11. OCEANIC AND REMOTE OPERATIONS

11.1. For Oceanic Remote Areas where high density traffic operations occur, a review of the airspace concept must be undertaken to convert to Continental En Route Operation where sufficient, surveillance is available so as to allow RNAV 5 operations.

12. CONTINENTAL EN ROUTE OPERATIONS

12.1. For airspace and corridors requiring structured routes for flow management, the ANSP will review existing conventional and RNAV routes to transition to PBN RNAV 5 or where operationally required RNAV 2/1.

13. TERMINAL OPERATIONS

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

13.2. The ANSP will continue to plan, develop and implement RNAV 1 SIDs and STARs, at major airports and make associated changes in airspace design. In addition, the ANSP will implement RNP 1 SIDs and STARs. RNAV 1 will be implemented in airspace where there is sufficient surveillance coverage and RNP 1 where there is no such coverage.

13.3. Where operationally feasible, States should develop operational concepts and requirements for Continuous Descent Operations (CDO) based on FMS Vertical Guidance and for applying time of arrival control based on RNAV and RNP procedures. This would reduce workload for pilots and controllers as well as increase fuel efficiency.

13.4. PBN SIDs and STARs would allow the following:

a) Reduction in controller-pilot communications;

b) Reduction of route lengths to meet environmental and fuel efficiency requirements;

c) Seamless transition from and to en route entry/exit points;

d) Sequence departures to maximize benefits of RNAV and identify automation requirements for traffic flow management, sequencing tools, flight plan processing, and tower data entry activities.

14. APPROACH OPERATIONS

The application of RNP APCH is expected to be implemented in the maximum possible number of aerodromes. To facilitate a transitional period, conventional approach procedures and conventional navigation aids should be maintained for non PBN equipped aircraft during this term.

Mozambique should promote the use of Approach with Vertical Guidance (APV) Operations (Baro-VNAV) to enhance safety of RNP Approaches and accessibility of runways. Furthermore, at aerodromes where there is no local altimeter setting available and where aircraft of maximum certificated take-off mass of 5700kg or more, using an aerodrome not suitably equipped for APV operations, RNP APCH (LNAV only) procedures should be promoted. This interim measure however, while having significant safety benefits, should not be taken as justification to defer the final implementation of APV. Where APV approaches have been developed —LNAV only‖ procedures should also be developed for aircraft that may not be suitable for APV.

The application of RNP AR Approach should be limited to selected runways where obvious operational benefits can be obtained due to the existence of significant obstacles.

14.1. Helicopter operations(To be developed)

15. Mid TERM IMPLEMENTATION TARGETS

a) Each instrument runway will have an associated RNP APCH (LNAV only).

b) RNAV 1 SID/STAR for Maputo and Beira International airports by 2016 .

c) Review existing conventional and RNAV routes to transition to PBN RNAV 5 or where operationally required RNAV 2/1 by 2016.

16. OCEANIC EVOLUTION

16.1. In the midterm, the ANSP will endeavor to work with international air traffic service providers to promote the application of RNP 10 and RNP 4 in additional sub-regions of the oceanic environment.

17. EN ROUTE EVOLUTION

17.1. The review of en route airspace will be completed by 2016.

18. IMPLEMENTATION

18.1. By the end of the midterm other benefits of PBN will have been enabled, such as flexible procedures to manage the mix of faster and slower aircraft in congested airspace and use of less conservative PBN requirements.

19. TERMINAL EVOLUTION

19.1. During this period, either RNP 1 or RNAV 1 will become a required capability for flights arriving and departing major airports based upon the needs of the airspace, such as the volume of traffic and complexity of operations. This will ensure the necessary throughput and access, as well as reduced controller workload, while maintaining safety standards.

19.2. With RNAV-1 operations as the predominant form of navigation in terminal areas by the end of the mid-term, the ANSP will have the option of removing conventional terminal procedures that are no longer expected to be used.

20. APPROACH EVOLUTION

20.1. In the midterm, implementation priorities for instrument approaches will still be based on RNP APCH (APV) and RNP AR APCH and full implementation is expected at the end of this term. Leading up to meeting this requirement RNP APCH (LNAV only) procedures should still be promoted for aerodromes where there is no local altimeter setting available and where aircraft of maximum certificated take-off mass of 5700kg or more, using an aerodrome not suitably equipped for APV operations.

