Approved by:

PRESIDENT

Civil Aviation Authority

PBN Implementation Plan

POLAND

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1. Background/Introduction

In future aviation concepts developed within SESAR and its US equivalent NextGen, the use of Performance Based Navigation (PBN) is considered to be a major ATM concept element. ICAO has drafted standards and implementation guidance for PBN in ICAO Doc 9613 "PBN Manual". The PBN concept represents a shift from sensor-based to performance based navigation connected with criteria for navigation accuracy, integrity, availability, continuity and functionality. Through PBN and changes in the communication, surveillance and ATM domain, many advanced navigation applications are possible to improve airspace efficiency, improve airport sustainability, reduce the environmental impact of air transport in terms of noise and emission, increase safety and improve flight efficiency.

It is evident that the application of GNSS will become even more common within the next decade. This calls for a preparation of the corresponding navigation infrastructure as well as (inter)national regulations and policy to facilitate the use of (augmented) GNSS during all phases of flight.

At the 37th General Assembly of ICAO held in 2010, the Republic of Poland agreed to ICAO resolution A37-11 "Performance based navigation global goals" which urges all States to implement RNAV and RNP ATS routes and approach procedures in accordance with the ICAO PBN concept. States are therefore requested to complete a PBN plan as a matter of urgency. The second part of the ICAO resolution calls for implementation of RNAV and RNP operations for en route and terminal areas and implementation of approach procedures with vertical guidance (APV both types: Baro-VNAV and/or SBAS including LNAV minima for all instrument runway ends by 2016. The exemption to that is implementation of only LNAV procedures at aerodromes where there are no aircraft suitably equipped with a maximum take-off mass of 5700kg or more.

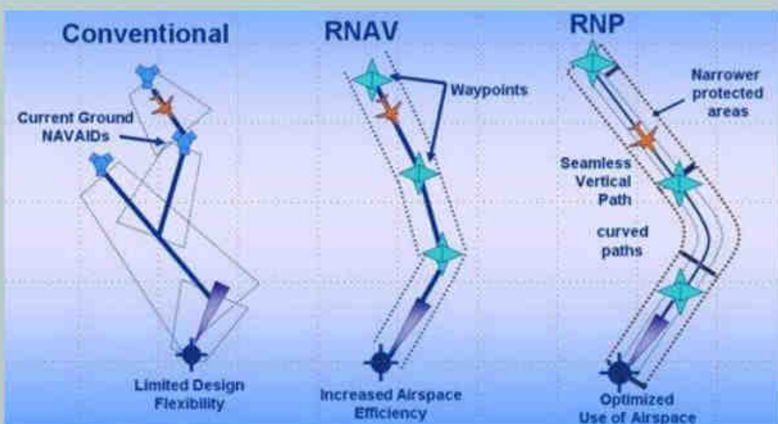
New Assembly resolution on PBN (A37-11), has replaced Assembly resolution A36-23. The main difference between the old and new Resolution is that Aerodromes that have no APV equipped aircraft operating on their runways are exempted from establishing APV procedures, however need to have at least LNAV approaches.

This document contains the Policy for the Application of PBN in the Republic of Poland. It provides a base on which PBN concept may be applied and the regulatory mechanism for the change that will have to be undertaken by the respective Air Navigation Service Providers (ANSPs) and operators in order to realize the projected benefits.

2. Performance Based Navigation Concept

2.1. General

The Performance-based Navigation (PBN) concept specifies that aircraft RNAV or RNP system performance requirements be defined in terms of accuracy, integrity, continuity and functionality required for the proposed operations in the context of a particular airspace concept, when supported by the appropriate navigation aid (NAVAID) infrastructure. Compliance with WGS 84 and data quality prescribed in Annex 15 are integral into PBN. It's a shift from sensor based to performance based navigation.



PBN is one of the enablers of an airspace concept. Communications, ATS surveillance and ATM are also essential elements of an airspace concept. PBN relies on the use of area navigation and comprises of three components:

- The Navigation Application which identifies the navigation requirements resulting from the Airspace Concept such as ATS routes and Instrument Flight Procedures;
- The NAVAID Infrastructure which refers to ground and space-based navigation aids;
- The Navigation Specification which is a technical and operational specification that identifies the required functionality of the area navigation equipment. It also identifies how the navigation equipment is expected to operate in the NAVAID Infrastructure to meet the operational needs identified in the Airspace Concept. The Navigation specification provides material which Poland can use as a basis for developing their certification and operational approval documentation.

