Performance Based Navigation (PBN) Implementation Plan Georgia

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1. Introduction

Georgian PBN implementation plan details the framework within which the ICAO PBN concept will be implemented in Georgia for the foreseeable future.
The primary drivers for this plan include safety enhancement, improved operational efficiency, increased airspace capacity and improved technology. The plan also supports national and international interoperability and global harmonization. The plan will serve as a basis to implement ICAO Assembly Resolution A37-11 and also will enable to follow priorities as outlined in ICAO Global Air Navigation Plan (GANP)
"Performance-based navigation global goals", of which an excerpt is given below, was adopted by the Assembly of the ICAO at its 37th meeting (October 2010).
"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: 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 a maximum certificated take-off mass of 5 700 kg or more;

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

2. Background

The continuing growth of aviation places increasing demands on airspace capacity and emphasizes the need for the optimum utilization of the available airspace.

Growth in scheduled and General Aviation aircraft is expected to increase point-to-point and direct routings. Reduction in fuel consumption also presents a significant challenge to all segments of the aviation community. This anticipated growth and higher complexity of the air transportation system should not result in increased flight delays, schedule disruptions, choke points, inefficient flight operations, and passenger inconvenience. Without improvements in system efficiency and workforce productivity, the aviation community and cost of operations will continue to increase. These circumstances can be partially alleviated by efficiencies in airspace and procedures through the implementation of PBN concepts.

In setting out requirements for navigation applications on specific routes or within a specific airspace, it is necessary to define requirements in a clear and concise manner. This is to ensure that both flight crew and ATC are aware of the on-board area navigation (RNAV) system capabilities and to ensure that the performance of the RNAV system is appropriate for the specific airspace requirements.

The early use of RNAV systems arose in a manner similar to conventional ground-based routes and procedures. A specific RNAV system was identified and its performance was evaluated through a combination of analysis and flight testing. For domestic operations the initial systems used VOR and DME for their position estimation.

These 'new' systems were developed, evaluated and certified. Airspace and obstacle clearance criteria were developed on the basis of available equipment performance. Requirements specifications were based upon available capabilities and, in some implementations, it was necessary to identify the individual models of equipment that could be operated within the airspace concerned.

Such prescriptive requirements result in delays to the introduction of new RNAV system capabilities and higher costs for maintaining appropriate certification. To avoid such prescriptive specifications of requirements, the PBN concept introduces an alternative method for defining equipage requirements by specification of the performance requirements. This is termed Performance Based Navigation (PBN).

3. Performance Based Navigation (PBN)

Performance based navigation (PBN) is a concept that encompasses both area navigation (RNAV) and required navigation performance (RNP) and revises the current RNP concept. Performance based navigation is increasingly seen 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. However, this system-specific approach imposes an unnecessary effort and expense on States, airlines and air navigation services (ANS) providers.

Performance based navigation eliminates the need for redundant investment in developing criteria and in operational modifications and training. Rather than build an operation around a particular system, under performance based navigation the operation is defined according to the operational goals, and the available systems are then evaluated to determine whether they are supportive.

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.
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.

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.

3.1. Benefits of Performance-Based Navigation (PBN)

The main benefits of implementing PBN in Georgia are:

a) Increased airspace safety through the implementation of continuous and stabilized descent procedures using vertical guidance;
b) Reduced need to maintain ground-based sensor-specific routes and procedures, and their associated costs;
c) Reduced aircraft flight time due to the implementation of optimal flight paths, with the resulting savings in fuel, reduction in noise and carbon emission, and enhanced environmental protection;
d) Use of the RNAV and/or RNP capabilities that already exist in a significant percentage of the aircraft fleet flying in Georgian Airspace - both domestic and international operations;
e) Improved airport and airspace arrival paths in all weather conditions, and the possibility of meeting critical obstacle clearance and environmental requirements through the application of optimized RNAV or RNP paths;
f) Implementation of more precise approach, departure, and arrival paths that will foster smoother traffic flows;
g) Decrease ATC and pilot workload by utilizing RNAV/RNP procedures and airborne capability;
h) Increase of predictability of the flight path.

RNAV and RNP specifications facilitate more efficient design of airspace and procedures, which collectively result in improved safety, access, capacity, predictability, operational efficiency and environmental effects.

4. Objectives of Georgian PBN implementation

Georgian PBN implementation is based on the following strategic objectives:

a) Provide a high-level strategy for the evolution of the navigation applications to be implemented in Georgia in the short term (2016-2017) and medium term (2017-2018). 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;

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.

4.1.Intent of Georgian PBN implementation plan

The PBN Implementation Plan was developed by Georgian national PBN implementation team and is intended to assist the main stakeholders of the aviation community plan a gradual transition to the RNAV and RNP concepts and their investment strategies. For example, airlines can use this Georgian PBN Implementation Plan to plan future equipage and additional navigation capability investments; air navigation service provider – "Sakaeronavigatsia" ltd can plan a gradual transition from ground infrastructure to space based Navigation. GCAA will be able to anticipate and plan for the criteria that will be needed in the future as well as the future regulatory workload and associated training requirements for their work force.

