INTERNATIONAL CIVIL AVIATION ORGANIZATION

SECOND MEETING OF THE APIRG PERFORMANCE-BASED NAVIGATION TASK FORCE (PBN/TF/2)
REPORT

(Nairobi, Kenya, 4 – 6 December 2008)

Prepared by the PBN TASK FORCE

The PBN Task Force is a Task Force of the AFI Planning and Implementation Regional Group (APIRG).

Its Reports are therefore submitted to APIRG through the ATS/AIS/SAR Sub-Group for review and action.

Table of Contents

Appendices:

PART I – HISTORY OF THE MEETING

1. Introduction

1.1 The Second PBN Task Force (PBN/TF/2) was convened pursuant to APIRG 16 meeting Conclusion 16/2 by the ICAO ESAF Office Nairobi, from 4 to 6 December 2008.

1.2 The Second meeting of the PBN Task Force was opened by Mr. Mamadou Ndiaye, Deputy Regional Director, ICAO ESAF Office.

1.3 The meeting nominated Mr. Matthys C. Horak, as the Chairman of the meeting. He thanked the participants for the confidence given to him and appealed for their full cooperation to come up with the expected conclusions and decisions.

2. Officers and Secretariat

2.1 Mr. Apolo Kharuga, Regional Officer, Air Traffic Management from the ICAO ESAF Office, Nairobi, was the Secretary of the meeting; Mr. Erwin Lassooij, RO/PBN Programme Coordinator HQ, and Mr. K. Brou RO/ATM Nairobi, assisted him.

3. Attendance

3.1 The meeting was attended by Sixty Seven (67) participants from 22 States and 6 International Organizations namely; ASECNA, EUROCONTROL, IATA, IFALPA, IFATCA and JEPPESEN. The list of participants is given at **Appendix A** to this report.

4. Working Language

4.1 The meeting was conducted in the English language.

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5. AGENDA

5.1 The following Agenda was adopted:

Agenda Item 1: Review and follow-up of the conclusions of the first meeting of the Performance Based Navigation Task Force (PBN TF/1) meeting.

Agenda Item 2: Review of the activities of the AFI Regional PBN Implementation Plan Work Group.

Agenda Item 3: Review of the activities of the State PBN Plan Work Group.

Agenda Item 4: Consideration of PBN matters arising from the Special AFI RAN 08 meeting.

Agenda Item 5: Any other business

List of Conclusions and Decisions:

Number	Title
Conclusion 2/1:	**Members of PBN Task Force** That the following States and International Organizations shall nominate experts to serve as members of the PBN Task Force: Algeria, Benin, Burundi, Botswana, Cameroon, Cape Verde, Chad, Democratic Republic of Congo (DRC), Egypt, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Mauritius, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Tunisia, Uganda, IFALPA, IFATCA, IATA, ASECNA and Roberts FIR.
Conclusion 2/2:	**Conduct of Surveys on aircraft equipage** **That:** a) ICAO Regional Offices conduct regular surveys on aircraft equipage within the AFI Region, as part of PBN implementation related activities; and b) ICAO regional surveys on aircraft equipage should be carried out in close coordination with States, IATA and AFRAA.
Conclusion 2/3:	**Civil/Military Coordination** That in order to ensure the safe and coordinated implementation of PBN in the AFI Region, States should ensure that the military aviation authorities are fully involved in the planning and implementing process.
Conclusion 2/4:	**Nomination of National PBN Programme Managers (NPPMs)** That States/service providers which have not done so, designate/nominate as soon as possible, but not later than **28 February 2009** a National PBN Programme Manager PBN (NPPM), who will be responsible for ensuring that the proper mechanism be put in place for the effective implementation of PBN. Note: The terms of reference of PBN programme managers are provided at **Appendix G** to this report
Conclusion 2/5:	**Implementation of PBN in the AFI Region** **That:** a) States in the AFI Region ensure that all requirements be met with a view to safely implementing PBN; and b) Implementation of PBN in the AFI Region be harmonized and coordinated with other adjacent Regions.

Number	Title
Conclusion 2/6:	**Training of all personnel involved with the implementation of PBN in the AFI Region** **That:** a) APIRG PBN Task Force identify training needs in order to assist States with RNAV/RNP implementation in the en-route, terminal, and approach flight phases, taking into account the performance-based navigation (PBN) concept. b) Seminars/Workshops be organized in the Region for training of relevant personnel directly involved in the implementation of PBN namely pilots, controllers, procedures designers, dispatchers, OPS/Air, operators etc; c) ICAO develop training modules on PBN by **31 Decembe**r **2009** that may be used by States for training; and d) States having difficulties in implementing PBN implementation programme, may either individually or in group explore the possibility of seeking outside expertise.
Conclusion 2/7:	**PBN Legislation** That the States include in their legislation and regulations the provisions relating to PBN.
Conclusion 2/8:	**Participation of representatives of States involved in PBN approval process** That representatives of States involved in the PBN approval process of aircraft operators, be invited to attend the future meetings of the PBN Task Force.
Conclusion 2/9:	**Funding of the PBN Implementation Programme** That regulatory bodies, operators, service providers and other stakeholders be granted budgetary allocations for acquisitions and other activities necessary for ensuring that all the requirements be met in a timely manner in order to safely implement PBN in the AFI Region.
Conclusion 2/10:	**AFI Regional PBN Implementation Plan** **That:** The Regional PBN Implementation Plan at **Appendix B** is applicable in the AFI Region.

Number	Title
Conclusion 2/11:	**National PBN Plan Template** **That:** a) States use the National PBN Plan Template at **Appendix C** in developing their National PBN Plans; and **b)** States complete their National PBN Plans as soon as possible, but not later than **31 December 2009.**
Conclusion 2/12:	**Follow up action of Special RAN Recommendations relating to PBN implementation** **That the PBN Task Force:** a) Initiate follow up action on the Special RAN Recommendations relevant to PBN shown at **Appendix D**; and b) Submit to APIRG a report on actions taken.
Conclusion 2/13:	**Amendment to the AFI CNS/ATM Plan (Doc.003)** That APIRG amend the relevant parts of the AFI/CNS/ATM Plan (Doc.003) to incorporate PBN issues.
Conclusion 2/14:	**AFI Region PBN Performance Objectives** That in accordance with Special AFI RAN 08 Recommendation 6/9, and in order to provide the direction to the implementation of PBN in the AFI Region in accordance with the ICAO planning framework, the AFI PBN performance objectives be developed based on the performance framework forms (PFFs) at **Appendix E** to this report.
Conclusion 2/15:	**AFI PBN Action Plan.** That the APIRG PBN Task Force develop the PBN Action Plan using the material at **Appendix F** to this report.
Conclusion 2/16:	**Renaming of APIRG PBN Task Force** That taking into consideration the PBN Task Force assigned objective to ensure that the implementation of the navigation element of the CNS/ATM system is based on clearly established operational requirement:

Number	Title
	APIRG: a) Consider the renaming of the PBN/GNSS Task Force as AFI PBN/GNSS Task Force; b) Amend the terms of reference of the PBN Task Force as at **Appendix H** to this report; and c) AFI GNSS Strategy be amended taking into consideration the AFI Regional PBN Plan developed by APIRG PBN Task Force.
Decision 2/1:	**Finalization and Distribution of AFI Regional PBN Plan and National PBN Plan Template** That the Secretariat finalize the AFI PBN Regional Plan and National PBN Plan Template developed by APIRG PBN Task Force (as shown in **Appendices B** and **C** to this report), and ensure that they are made available to all AFI States as soon as possible, but in any case not later than **28 February 2009**.
Decision 2/2:	**Establishment of a PBN Task Force Working Group on En-Route Operations** That an En-Route Working Group is established with the following members to develop the AFI PBN Performance Objectives and Action Plan for en – route phase of flight operations. **Members of Working Group for En-route** Algeria Benin Burundi CapeVerde DRC Egypt Lesotho Liberia Mauritius South Africa Sudan Tanzania Uganda ASECNA (Rapporteur) IATA IFALPA IFATCA Roberts FIR
Decision 2/3:	**Establishment of a PBN Task Force Working Group on Terminal and Approach Operations** That a Terminal/Approach Working Group is established to develop the AFI PBN Performance Objectives and Action Plan for terminal and approach phases of flight operations.

Number	Title
	Members of the Working Group for Terminal and Approach Botswana Cameroon Chad Ethiopia Ghana Kenya Liberia Nigeria Rwanda Senegal Seychelles (Rapporteur) Sierra Leone Tunisia ASECNA IATA IFALPA IFATCA Roberts FIR
Decision 2/4:	**Working Methodology** **That the Task Force will:** a) Utilize Electronic means to post WPs and IPs prior to meetings; website: www.icao.int/esaf/pbn; b) Post at least one week prior to the meetings on the following ICAO website: www.icao.int/esaf/pbn; c) Conduct paperless meetings as far as possible; d) All correspondence will be via electronic means.

