as primary or as backup approach procedures. RNP APCH to LNAV/VNAV and RNP APCH to LPV minima were the two options to fulfill the resolution. But the resolution A36-23 was updated at the 37th Assembly of ICAO, and resolution A37-11(supersedes A36-23) now presents RNP APCH to LNAV minima as an acceptable alternative to APV in places where APV implementation is not possible or does not make sense as no aircraft are suitably equipped for APV operations. RNP APCH implementation is part of the resolution for ICAO PBN deployment, the main objective of which is to improve safety. Refer to Appendix 1 for the executive part of the resolution A37-11.

Cyprus is fully supportive of the ICAO PBN concept. The PBN Implementation Plan for Cyprus meets the intent of ICAO Assembly Resolution A37-11 and addresses the particular needs of the Cyprus aviation environment. The implementation of any RNAV or RNP application shall be in compliance with ICAO PBN Manual (Doc 9613 4$^{th}$ Edition). This plan will enable the use of RNAV and RNP capabilities that will, when harmonized with ATM systems, deliver more efficient routes and predictability of service for the air transport industry, together with greater access to limited airspace resources for general and sport aviation.

The Cyprus PBN Implementation Plan meets the following strategic objectives:

a) Provide high-level strategy for the evolution of the navigation applications to be implemented in Cyprus in the short term (2013-2014), medium term (2015-2017) and long term (2018-2020). This strategy is based on the concepts of PBN, Area Navigation (RNAV) and Required Navigation Performance (RNP), which will be applied to aircraft operations involving instrument approaches, standard departure (SID) routes, standard arrival (STAR) routes, and ATS routes in accordance with the implementation goals in the Assembly resolution A37-11;
b) ensure that the implementation of the navigation portion of the CNS/ATM system is based on clearly established operational requirements;
c) avoid unnecessarily imposing the mandate for multiple equipment on board or multiple systems on the ground;
d) avoid the need for multiple airworthiness and operational approvals for intra- and inter-regional operations;
e) prevent commercial interests from outdoing ATM operational requirements, generating unnecessary costs for the State as well as for airspace users.

The implementation of PBN in Cyprus is based on the following principles:

a) Continued application of conventional air navigation procedures during the transition period, to guarantee availability to users that are not RNAV- and/or RNP-equipped;
b) Development of airspace concepts, applying airspace modeling tools as

well as real-time and accelerated simulations, which identify the navigation applications that are compatible with the aforementioned concept;

c) Conduct of cost-benefit analyses to justify the implementation of the RNAV and/or RNP concepts in each particular airspace;
d) Conduct of pre- and post-implementation safety assessments to ensure the application and maintenance of the established target levels of safety.
e) Alignment with the regional PBN implementation plan.

A multi-disciplinary team is needed to ensure that all necessary aspects of PBN implementation procedures are recognized and adequately addressed. The team will identify work areas, resource requirements and organizations responsible for actions.

**PBN IMPLEMENTATION PLAN**

## 1. Background

The global aviation community is facing significant challenges. As demand for air transportation services increase, States are faced with finding solutions to safely increase capacity, efficiency, and access, e.g. to terrain challenged airports. These constraints are largely a result of reliance upon conventional ground based navigation aids (VOR, NDB, DME, ILS). Cyprus has relied upon these Navaids which aircraft use to navigate along fixed routes and to conduct instrument approach procedures to land at aerodromes. The ground based systems however limit routes and procedures to their physical locations and do not permit the flexibility of point-to-point operations. With the exception of ILS they do not support approaches with vertical guidance.

To address the problems of route navigation and to improve operational efficiency the application of Area Navigation (RNAV) and more recently Required Navigation Performance (RNP) techniques have been developed. These new navigation specifications are based on new technologies like Global Navigation Satellite System (GNSS) and on board aircraft systems. Area Navigation allows an aircraft to fly any pre-defined path (usually a straight line between two points in space) with high accuracy (with linear lateral performance requirements). The key difference between the RNAV and RNP specifications is the onboard monitoring and alerting function associated with RNP. The new navigation specifications and Navaid infrastructure resulted in the development of navigation applications in various regions worldwide and for all phases of flight.

