PBN Implementation Plan

Republic of Macedonia

Version: SECOND EDITION

Date: 19th November 2018

CIVIL AVIATION AGENCY
Republic of Macedonia

Executive summary

Republic of Macedonia is a signatory of the Convention on International Civil Aviation; the Chicago Convention. The International Civil Aviation Organisation (ICAO), an entity of the United Nations, administers the convention.

In order to ensure a safe and efficient performance of the global Air Navigation System, ICAO has urged all Member 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 PBN Manual (ICAO Doc 9613). ICAO has recommended to member States the implementation of Performance Based Navigation (PBN), the regulatory framework for Area Navigation and 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.

A PBN implementation Plan is needed to facilitate an efficient, globally harmonized and coordinated transition from conventional navigation towards GNSS becoming the prime positioning source for RNAV and RNP applications in all phases of flight using Galileo/GPS/GLONASS, GBAS and SBAS.

The ICAO EUR Region is characterized by diverse air traffic volumes and densities, operational requirements and CNS/ATM capabilities, and thus different navigation applications may be applied by different homogeneous ATM areas, TMAs and airports. For this reason Republic of Macedonia should make clear their own individual plans in order to assist operators in their planning for the transition to PBN, based on the European Roadmap and the PBN Manual (ICAO Doc 9613). This being done by developing a Performance Based Navigation (PBN) Implementation Plan at national level, to ensure the implementation of RNAV and RNP operations (where required) for en-route and terminal areas.

The SECOND VERSION of the PBN Implementation plan of the Republic of Macedonia plan ensures the coherent navigation planning by providing proper guidance and direction to the Macedonian air navigation service provider (MNAV), airports, airspace operators and users, regulating agency (CAA Macedonia), as well as foreign operators who operate or plan to operate in the Republic of Macedonia.

NOTE: PBN Implementation plan represents a living document and it may be a subject of adjustment, due to the change or modification of the PBN Implementation approach in the Republic of Macedonia.

Edition	Date	Status	Author	Justification
Version 1.0	December 2016	Issued by CAA Macedonia	CAA Macedonia	First version
Version 2.0	November 2018	Issued by CAA Macedonia	CAA Macedonia	Revision due to: • implementation realisation; • operators equipage; • new PBN IR (EU) 2018/1048

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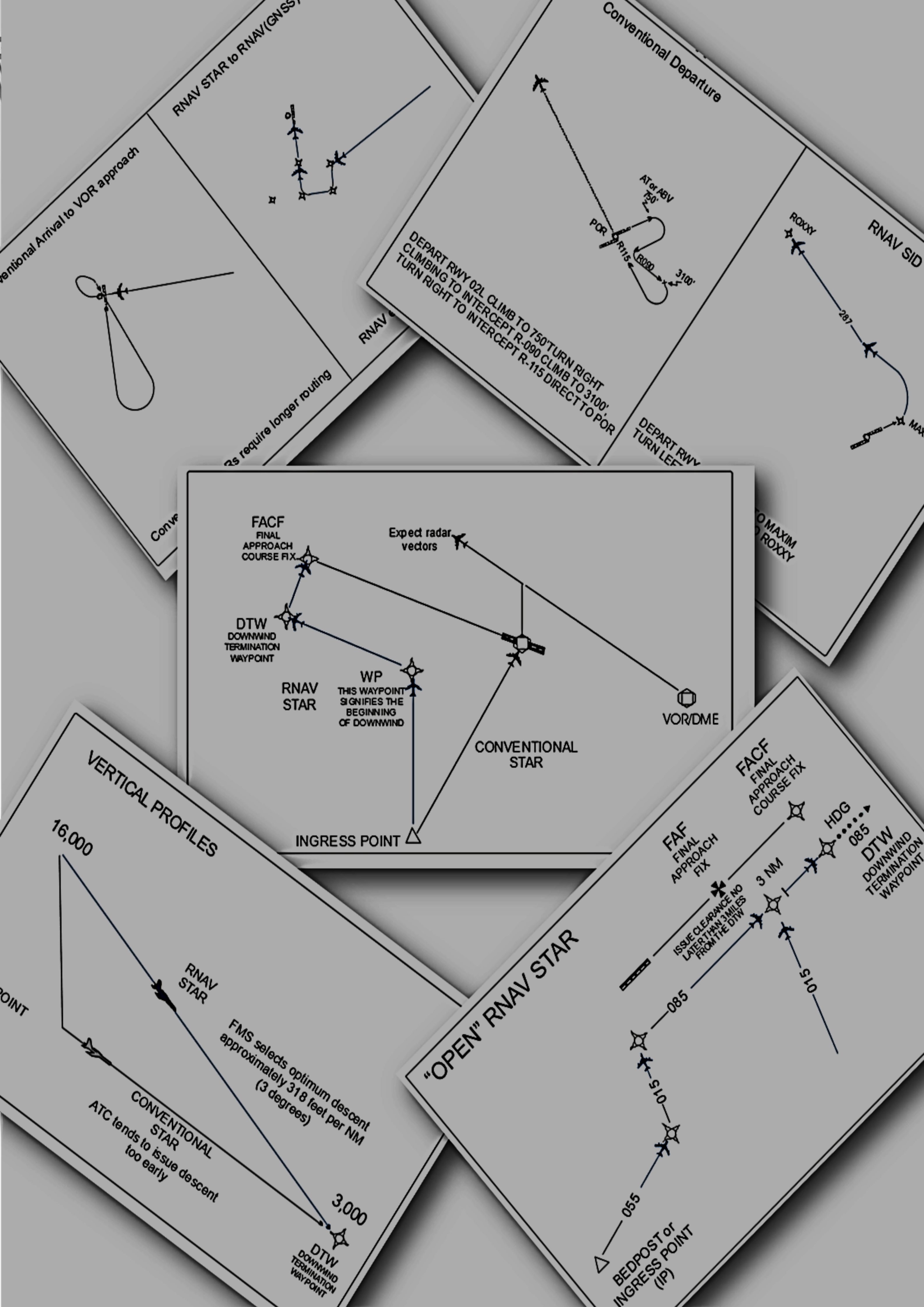

RNAV STAR to RNAV(GNSS)
Conventional Arrival to VOR approach
Conventional Departure
AT or ABV 750'
POR
R115
R090
3100'
DEPART RWY 02L CLIMB TO 750'TURN RIGHT CLIMBING TO INTERCEPT R-090 CLIMB TO 3100', TURN RIGHT TO INTERCEPT R-115 DIRECT TO POR
RNAV SID
ROXXY
287
FACF
FINAL APPROACH COURSE FIX
Expect radar vectors
DTW
DOWNWIND TERMINATION WAYPOINT
WP
THIS WAYPOINT SIGNIFIES THE BEGINNING OF DOWNWIND
RNAV STAR
CONVENTIONAL STAR
VOR/DME
INGRESS POINT
VERTICAL PROFILES
16,000
RNAV STAR
FMS selects optimum descent approximately 318 feet per NM (3 degrees)
CONVENTIONAL STAR
ATC tends to issue descent too early
3,000
DTW
DOWNWIND TERMINATION WAYPOINT
"OPEN" RNAV STAR
FACF
FINAL APPROACH COURSE FIX
FAF
FINAL APPROACH FIX
HDG
085
DTW
DOWNWIND TERMINATION WAYPOINT
3 NM
ISSUE CLEARANCE NO LATER THAN 3 MILES FROM THE DTW
085
015
015
055
BEDPOST or INGRESS POINT (IP)

1 Introduction

1.1 Performance Based Navigation (PBN)

Six strategic objectives have been identified by the ICAO in order to enable the implementation of its vision of safe, secure and sustainable development of civil aviation. The six strategic objectives are as follows:

- Safety - enhance global civil aviation safety;
- Security - enhance global civil aviation security;
- Environmental Protection - minimise the adverse effect of global civil aviation on the environment;
- Efficiency - enhance the efficiency of aviation operations;
- Continuity - maintain the continuity of aviation operations;
- Rule of Law - strengthen governance of international aviation.

To enable these objectives, ICAO has developed a range of higher level plans and initiatives that embrace the concept of the global harmonisation of aviation infrastructure, equipment and procedures and the use of technology to enable CNS/ATM initiatives that collectively promote international aviation safety, efficiency and continuity. Two such initiatives are:

- The Global Air Navigation Plan;
- The Global Aviation Safety Roadmap.

ICAO has set worldwide direction to rapidly transition to performance based navigation and approaches with vertical guidance. The Global Air Navigation Plan is an ICAO document that identifies a series of Global Plan Initiatives (GPI) which focus on specific performance objectives aimed at reducing global aviation's impact on the environment and increasing global ATM safety, efficiency and security through the use of available and foreseen aircraft and infrastructure technology.

Performance based navigation (PBN) presents a concept developed by ICAO, that encompasses both area navigation (RNAV) and required navigation performance (RNP) and revises the current RNP concept. PBN is perceived as the most practical solution for regulating the expanding domain of navigation systems.

Under the traditional approach, each new technology is associated with a range of system-specific requirements for obstacle clearance, aircraft separation, operational aspects (e.g. arrival and approach procedures), aircrew operational training and training of air traffic controllers. Performance based navigation eliminates the need for redundant investment in developing criteria and in operational modifications and training. Under performance-based navigation the operation is defined according to the operational goals.

The advantage of this approach is that it provides a clear, standardized operational approval which enables harmonized and predictable flight paths which result in more efficient use of existing aircraft capabilities, as well as improved safety, greater airspace capacity, better fuel efficiency, and resolution of environmental issues.

The 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. The PBN concept represents a shift from sensor-based to performance-based navigation.

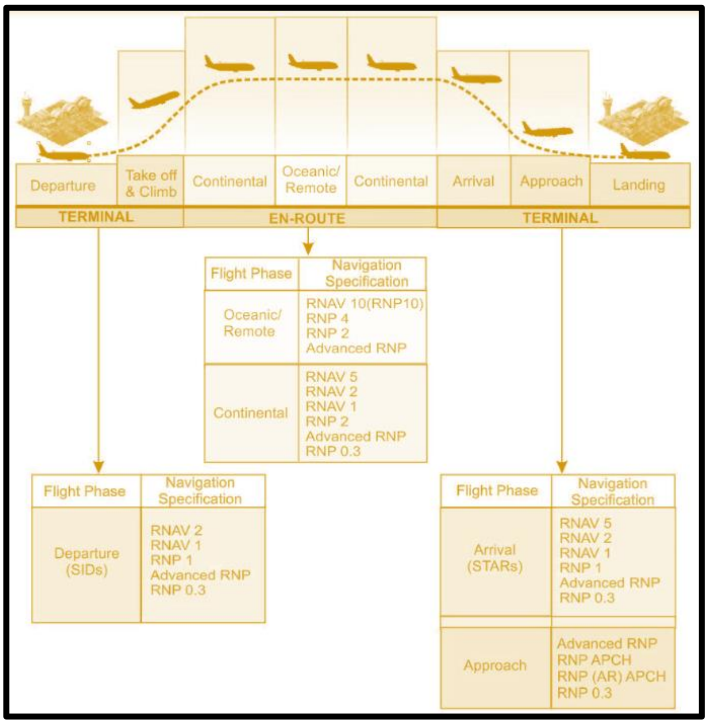

Figure 1 PBN Implementation options per flight phases

CIVIL AVIATION AGENCY
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Continental en-route airspace concepts are currently supported by RNAV and RNP applications. Oceanic and remote continental airspace concepts are currently supported by three navigation applications, RNAV 10, RNP 4 and RNP 2. Existing terminal airspace concepts, which include arrival and departure, are supported by RNAV applications and RNP used in the European (EUR) Region, the United States and, increasingly, elsewhere. The European terminal airspace RNAV application is known as P-RNAV (Precision RNAV) though this is expected to migrate to A-RNP. Approach concepts cover all segments of the instrument approach, i.e. initial, intermediate, final and missed approach. These include RNP specifications requiring a navigation accuracy of 0.3 NM to 0.1 NM or lower.