PART II: REPORT ON AGENDA ITEMS

Agenda Item 1: Review and follow-up of the conclusions of the first meeting of the Performance Based Navigation Task Force (PBN TF/1) meeting.

1.1 Under this Agenda Item the meeting reviewed and noted the action taken on the conclusions of the First meeting of the PBN Task Force meeting. It reinstated conclusions which were still in force and proposed the action to be taken before the next Task Force meeting. These conclusions appear in Part 1 of this report (Conclusions 2/1 through 2/9).

Agenda Item 2: Review of the activities of the AFI Regional PBN Implementation Plan Work Group

2.1 Under this agenda item the Task Force reviewed the draft AFI Regional PBN Plan document prepared by the Rapporteur of the Group and also considered other documents presented by the Secretariat on the same subject. The Rapporteur of the Group presented to the Task Force Plenary the draft AFI Regional Plan. The draft Plan was adopted by the Task Force with note that the Rapporteur would incorporate as soon as possible some few amendments and forward final Documents to the Secretary to be included in the final report of the meeting for onward distribution to the States in accordance with the established ICAO practices. In view of the discussions the meeting formulated the following Conclusion and Decision.

Conclusion 2/10: AFI Regional PBN Implementation Plan

That:

The Regional PBN Implementation Plan at Appendix B is applicable in the AFI Region.

Decision 2/1: Finalization and Distribution of AFI Regional PBN Plan and National PBN Plan Template

That the Secretariat finalize the AFI PBN Regional Plan and National PBN Plan Template developed by APIRG PBN Task Force (as shown in Appendices F and G to this report), and ensure that they are made available to all AFI States as soon as possible, but in any case not later than 31 January 2009.

Agenda Item 3: Review of the activities of the State PBN Plan Work Group

3.1 Under this agenda item the Task Force reviewed the draft State PBN Plan Template document prepared by the Rapporteur of the Work group on the subject. The Rapporteur of the Group presented to the Task Force Plenary the draft State PBN Plan Template. The draft State PBN Plan Template was adopted by the Task Force with note that the Rapporteur would as soon possible incorporate some few amendments and forward final Documents to the Secretary for inclusion in the report of the meeting for onward distribution to the States in accordance with the established ICAO practices. In view of the discussions the meeting formulated the following Conclusions and decisions.

Conclusion 2/11: National PBN Plan Template

That:

a) States use the National PBN Plan Template at Appendix C in developing their National PBN Plans; and
b) States complete their National PBN Plans as soon as possible, but not later than 31 December 2009.

Agenda Item 4: Consideration of PBN matters arising from the AFI Special RAN meeting

4.1 Under this agenda item the Task Force noted the Special RAN Recommendations: Rec. 6/7, Rec. 6/9, Rec. 6/10, Rec. 6/11, Rec. 6/13 and Rec. 6/17 (reproduced here below) relating to PBN and developed relevant conclusions aimed at their implementation.

Recommendation 6/7 – Establishment of a Tactical Action Group (TAG)

That:

a) A Tactical Action Group be created in the AFI Region with the Terms of Reference and Work Programme outlined in Appendix C to the Report on Agenda Item 6; and

b) States as a matter of priority make all efforts to assist and comply with requests from the TAG group.

Recommendation 6/9 - Performance-based navigation (PBN) performance objectives

That APIRG adopt the Performance Objectives as contained in the performance framework forms in Appendix D to the Report on Agenda Item 6.

a) Optimization of the air traffic services (ATS) route structure in en-route airspace;
b) Optimization of ATS route structure in terminal airspace; and
c) Implementation of vertically guided required navigation performance (RNP) approaches.

That States develop their national action plans to meet the requirements of the regional performance framework forms, as a matter of priority to meet the PBN implementation goals established by Assembly Resolution A36-23.

Recommendation 6/10 - Support for establishment of an African ICAO flight procedure office

That:

a) States and international organizations support the implementation of an AFI flight procedures office; and
b) ICAO disseminate a letter, with supporting documentation, inviting interested States and international organizations to submit proposals for establishment and hosting of the FPO.

Recommendation 6/11 - Implementation of WGS-84 and eTOD

That APIRG adopt the AIM Performance Objective: Implementation of world geodetic system-1984 (WGS-84) and electronic terrain and obstacle data (eTOD) as contained in the performance framework form in Appendix E to the Report on Agenda Item 6.

Recommendation 6/13 - Publication of GNSS-based RNP approach procedures

That:

a) States having taken part in the IATA area navigation (RNAV) global navigation satellite systems (GNSS) procedures development and implementation programme and which had not yet done so, publish GNSS-

based required navigation performance (RNP) approaches, and at the same time, remove any operational restrictions they may be in place; and

b) States that had not taken part in the IATA RNAV GNSS procedures development and implementation programme, seek assistance from appropriate organizations with the objective of designing and implementing GNSS-based RNP approach procedures.

Recommendation 6/14 - ICAO assistance with legal and regulatory issues associated with implementation of GNSS approach procedures

That ICAO provide assistance to States in overcoming legal and regulatory difficulties associated with implementation of global navigation satellite systems (GNSS) based approach procedures.

In view of the foregoing it formulated the following conclusion.

Conclusion 2/12: Follow up action of Special RAN Recommendations relating to PBN implementation.

That the PBN Task Force:

a) Initiate follow up action on the Special RAN Recommendations relevant to PBN shown at Appendix D; and
b) **Submit to APIRG a report on actions taken**.

Agenda Item 5: Venue and date of 3rd PBN seminar and 3rd PBN TF meeting

5.1 The 3rd PBN seminar and the 3 rd PBN TF meeting will tentatively be held in Nairobi in May 2009.

SECOND PERFORMANCE-BASED NAVIGATION (PBN) TASK FORCE MEETING (NAIROBI, KENYA, 4 – 6 DECEMBER 2008)

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AFI REGION

Performance Based Navigation Roadmap

Table of Contents

Table of Contents

1. INTRODUCTION

1.1 The AFI Region Performance Based Navigation (PBN) Roadmap details the framework within which the ICAO PBN concept will be implemented in the AFI Region for the foreseeable future. The AFI Region Roadmap for PBN is guided by ICAO Doc. 9613 and relevant SARPS. The primary driver for this plan is to maintain and increase safety, air traffic demand and capacity, and services and technology in consultation with relevant stakeholders. The AFI Region Roadmap also supports national and international interoperability and global harmonization.

2. BACKGROUND

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

2.2 Growth in scheduled and GA aircraft is expected to increase point-to-point and direct routings. The increasing cost of fuel also presents a significant challenge to all segments of the aviation community. This anticipated growth and higher complexity of the air transportation system could result in increased flight delays, schedule disruptions, choke points, inefficient flight operations, and passenger inconvenience, particularly when unpredictable weather and other factors constrain airport capacity. Without improvements in system efficiency and workforce productivity, the aviation community and cost of operations will continue to increase. Upgrades to the air transportation system must leverage current and evolving capabilities in the near term, while building the foundation to address the future needs of the aviation community stakeholders. These circumstances can be partially alleviated by efficiencies in airspace and procedures through the implementation of PBN concepts.

2.3 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.

2.4 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. For oceanic operations, inertial navigation systems (INS) were employed.

2.5 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.

2.6 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

3.1 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.

3.2 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.

3.3 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.

3.4 The advantage of this approach is that it provides clear, standardized operational approvals which enable 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.

3.5 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. These navigation specifications are defined at a sufficient level of detail to facilitate global harmonization by providing specific implementation guidance for States and operators.

3.6 Under PBN, generic navigation requirements are defined based on the operational requirements. Operators are then able to evaluate options in respect of available technologies and navigation services that could allow these requirements to be met. The chosen solution would be the most cost effective for the operator, rather than a solution being imposed as part of the operational requirements. Technologies can evolve over time without requiring the operation itself to be revisited, as long as the requisite performance is provided by the RNAV system. As part of the future work of the ICAO it is anticipated that other means for meeting the requirements of the Navigation Specifications will be evaluated and may be included in the applicable Navigation Specifications, as appropriate.

3.7 ICAO's Performance Based Navigation (PBN) concept aims to ensure global standardisation of RNAV and RNP specifications and to limit the proliferation of navigation specifications in use world-wide. 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.