ICAO has adopted PBN to address these challenges. **Performance-Based Navigation** (PBN) defines performance requirements for aircraft navigating on an ATS route, terminal procedure or in a designated airspace. It provides a way forward in addressing today's – and tomorrow's – aviation system capacity, efficiency, environmental and safety issues. PBN is ICAO's effort and objective to redefine the regional differences of various Area Navigation (RNAV) and Required Navigation Performance (RNP) specifications into a globally harmonized set of PBN applications. PBN's RNAV and RNP components provide a foundation for aviation system evolutionary developments such as SESAR and NextGen.

The performance requirements must be defined in a clear and concise manner in order to ensure that both flight crew and ATC are aware of the on board system suitability for the specific airspace requirements.

### 1.1 Traffic Forecast

With fuel prices remaining painfully high and the economic recovery delayed yet again, between September and November 2012, European flight counts remained at lower levels than in 2011 and Winter 2011-2012 saw heavy reductions in flights by a number of carriers. A weaker economic outlook and other recent events (airlines failures, slower-than-expected recovery from the Arab Spring) have all led to a downwards revision of the forecast over all.

According to the numbers from the Eurocontrol web site, the Statistics and Forecast Service (STATFOR), the forecast short and medium forecast for Cyprus are the following

| YEAR | ANNUAL GROWTH (Percentage) |
|---|---|
| 2012 | -3.8 |
| 2013 | 2.2 |
| 2014 | 1.6 |
| 2015 | 3.8 |
| 2016 | 4.0 |
| 2017 | 5.2 |
| 2018 | 4.3 |

General Annual growth 3.0%

As Cyprus is a member of the BLUE MED FAB below are the short and medium forecasts for traffic in BLUE MED FAB

| YEAR | ANNUAL GROWTH (Percentage) |
|---|---|
| 2012 | -0.8 |
| 2013 | -0.2 |
| 2014 | 2.0 |
| 2015 | 3.3 |
| 2016 | 3.6 |
| 2017 | 3.4 |
| 2018 | 3.2 |

General Annual Growth 2.8%

As it can be seen from the above tables traffic is expected to increase in the foreseeable future. The improved efficiency and capacity are the key enablers of PBN implementation which address such increase.

## 2. PBN CONCEPT

### 2.1 Area Navigation (RNAV)

#### 2.1.1 Capabilities

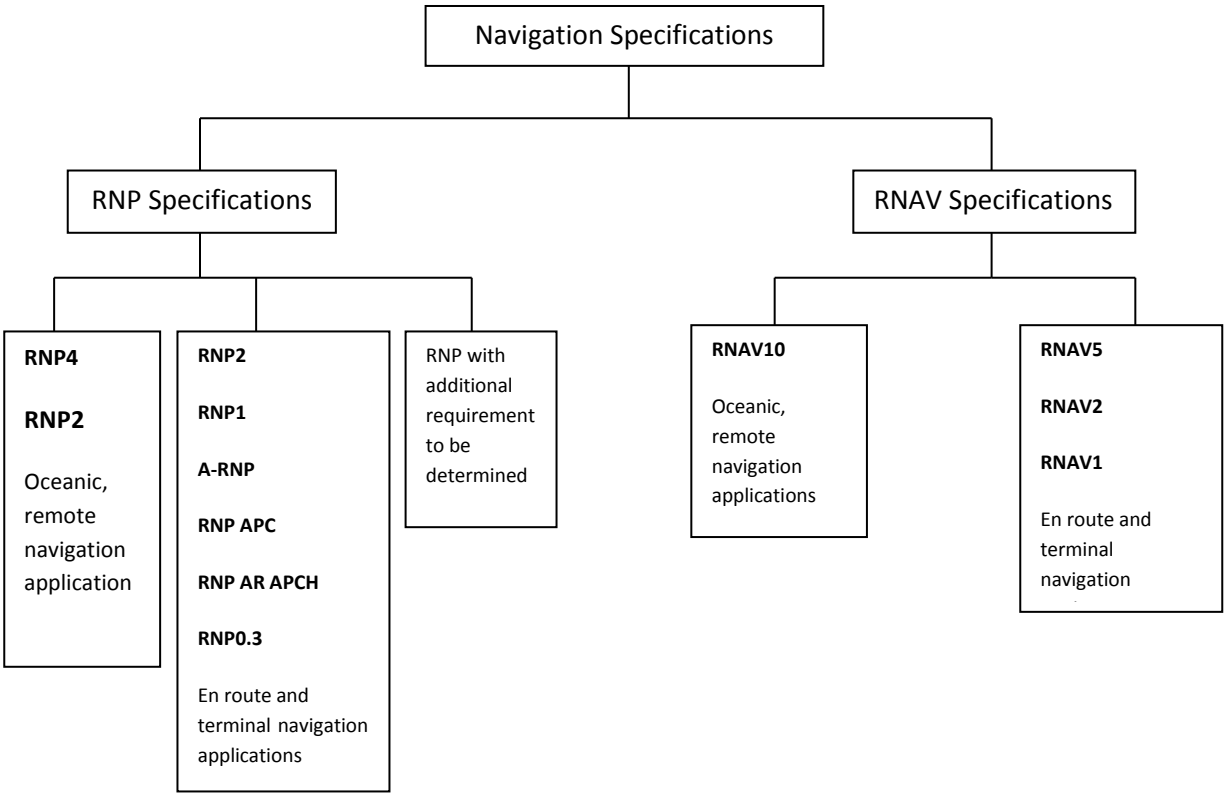
Area Navigation (RNAV) is a method of navigation which permits aircraft operation on any desired path: within the coverage of station-referenced Navaids or within the limits of the capability of self-contained systems or a combination of these capabilities. RNAV specifications DO NOT require on board navigation performance monitoring and alerting thus RNAV is less capable than RNP. RNAV tracks will normally require monitoring by ATC surveillance systems to achieve desired performance and separation safety standards. Although RNAV is widely used as a stand-alone specification, it will not be able to support future applications to meet the capacity program by SESAR (triple capacity of 2018, 3D, 4D concepts)