4.2.Principals applied in the development of Georgian PBN implementation plan

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

a) Continued application of conventional air navigation procedures during the transition period, to guarantee availability by 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) Must not conflict with the ICAO regional PBN implementation plan.

5. Stakeholders

Coordination is critical with the aviation community through collaborative forums. This will assist aviation stakeholders in understanding operational goals, determining requirements, and considering future investment strategies.

The stakeholders who will benefit from the concepts in this State PBN implementation plan include airspace operators, Air Navigation Service Provider –Sakaeronavigatsia ltd, GCAA and other stakeholders (i.e. Militaries, Airport operators). As driven by business needs, airlines and operators can use the State PBN roadmap to plan future equipage and capability investments. Similarly, Air Navigation Service Provider can determine requirements for future automation systems, and more smoothly modernize ground infrastructure. Finally, GCAA can anticipate and develop the key enabling criteria needed for implementation.

6. Challenges

6.1. Safety – Risks Associated with Major System Change

During the transition to a mature PBN environment we may face significant challenges. Some of the key identified possible challenges are:

- Adoption of supporting Civil Aviation Rules
- PBN capability register and aircraft minimum equipment lists (MEL)
- Integration of PBN capability into the ATM system (Flight Plan data fields)
- Mixed fleet/system operations
- Safety monitoring of ATM system
- Approach naming and charting conventions
- Navigation database integrity and control
- GNSS system performance and prediction of availability service
- Continued involvement in CNS/ATM and PBN development
- Resources of the GCAA, ANSP and industry to implement PBN
- Education and training of personnel employed by the GCAA, ANSP and aircraft operators.

7. RNAV Current status in Georgia

AIRSPACE	NAVIGATION SPECIFICATION
EN-ROUTE UPPER AIRSPACE	B-RNAV (RNAV-5)
EN-ROUTE LOWER AIRSPACE	Conventional
TERMINAL	
UGTB (Tbilisi)	Conventional SID/ STAR[1]
UGSB (Batumi)	Conventional SID/STAR
UGKO (Kutaisi)	Conventional SID/STAR
FINAL APROACH	
UGTB (Tbilisi)	Conventional ILS/DME, VOR/DME
UGSB (Batumi)	Conventional ILS/DME
UGKO (Kutaisi)	Conventional ILS/DME, VOR/DME

This table shows that significant portion of navigation applications in Georgia still are constructed on principles of conventional navigation. Taking into consideration all shortcomings of conventional navigation and all advantages of Performance Based Navigation a strong need is identified for gradual implementation of PBN in Georgia.

Note:

1. For the purpose of simplifying the text here and after in this document term STAR will be used not only as standard instrument arrival but also incorporate instrument approach phases of flight excluding only final approach.

8. Aircraft fleet readiness status

Since 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. This is added advantage in smooth implementation and transition to PBN. Of most interest to Georgia is GNSS RNAV1 and RNP APCH capabilities of aircraft as it was identified to be the most appropriate to implement GNSS-only based RNAV1 SIDs and STARs in all terminal areas (Tbilisi, Batumi, Kutaisi) and RNP APCH procedures for most runway ends. For this purpose aircraft equipment survey has been carried out and the survey showed that approximately 60% of aircraft involved in IFR operations and using main airports in Georgia are GNSS RNAV1 capable and 35% are RNP APCH capable. Hence it follows that significant portion of fleet are expected to benefit from implementing the above mentioned specifications and taking into account the tendency of growth of RNAV capabilities even more are expected to be at an advantage in the future.

9. Navigation infrastructure

Global Navigation Satellite System (GNSS)

GNSS-based PBN provides a seamless, harmonized and cost-effective guidance from departure to vertically guided final approach that provides safety, efficiency and capacity benefits.

GNSS is considered as main enabler of PBN operations in Georgian airspace for all phases of flight from en-route through to approach.

Other PBN navigation infrastructure

Besides the GNSS, in Georgia DME/DME, VOR/DME and INS/IRS are considered to be used to support PBN en-route operations with RNAV-5 navigation specification.
In 2015 3 DME stations have been deployed in Georgia and 2 additional DME stations are planned to be deployed in 2016. These stations together with existing ones (collocated DVOR/DME stations in Kutaisi and Tbilisi) will provide full DME/DME coverage within Tbilisi FIR at or above FL280 (mainly with excessive redundancy) and almost full coverage will be provided at or above FL195 with small gap in central part of Georgia. Excessive redundancy of coverage will prevail for FL 195 as well.
With regards to VOR/DME, there are 2 DVOR/DME stations installed in Georgia, one at Tbilisi (TBS) and second at Kutaisi (KTS). As maximum range of DVOR/DME RNAV coverage is limited to 75NM (60NM in case of conventional VOR/DME) as specified by PBN manual within some portion of Georgian FIR the VOR/DME coverage is not sufficient to enable RNAV-5 operations exclusively based on VOR/DME sensors. However radar service can be provided whenever required.