4. PBN BENEFITS

4.1 PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria. These include:

a) Reduces need to maintain sensor-specific routes and procedures, and their associated costs. For example, moving a single VOR ground facility can impact dozens of procedures, as that VOR can be used on routes, VOR approaches, as part of missed approaches, etc. Adding new sensor specific procedures will compound this cost, and the rapid growth in available navigation systems would soon make system-specific routes and procedures unaffordable.

b) Avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive. The expansion of satellite navigation services is expected to contribute to the continued diversity of RNAV systems in different aircraft. The original Basic GNSS equipment is evolving due to the augmentations of SBAS, GBAS and GRAS, while the introduction of Galileo and modernization of GPS and GLONASS will further improve performance. The use of GNSS/inertial integration is expanding.

c) Allows more efficient use of airspace (route placement, fuel efficiency, noise abatement).

d) Clarifies the way in which RNAV systems are used.

e) Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

4.2 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. Specifically, RNAV and RNP may:

a) Increase safety by using three-dimensional (3D) approach operations with course guidance to the runway, which reduce the risk of controlled flight into terrain.

b) Improve airport and airspace access in all weather conditions, and the ability to meet environmental and obstacle clearance constraints.

c) Enhance reliability and reduce delays by defining more precise terminal area procedures that feature parallel routes and environmentally optimized airspace corridors. Flight management systems (FMS) will then be poised to save operators

time and money by managing climb, descent, and engine performance profiles more efficiently.

d) Improve efficiency and flexibility by increasing use of operator-preferred trajectories airspace-wide, at all altitudes. This will be particularly useful in maintaining schedule integrity when convective weather arises.

e) Reduce workload and improve productivity of air traffic controllers.

4.3 Performance-based navigation will enable the needed operational improvements by leveraging current and evolving aircraft capabilities in the near term that can be expanded to address the future needs of aviation stakeholders and service providers.

5. STAKEHOLDERS

5.1 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. This, in turn, enables the aviation stakeholders to focus on addressing future efficiency and capacity needs while maintaining or improving the safety of flight operations by leveraging advances in navigation capabilities on the flight deck. RNAV and RNP have reached a sufficient level of maturity and definition to be included in key plans and strategies, such as this AFI Region PBN Roadmap.

5.2 The stakeholders who will benefit from the concepts in the AFI Region PBN Roadmap include airspace operators, air traffic service providers, regulators and standards organizations. As driven by business needs, airlines and operators can use the AFI Region PBN Roadmap to plan future equipage and capability investments. Similarly, air traffic service providers can determine requirements for future automation systems, and more smoothly modernize ground infrastructure. Finally, regulators and standards organizations can anticipate and develop the key enabling criteria needed for implementation.

5.3 The AFI Region PBN Roadmap also supports other CAA and government-wide planning processes, working on several fronts to address the needs of the aviation community. This Roadmap is a work in progress and will be amended through collaborative AFI Region States, industry efforts and consultations that establish a joint aviation community/government/industry strategy for implementing performance-based navigation. Critical initiative strategies are required to accommodate the expected growth and complexity over the next two decades. These strategies have five key features:

a) Expediting the development of performance-based navigation criteria and standards.

b) Introducing airspace and procedure improvements in the near term.

c) Providing benefits to operators who have invested in existing and upcoming capabilities.

d) Establishing target dates for the introduction of navigation mandates for selected procedures and airspace, with an understanding that any mandate must be rationalized on the basis of benefits and costs.

e) Defining new concepts and applications of performance-based navigation for the mid term and Long term and building synergy and integration among other capabilities toward the realization of the AFI Region PBN goals.

6. STRATEGY

6.1 This Roadmap provides a high-level strategy for the evolution of navigation capabilities to be implemented in three timeframes: near term (2008-2012), mid term (2013-2016), and Long term (2017 and Beyond). The strategy rests upon two key navigation concepts; Area Navigation (RNAV) and Required Navigation Performance (RNP). It also encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) operations, as well as en-route continental, oceanic and remote operations. The section on Long-term initiatives discusses integrated navigation, communication, surveillance and automation strategies.

6.2 To avoid proliferation of new navigation standards, States and other aviation stakeholders in the AFI region should communicate any new operational requirements with ICAO HQ, so that it can be taken into account by the PBN SG.

7. NEAR TERM (2008-2012) MID TERM (2013-2016) AND LONG TERM (2016 AND BEYOND) KEY TASKS

7.1 The key tasks involved in the transition to performance-based navigation are:

a) Establish navigation service needs through the Long term that will guide infrastructure decisions and specify needs for navigation system infrastructure, and ensure funding for managing and transitioning these systems.

b) Define and adopt a national policy enabling additional benefits based on RNP and RNAV.

c) Identify operational and integration issues between navigation and surveillance, air-ground communications, and automation tools that maximize the benefits of RNP.

d) Support mixed operations throughout the term of this Roadmap, in particular considering navigation system variations during the near term until appropriate standards are developed and implemented.

e) To support Civil/Military coordination and develop the policies needed to accommodate the unique missions and capabilities of military aircraft operating in civil airspace.

f) Harmonize the evolution of capabilities for interoperability across airspace operations.

g) Increase emphasis on human factors, especially on training and procedures as operations increase reliance on appropriate use of flight deck systems.

h) Facilitate and advance environmental analysis efforts required to support the development of RNAV and RNP procedures.

i) Maintain consistent and harmonized global standards for RNAV and RNP operations.

8. NEAR-TERM (2008-2012)

8.1 Initiatives in the near-term focus on investments by operators in current and new aircraft acquisitions; in satellite-based navigation and conventional navigation infrastructure as well as AFI Region States investments. Key components include wide-scale RNAV implementation and the introduction of RNP for en route, terminal, and approach procedures.

8.2 The near-term strategy will also focus on expediting the implementation and proliferation of RNAV and RNP procedures. As demand for air travel continues at healthy levels, choke points will develop and delays at the major airports will continue to climb. RNAV and RNP procedures will help alleviate those problems. Continued introduction of RNAV and RNP procedures will not only provide benefits and savings to the operators but also encourage further equipage.

8.3 ANSPs as a matter of urgency must adapt new flight plan procedures to accommodate PBN operations. This particularly addresses fields 10 and 18.

8.4 Operators will need to plan to obtain operational approvals for the planned Navigation Specifications for this period. Operators shall also review Regional PBN Implementation Plans from other Regions to assess if there is a necessity for additional Operational approvals.

9. OCEANIC AND REMOTE OPERATIONS

9.1 To promote global harmonization, the AFI Region States continues to work closely with its international partners in implementing RNAV-10 and where operationally required RNP-4 by 2010. Safety assessment shall be undertaken to evaluate reduced oceanic and remote longitudinal/lateral separation minima between aircraft approved for RNAV-10 and RNP-4 operations.

9.2 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.

10. CONTINENTAL EN-ROUTE OPERATIONS

10.1 For airspace and corridors requiring structured routes for flow management, AFI Region States will review existing conventional and RNAV routes to transition to PBN RNAV-5 or where operationally required RNAV-2/1.

11. TERMINAL OPERATIONS

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

11.2 AFI Region States will continue to plan, develop and implement RNAV-1 SIDs and STARs, at major airports and make associated changes in airspace design. In addition, AFI Region States will implement Basic RNP-1 SIDs and STARs. RNAV-1 will be implemented in airspace where there is sufficient surveillance coverage and Basic RNP-1 where there is no such coverage.

11.3 Where operationally feasible, States should develop operational concepts and requirements for continuous descent arrivals (CDAs) 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.

11.4 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.

12. APPROACH OPERATIONS

12.1 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.

12.2 States should promote the use of APV Operations (Baro-VNAV or SBAS) to enhance safety of RNP Approaches and accessibility of runways.

12.3 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.

12.4 RNP approaches include:

a) APV implemented at all instrument runways at major regional airports and all non-instrument runways serving aircraft weighing greater than 5,700kg.

13. SUMMARY TABLE NEAR-TERM (2008-2012)

Airspace	Nav. Specifications	Nav. Specifications where Operationally Required
En-Route Oceanic	RNAV-10	RNP-4
En-Route Remote Continental	RNAV-10	RNP-4
En-Route Continental	RNAV-5	RNAV-1
TMA Arrival/Departure	RNAV-1 in a surveillance environment	
	Basic RNP-1 in non-surveillance environment	
Approach	RNP APCH with Baro-VNAV OR RNP AR APCH if required	

14. NEAR TERM IMPLEMENTATION TARGETS

a) RNP APCH (with Baro-VNAV) in 30% of instrument runways by 2010 and 50% by 2012 and priority given to airports with operational benefits

b) RNAV-1 SID/STAR for 30% of international airports by 2010 and 50% by 2012 and priority given to airports with RNP Approach

c) Review existing conventional and RNAV routes to transition to PBN RNAV-5 or where operationally required RNAV-2/1 by 2012.

15. MID TERM (2013-2016) PRIORITIES

15.1 In the mid term, increasing demand for air travel will continue to challenge the efficiencies of the air traffic management system.