## 2.2 Required Navigation Performance (RNP)

### 2.2.1 Capabilities

RNP is the more capable of the two PBN navigation specifications and the main difference with RNAV is the on board navigation performance and alerting. This difference determines if the navigation system complies with the necessary safety level associated to an RNP application; it relates to both lateral and longitudinal navigation performance; and it allows the aircrew to detect that the navigation system is not achieving or cannot guarantee with a certain level of integrity, the navigation performance required for the operation. RNP systems provide improvements on the integrity of operations and this may permit closer route spacing. This allows only RNP systems to be used for navigation in a specific airspace. The use of RNP systems may therefore offer significant safety, operational and efficiency benefits.

The navigation specification designators are summarized below (Reference PBN Manual ICAO Doc 9613)




## 2.3 Current Status of RNAV and RNP Operations in Cyprus

Basic RNAV/RNAV 5 is mandatory for flights above FL095 within Cyprus FIR since 1998

Currently there are no RNAV or RNP procedures for the aerodromes in Cyprus

## 3. Benefits of PBN and Global Harmonization

PBN defines both lateral and vertical navigation for both straight and curved flight paths, and will be used for the next generation air traffic systems. With PBN route creation is no longer constrained by the geometry of ground-based radio navigation aids such as VOR/DME/NDB. Many aircraft have been already equipped with advanced navigational capabilities (GPS receivers and high performance FMS). Cyprus has seen a dramatic traffic increase from Eastern Europe and especially Russia. It is encouraging that almost all these airlines have replaced their fleet with "medium" to "high end" equipage aircraft which means that little or no change is required to operate in an RNAV and RNP environment. Many of the operators in general will benefit from the availability of RNP approaches.

The following benefits are expected:

- Global standardization of navigation specifications. PBN and the gradual transition towards GNSS-based environment is one of the main pillars of the SESAR/NextGen concept which in turn aids in achieving ICAO's Global ATM Concept

- Interoperability with other ICAO regions within the ECAC Area

- Safety improvement by providing a very precise lateral and vertical flight path according to Eurocontrol APV Baro Safety Assessment (gradual elimination of non-precision approaches will reduce the potential for CFIT). No accidents have been reported to date associated with the use of RNP/RNAV procedures. In contrast, for all CFIT accidents, 60% occur on non-precision approaches using conventional navaids

- Capacity increase. Delays, congestion and choke points at airports and in crowded airspace may be reduced because of new parallel offset routes through terminal airspace. Additionally, more closely spaced procedures for better use of airspace, and reduced or eliminated conflict in adjacent airport flows