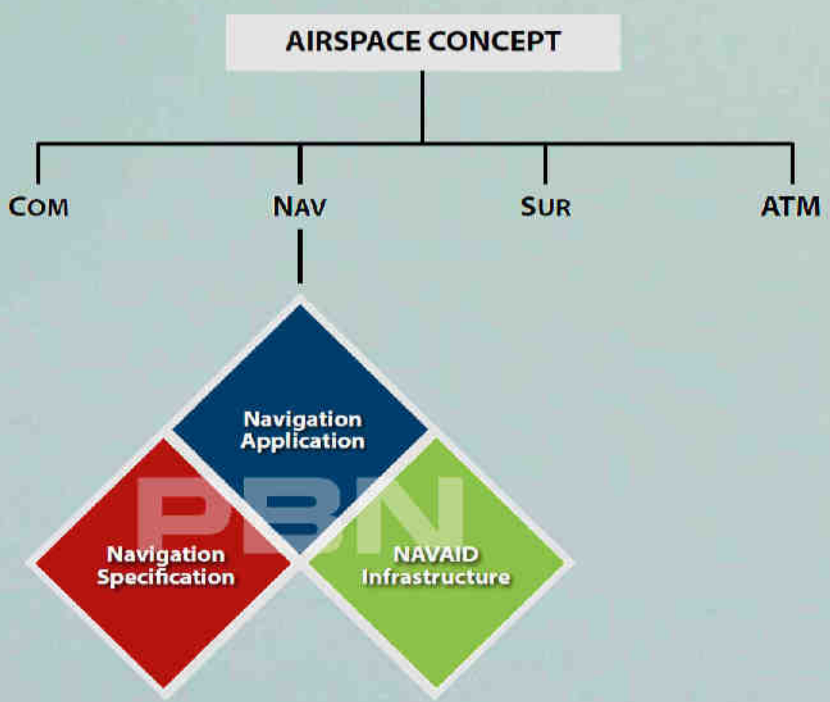


Figure 1. Airspace Concept (Introducing Performance Based Navigation (PBN) and Advanced RNP (A-RNP) - EUROCONTROL)

2.2. Navigation Specification

A navigation specification details the performance required of the RNAV or RNP system in terms of accuracy, integrity, and continuity; which navigation functionalities the RNAV or RNP system must have; which navigation sensors must be integrated into the RNAV or RNP system; and which requirements are placed on the flight crew and aircraft equipment.

The navigation specification is either an RNP specification or an RNAV specification. An RNP specification among other requirements includes a requirement for on-board performance monitoring and alerting. RNAV specification does not include this requirement.

For information what navigation specification designations has been defined by PBN concept and the phase of flight where it can be used refer to ICAO DOC 9613 Performance-based Navigation (PBN) Manual.

2.3. NAVAID Infrastructure

The NAVAID Infrastructure refers to ground or space-based NAVAIDs. Ground-based NAVAIDs include i.e. DME and VOR. Space-based NAVAIDs include GNSS elements as defined in *Annex 10 — Aeronautical Telecommunications*.

2.4. Navigation Applications

A navigation application is the use of the navigation specification and associated NAVAID infrastructure to ATS routes, instrument approach procedures and/or defined airspace volume in accordance with the airspace concept. An RNP application is supported by an RNP specification; an RNAV application is supported by an RNAV specification.

Navigation Specification	Flight Phase								EASA Material
	En route		Arrival	Approach				Departure	
	Oceanic/ Remote	Continental		Initial	Intermediate	Final	Missed[1]		
RNAV 10	10								AMC-20-12
RNAV 5[2]		5	5						AMC-20-04
RNAV 2		2	2					2	To be developed
RNAV 1		1	1	1	1		1	1	JAA TGL No. 10
RNP 4	4								To be developed
RNP 2	2	2							To be developed
RNP 1[3]			1	1	1		1	1	To be developed
Advanced RNP (A-RNP)[4]	2[5]	2 or 1	1	1	1	0.3	1	1	To be developed
RNP APCH[6]				1	1	0.3[7]	1		AMC-20-27 AMC-20-28
RNP AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1		AMC-20-26
RNP 0.3[8]		0.3	0.3	0.3	0.3		0.3	0.3	To be developed

Notes:

1 Only applies once 50 m (40 m, Cat H) obstacle clearance has been achieved after the start of climb.

2 RNAV 5 is an en-route navigation specification which may be used for the initial part of a STAR outside 30 NM and above MSA.