15.2 While the hub-and-spoke system will remain largely the same as today for major airline operations, the demand for more point-to-point service will create new markets and spur increases in low-cost carriers, air taxi operations, and on-demand services. Additionally, the emergence of VLJs is expected to create new markets in the general and business aviation sectors for personal, air taxi, and point-to-point passenger operations. Many airports will thus experience significant increases in unscheduled traffic. In addition, many destination airports that support scheduled air carrier traffic are forecast to grow and to experience congestion or delays if efforts to increase their capacity fall short. As a result, additional airspace flexibility will be necessary to accommodate not only the increasing growth, but also the increasing air traffic complexity.

15.3 The mid term will leverage these increasing flight capabilities based on RNAV and RNP, with a commensurate increase in benefits such as fuel-efficient flight profiles, better access to airspace and airports, greater capacity, and reduced delay. These incentives, which should provide an advantage over non-RNP operations, will expedite propagation of equipage and the use of RNP procedures.

15.4 To achieve efficiency and capacity gains partially enabled by RNAV and RNP, the AFI Region States and aviation industry will pursue use of data communications (e.g., for controller-pilot communications) and enhanced surveillance functionality, e.g. ADS-Broadcast (ADS-B). Data communications will make it possible to issue complex clearances easily and with minimal errors. ADS-B will expand or augment surveillance coverage so that track spacing and longitudinal separation can be optimized where needed (e.g., in non-radar airspace). Initial capabilities for flights to receive and confirm 3D clearances and time of arrival control based on RNP will be demonstrated in the mid term. With data link implemented, flights will begin to transmit 4D trajectories (a set of points defined by latitude, longitude, altitude, and time.) Stakeholders must therefore develop concepts that leverage this capability.

16. OCEANIC EVOLUTION

16.1 In the mid term, AFI Region States will endeavour 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 mid term 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. AUTOMATION FOR RNAV AND RNP OPERATIONS

19.1 By the end of the mid term enhanced en route automation will allow the assignment of RNAV and RNP routes based upon specific knowledge of an aircraft's RNP capabilities. En route automation will use collaborative routing tools to assign aircraft priority, since the automation system can rely upon the aircraft's ability to change a flight path and fly safely around problem areas. This functionality will enable the controller to recognize aircraft capability and to match the aircraft to dynamic routes or procedures, thereby helping appropriately equipped operators to maximize the predictability of their schedules.

19.2 Conflict prediction and resolution in most en route airspace must improve as airspace usage increases. Path repeatability achieved by RNAV and RNP operations will assist in achieving this goal. Mid-term automation tools will facilitate the introduction of RNP offsets and other forms of dynamic tracks for maximizing the capacity of airspace. By the end of the mid term, en route automation will have evolved to incorporate more accurate and frequent surveillance reports through ADS-B, and to execute problem prediction and conformance checks that enable offset manoeuvres and closer route spacing (e.g., for passing other aircraft and manoeuvring around weather).

20. TERMINAL EVOLUTION

20.1 During this period, either Basic 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.

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

21. TERMINAL AUTOMATION

21.1 Terminal automation will be enhanced with tactical controller tools to manage complex merges in busy terminal areas. As data communications become available, the controller tools will apply knowledge of flights' estimates of time of arrival at upcoming waypoints, and altitude and speed constraints, to create efficient manoeuvres for optimal throughput.

21.2 Terminal automation will also sequence flights departing busy airports more efficiently than today. This capability will be enabled as a result of PBN and flow management tools. Flights arriving and departing busy terminal areas will follow automation-assigned PBN routes.

22. APPROACH EVOLUTION

22.1 In the mid term, implementation priorities for instrument approaches will still be based on RNP APCH and RNP AR APCH and full implementation is expected at the end of this term.

22.2 The introduction of the application of landing capability using GBAS (currently non PBN) is expected to guarantee a smooth transition towards high performance approach and landing capability.

23. MID TERM IMPLEMENTATION TARGETS

a) RNP APCH (with Baro-VNAV) or APV in 100% of instrument runways by 2016

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

c) RNAV-1 or RNP-1 SID/STAR for 70% of busy domestic airports where there are operational benefits

d) Implementation of additional RNAV/RNP Routes as required

24. SUMMARY TABLE MID-TERM (2013-2016)

Airspace	**Nav. Specifications**	**Nav. Specifications where Operationally Required**
En-Route Oceanic	RNAV-10,	RNP-4
En-Route Remote Continental	RNAV-10,	RNP-4
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) and APV Expand RNP AR APCH where there are operational benefits	

25. LONG TERM (2016 AND BEYOND): ACHIEVING A PERFORMANCE-BASED NAVIGATION SYSTEM

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

25.2 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, AFI Region States and key Stakeholders need an operational concept that exploits the full capability of the aircraft in this time frame.

26. LONG TERM KEY STRATEGIES (2017 AND BEYOND)

26.1 Airspace operations in the Long term will make maximum use of advanced flight deck automation that integrates CNS capabilities. RNP, RCP, and 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.

26.2 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.

26.3 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 (as is now done with visual approaches).

26.4 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.

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

26.6 System-wide information exchange will enable real-time data sharing of 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.

26.7 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.

26.8 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.

26.9 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.

26.10 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.

26.11 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.

26.12 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.

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

27.1 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 National Air Space (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, distributed decision-making.

g) Systems 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 service providers 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.

28. KEY RESEARCH AREAS

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

29. 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?

30. FLIGHT DECK AUTOMATION

a) What FMS capabilities are required to enable the future concepts and applications?

b) How can performance-based communication and surveillance be leveraged in the flight deck to enable Long-term strategies such as real-time exchange of flight deck data?

31. AUTOMATION

a) To what extent can lateral or longitudinal separation assurance be fully automated, in particular on final approach during parallel operations?

b) To what extent can surface movement be automated, and what are the cost-benefit trade-offs associated with different levels of automation?

c) To what extent can conflict detection and resolution be automated for terminal ATC operations?

32. 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?

33. 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 CDAs be accomplished in busy airspace?

34. POLICY

a) How is information security ensured as information exchange increases?

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

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

35. PERIODIC REVIEW OF IMPLEMENTATION ACTIVITIES

35.1 Procedures to Modify the Regional Plan

35.2 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).

35.3 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.

Glossary

ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
ATC	Air Traffic Control
CDA	Continuous Descent Arrival
CNS	Communications, Navigation, Surveillance
EFVS	Enhanced Flight Visibility System
GA	General Aviation
GBAS	Ground-Based Augmentation System
GLS	GNSS Landing System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing 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
RCP	Required Communications Performance
RF	Radius-to-Fix
RNAV	Area Navigation
RNP	Required Navigation Performance

Glossary

RNPSORSG	Required Navigation Performance and Special Operational Requirements Study Group
RSP	Required Surveillance Performance
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival Route
VLJ	Very Light Jet
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System

AFI State PBN Plan Template

Performance Based Navigation (PBN) Implementation Plan

State X

Version 1

December 2008

Appendix C

AFI State PBN Plan Template

About the Plan

Requirement for PBN

1.1 ICAO Assembly Resolution A36-23 calls for each State to develop a national PBN implementation plan by December 2009. This is a template developed by the ICAO PBN Programme as an example for use by the ICAO Contracting States as they each develop their own plans. This is only one example of what subjects a "National PBN Implementation Plan" that meets the intent of the resolution might include. States are encouraged to tailor their plans to meet their needs. This may mean that the "PBN Implementation Plan" is not stand-alone, but part of a broader plan for development of aviation in the State. This is a determination that only the State can make. It should be pointed out that if the State has not yet met its obligations with regard to conversion to the WGS-84 coordinate system, this should be included in the plan, as all RNAV and RNP operations are conducted solely with reference to WGS-84 coordinates.

Why is a PBN implementation plan or roadmap needed?

1.2 With RVSM implemented or soon to be implemented in most of the world, the main tool for optimising the airspace structure is the implementation of performance-based navigation (PBN), which will foster the necessary conditions for the utilization of RNAV and RNP capabilities by a significant portion of airspace users in the Regions and State s.

1.3 Current planning by the Regional Planning and Implementation Groups is based on the Air Navigation Plans and the Regional CNS/ATM Plans. Currently, these plans are mostly made up of tables that do not contain the necessary details for the implementation of each of the CNS and ATM elements. For this reason, the Regions will be developing Regional PBN implementation plans. The necessary concurrent and follow-on step is to develop national plans that implement the regional plans at the State level and address PBN implementation strategy at the national level.

1.4 In view of the need for detailed navigation planning, it was deemed advisable to call for preparation of a national PBN Implementation Plan by each State, to provide proper guidance and direction to the domestic air navigation service provider(s), airspace operators and users, regulating agency, as well as foreign operators who operate or plan to operate in the State. This guidance should address the planned evolution of navigation, as one of the key systems supporting air traffic management, and describe the RNAV and RNP navigation applications that should be implemented in at least the short and medium term, in the State.

What are the objectives of the PBN Implementation Plan or Roadmap?