Performance requirements are defined in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements. 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. 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.

ICAO’s Performance Based Navigation (PBN) concept aims to ensure global standardization of RNAV and RNP specifications and to limit the proliferation of navigation specifications in use worldwide. It is a new concept based on the use of Area Navigation (RNAV) systems. Significantly, it is a move from a limited statement of required performance accuracy to more extensive statements for required performance in terms of accuracy, integrity, continuity and availability, together with descriptions of how this performance is to be achieved in terms of aircraft and flight crew requirements.

1.2 Legal Framework for PBN Implementation Plan

Resolution A36-23 from September 2007 issued by ICAO 36th General Assembly urged 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 Manual (Doc 9613);
- Complete PBN implementation plans by 2009 to achieve implementation of RNAV and RNP (where required) operations for en-route and terminal areas and implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) 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.

Resolution A37-11 from 2010 issued by ICAO 37th General Assembly, superseded the Resolution A36-23, and in addition to A36-23 urged States to:

- Requirement to add LNAV minima to any approach chart procedure with vertical guidance.
- Allow states to publish LNAV only approach if there is no traffic equipped for operations with vertical guidance.
- The ICAO Resolution A37-11 has now been followed up by an amendment to the National Regulation BSL G 4 – 1, valid from 1. January 2012. The new §7a. No (2) impose the introduction of APV to all instrument Runway ends by the end of 2016.

On 18th of July 2018 European Commission has issued Commission Implementing Regulation (EU) 2018/1048 of 18 July 2018 laying down airspace usage requirements and operating procedures concerning performance-based navigation (hereafter: PBN IR). PBN IR is applicable from 3rd December 2020. PBN IR has identify new goals:

- Transition plan – ATM/ANS Providers shall establish and implement a transition plan. Transition plan shall be consistent with the European ATM Master Plan and the common projects and consulted with relevant stakeholders (aerodrome operators, airspace users, Network Manager, adjacent ATM/ANS Providers) and submitted to competent authority for verification of compliance with PBN IR requirements.
- RNAV 5 shall be for all ATC routes at or above FL 150.
- By 25th of January 2024 at least one SID/STAR route per instrument runway end shall be RNAV 1. Convectional and PBN compliant SIDs/STARs may be used.
- By 6th of June 2030 only PBN compliant SIDs/STARs (at least RNAV 1) and other kinds of SIDs/STARs only for contingency purpose.
- Introduction of 3 lines of minima: LNAV, LNAV/VNAV and LPV.
- By 3rd December 2020 all instrument runway ends without existing precision approach to implement RNP APCH.
- By 25th of January 2024 implementation of RNP APCH for all instrument runway ends.

1.3 Objectives of PBN Implementation Plan

The Macedonian PBN implementation plan is targeted to meet the following strategic objectives:

a) Provide a high-level strategy, based on ICAO PBN concepts of RNAV and RNP navigation specifications, to transition Macedonian aviation from route based navigation using terrestrial radio-navigation aids to area navigation using satellite navigation.

b) Provide a general description of the planned evolution of the PBN applications in the long term (beyond 2030).

c) Ensure that the implementation of PBN is based on clearly established operational requirements.

d) Avoid unnecessarily imposing the mandate for multiple equipment on board or multiple systems on the ground.

e) Avoid the need for multiple airworthiness and operational approvals for international operations to/from Macedonian or for operations across Macedonian regions.

f) Prepare for the development towards Advanced RNP.

1.4 Benefits of PBN Implementation

Performance Based Navigation concept allows definition of both lateral and vertical navigation for both straight and curved flight paths. PBN allows route creation in a manner that is no longer constrained by the geometry of ground-based radio navigation aids such as VOR/DME/NDB.

The airspace of the Republic of Macedonia lays down on a Southeast traffic flow connecting northern Europe with the flows streaming to/from Middle-East, which is currently highly influenced by the geo-political situation in the region and beyond (i.e. situation in Syria and Ukraine and terrorist threats in Europe and surroundings that reduced the number of tourist passengers). Many aircraft flying in the Macedonian airspace have been already equipped with advanced navigational capabilities (GPS receivers and high-performance FMS). 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. Many of the operators in general will benefit from the availability of RNP approaches.

The following benefits are expected:

- Global standardization of navigation specifications where PBN and the gradual transition towards GNSS-based environment represents one of the main pillars of the SESAR/NextGen concept which in turn aids in achieving ICAO’s Global ATM Concept.
- PBN implementation ensures the interoperability with other ICAO regions within the ECAC Area. This interoperability can be reflected in the increased safety levels and more harmonised approach towards the implementation of the PBN concept.

- 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). For example, for all CFIT accidents, 60% occur on non-precision approaches using conventional NAVAID's.
- Capacity increase may be ensured by reducing delays, congestion and choke points at airports and in crowded airspace using new parallel offset routes through terminal airspace. PBN ensures the increase in traffic flows by means of parallel routes and additional fixes along the arrival and departure flight paths within terminal areas and increase of the airspace capacity by reducing the lateral and longitudinal separation between aircraft;
- There is a possibility of increased use of Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO). PBN Concept provides possibility for vertical guidance and implementation of continuous steady descent procedures to reduce the risk of controlled flight into terrain (CFIT). 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. PBN allows air traffic operations to be environmentally progressive by reducing aircraft emissions and avoiding noise-sensitive areas.
- People living close to the Airport perceive less jet noise and are exposed to fewer engine emissions due to the PBN operations
- Rationalization of infrastructure leading to savings from capital investment, maintenance and spectrum utilization with commensurate savings passed onto the operators. PBN can improve the overall economic benefits of operations by reducing navigation infrastructure investment and operational costs.
- Allowing aircraft operator to use their modern fleet capability as much as possible in the PBN environment ensuring additional benefits for capacity and environment. Simplified, strategic procedures will also lead to increased safety and predictability.

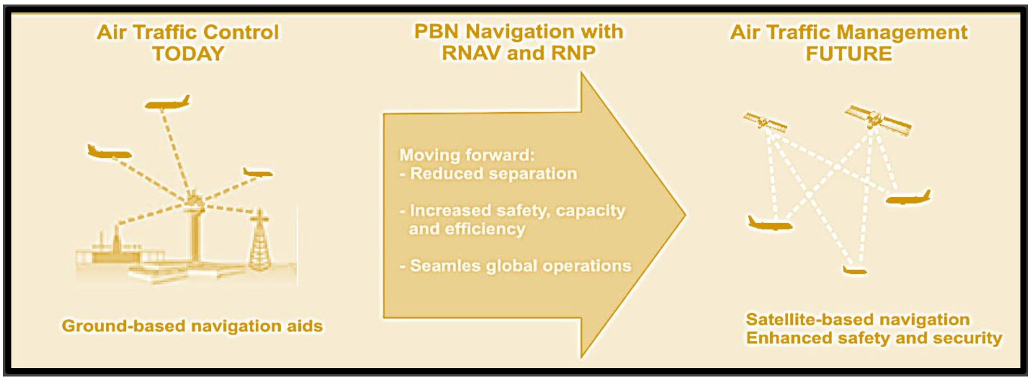


Figure 2 Transition from ATC operations today to the future ATM system

The future implementation of PBN in the Republic of Macedonia will enable all involved stakeholders to realize significant benefits as follows: fuel savings, increased safety level, time savings and predictability of defined routes flow, rationalisation of ground NAV infrastructure, reduced noise and CO2 emission. It is evident that the PBN implementation benefits are primarily envisaged by the financial and environmental nature, ensuring lower cost of aircraft operations, threw reduction of ground based NAV infrastructure at one hand, and on the other hand, the PBN implementation should have a huge positive impact on the environment by reducing noise and CO2 emissions.

1.5 Scope of PBN Implementation Plan

The geographical scope of the PBN Implementation Plan of the Republic of Macedonia is Skopje FIR. This plan describes the development of PBN applications in the future period.

Rationalisation of ground-based navigational infrastructure is not covered by this plan.

The plan identifies development of PBN applications that are covered by the ICAO Resolution A 37-11 and the PBN Implementation Roadmap for the ICAO European Region, i.e. applications in accordance with the navigation specifications in the PBN Manual (ICAO Doc 9613) [1]. Planned development of navigation applications other than these, is not covered in this plan.

This plan includes implementation goals defined by Commission Implementing Regulation (EU) 2018/1048 of 18 July 2018 laying down airspace usage requirements and operating procedures concerning performance-based navigation (i.e. PBN IR).

The following Navigation applications are not covered by the plan:

- Conventional operations (i.e. non-RNAV operations based on ground-based navigational aids)

- GLS operations

These operations are implemented in addition to the PBN applications and do not exempt any airport or TMA from the PBN development.

Continuous descend approach / continuous climb departure is enabled as a consequence of PBN implementation and will be covered during action planning and implementation at each location.

1.6 Analysis of Current situation

1.6.1 Navigation Infrastructure

The NAVAID infrastructure refers to ground- or space-based NAVAIDs. Ground-based NAVAIDs include DME and VOR. Requirements for NAVIADs for defined navigation specification that are formulated by ICAO Navigation Specifications in the PBN Manual, are described in the following table.

Table 1 PRB Navigation Specification

NAVIGATION SPECIFICATION	NAVAID				
	GNSS	IRU	DME/DME	DME/DME/ IRU	VOR/DME
RNAV 10	✓	✓			✓
RNAV 5	✓	✓	✓	✓	
RNAV 2 & 1	✓		✓		
RNP 4	✓				
RNP 2	✓		✓	✓	
RNP 1	✓		✓	✓	
Advanced RNP	✓		✓	✓	
RNP APCH/ LNAV/VNAV	✓				
RNP APCH/LPV	✓ + SBAS				
RNP AR APCH	✓				
RNP 0.3	✓				
Tick (Red), sensor mandatory Tick (Green), Sensor use subject to ANSP requirement & aircraft capability) Tick (Grey background), Sensor optional.					

Currently Republic of Macedonia has not sufficient DME coverage in order to apply DME/DME applications.

Space-based NAVAIDs include GNSS elements as defined in Annex 10 — Aeronautical Telecommunications.

EGNOS Safety of Life Service (SoL) requirements for civil aviation are defined in the following table.