- Increased use of Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO)

- Obstacle clearance constraints can be better accommodated by applying optimized PBN tracks

- PBN routes may be more direct, reducing the track miles flown, which means lower fuel use and lower emissions. Reduction of high-thrust go arounds. Flying down the middle of a defined path means less throttle activity and better avoidance of noise-sensitive areas, so people on the ground perceive less jet noise and are exposed to fewer engine emissions

- The navigation infrastructure is a key element in PBN and the transition to an RNAV environment is linked to a move towards a space-based navigation environment (Global Navigation Satellite System – GNSS) and a move away from dependence on traditional ground-based navigation infrastructure such as VOR and NDB facilities. This in turn will allow rationalization of infrastructure leading to savings from capital investment; maintenance and spectrum utilization with commensurate savings passed onto the operators through reduced navigation services charges and a requirement to carry less equipment

- From an aircraft operator perspective, certain carriers have long claimed that their fleet capability far exceeded anything the airspace could offer by way of capacity and environmental benefits. So with the modern air transport aircraft having this enhanced performance and functionality, PBN starts to harness that aircraft capability. For those with less well equipped aircraft, pressure to upgrade or be faced with exclusion from certain routes or procedures, has to be applied as an incentive rather than as a threat to their business

- PBN brings about a more disciplined approach through a limited set of specifications which are globally applied. The aircraft and equipment manufacturers therefore have greater certainty in their market place and can anticipate a tangible return on their capital investment in the aircraft's performance capability

- All runways in Cyprus have a conventional NPA procedure either as back-up or primary approach. The APV procedures with vertical guidance may lead to lower landing minima, thus increasing the use of a runway during lower visibility operations or in the event of an unserviceable ILS. In turn this can reduce the number of diversions

## 4. Challenges

### 4.1 Increasing Demands

The Global and European Aviation Community is encouraging States, including Cyprus, to advance air transportation by improving their ATM systems. The demand for air transportation remains and it is foreseen to continue to increase in the following years. The SES (Single European Sky) project is aiming at the defragmentation of airspace over Europe thus creating additional capacity and improving ATM efficiency.

The environmental consciousness is increasing along with the recent developments thus pollution, waste, noise are key factors in implementing ways for increased capacity and efficiency.

From the ATC perspective, airspace capacity must be increased whilst at the same time keep the controller workload at a justifiable level.

#### 4.1.1 En Route

Airspace design enroute must be based on a strategic ATS-route system along main traffic flows enabling optimum connections to the SID/STAR systems, coordinated connections to neighboring states, flexible use of airspace and fulfilling the capacity demand. This could possibly be done with RNAV 1 routes. This challenge can be an issue on the Blue Med project. Direct routing is applied whenever possible and Free Routing Airspace is one of the Blue Med objectives. The restructuring of airspace along with the provisions of tools in assisting the controllers can increase the capacity without imposing heavier burden on the controllers.

Fleet mixture is another challenge that has to be addressed. Minimum Equipment List can be mandated by Civil Aviation Rules. Incentives can also be given by a "better equipped, better served" rule.

#### 4.1.2 Terminal Areas (Departures and Arrivals)

The economic recession and the cost reduction driven policies adopted by airport owners/managers are making the case of adopting and investing in new technologies very difficult. The limited knowledge about navigation technology and its long term benefits are difficult to be fully understood.

Airspace design of TMAs must be based upon a strategic SID/STAR system enabling continuous climb departures and continuous descend approaches and which serve the declared airport capacity. Point of merge technique can be one of the solutions in increasing capacity.

Mixed mode operations and accommodation of general aviation must be addressed during the transition period to PBN

#### 4.1.3 Approach

The considerations mentioned above (4.1.2) are taken into account in the approach. Airspace capacity around airports can be increased by introducing RNP as the aircraft will fly precisely along published routes especially in turns. The procedural environment of Cyprus airports makes RNP operations a necessity.

### 4.2 PBN Implementation Challenges

During the transition to PBN environment the major stakeholders will face important challenges. The aviation authorities (executives, ANSPs, regulators) will have to deal with rules changes and preparatory work. The aviation industry will face significant challenges in managing a diverse range of navigation systems and requirements.