1.5 The PBN implementation plan should meet the following strategic objectives:

a) provide a high-level strategy for the evolution of the navigation applications to be implemented in the State in the short term (2008-2012) and medium term (2013-2016). 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 oceanic and continental areas 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.

What is the intent of the PBN Implementation Plan or Roadmap?

1.6 The PBN Implementation Plan should be developed by the State together with the stakeholders concerned and is intended to assist the main stakeholders of the aviation community plan a gradual transition to the RNAV and RNP concepts. The main stakeholders of the aviation community that benefit from this roadmap and should therefore be included in the development process are:

- Airspace operators and users
- Air navigation service providers
- Regulating agencies
- National and international organizations

1.7 The PBN Implementation Plan is intended to assist the main stakeholders of the aviation community plan the future transition and their investment strategies. For example, airlines and operators can use this roadmap to plan future equipage and additional navigation capability investments; air navigation service providers can plan a gradual transition for the evolving ground infrastructure. Regulating agencies 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.

What principles should be applied in development of the PBN Implementation Plan or Roadmap?

1.8 The implementation of PBN in the State should be 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 modelling 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 regional PBN implementation plan.

Appendix C

AFI State PBN Plan Template

Table of contents

Appendix C

AFI State PBN Plan Template

1. Introduction

The AFI Region Performance Based Navigation (PBN) Roadmap details the framework within which the ICAO PBN concept will be implemented in the AFI Region for the foreseeable future. The AFI Region Roadmap for PBN is guided by ICAO Doc. 9613 and relevant SARPs. The primary driver for this plan is to maintain and increase safety, air traffic demand and capacity, and services and technology in consultation with relevant stakeholders. The AFI Region Roadmap also supports national and international interoperability and global harmonization.

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. The increasing cost of fuel also presents a significant challenge to all segments of the aviation community. This anticipated growth and higher complexity of the air transportation system could result in increased flight delays, schedule disruptions, choke points, inefficient flight operations, and passenger inconvenience, particularly when unpredictable weather and other factors constrain airport capacity. Without improvements in system efficiency and workforce productivity, the aviation community and cost of operations will continue to increase. Upgrades to the air transportation system must leverage current and evolving capabilities in the near term, while building the foundation to address the future needs of the aviation community stakeholders. 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. For oceanic operations, inertial navigation systems (INS) were employed.

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 clear, standardized operational approvals 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. These navigation specifications are defined at a sufficient level of detail to facilitate global harmonization by providing specific implementation guidance for States and operators.

Under PBN, generic navigation requirements are defined based on the operational requirements. Operators are then able to evaluate options in respect of available technologies and navigation services that could allow these requirements to be met. The chosen solution would be the most cost effective for the operator, rather than a solution being imposed as part of the operational requirements. Technologies can evolve over time without requiring the operation itself to be revisited, as long as the requisite performance is provided by the RNAV system. As part of the future work of the ICAO, it is anticipated that other means for meeting the requirements of the Navigation Specifications will be evaluated and may be included in the applicable Navigation Specifications, as appropriate.

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 State ment of required performance accuracy to more extensive State ments 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. RNAV Current status in [State X]

3.1.1 RNAV, ATS routes, SIDs, STARs and approaches

3.1.2 Fleet equipage

(To be developed by State)

3.2 Benefits of PBN and global harmonization

PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria. These include:

- Reduces need to maintain sensor-specific routes and procedures, and their associated costs. For example, moving a single VOR ground facility can impact dozens of procedures, as that VOR can be used on routes, VOR approaches, as part of missed approaches, etc. Adding new sensor specific procedures will compound this cost, and the rapid growth in available navigation systems would soon make system-specific routes and procedures unaffordable.

- Avoids need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive.

- Allows more efficient use of airspace (route placement, fuel efficiency, noise abatement).

- Clarifies the way in which RNAV systems are used.

- Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

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. Specifically, RNAV and RNP may:

- Increase safety by using three-dimensional (3D) approach operations with course guidance to the runway, which reduce the risk of controlled flight into terrain.

- Improve airport and airspace access in all weather conditions, and the ability to meet environmental and obstacle clearance constraints.

- Enhance reliability and reduce delays by defining more precise terminal area procedures that feature parallel routes and environmentally optimized airspace corridors. Flight management systems (FMS) will then be poised to save operators time and money by managing climb, descent, and engine performance profiles more efficiently.

- Improve efficiency and flexibility by increasing use of operator-preferred trajectories airspace-wide, at all altitudes. This will be particularly useful in maintaining schedule integrity when convective weather arises.

- Reduce workload and improve productivity of air traffic controllers.

Performance-based navigation will enable the needed operational improvements by leveraging current and evolving aircraft capabilities in the near term that can be expanded to address the future needs of aviation stakeholders and service providers.

3.3 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. This, in turn, enables the aviation stakeholders to focus on addressing future efficiency and capacity needs while maintaining or improving the safety of flight operations by leveraging advances in navigation capabilities on the flight deck. RNAV and RNP have reached a sufficient level of maturity and definition to be included in key plans and strategies, such as this State PBN plan.

The stakeholders who will benefit from the concepts in this State PBN plan include airspace operators, air traffic service providers, regulators, and standards organizations. As driven by business needs, airlines and operators can use the State PBN roadmap to plan future equipage and capability investments. Similarly, air traffic service providers can determine requirements for future automation systems, and more smoothly modernize ground infrastructure. Finally, regulators and standards organizations can anticipate and develop the key enabling criteria needed for implementation.

This plan is a work in progress and will be amended through collaborative AFI Region States, industry efforts and consultations that establish a joint aviation community/government/industry strategy for implementing performance-based navigation. Critical initiative strategies are required to accommodate the expected growth and complexity over the next two decades. These strategies have five key features:

- Expediting the development of performance-based navigation criteria and standards.
- Introducing airspace and procedure improvements in the near term.
- Providing benefits to operators who have invested in existing and upcoming capabilities.
- Establishing target dates for the introduction of navigation mandates for selected procedures and airspace, with an understanding that any mandate must be rationalized on the basis of benefits and costs.
- Defining new concepts and applications of performance-based navigation for the mid term and Long term and building synergy and integration among other capabilities toward the realization of the AFI Region PBN goals.

4. Challenges

4.1 Increasing Demands

(To be developed by State)

4.1.1 En route

4.1.1.1 Oceanic and Remote Continental

(To be developed by State)

4.1.1.2 Continental

(To be developed by State)

4.1.2 Terminal Areas (Departures and Arrivals)

(To be developed by State)

4.1.3 Approach

(To be developed by State)

4.2 Efficient Operations

4.2.1 En route

4.2.1.1 Oceanic and remote continental

(To be developed by State)

4.2.1.2 Continental

(To be developed by State)

4.2.2 Terminal Areas

(To be developed by State)

4.2.3 Approach

(To be developed by State)

4.3 Environment

(To be developed by State)

5. Implementation strategy

This plan provides a high-level strategy for the evolution of navigation capabilities to be implemented in three timeframes: near term (2008-2012), mid term (2013-2016), and Long term (2017 and Beyond). The strategy rests upon two key navigation concepts: Area Navigation (RNAV) and Required Navigation Performance (RNP). It also encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) operations, as well as en-route continental, oceanic and remote operations. The section on Long-term initiatives discusses integrated navigation, communication, surveillance and automation strategies.

To avoid proliferation of new navigation standards, [State X] and other aviation stakeholders in the AFI region should communicate any new operational requirements with ICAO HQ, so that it can be taken into account by the ICAO Study Group in charge of PBN.

Near Term (2008-2012) Mid Term (2013-2016) and Long Term (2017 and Beyond) Key Tasks

The key tasks involved in the transition to performance-based navigation are:

- Establish navigation service needs through the Long term that will guide infrastructure decisions and specify needs for navigation system infrastructure, and ensure funding for managing and transitioning these systems.
- Define and adopt a national policy enabling additional benefits based on RNP and RNAV.
- Identify operational and integration issues between navigation and surveillance, air-ground communications, and automation tools that maximize the benefits of RNP.
- Support mixed operations throughout the term of this Roadmap, in particular considering navigation system variations during the near term until appropriate standards are developed and implemented.
- To support Civil/Military coordination and develop the policies needed to accommodate the unique missions and capabilities of military aircraft operating in civil airspace.
- Harmonize the evolution of capabilities for interoperability across airspace operations.
- Increase emphasis on human factors, especially on training and procedures as operations increase reliance on appropriate use of flight deck systems.
- Facilitate and advance environmental analysis efforts required to support the development of RNAV and RNP procedures.
- Maintain consistent and harmonized global standards for RNAV and RNP operations.

5.2 Near term strategy (2008-2012)

In the near-term, initiatives focus on investments by operators in current and new aircraft acquisitions, in satellite-based navigation and conventional navigation infrastructure as well as [States X] investments. Key components include wide-scale RNAV implementation and the introduction of RNP for en route, terminal, and approach procedures.