3 The RNP 1 specification is limited to use on STARs, SIDs, the initial and intermediate segments of IAPs and the missed approach after the initial climb phase. Beyond 30 NM from the ARP, the accuracy value for alerting becomes 2 NM.

4 A-RNP also permits a range of scalable RNP lateral navigation accuracies.

5 Optional — requires higher continuity.

6 There are two sections to the RNP APCH specification: Section A is enabled by GNSS and baro-VNAV, Section B is enabled by SBAS.

7 RNP 0.3 is applicable to RNP APCH Section A. Different angular performance requirements are applicable to RNP APCH Section B only.

8 The RNP 0.3 specification is primarily intended for helicopter operations.

Table 1. Overview of navigation specifications by flight phase and associated EASA material

3. Current Status

3.1. PBN Capabilities

Today, the majority of large commercial aircraft have a PBN capability (RNAV and in some cases RNP). In some regions of Europe, it is mandatory for aircraft to meet certain PBN specifications. For example, Europe implemented a mandatory RNAV 5 (B-RNAV) carriage requirement in all en-route airspace in 1998. Some aircraft achieve such basic RNAV performance without GNSS avionics, and so require the availability of an appropriate terrestrial navigation infrastructure within the region (typically based on DME). However, GNSS-based PBN equipage levels are increasing and are expected to continue to increase. This trend provides an opportunity to rationalize terrestrial infrastructure, particularly in areas with a high density of terrestrial navigation aids.

It has been agreed that introduction of GNSS sensor for arrival and departure purposes shall be released in accordance with the common requirements (CR) of EU regulation 1035/2011 throughout Polish CAA approval of instrument flight procedures. Moreover the Polish Air Navigation Services Agency (PANSA) signed an agreement with GUGiK (Polish Head Office of Geodesy and Cartography) to use ASG-EUPOS to monitor the status the GPS system and with DFS (German ANSP) to publish RAIM prediction.

3.2. Current status of RNAV operations in Poland

3.2.1. En-route

The network of ATS routes based on the RNAV5 navigation specification (also known as B-RNAV in Europe) has been introduced in 1998 in all ECAC en-route space from FL 95 and above including FIR Warszawa. VOR/DME remained available for substitute navigation. The Republic of Poland applies the policy defined within the scope of regional air navigation agreements with other members of Europe ICAO region and of ECAC.

3.2.2. Terminal Areas

Within the scope of a coordinated approach under the aegis of Eurocontrol, the Republic of Poland, with other ECAC member States, has committed itself to gradual implementation of RNAV 1 trajectories (also called P-RNAV in Europe) in

Terminal Areas. Since 2009 RNAV 1, SID and STAR procedures have been implemented within Warsaw TMA. It is planned to extend RNAV 1/RNP 1 trajectories to other terminal areas (see Table 4. RNAV1/RNP1 SID and STAR implementation status in TMA's).

3.2.3. Instrument Approach Procedures

Currently conventional instrument approach procedures (ILS, VOR and NDB based) and simultaneously RNAV GNSS procedures based on GNSS ABAS and SBAS (LNAV, LNAV/VNAV and LPV minima) are published for Polish Airports. However the APV approaches are available on a few aerodromes, its implementation is on-going and will cover all instrument RWY ends introducing LPV200 minima.

4. Expected benefits of PBN and Global Harmonization

4.1. General

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. The extent of actual benefits listed below that can be achieved depends on the airspace configuration, type of airport, traffic characteristics and flows and the implementation of other enablers in the CNS/ATM domain.

4.2. Benefits – Safety

- PBN reduces the risk of Controlled Flight Into Terrain (CFIT) accidents by providing a very precise lateral and vertical flight path.
- PBN provides consistent, stabilized approaches to all runway ends, which is a significant benefit for smaller airports that lack the capability for precision approaches.
- The increased pilot situational awareness further enhances the safety level of operations.

4.3. Benefits – Environment

- PBN routes may be more direct, reducing the track miles flown, which means lower fuel burn and lower emissions. This benefit is generally easier to realize for the en-route phase however possibilities do exist for the terminal area.
- PBN is an enabler for Continuous Descent Operations (CDO) and Continuous Climb Departures (CCD) since a fixed lateral path is needed. CDOs reduce noise impact, fuel burn and emission levels. Optimized descent profiles – CDA have been established on most busiest Polish aerodromes.
- PBN-based procedures offer more flexibility to define approach and departure routes in order to avoid populated areas and reduces track dispersion.
- Indirectly, the reduction in emission through enhanced route design and usage provides a path for airline growth when the Emission Trading Scheme (ETS) for aviation is implemented.