Table 2 EGNOS Safety of Life Service (SoL) requirements

Typical Operation	Horizontal Accuracy (95%)	Vertical Accuracy (95%)	Integrity	Time-To-Alert (TTA)	Horizontal Alert Limit (HAL)	Vertical Alert Limit (HAL)	Continuity	Availability
Initial Intermediate Non-precision approaches & Departure	220 m (720 ft)	N/A	1 –1x10-7/h	10 s	556 m (0.3 NM)	N/A	1 – 1x10-4/h to 1 – 1x10-8/h	0.99 to 0.99999
Approach operations with vertical guidance (APV-I)	16.0 m (52 ft)	20 m (66 ft)	1 – 2x10-7 (per approach)	10 s	40 m (130 ft)	50 m (164 ft)	1 – 8x10-6/15s	0.99 to 0.99999

According to EGNOS Service Provider Monthly Performance Report for November 2016[1] Republic of Macedonia is within the area which is considered compliant to Safety-of-Life (SOL) requirements on availability, continuity and accuracy for NPA, APV-I and LPV-200 applications. The following table presents the measured results.

Table 3 Safety-of-Life (SOL) requirements on availability, continuity and accuracy

	Availability	Continuity	Accuracy
EGNOS Non-precision Approach (NPA)	> 99.9%	< 1.00E-05	100%
EGNOS Approach with Vertical Guidance (APV-I)	> 99.9%	< 1.00E-05	100%
EGNOS Localizer Performance with Vertical Guidance to a decision altitude of 200FT (LPV-200)	> 99.9%	< 1.00E-04	100%

[1] The EGNOS Service Provider Monthly Performance Report November 2016, ESSP-DRD-18676Iss., 01-00 Date: 05.12.2016

1.6.2 Current Navigation Specification Status

The following tables / subchapters present the current Navigation specification status in the Republic of Macedonia in en-route, terminal and final approach areas.

1.6.2.1 En-Route

Airspace	Navigation Specification
EN-ROUTE	RNAV-5

1.6.2.2 Terminal

Airspace	Navigation Specification
SKOPJE TMA	CONVENTIONAL (VOR/DME)

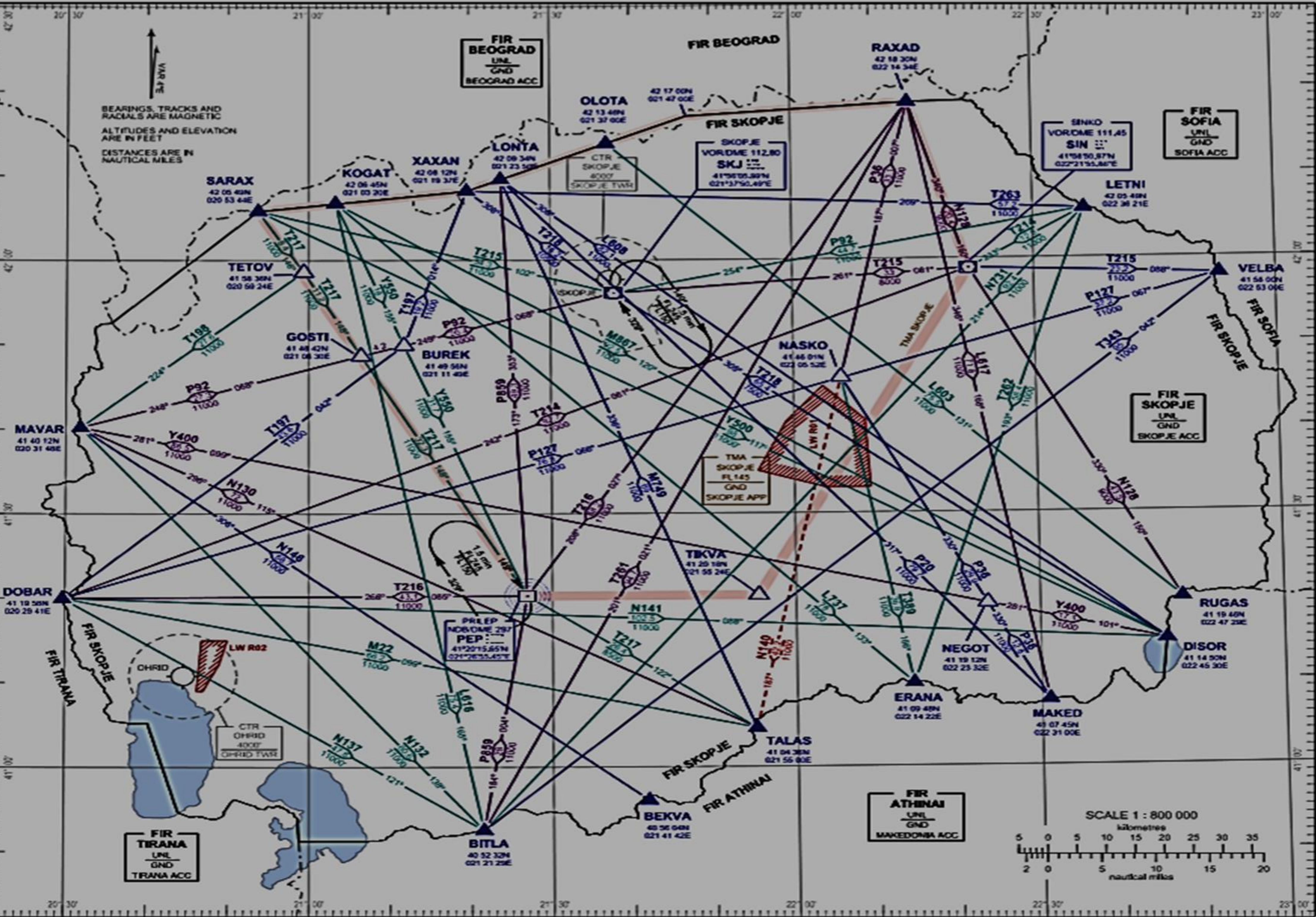
1.6.2.3 Final Approach

Airspace	Navigation Specification
LWSK RWY34	IAP (ILS)
LWSK RWY16	NPA
LWOH RWY01	IAP (ILS)
LWOH RWY19	NPA

1.6.3 Aircraft Equipage

A detailed aircraft equipage assessment has been made and is represented in the following chapter. It has to be noted that all major commercial aircraft manufacturers since the 1980's have included RNAV capabilities and also the commercial aircraft currently produced incorporate an RNP capability, almost 80-90 % of the new IFR fleet strength are RNAV and RNP capable.

FIR SKOPJE ENROUTE CHART - ICAO LOWER AIRSPACE < FL245



2 PBN Implementation challenges

2.1 Navigation Infrastructure

There is currently sufficient navigation infrastructure for en route flights above FL 195 which is represented by the Eurocontrol study (see figure below).

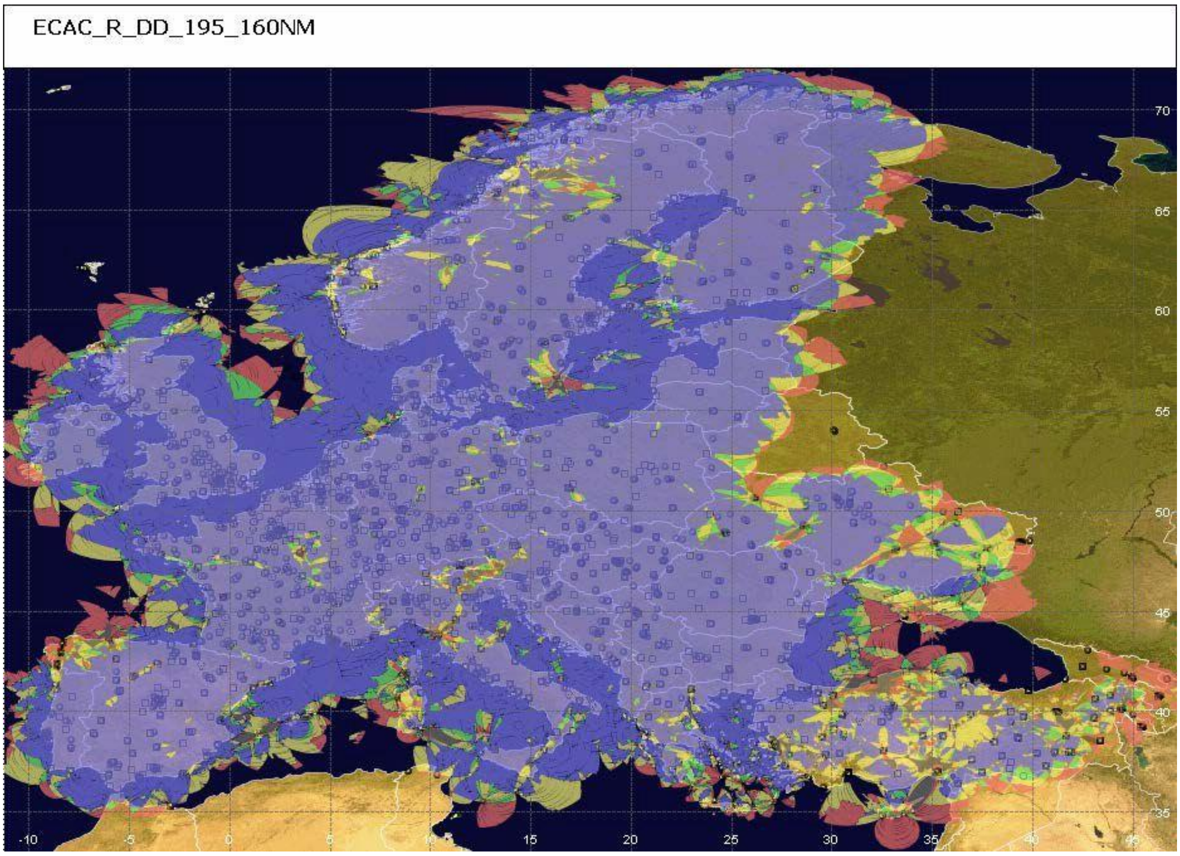


Figure 3 Navigation infrastructure coverage above FL 195

For TMA area there in currently no sufficient DME coverage for DME/DME applications.

In order to fulfil requirement for adequate DME/DME application use of DEMETER tool is planned to define additional DME that could provide coverage in Skopje TMA, or possible re-allocation of existing facilities or commissioning of additional DME(s).

2.2 Aircraft Equipage

This section presents the analysis of the airline operators equipage for the arriving traffic at Skopje (LWSK) and Ohrid Airport (LWOH).

The assessment was performed for the:

- January to September 2016 (the year when the first PBN Implementation plan was submitted;
- “year to date period” 2018 (covering January to September 2018),

providing the sample for the analysis of the Operators PBN equipage.