- Mixed fleet/systems operations
- Adoption of Civil Aviation Rules. Policy for the application of PBN in Cyprus airspace in accordance with International obligations like i.e. ICAO, SES, SESAR, BLUE MED
- GNSS system performance and prediction of availability service. Limitation on the use of GNSS (requirements for conventional back-up, etc)
- Operational benefits analysis
- Publication of high level strategy statements
- Flight procedure design. Approach naming and charting conventions
- Navigation database integrity and control
- Availability of competence resources/ key personnel within all stakeholders organizations
- Pilot, engineer, ATC training and endorsement
- Workload for Safety Assessment for each RNP APCH procedure

### 4.3 Efficient Operations

Synchronized integration of PBN and non PBN air routes, airspace and aircraft will be vital if efficiency gains can be fully realized. The benefits from efficient operations are not likely to be experienced in the near future since changes in traffic route design and traffic flows take a significant amount of time to be implemented. It is necessary to cooperate with neighboring service providers to maximize the benefits from PBN implementation. For Cyprus the BLUE MED implementation plan is a key enabler in achieving increased efficiency and capacity objectives. Part of the BLUE MED plan can be seen in Appendix 2.

#### 4.3.1 En Route

RNAV routes will be designed to improve operational efficiency. BLUE MED presents the regional strategy addressing the issues of increased efficiency and capacity (e.g. Free Route Operations)

#### 4.3.2 Terminal Areas

Through PBN greater flexibility of airspace design in the terminal airspace will contribute to efficiency.

To shorten the routes to the maximum possible extent, arrival routes will be connected to the approach phase with a continuous descent profile from top of descent (CDO). Reduced track distances will also apply for departure routes. De-confliction of SIDs and STARS to the maximum possible extent will allow continuous climb operations.

The PBN enabled ‘direct to’ ATS routes will have a positive impact in reduction of noise and fuel consumption.

#### 4.3.3 Approach

PBN enabled approaches with vertical guidance based on Baro-VNAV will be designed for all airports in Cyprus in the foreseeable future. The replacement of non-precision approaches can result in significant benefit to operating minima such as required visibility and Decision Height (DH). Specifically reduced DH to a given runway end will result in fewer flights diverting to alternate airports or cancelled.

### 4.4 Environment

Environmental challenges include minimizing the impact of noise and emissions on both the communities in the proximity of aerodromes and the global environment. There should be a consensus between airport and operators on one hand and government, municipalities and environmental authorities on the other, of the benefits and limitations of designing and flying the RNAV and RNP procedures. This collaborative approach will deliver environmental benefits while preserving aviation safety and efficiency.

## 5. Implementation

The PBN implementation strategy in Cyprus is divided in three parts (terms). Short Term (2013-2014), Medium Term (2015-2017) and Long Term (2018-2020).

### 5.1 Short Term (2013-2014)

#### 5.1.1 En-route

Existing B-RNAV routes will be continued for en-route applications to at least 2018. New RNAV routes are to be based on the RNAV 5 Standard. Route design criteria for RNAV 5 routes are to be determined by referring to the ICAO PANS OPS Manual and the ICAO PBN Manual. Direct Routing will still be applied. Free Routing Operations will apply in accordance with the BM Objectives.

#### 5.1.2 Terminal Areas (Departures and Arrivals)

The restructuring of the airspace around Larnaca in accordance with ICAO PANS OPS requirements is at a mature stage. A Terminal Area has been designed, new fixed transition altitude has been decided and new conventional STARS and SIDS and let down procedures are already designed. The publication is expected in the next six months.

The same airspace design concept will also apply for Paphos as soon as the Larnaca procedures are published. The process is expected to be completed in the second mid of 2014.

Cyprus will implement RNAV 1/RNP procedures to be supported though the use of GNSS .The RNAV 1 SIDS and STARS will overlay the new conventional procedures. In an environment without adequate ground navigation infrastructure, the SID/STAR application of RNAV 1 might necessitate exclusive application of GNSS. In this phase, aircraft that do not meet the RNAV 1 Standards (non-capable) will be requested to fly on VOR/DME/NDB routes, whereas aircraft that meet the RNAV 1 Standards (capable) are to fly in general on RNAV routes (Mixed Operations). These RNAV1 trajectories will also improve efficiency in running continuous climb and descent operations.
Monitoring will allow national feedback. The airlines will thus be invited, through working bodies, to monitor the planned deployment of these RNAV1 trajectories and inform the DCA as soon as possible of the equipment and RNAV 1 approval plan for their fleet.
Studies are to be conducted for development of RNP 1 routes. Currently there are certifications RNAV 1, RNAV 5, RNP APCH. No certification for RNP 1. This is expected to be incorporated with the Advanced RNP certification.