4.4. Benefits – Capacity and efficiency

- RNP-APCH flight procedures facilitate approaches to runways that currently do not have a straight-in approach.
- The APV procedures with vertical guidance may lead to lower landing minima, thus increasing the use of a runway during lower visibility or in the event of an unserviceability of ILS system. It leads to the reduced number of diversions and circling operations.

- Enables closely spaced parallel tracks using Fixed Radius Transition (FRT) functionality or Fixed Radius Paths (FRP) reaching increased fuel efficiency, increased airspace capacity and reduced flight time variance.
- PBN poses more flexibility for route design in context of the redesigning of the airspace in Poland. PBN may reduce airspace conflicts between adjacent airports and in some cases between civil routes and airspace used by the military.
- Reduction of controller workload due to predictable traffic flows and potential for less dependencies in inbound-outbound traffic flows, which follows to less need for radio communication.
- RNAV or RNP-based holdings may require a smaller amount of protection airspace.
- The final approach segment can be designed closer to the airport through usage of RF-legs.
- GNSS-based final precision approaches (e.g. GBAS or SBAS LPV200) eliminate the need to safeguard ILS protection areas. When the ILS will be replaced by GLS system then ILS protection areas do not longer exist then the runway can be declared vacated earlier. This reduces the runway occupancy time which in turn may lead to an increase in landing capacity.

4.5. Benefits – Infrastructure cost and maintenance

- In the context of the replacement of conventional NPAs by APV Baro-VNAV or APV SBAS flight procedures, PBN enables a gradual decommissioning of conventional NAVAIDs such as NDB and VOR. This leads to cost reduction for the users due to eliminating costs for procurement and maintenance.
- In case of GBAS: installation does not need to be installed near runway, additionally one GBAS installation can replace several ILS installations and GBAS facilitates flexible procedures for approach and departure.

4.6. Benefits – Interoperability

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

5. Policy for the Application of PBN in Poland

5.1. General

Polish CAA fully supports Performance based Navigation concept as defined in Doc 9613 (PBN Manual) and commits itself, that any new ATS route (including SIDs/STARs) as well as instrument approach procedures to be based on an appropriate PBN specification.

Mindful of the need for a gradual transition to PBN, particularly with respect to terminal and approach procedures, some conventional procedures may be permitted to remain for backup purposes and to allow continued access for non-PBN approved aircraft, for a limited period to be determined by Civil Aviation Authority in consultation with PANSA. After this time all aircraft operating into Polish airspace where PBN is notified will require an appropriate approval.

Flight Phase	NAV Application	NAV Specification	NAV Back-up Infrastructure
En-route	ATS-routes	RNAV 5 (B-RNAV)	VOR/DME (required) Radar
Terminal	SID/STAR	RNAV 1, RNP 1 (P-RNAV)	DME/DME (as required) Radar
Approach	IAP	RNP APCH	Conventional (ILS, VOR, NDB)

Table 2 NAV backup infrastructure for PBN applications based on GNSS sensor

5.2. En-route

All ATS routes within FIR Warszawa require aircraft compliance with the RNAV 5 navigation specification and ensure infrastructure and ATM operations consistent with the RNAV 5 navigation specification except where a case can be made for application of a higher standard e.g., RNAV 1 or eventually, Advanced-RNP.

RNAV 5 is directly equivalent to the European Basic RNAV (B-RNAV) navigation application introduced in ECAC in 1998. It therefore predates the PBN concept and existing airworthiness approval criteria continue to be used. In comparison with other navigation specifications, RNAV 5 has only rudimentary functionality e.g., there is no requirement for a navigation data base. RNAV 5 is therefore an entry-level navigation specification for many States and Regions looking to modernize their airspace structure, yet without an extensive navigation infrastructure. As such, the ± 5 NM navigation accuracy for at least 95% of the time can be met using VOR/DME RNAV or even IRS under limited conditions.

5.3. Terminal Areas

5.3.1. Arrivals & Departures

All existing conventional STARs and SIDs should be phased out on an opportunity basis and replaced by PBN terminal procedures e.g., RNAV 1, Basic-RNP 1 or Advanced-RNP.