21. MID TERM IMPLEMENTATION TARGETS

a) RNP APCH (APV Baro-VNAV) in 100% of instrument runways where practical, by 2016

b) RNAV 1 or RNP 1 SID/STAR for 100% of international airports by 2016

c) Implementation of additional RNAV/RNP Routes as required

22. SUMMARY TABLE MID TERM (2013-2016)

Airspace	Nav. Specifications	Nav. Specifications where Operationally Required
En Route Oceanic	RNAV 10,	RNP 4
En Route Remote	RNAV 10,	RNP 4
Continental		
En Route Continental	RNAV 2, RNAV 5	RNAV 1

TMA Arrival/Departure	Expand RNAV 1, or RNP 1 application Mandate RNAV 1, or RNP 1 in high density TMAs	
Approach	Expand RNP APCH with (Baro-VNAV) with LNAV only procedures (See note below). Implement RNP AR APCH where there are operational benefits	
Note: Where altimeter setting does not exist or aircraft of maximum certificated take-off mass of 5700kg or more, using an aerodrome that is suitably equipped for APV.		

23. LONG TERM (2017 AND BEYOND): ACHIEVING A PERFORMANCE-BASED NAVIGATION SYSTEM

23.1. The Long-term environment will be characterized by continued growth in air travel and increased air traffic complexity.

23.2. No one solution or simple combination of solutions will address the inefficiencies, delays, and congestion anticipated to result from the growing demand for air transportation. Therefore, the ANSP, and key Stakeholders need an operational concept that exploits the full capability of the aircraft in this time frame.

24. LONG TERM KEY STRATEGIES (2017 AND BEYOND)

24.1. Airspace operations in the Long term will make maximum use of advanced flight deck automation that integrates Communication, Navigation, Surveillance (CNS) capabilities. Required Navigation Performance (RNP), Required Communication Performance (RCP), and Required Surveillance Performance (RSP) standards will define these operations. Separation assurance will remain the principal task of air traffic management in this time frame. This task is expected to leverage a combination of aircraft and ground-based tools. Tools for conflict detection and resolution, and for flow management, will be enhanced significantly to handle increasing traffic levels and complexity in an efficient and strategic manner.

24.2. Strategic problem detection and resolution will result from better knowledge of aircraft position and intent, coupled with automated, ground-based problem resolution. In addition, pilot and air traffic controller workload will be lowered by substantially reducing voice communication of clearances, and furthermore using data communications for clearances to the flight deck. Workload will also decrease as the result of automated confirmation (via data communications) of flight intent from the flight deck to the ground automation.

24.3. With the necessary aircraft capabilities, procedures, and training in place, it will become possible in certain situations to delegate separation tasks to pilots and to flight deck systems that depict traffic and conflict resolutions. Procedures for airborne separation assurance will reduce reliance on ground infrastructure and minimize controller workload. As an example, in IMC an aircraft could be instructed to follow a leading aircraft, keeping a certain distance. Once the pilot agreed, ATC would transfer responsibility for maintaining spacing.

24.4. Performance-based operations will exploit aircraft capabilities for ―electronic‖ visual acquisition of the external environment in low-visibility conditions, which may potentially increase runway capacity and decrease runway occupancy times.

24.5. Improved wake prediction and notification technologies may also assist in achieving increased runway capacity by reducing reliance on wake separation buffers.

24.6. System-wide information exchange will enable real-time data sharing of National Airspace System (NAS) constraints, airport and airspace capacity, and aircraft performance. Electronic data communications between the ATC automation and aircraft, achieved through data link, will become widespread possibly even mandated in the busiest airspace and airports. The direct exchange of data between the ATC automation and the aircraft FMS will permit better strategic and tactical management of flight operations.

24.7. Aircraft will downlink to the ground-based system their position and intent data, as well as speed, weight, climb and descent rates, and wind or turbulence reports. The ATC automation will uplink clearances and other types of information, for example, weather, metering, choke points, and airspace use restrictions.

24.8. To ensure predictability and integrity of aircraft flight path, RNP will be mandated in busy en route and terminal airspace. RNAV operations will be required in all other airspace (except oceanic). Achieving standardized FMS functionalities and consistent levels of crew operation of the FMS is integral to the success of this Long-term strategy.