PBN Operators equipage analysis was performed by using EUROCONTROL CNS Dashboard. The CNS dashboard analyses declared capabilities of flights and aircraft flying in Europe. It does so by:

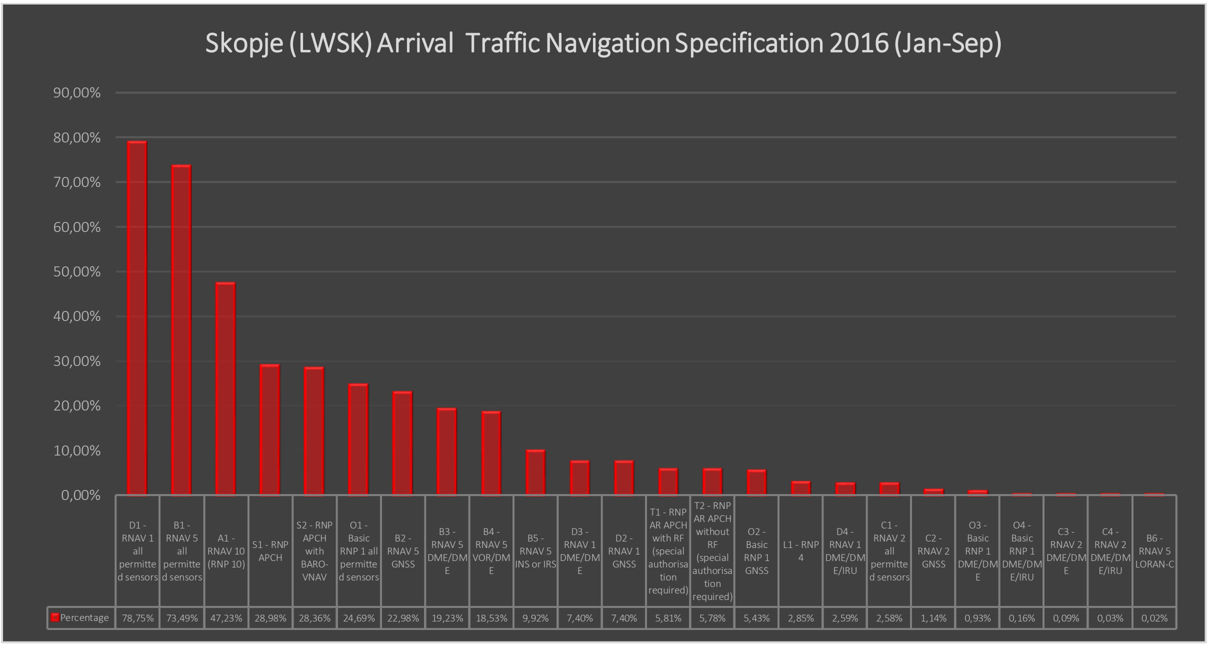
- analysing CNS and PBN information in the ICAO Flight Plans available to the Network Manager (in Item 10 and 18 according ICAO FPL 2012), and
- correlating this with data in PRISME Fleet 2 (EUROCONTROL Worldwide fleet aircraft database) where relevant.

Analytical results (graphs and tables) are available in terms of flights/aircrafts equipage for the traffic arriving at Skopje (LWSK) and Ohrid Airport (LWOH).

2.2.1 Skopje Airport Arrival Traffic PBN Operators Equipage Analysis

The following graph presents the Skopje arrival traffic navigation specification for “January-September” 2016 period. Total number of arriving flights at Skopje airport for abovementioned period was 5 797. Of the total number of flights, the following navigation specifications were used when taking into account TOP 10 navigation specifications:

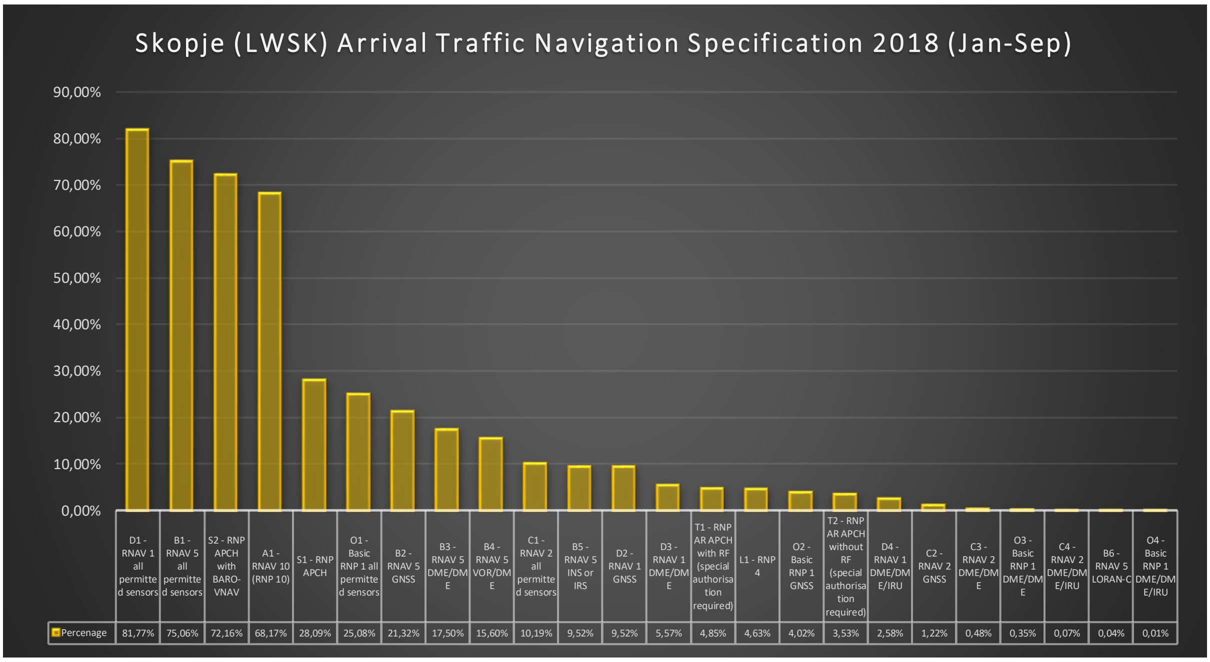
- D1 - RNAV 1 all permitted sensors;
- B1 - RNAV 5 all permitted sensors;
- A1 - RNAV 10 (RNP 10);
- S1 - RNP APCH;
- S2 - RNP APCH with BARO-VNAV;
- O1 - Basic RNP 1 all permitted sensors;
- B2 - RNAV 5 GNSS;
- B3 - RNAV 5 DME/DME;
- B4 - RNAV 5 VOR/DME;
- B5 - RNAV 5 INS or IRS.



Graph 1 Skopje Arrival Traffic Navigation Specification (Jan-Sep 2016)

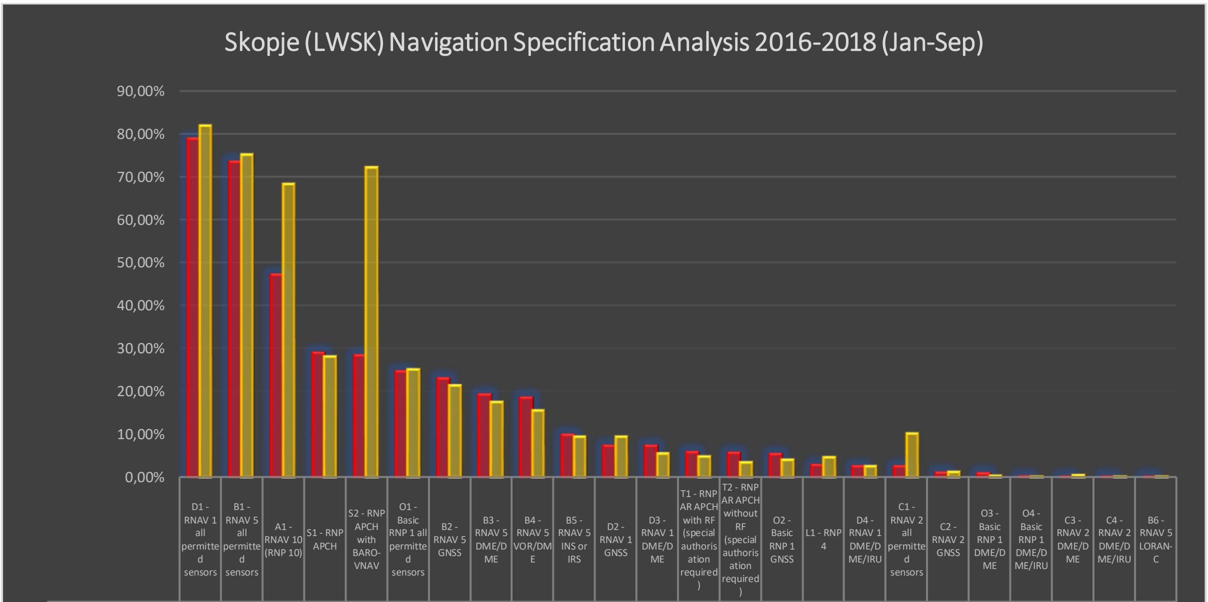
The following graph presents the Skopje arrival traffic navigation specification for "year to date" 2018 period. Total number of arriving flights at Skopje airport for abovementioned period was 6 861. Of the total number of flights, the following navigation specifications were used when taking into account TOP 10 navigation specifications:

- D1 - RNAV 1 all permitted sensors;
- B1 - RNAV 5 all permitted sensors;
- S2 - RNP APCH with BARO-VNAV;
- A1 - RNAV 10 (RNP 10);
- S1 - RNP APCH;
- O1 - Basic RNP 1 all permitted sensors;
- B2 - RNAV 5 GNSS;
- B3 - RNAV 5 DME/DME;
- B4 - RNAV 5 VOR/DME;
- C1 - RNAV 2 all permitted sensors;



Graph 2 Skopje Arrival Traffic Navigation Specification ("year to date" 2018)

When analysing both periods, 2016 vs 2018 it is visible that there is around 18% of more arrival traffic at LWSK Airport. This value has to be taken into account when analysing the Navigation Specification change effect. Between the analysed periods of 2016 and 2018, most of the aircrafts arriving at LWSK Airport have been equipped with the following navigation specifications: RNAV 1 all permitted sensors, RNAV 5 all permitted sensors and RNP APCH with BARO-VNAV (with more than 70% of equipage). The most significant increase in the aircraft navigation specification equipage, when comparing the 2018 vs. 2016 analysed period, have the following navigation specifications: RNP APCH with BARO-VNAV increase of almost 44%.