RNAV 1 is the ICAO term for terminal airspace navigation applications based on a navigation infrastructure predicated on use of GNSS, DME/DME or DME/DME/IRU ensuring navigation accuracy ± 1 NM for at least 95% of the time. In ECAC airspace, P-RNAV was introduced in 2000 and therefore pre-dates RNAV1. Although P-RNAV is directly equivalent to RNAV 1 in terms of performance and functionality, the underlying navigation infrastructure was assumed to be either GNSS or DME/DME. Consequently, an aircraft approved for European Precision RNAV having only a DME/DME terminal airspace capability may not qualify for RNAV 1 operations in another Region where the infrastructure has been based on aircraft being equipped with Inertial Reference Units (IRU) i.e., supporting DME/DME/IRU. It requires a navigation database and support of specific ARINC 424 Path Terminators. As a condition of an operational approval, the operator should obtain their navigation data base (and updates) from an approved supplier so as to provide a measure of integrity in the aeronautical data process.

Basic-RNP 1 has the identical navigation performance and functionality as RNAV 1 except it requires onboard performance monitoring and alerting, typically supported by GNSS. Intended for terminal airspace environments without adequate DME coverage, the claim that Basic-RNP 1 is equivalent to RNAV 1 in a non-radar environment is a somewhat simplistic as one has to consider how the navigation specification is intended to be used in the given CNS and ATM environment and other mitigating factors e.g., route spacing and traffic density. If GPS equipment is used outside of 30 NM from the aerodrome reference point, the alerting will switch to an en-route value (± 2 NM). Consequently, when implementing Basic-RNP 1 SIDs and STARs beyond 30 NM from the aerodrome, flight crew procedures must account for the automatic switching e.g., manually select the lateral deviation indicator full-scale sensitivity to not greater than 1 NM.

Advanced-RNP is designed to encompass en-route, terminal and approach operations with a discrete set of flight phase navigation accuracies from RNP 2 to RNP 0.3, selectable through the navigation database. As such, Advanced-RNP is designed as a navigation specification reflecting the modern aircraft capability rather than separate flight phase navigation applications. This will enable cost savings to be made for the aircraft manufacturers through having a single airworthiness assessment, from which the specific operational approvals can be granted depending on the nature of the airspace application. In this way, proliferation of navigation specifications should be avoided. The navigation specification has certain "core" features with growth options for functions including Fixed Radius Transition (FRT) and Trajectory Based Operations comprising Required Time of Arrival and the commensurate integrated VNAV functionality that will have to accompany it. Advanced-RNP is significant in that it is the cornerstone for the proposed PBN Implementing Rule in Europe.

5.3.2. RNAV Holding

All new holds shall be designed to be flown manually using a single RNAV fix as the holding waypoint. Where the fleet equipage can support holding functionality i.e., the RNAV system is able to compensate for the effect of wind coming from the outside of the outbound turn by a reduction in bank angle, holds may be designed in accordance with the appropriate ICAO Doc 8168 criteria.

In line with the introduction of RNAV 5 on all ATS routes, it is assumed that all aircraft, as a minimum, will be able to conduct the simplest form of RNAV holding.

5.4. Instrument Approach Procedures (IAPs)

All existing conventional NPAs will be phased out and replaced by PBN approach procedures (RNP Approaches) e.g., NPA RNAV GNSS (LNAV), APV BARO-VNAV or APV SBAS (see Table 5). For a limited period the conventional NPAs (preferably VOR) may be operational as a backup.

For precision approaches – conventional ILS systems is planned to be used with the same status as GLS systems (GBAS).

5.4.1. RNP APCH Navigation Specification

In line with the ICAO 37th General Assembly Resolution A37-11, States are encouraged to implement RNP APCH instrument flight procedures with vertical guidance APV (Baro-VNAV and/or APV SBAS) including NPA ABAS (LNAV minima) at all instrument runway ends. Missed Approaches should be designed to be flown with RNAV systems. The RNP APCH navigation specification leads to approach procedures published under the name "RNAV (GNSS)". This appellation is inherited from previous years with publication of the PBN Manual. It has been kept for (economic and technical) reasons related to aeronautical databases present on board aircraft.

Four types of approach procedures can be designed and published on one RNAV (GNSS) map title for a runway threshold:

- Non Precision Approach (NPA) identified by the presence of the line of LNAV minima – only lateral guidance (2D) based on the ABAS augmented GNSS signal is provided for final approach.
- Non Precision Approach (NPA) identified by the presence of the line of LP minima – only lateral guidance (2D) based on an SBAS augmented GNSS signal is provided for final approach.
- Approach with vertical guidance of barometric type in final (APV Baro-VNAV) identified by the presence of the line of LNAV/VNAV minima – lateral guidance is based on the ABAS augmented GNSS signal. Vertical guidance is based on baro altimeter coupled with FMS.
- Approach with SBAS type vertical guidance in final (APV SBAS) identified by the presence of the line of LPV minima – lateral and vertical guidance (3D) is based on the SBAS augmented GNSS signal.