#### 5.1.3 Approach Procedures

New RNP APCH (RNAV GNSS) will be designed without vertical guidance to intercept the ILS (precision rwy ends) or the FAF (non precision rwy ends). To facilitate transitional period, conventional approach procedures and conventional navigation aids should be maintained for non- equipped aircraft.

#### 5.1.4 Helicopter Operations

No change to existing procedures

### 5.2 Medium Term (2015-2017)

#### 5.2.1 En-route

First thinking will be conducted by the DCA, especially within the scope of BM, to analyze the benefits and the appropriateness of using new navigation specifications for the en route network, so as to reduce spacing between routes and improve traffic flow. In addition a Free Route Airspace with the aim to provide selectable user preferred routes in Cyprus airspace is established.

#### 5.2.2 Terminal Areas (Departures and Arrivals)

Consistent RNAV operations from departure to arrival are to be developed. Terminal Control Airspace (TMA) RNAV 1 & RNP 1 will be designed. The application of RNAV 1/RNP 1 will also depend on GNSS availability and aircraft navigation capability. Where a surveillance service is available it will be provided by the existing PSR/SSR network and by ADS-B systems when these are commissioned, integrated with ATM system and certified for use. Mixed operations are expected to be permitted (equipped or non-equipped).

First thinking will be conducted by the DCA and its BM partners to analyze the benefits and appropriateness of using new navigation specifications for terminal areas, as with the future Advanced RNP. Use of better levels of accuracy but also advanced functionalities (fixed radius turn enabled by the RF function) could indeed allow new design solutions to be offered in TMAs for complex operational environments.

#### 5.2.3 Approach Procedures

Priority should be given to the implementation of Approach Procedures (RNAV GNSS) with vertical guidance (APV) (APV Baro-VNAV). APV Baro-VNAV criteria is waiting for enhancements like offset criteria and Vertical Error Budget (VEB) methodology. The standard approach procedure will be GNSS based. This will significantly contribute to improving safety because it reduces pilot workload and prevents CFIT. APV procedures of 50% for all instrument runway ends should be completed at the end of 2017. ILS will be retained and ground based approaches are considered to be essential for contingency purposes.

#### 5.2.4 Helicopter Operations

No change to existing procedures

### 5.3 Long Term (2018-2020)

#### 5.3.1 En-route

The mandate for GNSS carriage will together require the withdrawal of the RNAV 5 mandate in ECAC area. Routes based on RNAV 5 standards are to be changed gradually to RNAV 1/RNP 1. In addition a possible extended Free Route Airspace with the aim to provide selectable user preferred routes in Cyprus airspace is established. This aims to construct a nationwide route network in Cyprus based on RNAV/RNP that can achieve a higher level of operational efficiency. Multiple constellations with dual frequency will become available in the European Region (GPS, GLONASS, GALILEO, and EGNOS). This will allow the use of satellite resources alone for aircraft navigation to be consolidated and made thoroughly reliable Terrestrial navigation systems will be retained as contingency infrastructure. Communications will be provided by VHF network and possibly CPDLC.

#### 5.3.2 Terminal Areas (Departures and Arrivals)

Departure and arrival routes that are designed based on the RNAV 1 standards are to be changed gradually to routes based on RNP 1 and consequently to Advanced RNP (A-RNP) when it is introduced. This will require a higher level of navigational performance and FMS functionality enabling higher level of operational efficiency by closely linking 4D-RNAV and ATM. Use of better levels of accuracy but also advanced functionalities (fixed radius turn enabled by the RF function) could indeed allow new design solutions to be offered in TMAs for complex operational environments.

#### 5.3.3 Approach Procedures

In this phase, the full availability of RNP APCH with Baro-VNAV at airports is expected. Whilst in many cases provide the only means of executing vertically guided approach for the runways without precision approach capability, these will also serve as a back-up to precision approaches. Multiconstellation will alone GNSS procedures. ILS remains as final approach and landing application over foreseeable future.