24.9. The most capable aircraft will meet requirements for low values of RNP (RNP 0.3 or lower en route. Flights by such aircraft are expected to benefit in terms of airport access, shortest routes during IMC or convective weather, and the ability to transit or avoid constrained airspace, resulting in greater efficiencies and fewer delays operating into and out of the busiest airports.

24.10. Enhanced ground-based automation and use of real-time flight intent will make time-based metering to terminal airspace a key feature of future flow management initiatives. This will improve the sequencing and spacing of flights and the efficiency of terminal operations.

24.11. Uniform use of RNP for arrivals and departures at busy airports will optimize management of traffic and merging streams. ATC will continue to maintain control over sequencing and separation; however, aircraft arriving and departing the busiest airports will require little controller intervention. Controllers will spend more time monitoring flows and will intervene only as needed, primarily when conflict prediction algorithms indicate a potential problem.

24.12. More detailed knowledge of meteorological conditions will enable better flight path conformance, including time of arrival control at key merge points. RNP will also improve management of terminal arrival and departure with seamless routing from the en route and transition segments to the runway threshold. Enhanced tools for surface movement will provide management capabilities that synchronize aircraft movement on the ground; for example, to coordinate taxiing aircraft across active runways and to improve the delivery of aircraft from the parking areas to the main taxiways.

25. SUMMARY OF LONG TERM KEY STRATEGIES (2017 AND BEYOND)

25.1. The key strategies for instituting performance-based operations employ an integrated set of solutions.

a) Airspace operations will take advantage of aircraft capabilities, i.e. aircraft equipped with data communications, integrated displays, and FMS.

b) Aircraft position and intent information directed to automated, ground-based ATM systems, strategic and tactical flight deck-based separation assurance in selected situations (problem detection and resolution).

c) Strategic and tactical flow management will improve through use of integrated airborne and ground information exchange.

d) Ground-based system knowledge of real-time aircraft intent with accurate aircraft position and trajectory information available through data link to ground automation.

e) Real-time sharing of NAS flight demand and other information achieved via ground-based and air-ground communication between air traffic management and operations planning and dispatch.

f) Overall system responsiveness achieved through flexible routing and well-informed, collaborative decision-making.

g) System ability to adapt rapidly to changing meteorological and airspace conditions.

h) System leverages through advanced navigation capabilities such as fixed radius transitions, RF legs, and RNP offsets.

i) Increased use of operator-preferred routing and dynamic airspace.

j) Increased collaboration between the ANSP and operators.

k) Operations at the busiest airports will be optimized through an integrated set of capabilities for managing pre-departure planning information, ground-based automation, and surface movement.

l) RNP-based arrival and departure structure for greater predictability.

m) Ground-based tactical merging capabilities in terminal airspace.

n) Integrated capabilities for surface movement optimization to synchronize aircraft movement on the ground. Improved meteorological and aircraft intent information shared via data link.

26. KEY RESEARCH AREAS

26.1. The aviation community must address several key research issues to apply these strategies effectively. These issues fall into several categories.

27. NAVIGATION

a) To what extent can lower RNP values be achieved and how can these be leveraged for increased flight efficiency and access benefits?

b) Under what circumstances RNAV should be mandated for arriving/departing satellite airports to enable conflict-free flows and optimal throughput in busy terminal areas?

28. PROCEDURES

a) How can time of arrival control be applied effectively to maximize capacity of arrival or departure operations, in particular during challenging wind conditions?

b) In what situations is delegation of separation to the flight crews appropriate?

c) What level of onboard functionality is required for flight crews to accept separation responsibility within a manageable workload level?

29. AIRSPACE

a) What separation standards and procedures are needed to enable smoother transition between en route and terminal operations?

b) How can fuel-efficient procedures such as CDOs and CCOs be accomplished in busy airspace?

30. POLICY

How is information security ensured as information exchange increases?

What are the policy and procedure implications for increased use of collaborative decision-making processes between the service provider and the operator?

30.1. The answers to these and other research questions are critical to achieving a PBN system. Lessons learned from the near-term and midterm implementation of the Roadmap will help answer some of these questions. The aviation community will address others through further concept development, analysis, modeling, simulation, and field trials. As concepts mature and key solutions emerge, the community will develop more detailed implementation strategies.