In Europe, SBAS reinforcement has been enabled by bringing into operational service on 2 March 2011 of the Safety-of-Life service ensured by the EGNOS operator (ESSP). EGNOS receivers can be used during all flight phases, but it is in the approach domain that the main operational benefits are to be expected. APV SBAS procedures represent an alternative resource for aerodromes that are not equipped with ILS. This mainly concerns aerodromes served by business aviation, regional airlines or general aviation. The advantage of implementing these procedures can be measured in terms of improved safety (vertical guidance in final approach) and regularity of service (reduction of operational minima). The Decision Height (DH) associated with this type of final approach stands at 250ft with APV1 signal standard but could be lowered up to 200ft with LPV200 signal standard – equivalent to ILS cat I. APV SBAS procedures are also beneficial for certain operations in helicopters when a steep slope is required. Such procedures, requiring no ground infrastructure, can be set up on sites for operations like hospitals or oil rigs. The main limitation concerning these approaches is the rather low equipage rate of SBAS avionics in fleets, (approx. 3% in 2012 according to

EUROCONTROL and IATA analysis and surveys). But this number is growing fast reaching about 30% in 2017 according to IATA. Nevertheless, aircraft manufacturers and equipment manufacturers are aware of the benefits and therefore more and more often are proposing an SBAS capability.

According to APV BARO-VNAV - nowadays, the main part of the Airbus or Boeing aircraft fleet is equipped with systems capable of performing this type of approach procedure. However, this relatively costly system is not present over the GA and helicopter fleets. It may be present on certain types of business or regional aviation aircraft. APV Baro-VNAV approaches should thus firstly be published on aerodromes receiving commercial traffic, after study of the fleets concerned. Although these approaches include vertical guidance, the latter does not achieve the levels of accuracy and integrity obtained with systems like ILS. When deployed on runways already equipped with ILS, these approaches prove to be useful as a backup during periods of failure or scheduled maintenance of ILS. In the absence of ILS, they will allow safety during the final approach phases to be improved.

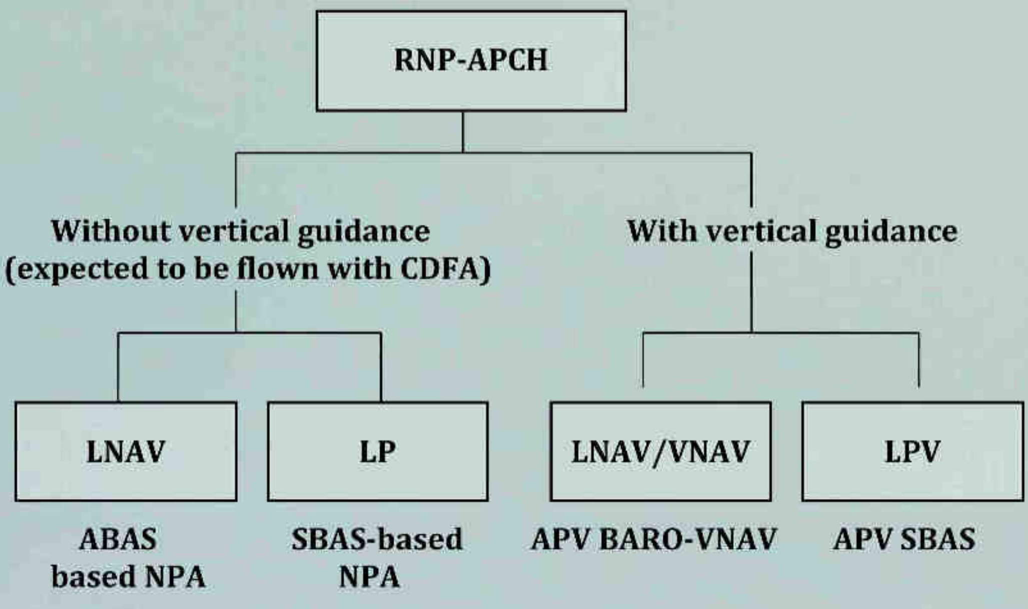


Figure 2. The four types of RNP APCH