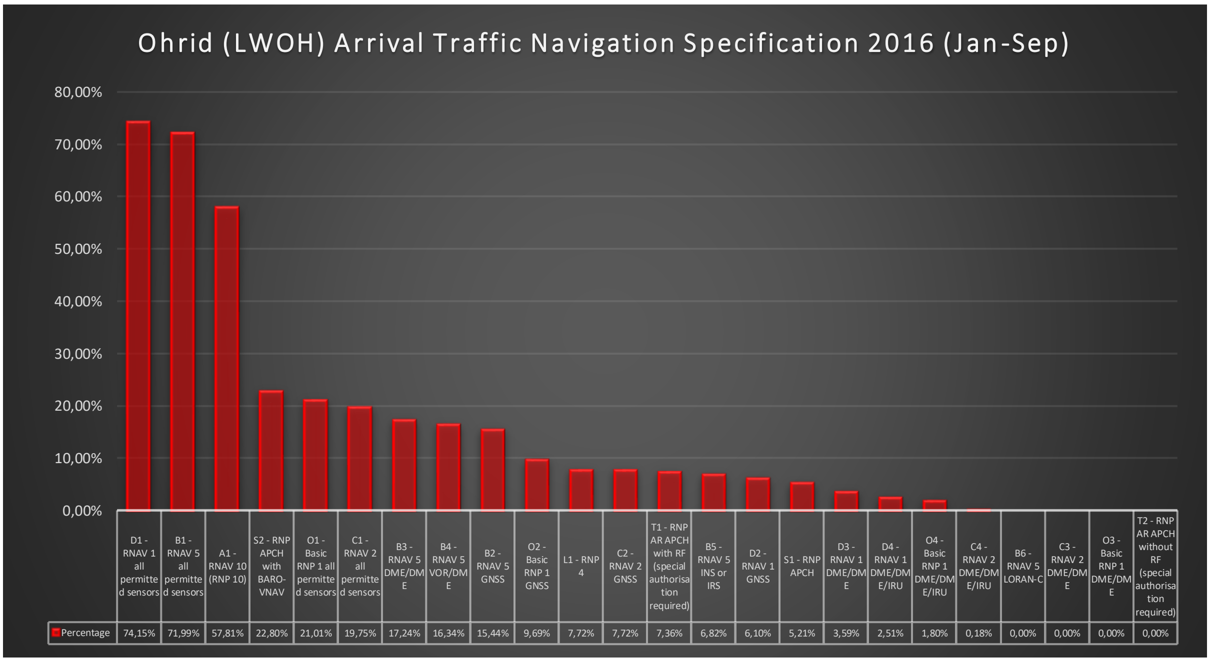
	D1 - RNAV 1 all permitted sensors	B1 - RNAV 5 all permitted sensors	A1 - RNAV 10 (RNP 10)	S1 - RNP APCH	S2 - RNP APCH with BARO-VNAV	O1 - Basic RNP 1 all permitted sensors	B2 - RNAV 5 GNSS	B3 - RNAV 5 DME/DME	B4 - RNAV 5 VOR/DME	B5 - RNAV 5 INS or IRS	D2 - RNAV 1 GNSS	D3 - RNAV 1 DME/DME	T1 - RNP AR APCH with RF (special authorisation required)	T2 - RNP AR APCH without RF (special authorisation required)	O2 - Basic RNP 1 GNSS	L1 - RNP 4	D4 - RNAV 1 DME/DME/IRU	C1 - RNAV 2 all permitted sensors	C2 - RNAV 2 GNSS	O3 - Basic RNP 1 DME/DME	O4 - Basic RNP 1 DME/DME/IRU	C3 - RNAV 2 DME/DME	C4 - RNAV 2 DME/DME/IRU	B6 - RNAV 5 LORAN-C
2016 (% of PBN equipage)	78,75%	73,49%	47,23%	28,98%	28,36%	24,69%	22,98%	19,23%	18,53%	9,92%	7,40%	7,40%	5,81%	5,78%	5,43%	2,85%	2,59%	2,58%	1,14%	0,93%	0,16%	0,09%	0,03%	0,02%
2018 (% of PBN equipage)	81,77%	75,06%	68,17%	28,09%	72,16%	25,08%	21,32%	17,50%	15,60%	9,52%	9,52%	5,57%	4,85%	3,53%	4,02%	4,63%	2,58%	10,19%	1,22%	0,35%	0,01%	0,48%	0,07%	0,04%

Graph 3 LWSK Comparative Analysis

2.2.2 Ohrid Airport Arrival Traffic PBN Operators Equipage Analysis

The following graph presents the Ohrid arrival traffic navigation specification for "January-September" 2016. Total number of arriving flights at Ohrid airport for abovementioned period was 557. Of the total number of flights, the following navigation specifications were used when taking into account TOP 10 navigation specifications:

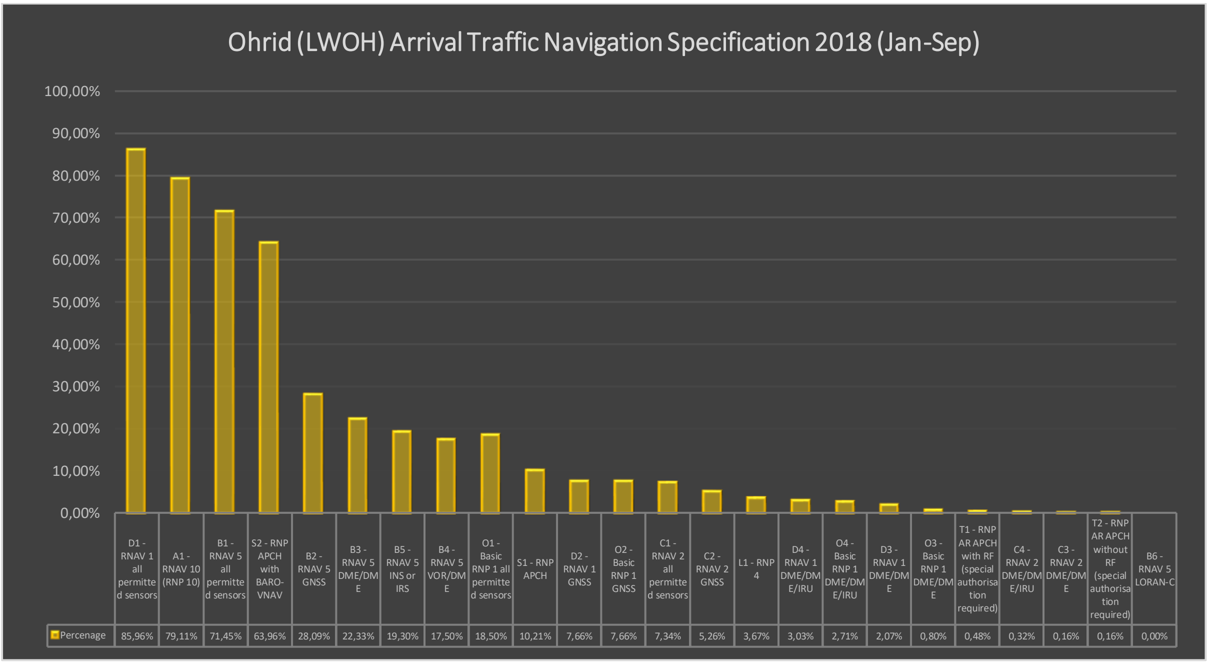
- D1 - RNAV 1 all permitted sensors;
- B1 - RNAV 5 all permitted sensors;
- A1 - RNAV 10 (RNP 10);
- S2 - RNP APCH with BARO-VNAV;
- O1 - Basic RNP 1 all permitted sensors;
- C1 - RNAV 2 all permitted sensors;
- B3 - RNAV 5 DME/DME;
- B4 - RNAV 5 VOR/DME;
- B2 - RNAV 5 GNSS;
- O2 - Basic RNP 1 GNSS.



Graph 4 Ohrid Arrival Traffic Navigation Specification (Jan-Sep 2016)

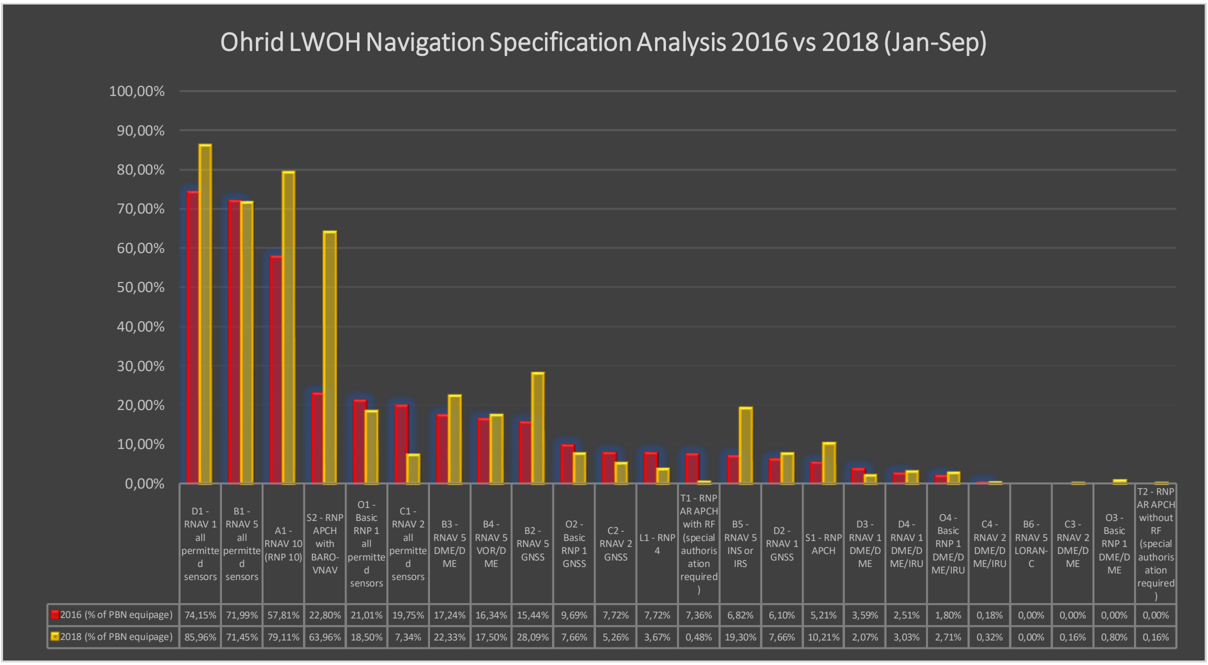
The following graph presents the Ohrid arrival traffic navigation specification for "year to date" 2018 period. Total number of arriving flights at Ohrid airport for abovementioned period was 627. Of the total number of flights, the following navigation specifications were used when taking into account TOP 10 navigation specifications:

- D1 - RNAV 1 all permitted sensors;
- A1 - RNAV 10 (RNP 10);
- B1 - RNAV 5 all permitted sensors;
- S2 - RNP APCH with BARO-VNAV;
- B2 - RNAV 5 GNSS;
- B3 - RNAV 5 DME/DME;
- B5 - RNAV 5 INS or IRS;
- B4 - RNAV 5 VOR/DME;
- O1 - Basic RNP 1 all permitted sensors;
- S1 - RNP APCH.



Graph 5 Ohrid Arrival Traffic Navigation Specification ("year to date" 2018)

When analysing both periods, 2016 vs 2018 it is visible that there is around 13% of more arrival traffic at LWOH Airport. This value has to be taken into account when analysing the Navigation Specification change effect. Between the analysed periods of 2016 and 2018, most of the aircrafts arriving at LWOH Airport have been equipped with the following navigation specifications: RNAV 1 all permitted sensors, RNAV 10 (RNP 10) and RNAV 5 all permitted sensors (with more than 70% of equipage). The most significant increase in the aircraft navigation specification equipage, when comparing the 2018 vs. 2016 analysed period, have the following navigation specifications: RNP APCH with BARO-VNAV increase of almost 42% (see graph below).