#### 5.3.4 Helicopter Operations

No change to existing procedures

## 6. PBN Implementation Strategy in Cyprus

The implementation of PBN operations will result from the cooperation of the stakeholders involved. The main processes are listed below:

### 6.1 Determine Requirements – Airspace concept development

- Select relevant stakeholders. Seek opinions for the preparation of processes
- Assess fleet capability and navaid infrastructure
- Assess GNSS infrastructure
- Identify performance and functional requirements
- Cost/benefit analysis

### 6.2 Identify Navigation Specifications for Implementation

- Review and select ICAO Navigation specifications and appropriate airworthiness circulars and procedure design guidance material
- Identify the appropriate ICAO navigation specifications to apply in the Cyprus communication and ATM environment

### 6.3 Plan and Implement

- Formulate safety plan
- Validate airspace concept for safety
- Design procedure (En-route, arrivals, departures and approaches)
- Make implementation decisions
- Conduct flight inspection and validation
- ATC system considerations
- Provide awareness and training for ATC and flight crews
- Establish operational implementation date

***Abbreviations and Definitions***

**4D RNAV**: Lateral, longitudinal, vertical and time guidance

**ADS-B:** Automatic dependent surveillance-broadcast is a surveillance technology for tracking aircraft

**AIS:** Aeronautical Information Service

**ANSP:** Air Navigation Service Provider is a body that manages flight traffic on behalf of a company, region or country

**APV:** Approach Procedures with Vertical Guidance. An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations (ICAO 8168 – PANS OPS)

**ATM:** Air Traffic Management - the activity of or organization managing air traffic

**Baro VNAV:** Barometric vertical navigation is a navigation system that presents to the pilot computed vertical guidance referenced to a specified vertical path angle (VPA), nominally 3°. The computer-resolved vertical guidance is based on barometric altitude and is specified as a VPA from reference datum height (RDH) (PANS OPS)

**CCO:** Continuous Climb Operations

**CDO:** Continuous Descent Operations

**CFIT:** Controlled Flight Into Terrain

**CNS:** Communications, Navigation and Surveillance

**CPDLC:** Controller – pilot data link communications (CPDLC), also referred to as controller pilot data link (CPDL), is a method by which air traffic controllers can communicate with pilots over a datalink system

**DME:** Distance Measuring Equipment

**ECAC:** European Civil Aviation Conference

**EGNOS:** European Geostationary Navigation Overlay Service is a satellite based augmentation system (SBAS) developed by the European Space Agency, the European Commission and EUROCONTROL. It supplements the GPS, GLONASS and Galileo systems by reporting on the reliability and accuracy of the positioning data.

**FAB:** Functional Airspace Block is defined in the SES-2 legislative package, as follows: A FAB means an airspace block based on operational requirements and established regardless of State boundaries, where the provision of air navigation services and related functions are performance-driven and optimized with a view to introducing, in each functional airspace block, enhanced cooperation among air navigation service providers or, where appropriate, an integrated provider.

**GALILEO:** Galileo is a global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA)

**GLONASS:** *Globalnaya Navigatsionnaya Sputnikovaya Sistema* or Global Navigation Satellite System, is a radio-based satellite navigation system operated for the Russian government by the Russian Aerospace Defense Forces. It both complements and provides an alternative to the United States' Global Positioning System (GPS) and is the only alternative navigational system in operation with global coverage and of comparable precision

**GNSS:** Global Navigation Satellite System is a generic term for all satellite navigation systems and their augmentations. GNSS includes GPS, ABAS, SBAS, GBAS, Galileo, Glonass, Compass

**ICAO:** International Civil Aviation Organization

**ILS:** Instrument Landing System

**LNAV:** Lateral Navigation - the minima line on the chart for RNP Approaches without vertical guidance

**VNAV:** Vertical Navigation

**LNAV/VNAV:** the minima line based on Baro-VNAV system performances that can be used by aircraft approved according to AMC 20-27 or equivalent

**NextGen:** Next Generation Air Transportation System proposes to transform America's air traffic control system from a ground-based system to a satellite-based system

**NDB:** Non Directional Beacon

**PBN:** Performance-Based Navigation. The PBN concept specifies Navigation Specifications in terms of navigation system performance accuracy, integrity and continuity along with the functionality required onboard an aircraft for the proposed operations