The near-term strategy will also focus on expediting the implementation and proliferation of RNAV and RNP procedures. As demand for air travel continues at healthy levels, choke points will develop and delays at the major airports will continue to climb. RNAV and RNP procedures will help alleviate those problems. Continued introduction of RNAV and RNP procedures will not only provide benefits and savings to the operators but also encourage further equipage.

ANSPs as a matter of urgency must adapt new flight plan procedures to accommodate PBN operations. This particularly addresses fields 10 and 18.

Operators will need to plan to obtain operational approvals for the planned Navigation Specifications for this period. Operators shall also review Regional PBN Implementation Plans from other Regions to assess if there is a necessity for additional Operational approvals.

5.2.1 En route

5.2.1.1 Oceanic and Remote Continental

To promote global harmonization, [State X] continues to work closely with its international partners in implementing RNAV–10 and where operationally required RNP-4 by 2010. Safety assessment shall be undertaken to evaluate reduced oceanic and remote longitudinal/lateral separation minima between aircraft approved for RNAV-10 and RNP-4 operations.

For Oceanic and 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.

5.2.1.2 Continental

For airspace and corridors requiring structured routes for flow management, [State X] will review existing conventional and RNAV routes to transition to PBN RNAV-5 or where operationally required RNAV-2/1.

5.2.2 Terminal Areas (Departures and Arrivals)

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

[State X] will continue to plan, develop and implement RNAV-1 SIDs and STARs, at major airports and make associated changes in airspace design. In addition, [State X] will implement Basic RNP-1 SIDs and STARs. RNAV-1 will be implemented in airspace where there is sufficient surveillance coverage and Basic RNP-1 where there is no such coverage.

Where operationally feasible, [State X] should develop operational concepts and requirements for continuous descent arrivals (CDAs) 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.

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;
- 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.

5.2.3 Approach

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.

[State X] should promote the use of APV Operations (Baro-VNAV or SBAS) to enhance safety of RNP Approaches and accessibility of runways.

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.

RNP approaches include:

- APV implemented at all instrument runways at major regional airports and all non-instrument runways serving aircraft weighing greater than 5,700kg.

5.2.5 Summary near term strategy

Airspace	**Nav. Specifications**	**Nav. Specifications where operationally required**
En-Route Oceanic	RNAV-10	RNP-4
En-Route Remote Continental	RNAV-10	RNP-4
En-Route Continental	RNAV-5	RNAV-1
TMA Arrival/Departure	RNAV-1 in a surveillance environment Basic RNP-1 in non-surveillance environment	
Approach	RNP APCH with Baro-VNAV or RNP AR APCH if required	

1.9 Implementation Targets

- RNP APCH (with Baro-VNAV) in 30% of instrument runways by 2010 and 50% by 2012 and priority given to airports with operational benefits
- RNAV-1 SID/STAR for 30% of international airports by 2010 and 50% by 2012 and priority given to airports with RNP Approach
- Review existing conventional and RNAV routes to transition to PBN RNAV-5 or where operationally required RNAV-2/1 by 2012.

5.3 Medium term strategy (2013-2016)

In the mid term, increasing demand for air travel will continue to challenge the efficiencies of the air traffic management system.

While the hub-and-spoke system will remain largely the same as today for major airline operations, the demand for more point-to-point service will create new markets and spur increases in low-cost carriers, air taxi operations, and on-demand services. Additionally, the emergence of VLJs is expected to create new markets in the general and business aviation sectors for personal, air taxi, and point-to-point passenger operations. Many airports will thus experience significant increases in unscheduled traffic. In addition, many destination airports that support scheduled air carrier traffic are forecast to grow and to experience congestion or delays if efforts to increase their capacity fall short. As a result, additional airspace flexibility will be necessary to accommodate not only the increasing growth, but also the increasing air traffic complexity.

The mid term will leverage these increasing flight capabilities based on RNAV and RNP, with a commensurate increase in benefits such as fuel-efficient flight profiles, better access to airspace and airports, greater capacity, and reduced delay. These incentives, which should provide an advantage over non-RNP operations, will expedite propagation of equipage and the use of RNP procedures.

To achieve efficiency and capacity gains partially enabled by RNAV and RNP, [State X] and aviation industry will pursue use of data communications (e.g., for controller-pilot communications) and enhanced surveillance functionality, e.g. ADS-Broadcast (ADS-B). Data communications will make it possible to issue complex clearances easily and with minimal errors. ADS-B will expand or augment surveillance coverage so that track spacing and longitudinal separation can be optimized where needed (e.g., in non-radar airspace). Initial capabilities for flights to receive and confirm 3D clearances and time of arrival control based on RNP will be demonstrated in the mid term. With data link implemented, flights will begin to transmit 4D trajectories (a set of points defined by latitude, longitude, altitude, and time.) Stakeholders must therefore develop concepts that leverage this capability.

5.3.1 En route

5.3.1.1 Oceanic and Remote Continental

In the mid term, [State X] will endeavour 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.

5.3.1.2 Continental

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

Implementation

By the end of the mid term 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.

Automation for RNAV and RNP Operations

By the end of the mid term enhanced en route automation will allow the assignment of RNAV and RNP routes based upon specific knowledge of an aircraft's RNP capabilities. En route automation will use collaborative routing tools to assign aircraft priority, since the automation system can rely upon the aircraft's ability to change a flight path and fly safely around problem areas. This functionality will enable the controller to recognize aircraft capability and to match the aircraft to dynamic routes or procedures, thereby helping appropriately equipped operators to maximize the predictability of their schedules.

Conflict prediction and resolution in most en route airspace must improve as airspace usage increases. Path repeatability achieved by RNAV and RNP operations will assist in achieving this goal. Mid-term automation tools will facilitate the introduction of RNP offsets and other forms of dynamic tracks for maximizing the capacity of airspace. By the end of the mid term, en route automation will have evolved to incorporate more accurate and frequent surveillance reports through ADS-B, and to execute problem prediction and conformance checks that enable offset manoeuvres and closer route spacing (e.g., for passing other aircraft and manoeuvring around weather).

5.3.2 Terminal Areas (Departures and Arrivals)

During this period, either Basic 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.

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

Terminal Automation

Terminal automation will be enhanced with tactical controller tools to manage complex merges in busy terminal areas. As data communications become available, the controller tools will apply knowledge of flights' estimates of time of arrival at upcoming waypoints, and altitude and speed constraints, to create efficient maneuvres for optimal throughput.

Terminal automation will also sequence flights departing busy airports more efficiently than today. This capability will be enabled as a result of PBN and flow management tools. Flights arriving and departing busy terminal areas will follow automation-assigned PBN routes.

5.3.3 Approach

In the mid term, implementation priorities for instrument approaches will still be based on RNP APCH and RNP AR APCH and full implementation is expected at the end of this term.

The introduction of the application of landing capability, using GBAS (currently non PBN) is expected to guarantee a smooth transition towards high performance approach and landing capability.

5.3.4 Helicopter operations (To be developed by State)

5.3.5 Medium term strategy summary

Airspace	Nav. Specifications	Nav. Specifications where operationally required
En-Route Oceanic	RNAV-10,	RNP-4
En-Route Remote Continental	RNAV-10,	RNP-4
En-Route Continental	RNAV-2, RNAV-5	RNAV-1
TMA Arrival/Departure	Expand RNAV-1, or basic RNP-1 application Mandate RNAV-1, or basic RNP-1	
Approach	Expand RNP APCH with (Baro-VNAV) and APV Expand RNP AR APCH where there are operational benefits	

Implementation Targets

- RNP APCH (with Baro-VNAV) or APV in 100% of instrument runways by 2016
- RNAV-1 or RNP-1 SID/STAR for 100% of international airports by 2016
- RNAV-1 or RNP-1 SID/STAR for 70% of busy domestic airports where there are operational benefits
- Implementation of additional RNAV/RNP Routes as required

5.4 Long term strategy (2017 and beyond)

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

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, [State X] and key Stakeholders need an operational concept that exploits the full capability of the aircraft in this time frame.

5.4.1 Long Term Key Strategies (2017 and Beyond)

Airspace operations in the Long term will make maximum use of advanced flight deck automation that integrates CNS capabilities. RNP, RCP, and 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.

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.

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 (as is now done with visual approaches).

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.

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

System-wide information exchange will enable real-time data sharing of 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.

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.

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.

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.

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.

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.

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.