	D1 - RNAV 1 all permitted sensors	B1 - RNAV 5 all permitted sensors	A1 - RNAV 10 (RNP 10)	S2 - RNP APCH with BARO-VNAV	O1 - Basic RNP 1 all permitted sensors	C1 - RNAV 2 all permitted sensors	B3 - RNAV 5 DME/DME	B4 - RNAV 5 VOR/DME	B2 - RNAV 5 GNSS	O2 - Basic RNP 1 GNSS	C2 - RNAV 2 GNSS
2016 (% of PBN equipage)	74,15%	71,99%	57,81%	22,80%	21,01%	19,75%	17,24%	16,34%	15,44%	9,69%	7,72%
2018 (% of PBN equipage)	85,96%	71,45%	79,11%	63,96%	18,50%	7,34%	22,33%	17,50%	28,09%	7,66%	5,26%

	L1 - RNP 4	T1 - RNP AR APCH with RF (special authorisation required)	B5 - RNAV 5 INS or IRS	D2 - RNAV 1 GNSS	S1 - RNP APCH	D3 - RNAV 1 DME/DME	D4 - RNAV 1 DME/DME/IRU	O4 - Basic RNP 1 DME/DME/IRU	C4 - RNAV 2 DME/DME/IRU	B6 - RNAV 5 LORAN-C	C3 - RNAV 2 DME/DME	O3 - Basic RNP 1 DME/DME	T2 - RNP AR APCH without RF (special authorisation required)
2016 (% of PBN equipage)	7,72%	7,36%	6,82%	6,10%	5,21%	3,59%	2,51%	1,80%	0,18%	0,00%	0,00%	0,00%	0,00%
2018 (% of PBN equipage)	3,67%	0,48%	19,30%	7,66%	10,21%	2,07%	3,03%	2,71%	0,32%	0,00%	0,16%	0,80%	0,16%

Graph 6 LWOH Comparative Analysis

Taking into consideration that LWOH is a non-radar environment and that introduction of SIDs/STARs based on PBN will increase safety and capacity of operations.

Due to lack of ATC radar as a back up to RNAV 1 application, with application of RNP 1 is expected to be introduced for LWOH SIDs/STARs.

Equipage analysis present that there is not sufficient capability of airline operators operating on LWOH this implementation will be planned as a long-term goal.

2.3 Training

Air traffic controllers providing control services in airspace where there will be new navigation specifications have to be trained based on the new needs and requirements. Initial and recurring training represent a critical step in ensuring that new knowledge is incorporated, and that existing knowledge is current and retained. Air traffic controllers should be trained on simulator in order to reinforce routine PBN, mixed-mode operations, and contingencies including runway changes, NAVAID/GNSS failure or interference, and emergencies.

PBN concept is applied in most of Europe and aircraft crew are usually trained, however a there could be increased need for PBN approvals.

2.4 Traffic evolution

The traffic distribution in the Republic of Macedonia is characterised by a very high share of overflights, which amount to almost 90% of the overall traffic. Domestic traffic (mainly between the airports of Skopje and Ohrid) is insignificant, while around 10% of the overall traffic are international arrival and departures to/from the Republic of Macedonia (see table below).

Table 4 STATFOR Seven year forecast for the Republic of Macedonia

		Total Traffic												
Scenario	DAIO	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1. High Scenario	AD						17.723	19.683	21.383	23.275	24.826	26.503	28.207	29.833
	I						19	18	23	24	22	23	24	23
	O						153.365	173.873	192.354	202.877	211.070	219.158	228.493	237.705
1. High Scenario Total							**171.107**	**193.573**	**213.760**	**226.176**	**235.918**	**245.685**	**256.724**	**267.561**
2. Base Scenario	AD	10.795	11.887	13.484	14.898	16.474	17.723	19.575	20.667	21.694	22.591	23.543	24.484	25.484
	I	104	71	40	51	18	19	17	13	14	12	13	13	12
	O	101.654	100.760	132.858	137.194	129.108	153.365	173.509	189.184	195.186	200.146	204.894	210.523	216.527
2. Base Scenario Total		**112.553**	**112.718**	**146.382**	**152.143**	**145.600**	**171.107**	**193.102**	**209.864**	**216.894**	**222.748**	**228.449**	**235.020**	**242.024**
3. Low Scenario	AD						17.723	19.480	20.028	20.363	20.753	21.177	21.571	21.988
	I						19	17	5	6	4	5	5	4
	O						153.365	173.161	185.858	188.111	190.355	192.255	194.938	198.073
3. Low Scenario Total							**171.107**	**192.658**	**205.891**	**208.480**	**211.112**	**213.437**	**216.515**	**220.066**

The traffic growth in the Republic of Macedonia is mainly affected by high seasonality and uncertainties related to the geo-political situation in the surroundings, that can nowadays be visible with the conflict situation in Syria, Ukraine situation and the level of terrorist threats that impact the tourism and traffic flows moving from one part of Europe to another.

In 2014 there was a substantial increase in traffic numbers of around 30% due to the Kosovo airspace (KFOR sector) opening, which influenced the traffic flows within the AoR of ACC Skopje. In 2018 increase of traffic is foreseen to up to 13% when comparing to 2017 while for the forthcoming period between 2017 and 2024 it is expected to increase by 41%[2].

It is important to note that Republic of Macedonia has high seasonality, whereas in the winter periods of 2018 there was around 250 flights per day while during summer period of 2018 these numbers reached 850 flights per day.

[2] EUROCONTROL Seven Year Flights IFR Movements and Service Unit Forecast 2018-2024, GDP, 2018

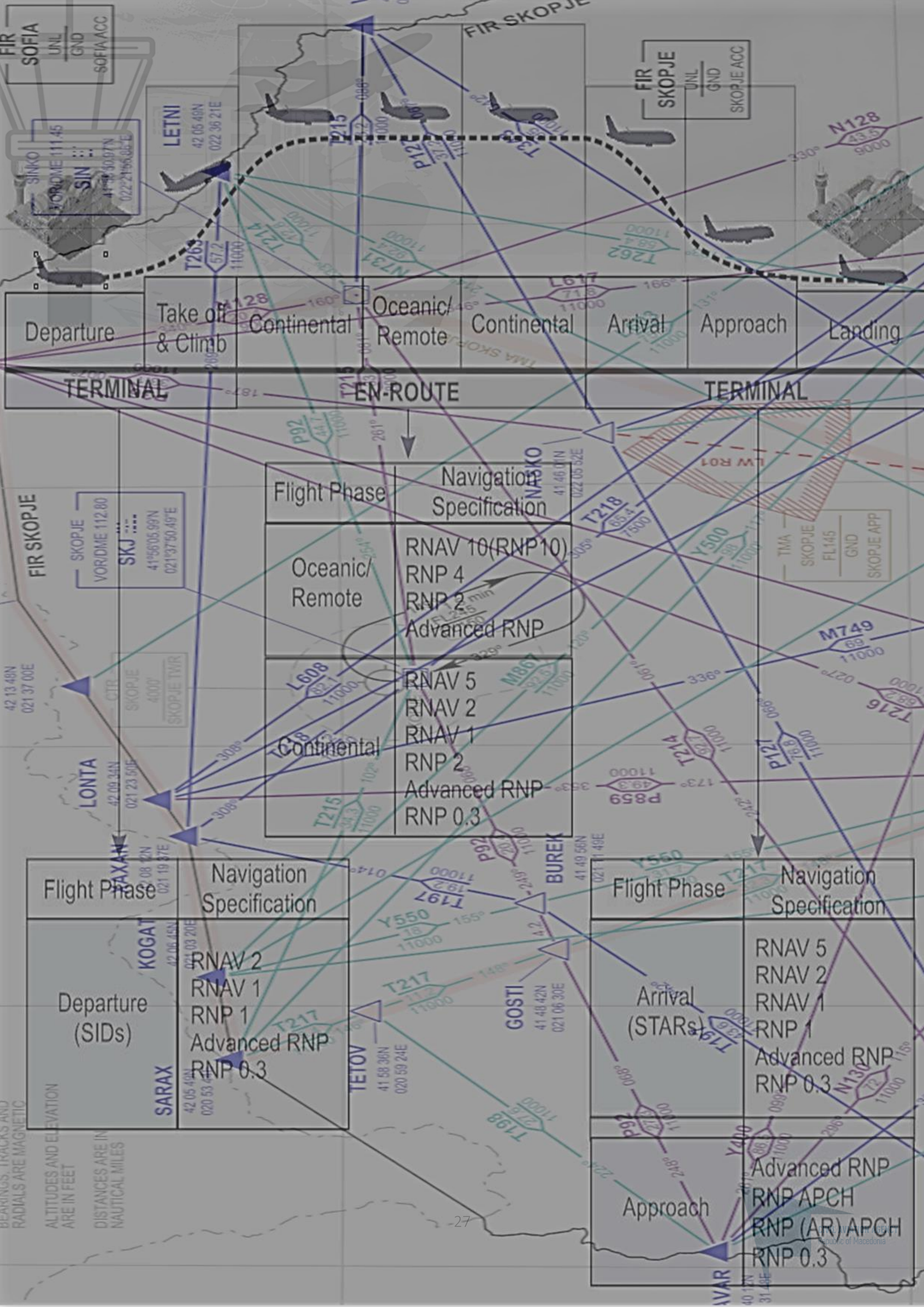
The current traffic market share in Republic of Macedonia is as in most countries in the Region characterised by the usually high percentage of traditional scheduled airlines (around 38%) and even higher percentage values of low-cost airlines, of almost around 43% of overall Macedonian air transport market[3].

Table 5 City-pairs flights in en-route area

AP PAIR	MONTH AVG FLIGHTS	LAST YEAR VARIATION
MUENCHEN 2 <-> THESSALONIKI	8,0	22,7%
PRAHA RUZYNE <-> NIKOS/KAZANTZAKIS	6,6	11,3%
KHANIA SOUDA <-> COPENHAGEN KASTRUP	5,9	-4,5%
FRANKFURT MAIN <-> ATHINAI E. VENIZELOS	5,8	57,2%
MUGLA-DALAMAN <-> LONDON/GATWICK	5,7	38,6%
PRISTINA AIRPORT, UNMIK (ON A TEMPORARY BASIS) <-> ANTALYA	5,3	34,4%
MAKEDONIA <-> DUESSELDORF	5,0	13,2%
TEGEL-BERLIN <-> NIKOS/KAZANTZAKIS	4,8	63,9%
MAKEDONIA <-> LONDON/GATWICK	4,7	7,4%
SCHOENEFELD-BERLIN <-> MAKEDONIA	4,7	4,3%

It is visible from the table above that in July 2018, the most frequented month in a year, the highest number of flights between the Airport pairs were between Munchen and Thessaloniki and Prague and Nikos. From the table above it is evident that Republic of Macedonia lays on the South-East traffic flow and as a result any geo-political influence on the South-East Axis (traffic flow) is highly influencing the traffic evolution within the AoR of ACC Skopje.

[3] https://ext.eurocontrol.int/analytics/saw.dll?Dashboard


Departure
Take off & Climb
Continental
Oceanic/ Remote
Continental
Arrival
Approach
Landing
TERMINAL
EN-ROUTE
TERMINAL
Flight Phase
Navigation Specification
Oceanic/ Remote
RNAV 10(RNP10)
RNP 4
RNP 2
Advanced RNP
Continental
RNAV 5
RNAV 2
RNAV 1
RNP 2
Advanced RNP
RNP 0.3
Flight Phase
Navigation Specification
Departure (SIDs)
RNAV 2
RNAV 1
RNP 1
Advanced RNP
RNP 0.3
Flight Phase
Navigation Specification
Arrival (STARs)
RNAV 5
RNAV 2
RNAV 1
RNP 1
Advanced RNP
RNP 0.3
Approach
Advanced RNP
RNP APCH
RNP (AR) APCH
RNP 0.3
FIR SOFIA
FIR SKOPJE
FIR SKOPJE
SKOPJE VOR/DME 112.80
SKJ
TMA SKOPJE FL145 GND SKOPJE APP
LETNI
LONTA
KOGAT
SARAX
TETOV
GOSTI
BUREK
NASKO
BEARINGS, TRACKS AND RADIALS ARE MAGNETIC
ALTITUDES AND ELEVATION ARE IN FEET
DISTANCES ARE IN NAUTICAL MILES

3 Implementation Roadmap

Implementation roadmap is used for defining the general goals in the implementation of PBN in en route, terminal areas and in approach.