**PSR/SSR:** Primary Radar Surveillance/Secondary Radar Surveillance

**RF** function: Radius to Fix leg is defined as a constant radius circular path around a defined turn center that terminates at a fix

**RNAV:** Area Navigation is a method of navigation that permits aircraft operation on any desired flight path within the coverage of ground or space based navigation aids or within the limits of the capability of self-contained aids, or a combination of these

**RNP:** Required Navigation Performance

**RNP APCH:** RNP Approach supports all leg types and path terminators used in standard RNAV

**SESAR:** Single European Sky ATM Research is the name given to the collaborative project that is intended to completely overhaul the European airspace and its Air Traffic Management (ATM)

**SID:** Standard Instrument Departure

**STAR:** Standard Arrival

**VOR:** Very High Frequency Omni Directional Range

**APPENDIX 1** *ICAO Assembly Resolutions A37-11*

The implementation of RNP APCH procedures with vertical guidance (APV) was primarily encouraged by ICAO Assembly Resolution 36-23 which urges the States to implement APV procedures to all instrument runway ends by 2016, either as primary or as backup approach procedures. RNP APCH to LNAV/VNAV and RNP APCH to LPV minima were the two options to fulfill the resolution. But the resolution A36-23 was updated at the 37th Assembly of ICAO, and resolution A37-11(supersedes A36-23) now presents RNP APCH to LNAV minima as an acceptable alternative to APV in places where APV implementation is not possible or does not make sense as no aircraft are suitably equipped for APV operations. RNP APCH implementation is part of the resolution for ICAO PBN deployment, the main objective of which is to improve safety.

The executive part of the resolution A37-11 states:

*[…]The Assembly:*

*1. Urges all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the Performance-based Navigation (PBN) Manual (Doc 9613);*

*2. Resolves that:*

*a) States complete a PBN implementation plan as a matter of urgency to achieve:*

*1) implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and*

*2) implementation of approach procedures with vertical guidance (APV) (Baro - VNAV and/or augmented GNSS), including LNAV only minima for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and*

*3) implementation of straight-in LNAV only procedures, as an exception to 2) above, for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with amaximum certificated take-off mass of 5 700 kg or more;*

*b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands;*

*3. Urges that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway end serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones;*

*4. Instructs the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly, as necessary;*

*5. Requests the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report annually to ICAO any deficiencies that may occur; and*

*6. Declares that this resolution supersedes Resolution A36-23. […]*

**APPENDIX 2** *BLUE MED FOR RNP APPROACH PROCEDURES WITH APV AND FREE ROUTING OPERATIONS*

***RNP Approach Procedures with APV***

RNP APCH procedures are the simplest RNP procedures that provide instrument approaches to runways. RNP APCH procedures are well suited for providing instrument approaches to runways that do not currently have adequate ground-based navigation facilities to support an instrument approach or to back up existing ground-based navigation procedures

RNP APCH procedures with APV allow precision-like guidance to runways without the need for ground infrastructure. While RNP APCH procedures with APV do not provide for curved paths or other advanced capabilities of RNP AR, they offer a simplified solution that provides precise vertical guidance to runways. RNP APCH procedures with APV capability provide an immediate solution to ICAO's global call for implementation of PBN approaches to all instrument runways ends by end of 2016. As a matter of fact, ICAO have recommended that States plan the implementation of approach procedures with vertical guidance (APV) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016. This recommendation covers the publication of either or both RNAV approach down to LNAV/VNAV and LPV minima (also called respectively APV Baro and APV SBAS).

***Free Route Operations***

The Free Route Airspace is a specified airspace in which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate way points, subject to airspace availability. Within this airspace flights remain subject to air traffic control.

***RNP Approach Procedures with APV BLUE MED plans***

The BLUE MED Implementation Programme, in line with the IDP, plans the coordinated deployment of RNP procedures with APV within the BLUE MED area. This activity foresees the identification of a national RNP approach deployment plan (with local priorities), design and publish of procedures for APV/BARO and/or APV/SBAS and Safety Case development. All RNP activities will be coordinated and periodically reviewed by the Focal Points appointed for the BM-IP. Below the Implementation Programs and the IDP National plans for the BLUE MED FAB Members' ANSPs.