5.4.2 Summary of Long Term Key Strategies (2017 and Beyond)

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

- Airspace operations will take advantage of aircraft capabilities, i.e. aircraft equipped with data communications, integrated displays, and FMS.
- 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).
- Strategic and tactical flow management will improve through use of integrated airborne and ground information exchange.
- Ground-based system knowledge of real-time aircraft intent with accurate aircraft position and trajectory information available through data link to ground automation.
- Real-time sharing of National Air Space (NAS) flight demand and other information achieved via ground-based and air-ground communication between air traffic management and operations planning and dispatch.
- Overall system responsiveness achieved through flexible routing and well-informed, distributed decision-making.
- Systems ability to adapt rapidly to changing meteorological and airspace conditions.
- System leverages through advanced navigation capabilities such as fixed radius transitions, RF legs, and RNP offsets.
- Increased use of operator-preferred routing and dynamic airspace.
- Increased collaboration between service providers and operators.

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.

- RNP-based arrival and departure structure for greater predictability.
- Ground-based tactical merging capabilities in terminal airspace.
- Integrated capabilities for surface movement optimization to synchronize aircraft movement on the ground. Improved meteorological and aircraft intent information shared via data link.

5.4.3 Key Research Areas

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

Navigation

- To what extent can lower RNP values be achieved and how can these be leveraged for increased flight efficiency and access benefits?
- Under what circumstances RNAV should be mandated for arriving/departing satellite airports to enable conflict-free flows and optimal throughput in busy terminal areas?

Flight Deck Automation

- What FMS capabilities are required to enable the future concepts and applications?
- How can performance-based communication and surveillance be leveraged in the flight deck to enable Long-term strategies such as real-time exchange of flight deck data?

Automation

- To what extent can lateral or longitudinal separation assurance be fully automated, in particular on final approach during parallel operations?
- To what extent can surface movement be automated, and what are the cost-benefit trade-offs associated with different levels of automation?
- To what extent can conflict detection and resolution be automated for terminal ATC operations?

Procedures

- How can time of arrival control be applied effectively to maximize capacity of arrival or departure operations, in particular during challenging wind conditions?
- In what situations is delegation of separation to the flight crews appropriate?

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

Airspace

- To what extent can airspace be configured dynamically on the basis of predicted traffic demand and other factors?
- What separation standards and procedures are needed to enable smoother transition between en route and terminal operations?
- How can fuel-efficient procedures such as CDAs be accomplished in busy airspace?

Glossary

3D	Three-Dimensional
4D	Four-Dimensional
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
ATC	Air Traffic Control
CDA	Continuous Descent Arrival
CNS	Communications, Navigation, Surveillance
EFVS	Enhanced Flight Visibility System
GA	General Aviation
GBAS	Ground-Based Augmentation System
GLS	GNSS (Global Navigation Satellite System) Landing System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization

IFR	Instrument Flight Rules
ILS	Instrument Landing 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
RCP	Required Communications Performance
RF	Radius-to-Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
RNPSORSG	Required Navigation Performance and Special Operational Requirements Study Group

RSP	Required Surveillance Performance
SAAAR	Special Aircraft and Aircrew Authorization Required
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
VLJ	Very Light Jet
VNAV	Vertical Navigation
WAAS	Wide Area Augmentation System

Appendix C

AFI State PBN Plan Template

Appendix A – Oceanic and Remote Continental implementation schedule by area or city pair (to be developed by State)

Appendix B – En route continental implementation schedule by area or city pair (to be developed by State)

Appendix C – Terminal area and approach implementation schedule by aerodrome (to be developed by State)

SP AFI/08-WP/84

Report on Agenda Item 6

6.21 It was noted that the PMT was made up of representatives from several States and international organizations with support from ICAO Headquarters as well as the ATM Regional Offices in Dakar and Nairobi. In addition, the PMT had been fortunate to have participated in the weekly teleconferences, representatives from Angola and the ATS provider from the Democratic Republic of Congo (DRC) and the Régie Des Voies aériennes, (RVA). The meeting was informed that in the opinion of the PMT, great strides had been taken toward enhancing the safety of operations however, the PMT also believed that with consistent follow-up there could be greater safety gains.

6.22 The meeting was informed that the PMT during the weekly teleconferences had been experimenting with very good results, with a low-cost web application that allowed members to viewe each other's screens thus allowing presentations to be made remotely. The application which included voice over internet protocol (VOIP) cost less than USD$50 a month with unlimited meeting scheduling. In this context, the meeting agreed that funding avenues should be pursued in order to minimize costs and maximize benefits and participation.

6.23 The meeting agreed that the PMT should be renamed as the Tactical Action Group (TAG), with terms of reference and a work programme. It was agreed that the group, through its by-weekly teleconferences, should tactically address any deficiencies or operational errors identified. The meeting therefore agreed to the following recommendations:

Recommendation 6/7 – Establishment of a Tactical Action Group (TAG)

That:

a) a Tactical Action Group be created in the AFI Region with the Terms of Reference and Work Programme outlined in Appendix C to the Report on Agenda Item 6; and

b) States as a matter of priority make all efforts to assist and comply with requests from the TAG group.

6.24 In the post-RVSM implementation period, it was noted that data would continue to be collected and analyzed in order to maintain the highest safety levels. This data would be provided to ARMA by operators, States, other regional monitoring agencies and stakeholders. ARMA, on a yearly basis would report on the safety level of RVSM operations. In this context, the meeting recalled the importance of providing data to the ARMA for analyses and reporting and stressed the need for all States to meet their obligations in this respect.

6.25 The meeting was pleased to note that the results of the latest data analysis carried out by ARMA showed that there had been a steady decrease in the collision risk in the region. The meeting accepted that this improvement was due to the RVSM National Safety Plans and the feedback and follow-up carried out by ARMA and the PMT.

6.26 The meeting was advised that operational errors leading to large height deviations were critical contributors to the erosion of safety levels. For this reason the meeting agreed with a proposal by ARMA to establish an RVSM scrutiny group early in 2009 to assist with the management of operational errors.

6.27 The meeting was informed of the scope of activities carried out by ARMA in support of RVSM implementation and proposed follow-up activities as follows:

a) maintain a database of State RVSM operational approvals (operators/aircraft);

b) monitor aircraft height-keeping performance and the occurrence of large height deviations reporting results appropriately;

c) conduct safety assessments and report results appropriately;

d) monitor operator compliance with State approval requirements; and

e) initiate necessary remedial actions if RVSM requirements are not met.

6.28 On the basis of the above, the meeting agreed that in order for the AFI Region to meet its obligations toward continuous monitoring and regular assessment of the safety level in RVSM airspace, a structured approach should be implemented and agreed to the following recommendation:

Recommendation 6/8 – Reduced vertical separation minimum (RVSM) monitoring and follow-up activities

That AFI States support:

a) the long-term submission of State RVSM operationally approved aircraft to the AFI Regional Monitoring Agency (ARMA);

b) provision of long-term support to the AFI height monitoring programme;

c) long-term collection of safety assessment data;

d) the availability of personnel to fulfil the role of RVSM National Programme Managers;

e) the establishment of the ARMA scrutiny group in 2009; and

f) measures to reduce the large number of horizontal incidents in the AFI Region.

6.29 The meeting noted that as required by the AFI RVSM safety policy, a Post Operational Safety Case (POSC) would be completed to ensure that all the PISC aspects had been met and that RVSM was meeting safety expectations.

Implementation of performance-based navigation (PBN)

6.30 The meeting recalled that APIRG, at its sixteenth meeting held in Rubavu, Rwanda from 19 to 23 November 2007, discussed various issues related to the implementation of PBN in the AFI Region in the context of a performance-based global ATM system, taking into consideration the benefits of PBN, recent actions by ICAO at the global and regional levels, and in consideration of the role that APIRG, the States and stakeholders should play.

SP AFI/08-WP/84

Report on Agenda Item 6

6.31 The meeting noted that the Global Air Navigation Plan contained Global Plan Initiatives (GPIs) which were aimed at taking advantage of advanced aircraft capabilities however, continued development of diverging navigation specifications would result in negative safety and efficiency impacts and penalties to States and industry. In this respect, the meeting urged States and aircraft operators to use the common navigation specifications contained in the Manual on Performance Based Navigation (PBN, Doc 9613).

6.32 The meeting recalled Assembly Resolution A36-23 which was adopted to support implementation of PBN globally. The resolution urged all States to implement area navigation (RNAV) and required navigation performance (RNP) routes and approach procedures in accordance with the PBN Manual.

6.33 The meeting recalled that as an early step toward PBN implementation in the AFI Region, one pair of RNP 10 routes was implemented in May 2006 with excellent results. These routes, informally known as Red Carpet I (RC I) routes, were the first long-range AFI RNAV routes anchored by points at the South Africa/Botswana border and the Mediterranean coast in Algeria and Tunisia. A second pair of RNAV RNP 10 (RNAV 10) routes was implemented in 2007. These routes were also serving the southern African and European Regions but on a more easterly course than RC I.

6.34 The meeting agreed that the current RNP 10 routes should be seen as an interim step toward a more appropriate solution that would likely see the implementation of RNP 4 in oceanic and remote areas and RNAV 5 in more dense airspace. In an effort to continue the progress achieved through PBN in the near term, current efforts would continue toward implementation of additional RNP 10 routes in a generally east-west direction.