31. PERIODIC REVIEW OF IMPLEMENTATION ACTIVITIES

Procedures to Modify the Regional Plan

31.1. Whenever a need is identified for a change to this document, the Request for Change (RFC) Form (to be developed) should be completed and submitted to the ICAO Regional Offices. The Regional Offices will collate RFCs for consideration by the PBN Task Force (ATM/SAR/AIS Sub-group of APIRG).

31.2. When an amendment has been agreed by a meeting of the PBN Task Force, a new version of the PBN Regional Plan will be prepared, with the changes marked by an ―‖ in the margin, and an endnote indicating the relevant RFC, to enable a reader to note the origin of the change. If the change is in a table cell, the outside edges of the table will be highlighted. Final approval for publication of an amendment to the PBN Regional Plan will be the responsibility of APIRG.

Appendix A – List of Airports/Runway Approaches

INTERNATIONAL AIRPORTS			PBN PLAN			TIMELINE
Airport	Runway	Current Approach	RNP Approach	SID	STAR	
FQMA	05	RNAV	APV	RNP 1	RNP 1	201[illegible]
	23	ILS/RNAV	APV	RNP 1	RNP 1	201[illegible]
FQBR	12	ILS/RNAV	APV	RNP 1	RNP 1	201[illegible]

	30	RANAV	APV	RNP1	RNP1	2016
FQNP	05	RNAV	APV	RNP1	RNP1	2016
	23	VOR/DME/RNAV	APV	RNP 1	RNP 1	2016
FQNC	NONE	NONE	APV	RNP1	RNP1	2016
	NONE	NONE	APV	RNP1	RNP1	2016

MAJOR DOMESTIC AIRPORTS

FQPB	17	NDB/RNAV	APV	RNP 1	RNP1	2016
	35	NONE	APV	RNP1	RNP1	2016
FQVL	17	NDB/RNAV	APV	RNP 1	RNP 1	2016
	35	RNAV	APV	RNP1	RNP1	2016
FQTT	01	VOR/DME/RNAV	APV	RNP 1	RNP 1	2016
	19	NONE	APV	RNP1	RNP1	2016
FQQL	18	VOR/DME/RNAV	APV	RNP 1	RNP 1	2016
	36	NONE	APV	RNP1	RNP1	2016
FQIN	16	NDB/RNAV	LNAV	RNP 1	RNP 1	2016
	34	NONE	LNAV	RNP1	RNP1	2016
FQLC	08	VOR/DME/RNAV	APV	RNP 1	RNP 1	2016
	26	NONE	APV	RNP1	RNP1	2016
FQCH	01	NDB/RNAV	APV	RNP1	RNP1	2016
	19	NONE	APV	RNP1	RNP1	2016

Appendix B-List of airways and coordination points

UT 122: ORNAD- VMA- APLAR - SUNIR;

UT 125: ANVAK- VMA;

UT 444: DUTGI- IBKAR- SUNIR;

UT 536: VMA- IMPAM- EROPA;

UT 446: UNPEN-ANTAT- VL;

UT 512: ETLOP- ETKES- VBR;

UT 513: GADNO- GEPAT- VBR;

UT 515: ETLEG- IBMAS- VBR;

UT 516: IMKIB- NETEM- VL

UT 517: IMKIB-IMDIR-VL

UT 518: IXEMA- IBGUT- VL

UT 519: NERUL-UNKER-VL

Appendix C – Action Plans with interim milestones

Oceanic and Remote Continental implementation schedule

2013 2015 2016/17

RNAV 10	RNAV 10 or PBN RNAV-5 or	RNAV 10 or PBN RNAV-5 or
RNP4 where operationally required	RNP4 where operationally required	RNP4 where operationally required

RNAV 5 will be allowed when sufficient surveillance is available.

En route continental implementation schedule

2013 2015 2016/17

Conventional/ RNAV 5	RNAV-2 or RNAV 5	PBN RNAV-5 or RNAV 2
RNAV 1where operationally required	RNAV 1 where operationally required	RNAV 1 where operationally required

- RNAV 5 will be allowed when sufficient surveillance is available.