PBN IR is requiring from ATM/ANS Provider to develop transition plan in order to be consistent with the European ATM Master Plan and the common projects and consulted with relevant stakeholders (aerodrome operators, airspace users, Network Manager, adjacent ATM/ANS Providers) and it shall be submitted to competent authority for verification of compliance with PBN IR requirements.

3.1 En route Airspace Implementation

	NAVIGATION SPECIFICATION		
AIRSPACE	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
EN-ROUTE	RNAV 5	RNAV 5	RNAV 5

	NAVIGATION INFRASTRUCTURE		
AIRSPACE	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
EN-ROUTE	Main: GNSS Back up: VOR/DME, DME/DME, ATC radar	Main: GNSS Back up: VOR/DME, DME/DME, ATC radar	Main: GNSS Back up: VOR/DME, DME/DME, ATC radar

3.2 Terminal Areas

	NAVIGATION SPECIFICATION		
	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
Skopje TMA	RNAV 1	RNAV 1	RNP 1

	NAVIGATION INFRASTRUCTURE		
	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
Skopje TMA	Main: GNSS Back up: DME/DME, VOR/DME, ATC radar	Main: GNSS Back up: DME/DME	Main: GNSS Back up: DME/DME

3.3 Instrument Flight Procedures

	NAVIGATION SPECIFICATION		
RUNWAY	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
LWSK RWY34	LNAV/VNAV (APV Baro)[4]	LPV	
LWSK RWY16	LNAV/VNAV (APV Baro)[5]		LPV
LWOH RWY01	LNAV/VNAV (APV Baro)[6]	LPV	
LWOH RWY19	LNAV/VNAV (APV Baro)[7]		LPV

	NAVIGATION INFRASTRUCTURE		
RUNWAY	Short term plan (by 03 Dec 2020)	Medium term plan (by 25 Jan 2024)	Long term plan (by 6 June 2030)
LWSK RWY34	GNSS	GNSS	GNSS
LWSK RWY16	GNSS	GNSS	GNSS
LWOH RWY01	GNSS	GNSS	GNSS
LWOH RWY19	GNSS	GNSS	GNSS

[4] Local Single Sky ImPlementation (LSSIP) THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA Year 2017 - Level 2
[5] Local Single Sky ImPlementation (LSSIP) THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA Year 2017 - Level 2
[6] Local Single Sky ImPlementation (LSSIP) THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA Year 2017 - Level 2
[7] Local Single Sky ImPlementation (LSSIP) THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA Year 2017 - Level 2

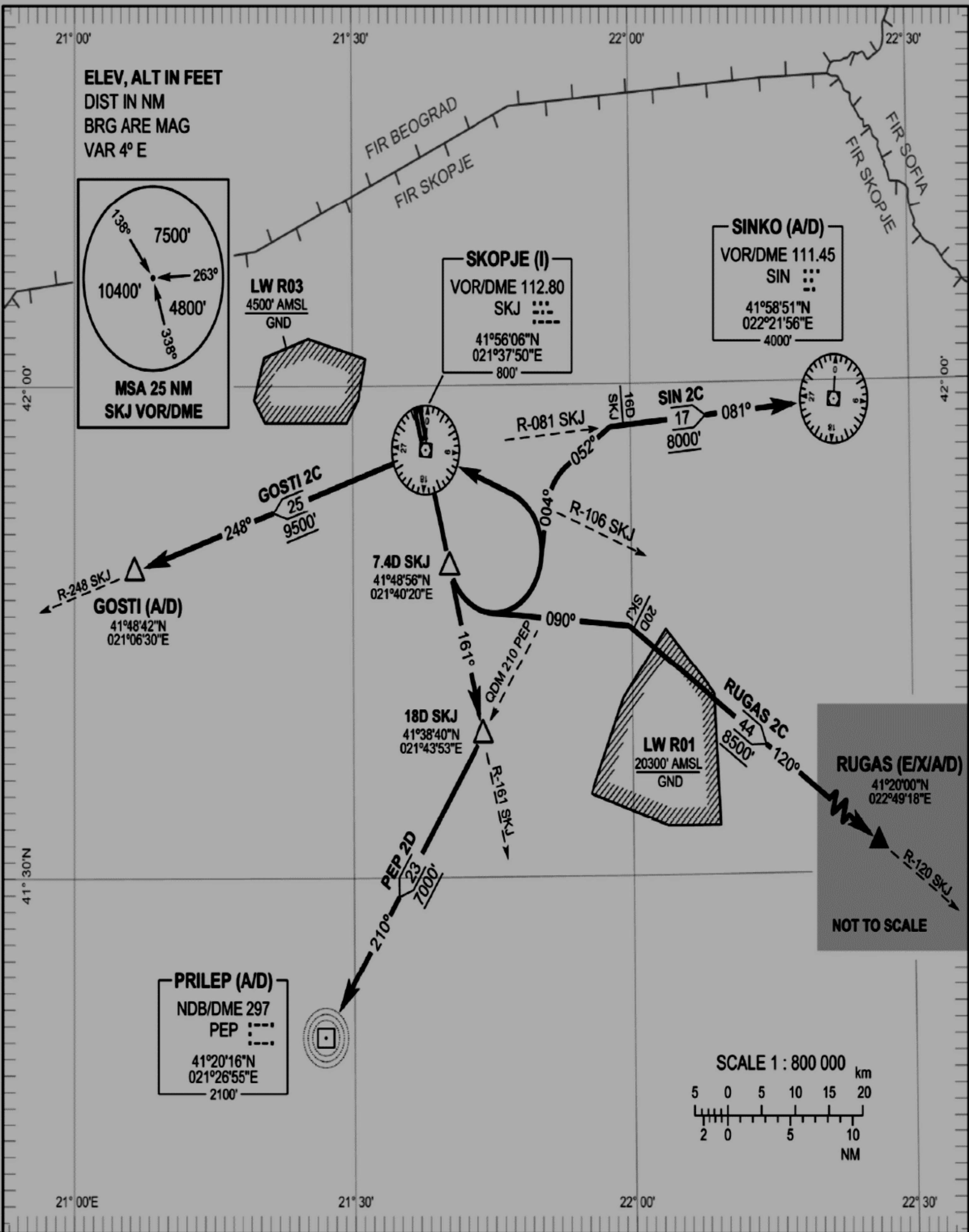
STANDARD DEPARTURE CHART - INSTRUMENT (SID) - ICAO

TRANSITION ALTITUDE
11000'

TWR	118.500
APP	120.300
RADAR	120.300

SKOPJE / Alexander the Great (LWSK) RWY 16

GOSTI 2C PEP 2D
RUGAS 2C SIN 2C



4 PBN Implementation Strategy

4.1 Determine Requirements – Airspace Concept Development

To determine specific requirements for PBN implementation following activity shall be performed:

- Selection of relevant stakeholders - seek opinions for the preparation of processes
- Assessment of fleet capability;
- Assessment of NAVAID infrastructure (ground based and space based);
- Identification of performance and functional requirements;
- Cost/benefit analysis;

In order to satisfy explicit and implicit strategic objectives (safety, capacity, flight efficiency, environment and access) and to achieve full benefits PBN implementation an Airspace concept shall be defined. An Airspace concept shall describe the intended operations within Republic of Macedonia airspace.

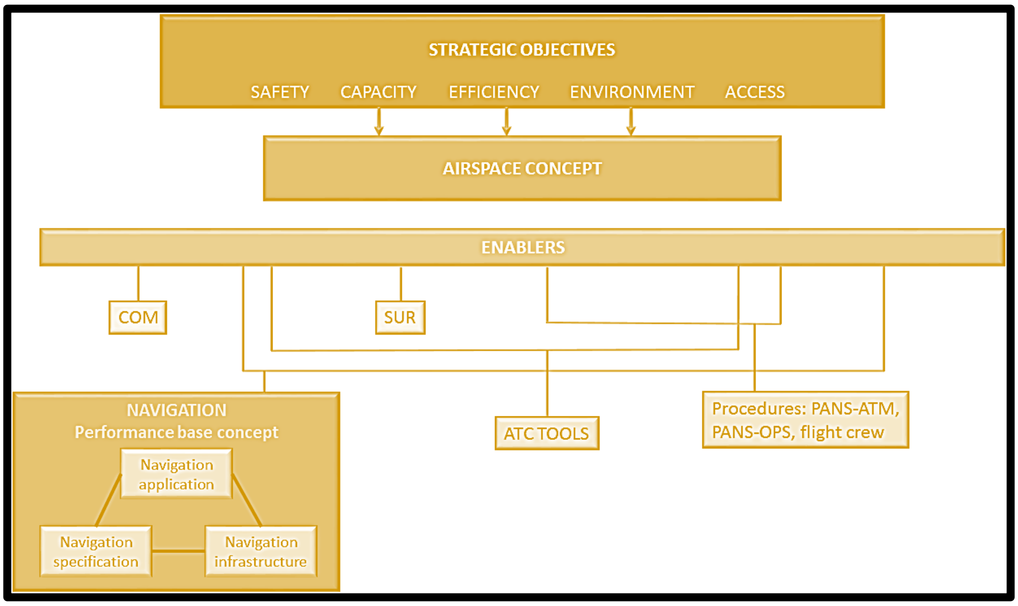


Figure 4 Relationship: PBN and airspace concept

Various stakeholders are involved in the development of the airspace concept and the resulting navigation application(s). These stakeholders are the airspace planners, procedure designers, aircraft manufacturers, pilots and air traffic controllers; each stakeholder has a different role and set of responsibilities.