10. Surveillance infrastructure

At the present time surveillance in Georgia is provided by utilizing 1 PSR/MSSR, 3 MSSR and 1 SSR stations. Coverage is relatively restricted at low levels due to mountainous terrain but all terminal areas are provided by full radar coverage so surveillance vectoring could be considered as a back-up mode for RNAV operations in terminal area or as alternative guidance for non-equipped aircraft.

11. Implementation strategy

This plan provides a high-level strategy for the evolution of navigation capabilities to be implemented in two timeframes: near term (2016-2017) and mid-term (2017-2018). The strategy rests upon two key navigation concepts: Area Navigation (RNAV) and Required Navigation Performance (RNP). It encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) operations, as well as en-route operations.

11.1. Near term strategy (2016-2017)

In the near-term the navigation focus is on satellite-based navigation.

Georgia will ensure that training is provided for ATC staff with respect to the impact PBN will have on aircraft track keeping especially the difference expectations for aircraft on RNAV and RNP. ATC training will be in line with the recommendations within the ICAO PBN Manual, especially with respect to the mixed navigation environment which will exist in the short term.

11.1.1. En route

In the near-term it is planned to upgrade all conventional routes in lower airspace to RNAV 5 while maintaining a minimum network of conventional routes for non-equipped aircraft.

11.1.2. Terminal Areas (Departures and Arrivals)

There are only 3 airports with instrument runways in Georgia (Tbilisi, Batumi and Kutaisi), with precision ILS approaches at all instrument runway ends and non-precision VOR/DME approaches as back up at Tbilisi and Kutaisi. SIDs and STARs are conventional and radar surveillance is provided in all terminal areas.

Under Conventional SIDs and STARs and tactical Radar Vectoring by ATC aircraft are often subjected to 'level-off's on descend phase.

RNAV reduces conflict between traffic flows by consolidating flight tracks. RNAV-1 SIDs and STARs improve safety, capacity, and flight efficiency and also lower communication errors.

PBN SIDs and STARS would allow the following:

- Reduction in controller-pilot communications;
- Reduction of route lengths to meet environmental and fuel efficiency requirements;
- Seamless transition from and to en-route entry/exit points;

In the short term, Georgia will implement RNAV-1 SIDs and STARs, first in Kutaisi (UGKO) and Batumi (UGSB) airport TMAs and make associated changes in airspace design, while maintaining conventional procedures and conventional navigation aids for not accordingly equipped aircraft.

Where operationally feasible, Georgia should develop operational concepts and requirements for continuous descent arrivals (CDAs) based on FMS Vertical Guidance.

11.1.3. Final Approach

ICAO has recommended to all member states the implementation of approach procedures with vertical guidance (APV) for all instrument runway ends, either as the primary approach or as a backup for precision approaches. Since Georgia is out of service area of any satellite based augmentation system (SBAS), it is only feasible to implement APV through Baro-VNAV, which will be considered in midterm, since there are ILS precision approaches to all instrument runway ends in Georgia, as primary approach.

In the short term, Georgia will maintain ILS precision approaches to all instrument runway ends as primary approach and non-precision (VOR/DME) approaches as back up.

11.2 Midterm strategy (2017-2018)

11.2.1 Terminal Areas (Departures and Arrivals)

Implementation of RNAV1 (GNSS) SID/STAR's at Tbilisi TMA, while maintaining conventional procedures and conventional navigation aids for not accordingly equipped aircraft.

11.2.2 Final Approach

Implementation of APV Baro-VNAV (including LNAV-only minima) at all instrument runway ends as a back up for ILS precision approaches.

11.3 Implementation plan summary

	En-route	TMA	Final Approach
2016-2017	Conversion of lower airspace to RNAV5	Implementation of RNAV1 (GNSS) SID/STAR's at Kutaisi (UGKO) and Batumi (UGSB) airports	Maintaining ILS precision approaches to all instrument runway ends as primary and non-precision (VOR/DME) approaches as back up
2017-2018		Implementation of RNAV1 (GNSS) SID/STAR's at Tbilisi (UGTB) airport	Implementation of APV Baro-VNAV (including LNAV-only minima) at all instrument runway ends as a backup for ILS precision approaches

Abbreviations:

ANSP – Air navigation service provider

APCH – Approach

APV – Approach procedure with vertical guidance

ATC – Air traffic controller

ATM – Air traffic management

ATS – Air traffic service

CAA – Civil aviation agency

CDA – Continuous descent arrival

CNS – Communications, navigation, surveillance

DME – Distance measuring equipment

DVOR – Doppler VOR

FMS – Flight management System

GNSS – Global navigation satellite system

ILS – Instrument landing system

INS – Inertial navigation system

IRS – Inertial reference system

LNAV – Lateral navigation

MEL – Minimum equipment list

MSSR – Monopulse secondary surveillance radar

PBN – Performance based navigation

PSR – Primary surveillance radar

RAIM – Receiver autonomous integrity monitoring

RNAV – Area navigation

RNP – Required navigation performance

SBAS – Satellite based augmentation system

SID – Standard instrument departure

SSR – Secondary surveillance radar

STAR – Standard instrument arrival

VNAV – Vertical navigation

VOR – VHF omnidirectional radio range