Terminal area and approach implementation schedule

TMA STARS / SIDS

2013 20152016/17

RNAV -1 with surveillance 30% for International airport by 2013	**Expand RNAV-1, or RNP-1** 100% for International airport by 2016	
RNP 1Without surveillance	RNAV -1, or RNP-1 Mandatory	

Approach

2013 2015 2016/17

Approach RNP APCH with Baro VNAV or 30% of instrument runway by 2015 And 50% by 2016	**Expand RNAV-1, or RNP-1** 100% for International airport by 2016	
Airports with RNP approach 50% by 2016 **RNP AR APCH if required**	Airports **Expand RNP AR APCH with operational benefits**	

Appendix D - Terms of Reference for National PBN Programme Manager.

National PBN Programme Manager (NPPM):

1) Responsible for ensuring that proper mechanisms are put in place for the effective implementation of PBN, including:

a) Establishment of a National PBN Implementation Group.

b) Development of a National PBN Implementation Plan.

2) Act as Focal Points and Coordinators of the activities of States' PBN Implementation

Groups, including but not limited to the following:

a) Study of PBN operations technology and the Global and Regional guidance material.

b) Review of the regional air navigation plan and take account of regional ATM Objectives and regional ATM requirements in terms of communication, navigation and surveillance elements.

c) Coordination with adjacent States.

d) Consistent with ICAO's regional air navigation plan, identification of the principal objectives of the State for implementation of CNS/ATM systems.

e) Review of the current and planned infrastructures in terms of airports, airspace, air routes, communications, and navigation and surveillance elements.

f) Assessment of the current traffic density and carry out air traffic forecasts with emphasis on aircraft movements and regional flows of traffic.

g) Evaluation of the current ATM system, focusing on route structure, separation standards, equipage, maintenance, operations and procedures in order to identify any weaknesses.

h) As a result of gap analyses, development of functional requirements that would result in improvements/benefits both in the short term and the long term, keeping in view users' requirements.

i) Establishment of PBN operational objectives and supporting CNS elements that are most suitable for the scenario, taking into account the planning situation in adjacent States, the development status of ICAO guidance material (SARPs, PBN Manual, etc.) and the regional approach to air navigation planning.

j) Establishment of implementation time lines for new systems and decommissioning time lines for current ground systems that is not required as a result of the transition to PBN operations.

k) Carrying out of cost-benefit analyses to determine the most appropriate plan, using the iteration process.

I) Harmonization with the regional plan.

m) Formalization and maintenance of the planning document; and initiation of actions for the implementation of PBN.

The composition of the National PBN Implementation Group should include members from participating organizations, such as:

a) the national administration;

b) the regulating agency;

c) ATM service provider;

d) airspace users;

e) the airport authority;

f) research and development organizations;

g) military authorities, including air defense; and

h) other relevant bodies.

3) Participate in, coordinate and provide support to, APIRG PBN Implementation Task Force meetings and assigned tasks.

Appendix E Acronyms

ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
AFI	Africa Indian-Ocean
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
APIRG	Africa-Indian Ocean Planning and Implementation Regional Group
APV	Approach with Vertical Guidance (Baro VNAV, SBAS)
ATC	Air Traffic Control
ATM	Air Traffic Management
ATM/SAR/AIS	Air Traffic Management/Search and Rescue/Aeronautical Information Services
Baro VNAV	Barometric Vertical Navigation
Basic RNP1	Basic Required Navigation Performance 1
CAA	Civil Aviation Authority
CDA	Continuous Descent Approach
CNS	Communications, Navigation, Surveillance
DME	Distance Measuring Equipment
EFVS	Enhanced Flight Visibility System
FMS	Flight Management System
GA	General Aviation
GBAS	Ground-Based Augmentation System
GLS	GNSS Landing System
GLONASS	Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRAS	Ground-Based Regional Augmentation System

ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IMC	Instrument Meteorological Conditions
LNAV	Lateral Navigation
LPV	Localizer Performance with Vertical Guidance
NAS	National Airspace System
NAVAID	Navigation Aid
NM	Nautical Miles
PBN	Performance Based Navigation
PBN SG	Performance Based Navigation Study Group
RCP	Required Communications Performance
RF	Radius-to-Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance, Authorization Required
RNP AR APCH	Required Navigation Performance, Authorization Required, Approach
RNPSORSG Study Group	Required Navigation Performance and Special Operational Requirements
RSP	Required Surveillance Performance
SBAS	Satellite Based Augmentation System
SARPS	Standards and Recommended Practices
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
VOR	Very High Frequency Omni Directional Range

VLJ	Very Light Jet
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System