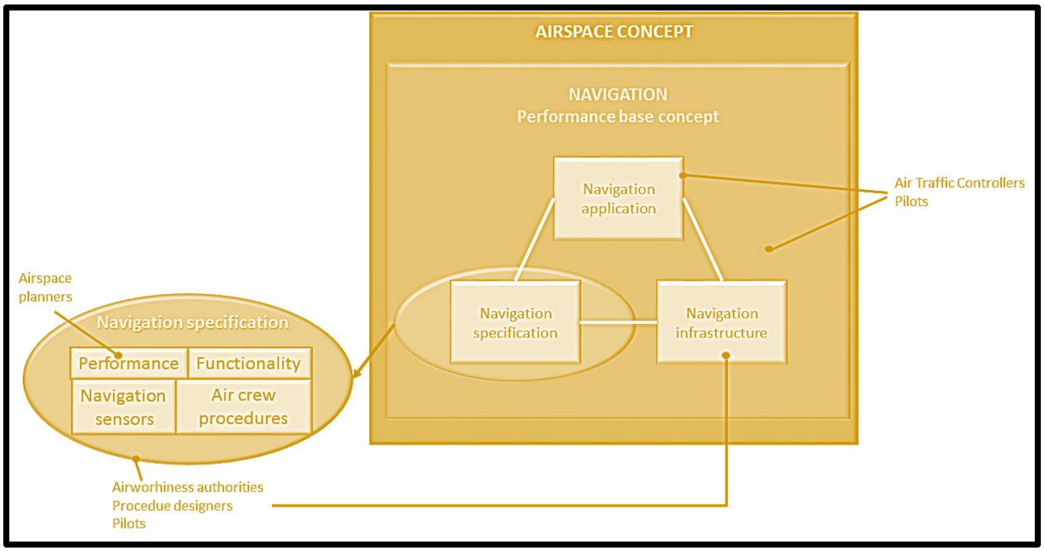


Figure 5 PBN elements and specific points of interest of various stakeholders

4.2 Planning and Implementation

Following activities should be performed:

- Formulation of safety plan - this safety plan details how the safety assessment is to be accomplished for the proposed PBN implementation;
- Design of volumes/sectors, route/holds and - establish PBN flight procedure design capability and route planning capability;
- Validation airspace concept for safety - the main objectives of validating the airspace concept are:
    - To prove that the airspace design has successfully enabled efficient ATM operations in the airspace;
    - To assess whether the objectives can be achieved by implementation of the airspace design and the airspace concept in general;

- To identify potential weak points in the concept and develop mitigation measures;
- To provide evidence that the design is safe, i.e. to support the safety assessment.

- Flight inspections and validations - Of primary interest is the actual coverage of the NAVAID infrastructure required to support the flight procedures designed by the flight procedure designer

- ATC system integration considerations - The new airspace concept may require changes to the ATC system interfaces and displays to ensure air traffic controllers have the necessary information on the aircraft capabilities. Changes arising from mixed equipage scenarios could include, for example:
  - Modifying the air traffic automation's flight data processor (FDP);
  - Making changes, if necessary, to the radar data processor (RDP);
  - Requiring changes to the ATC situation display and flight strips; and
  - Requiring changes to ATC support tools.

- Awareness and training for ATC and flight crews - The introduction of PBN can involve considerable investment in terms of training, education and awareness material for both flight crew and controllers. A PBN workshops should be organised in order to enable all stakeholders to come together and discuss their particular vision of PBN and its implementation in Republic of Macedonia.

  Except from publishing all relevant PBN information in the Republic of Macedonia AIP, Aeronautical Information Circular should also be issued with description of the application of PBN in the Republic of Macedonia Airspace. AIC should outline the timeframe within which navigation capabilities are likely to be available such that; airspace planning should utilise these capabilities and, airline operators should expect a requirement for them to be equipped and certificated to operate to defined navigation performance standards.

- Implementation – There should be an adequate representation of the members of the PBN implementation team available in the operations, in order to:
  - Monitor the implementation process;

- Provide support and information to operational controllers and pilots.

- Post implementation review - After the implementation of the airspace change, which has introduced PBN, the system, needs to be monitored to ensure that safety of the system is maintained and determine whether strategic objectives are achieved. One of the most important monitoring activities is the verification of safety objectives coming from safety assessments for PBN implementation. If during post implementation phase an unforeseen event occur and safety objectives are no longer met, a mitigation measures should be put in place as soon as possible. In exceptional circumstances, this could require the withdrawal of RNAV or RNP operations while specific problems are addressed.


TETOV
41 58 36N
020 59 24E
GOSTI
41 45 42N
021 06 30E
BUREK
41 49 56N
021 11 40E
SKOPJE
NASKO
TIKVA
41 20 18N
021 55 24E
T217
T198
T215
T218
L608
Y550
T197
P92
M867
P859
T214
Y400
P127
N130
Y500
T216
M749
N146
T261
N141
108.9
5.4D OHR
R-171 OHR
141°
197°
014°
176°
3304
4081
(3947)
3202
3452
2973
2992
OHRID
LAKE
BASE TURN LIM

Definitions

Aircraft-based augmentation system (ABAS). An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.

Note. The most common form of ABAS is receiver autonomous integrity monitoring (RAIM).

Airspace concept. An airspace concept provides the outline and intended framework of operations within an airspace. Airspace concepts are developed to satisfy explicit strategic objectives such as improved safety, increased air traffic capacity and mitigation of environmental impact etc. Airspace Concepts can include details of the practical organization of the airspace and its users based on particular CNS/ATM assumptions, e.g. ATS route structure, separation minima, route spacing and obstacle clearance.

Approach procedure with vertical guidance (APV). An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.

Area navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Note. Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation.

Area navigation route. An ATS route established for the use of aircraft capable of employing area navigation.

Area navigation (RNAV) X specification'. A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, whereby 'X' refers to the lateral navigation accuracy in nautical miles.

ATS surveillance service. A term used to indicate a service provided directly by means of an ATS surveillance system.

ATS surveillance system. A generic term meaning variously, ADS-B, PSR, SSR or any comparable ground-based system that enables the identification of aircraft.

Note. A comparable ground-based system is one that has been demonstrated, by comparative assessment or other methodology, to have a level of safety and performance equal to or better than monopulse SSR.

Conventional navigation procedures. ATS routes and instrument approach procedures predicated on the use of ground-based navigation aids that do not enable compliance with the PBN requirements.

Lateral Navigation. A kind of RNP procedure based on lateral guidance only.

Lateral navigation (LNAV), lateral navigation/vertical navigation (LNAV/VNAV) and localizer performance with vertical guidance (LPV). The labels to identify the different types of operating minima on approach charts depicting approach procedures based on Global Navigation Satellite Systems (GNSS) which are classified as RNP approaches (RNP APCH);

Localizer Performance with Vertical Guidance. A kind of RNP approaches provide both horizontal and approved vertical approach guidance, using SBAS. This approach is also called APV –SBAS approach.

Localizer Performance without Vertical Guidance. A kind of RNP approaches based on lateral navigation, using SBAS.

Mixed navigation environment. An environment where different navigation specifications may be applied within the same airspace (e.g. RNP 10 routes and RNP 4 routes in the same airspace) or where operations using conventional navigation are allowed in the same airspace with RNAV or RNP applications.

Navigation aid (NAVAID) infrastructure. NAVAID infrastructure refers to space-based and or ground-based navigation aids available to meet the requirements in the navigation specification.

Navigation application. The application of a navigation specification and the supporting NAVAID infrastructure, to routes, procedures, and/or defined airspace volume, in accordance with the intended airspace concept.

Note. The navigation application is one element, along with communication, surveillance and ATM procedures which meet the strategic objectives in a defined airspace concept.

Navigation function. The detailed capability of the navigation system (such as the execution of leg transitions, parallel offset capabilities, holding patterns, navigation databases) required to meet the airspace concept.

Note. Navigational functional requirements are one of the drivers for the selection of a particular navigation specification. Navigation functionalities (functional requirements) for each navigation specification can be found in Volume II, Parts B and C.

Navigation specification. A set of aircraft and aircrew requirements needed to support performance-based navigation operations within a defined airspace. There are two kinds of navigation specification:

- RNAV specification. A navigation specification based on area navigation that does not include the requirement for performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1.
- RNP specification. A navigation specification based on area navigation that includes the requirement for performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4, RNP APCH. An RNP X means that a navigation system must be able to calculate its position to within a circle with a radius of X nautical miles.

  Note. The Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, contains detailed guidance on navigation specifications.

Performance-based navigation. Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

Note. Performance requirements are expressed in navigation specifications in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept.

Procedural control. Air traffic control service provided by using information derived from sources other than an ATS surveillance system.

Receiver autonomous integrity monitoring (RAIM). A form of ABAS whereby a GNSS receiver processor determines the integrity of the GNSS navigation signals using only GPS signals or GPS signals augmented with altitude (baroaiding). This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one additional satellite needs

to be available with the correct geometry over and above that needed for the position estimation, for the receiver to perform the RAIM function.

Required navigation performance. (RNP) X specification means a navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, whereby ‘X’ refers to the lateral navigation accuracy in nautical miles or the operation type and required functionalities.

RNAV operations. Aircraft operations using area navigation for RNAV applications. RNAV operations include the use of area navigation for operations which are not developed in accordance with this manual.

RNAV system. A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. An RNAV system may be included as part of a flight management system (FMS).

RNP operations. Aircraft operations using an RNP system for RNP navigation applications. RNP route. An ATS route established for the use of aircraft adhering to a prescribed RNP navigation specification.

RNP Authorisation Required Approach. An approach which always requires a specific operational approval (SPA). Such procedures are useful in particular environments rich in obstacles and dense terminal areas.

RNP system. An area navigation system which supports on-board performance monitoring and alerting.

Satellite-based augmentation system (SBAS). A wide-coverage augmentation system in which the user of a GNSS receives augmentation information from a satellite-based transmitter

Standard instrument arrival (STAR). Designated instrument flight rule arrival route linking a significant point, normally on an air traffic service (ATS) route, with a point at which a published instrument approach procedure can be commenced.

Standard instrument departure (SID). Designated instrument flight rule departure route linking the aerodrome with a specified significant point, normally on a designated ATS route, at which the en route phase of a flight commences.

Abbreviations

ABAS: Aircraft-based augmentation system

ADS-B: Automatic dependent surveillance - broadcast

ADS-C: Automated dependent surveillance – contract

AIC: Aeronautical Information Circular

AIP: Aeronautical information publication

ANSP: Air navigation service provider

AOC: Air Operator Certificate

APV: Approach procedure with vertical guidance

ATM: Air traffic management

ATS: Air traffic service(s)

Baro-VNAV: refers to one such system that uses altimetry to measure vertical position

B-RNAV: Basic Area Navigation

CCO: Continuous Climb Operations

CDO: Continuous Descent Operations

DME: Distance measuring equipment

EASA: European Aviation Safety Agency

EGNOS: European Geostationary Navigation Overlay Service

EUROCAE: European Organisation for Civil Aviation Equipment

EUROCONTROL: European Organisation for the Safety of Air Navigation

FAB: Functional Airspace Block

FATO: final approach and take-off area

FTE: Flight technical error

FMS: Flight management system

FRT: Fixed radius transition

GBAS: Ground-based augmentation system

GNSS: Global navigation satellite system

GPS: Global positioning system

GRAS: Ground-based regional augmentation system

IAP: Instrument approach procedure(s)

IFP: Instrument flight procedure

INS: Inertial navigation system

IRS: Inertial reference system

IRU: Inertial reference unit

LNAV: Lateral navigation

LPV: Localizer performance with vertical guidance

LWSK: Skopje airport

MNPS: Minimum navigation performance specification

NAVAID: Navigation aid

PBN: Performance-based navigation

NDB: Non Directional Beacon

NPA: Non Precision Approach

PSR: Primary surveillance radar

RAIM: Receiver autonomous integrity monitoring

RF: Radius to fix

RNAV: Area navigation

RNP: Required navigation performance

RNP APCH: RNP approach

SBAS: Satellite-based augmentation system

SESAR: Single European Sky ATM Research

SID: Standard instrument departure

SSR: Secondary surveillance radar

STAR: Standard instrument arrival

VNAV: Vertical navigation

VOR: Very high frequency (VHF) omnidirectional radio range

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