6.35 As a result of the foregoing and to support a structured approach to PBN implementation, the meeting agreed that high-level performance objectives were required. On this basis, the meeting agreed to the following recommendation to guide the work of APIRG on PBN:

Recommendation 6/9 — Performance-based navigation (PBN) performance objectives

That APIRG adopt the Performance Objectives as contained in the performance framework forms in Appendix D to the Report on Agenda Item 6:

a) optimization of the air traffic services (ATS) route structure in en-route airspace;

b) optimization of the ATS route structure in terminal airspace; and

c) implementation of vertically guided required navigation performance (RNP) approaches.

That States develop their national action plans to meet the requirements of the regional performance framework forms, as a matter of priority to meet the PBN implementation goals established by Assembly Resolution A36-23.

Establishment of a flight procedures office (FPO)

6.36 The meeting agreed that one of the most promising aspects of PBN was related to the implementation of new instrument flight procedures, which would take advantage of databases on aircraft. However, quality assurance in the flight procedure design process would take on added significance for PBN-based procedures. The meeting recognized that many States in the AFI Region lacked the expertise to establish a sustainable internal procedure design capability, meeting the requirements of the *Procedures for Air Navigation Services – Aircraft Operations* (PANS-OPS, Doc 8168) and to meet their responsibilities in accordance with Annex 15 with respect to the quality of their instrument flight procedures.

6.37 The meeting was made aware that most ICAO regions suffered the same difficulties with respect to the new types of flight procedures and that ICAO was working to establish flight procedures offices (FPO) in each region to assist and accelerate the implementation of PBN.

6.38 The meeting noted that an FPO would employ best practices in training, automation and quality assurance to address the procedure design needs of States. It would be managed by a full-time ICAO employee whose position would be funded from the FPO funding sources. The meeting agreed that location, size and initial operational capability date of the FPO should be based on demand for the services and the level of financial support extended by the States and international organizations for start-up and initial operating costs.

6.39 The objectives of the FPO would be to foster implementation of flight procedures, developed with the appropriate quality systems, especially PBN and vertically guided instrument approach procedures by:

a) assisting those States with sufficient procedure design requirements to establish a sustainable internal procedure design capability to meet the requirements of PANS-OPS and their responsibility under Annex 15 for the quality of their procedures;

b) providing the appropriate level of technical expertise necessary to enable States that do not have the density of procedures necessary to sustain an internal procedure design capability, to meet their responsibilities under Annex 15 and PANS-OPS; and

c) providing a vehicle to improve quality in the States' procedure design process through access to procedure design automation solutions and associated data storage.

6.40 The meeting was presented with an offer from ASECNA to accommodate the ICAO FPO within its organization. The meeting welcomed the offer from ASECNA. France also informed the meeting that the French DGAC would be willing to provide support to the FPO when established.

6.41 The meeting supported the concept of an FPO however, ICAO was requested to provide additional detail on the concept and to circulate a request to States for proposals to support the establishment of the FPO, taking into consideration the need for complementary capacity within States in order for them to discharge their regulatory responsibilities with respect to issues associated with implementation of RNP approaches.

SP AFI/08-WP/84

Report on Agenda Item 6

6.42 On the basis of the above, the meeting, while noting that implementation of PBN in the region was important and would yield safety, efficiency and environmental benefits, agreed to the following recommendation:

Recommendation 6/10 — Support for establishment of an Africa ICAO flight procedure office

That:

a) States and international organizations support the implementation of an AFI flight procedures office; and

b) ICAO disseminate a letter, with supporting documentation, inviting interested States and international organizations to submit proposals for establishment and hosting of the FPO.

World geodetic system (WGS-84) and electronic terrain and obstacle data (eTOD)

WGS-84

6.43 The meeting noted that on 28 February 1994, the Council adopted Amendment 28 to Annex 15 — *Aeronautical Information Services* which included the specification of world geodetic system-1984 (WGS-84) as the standard geodetic reference system for international aviation. Shortly thereafter, amendments were adopted to Annex 4 — *Aeronautical Charts* and Annex 11 — *Air Traffic Services* which included requirements regarding the provision of geographical coordinate information in terms of WGS-84. These requirements became applicable on 1 January 1998.

6.44 The meeting recalled that APIRG and States had been working toward WGS-84 implementation for many years and that a large part of the work had been completed by most States however, considerable work remained. Additionally, WGS-84 required regular maintenance. The major difficulties reported by States were insufficient funding for WGS-84 implementation and maintenance; lack of effective coordination between the aeronautical and geodetic departments; and a lack of reliable equipment to conduct the task.

6.45 The meeting recognized that this implementation is now all the more important, as the availability of geographical coordinates in the commonly agreed WGS-84 reference system is a prerequisite for States to obtain the benefits of PBN, and is also an important step in preparing for the transition from Aeronautical Information Services (AIS) to Aeronautical Information Management (AIM) where the provision of digital geographic data of appropriate quality will be essential.

e-TOD

6.46 The meeting was reminded that on 23 February 2004, the Council adopted Amendment 33 to Annex 15 which included the addition of a new Chapter 10 — Electronic Terrain and Obstacle Data, a new Appendix 8 – Terrain and Obstacle Data Requirements, and a number of amendments to Appendix 1 — Contents of Aeronautical Information Publication (AIP) and Appendix 7 — Aeronautical Data Quality Requirements. The applicability dates for Amendment 33 to Annex 15 are as follows:

a) 20 November 2008 for those parts of the amendment related to the availability of terrain and obstacle data in accordance with Area 1 specifications (entire territory of a State) and for the availability of terrain data in accordance with Area 4 specifications (Category II or III operations area); and

b) 8 November 2010 for those parts of the amendment related to the availability of terrain and obstacle data in accordance with Area 2 (terminal control area) and Area 3 (aerodrome/heliport area) specifications.

6.47 In this context, the meeting was made aware that Annex 15 required States to provide terrain and obstacle data at different precisions for different areas as necessary to accommodate current and planned new air navigation systems or functions. Four coverage areas had been defined for which specific levels of precision were required, with Area 1 requiring the least precision and Area 4 requiring the greatest.

6.48 It was agreed that significant safety and efficiency benefits for international civil aviation could be provided by in-flight and ground-based applications that relied on quality eTOD however, performance of these applications, which often made use of multiple data sources, could be degraded by data with inconsistent or inappropriate specifications for quality.

6.49 It was recognized that implementation of eTOD requirements was a challenging process that must be accomplished with a high level of commitment, careful planning, sharing of resources and a structured tracking of regional progress. A series of short- and medium-term tasks should therefore be established with a view to facilitating implementation. The meeting agreed to the following recommendation to guide the work of APIRG:

Recommendation 6/11 — Implementation of WGS-84 and eTOD

That APIRG adopt the AIM Performance Objective: Implementation of world geodetic system-1984 (WGS-84) and electronic terrain and obstacle data (eTOD) as contained in the performance framework form in Appendix E to the Report on Agenda Item 6.

6.50 The meeting noted a study underway aimed at the establishment of an AFI Centralized AIS Database (AFI-CAD) Programme. The framework and guidance material had been agreed by APIRG Conclusion 16/41 and further work was currently by the AIS/MAP Task Force in APIRG.

ATS routes and route systems

Atlantic Ocean random routing area (AORRA)

6.51 The meeting addressed the implementation of AORRA and noted that Phase 1 of the implementation had been accomplished and that three more phases were required to complete the implementation process. In this regard, the meeting recalled that the South Atlantic Planning Group (SAT) at its Fourteenth Meeting held in Montevideo, Uruguay in May 2008, agreed to proceed with the implementation of AORRA Phase II in December 2008, and that as of 23 October 2008 a common aeronautical information publication (AIP) Supplement for implementing Phase II was to be disseminated. Phases III and IV were planned for implementation by 17 December 2009.

6.52 Noting, that due to poor coordination, some States would not be ready, the meeting agreed on the following recommendation to support implementation of AORRA:

Recommendation 6/12 — Full implementation of Atlantic Ocean random RNAV routing area (AORRA)

That ICAO:

a) take immediate action to inform all concerned States that implementation of AORRA Phase II will be delayed until further notice; and

b) as a matter of urgency, facilitate and coordinate implementation of all phases of AORRA and assist in determining a suitable date for AORRA Phase II implementation.

ATS routes

6.53 The meeting noted that in order to accommodate traffic demand in the AFI Region, APIRG had adopted a number of conclusions related to the implementation of ATS routes. It was further noted that with some exceptions, most of the recommended routes had not yet been implemented. Furthermore, new ATS route requirements had been identified by the aircraft operators. To support the effort, APIRG had identified the need to establish an internationally funded project in the AFI Region (APIRG Conclusion 15/27 refers) however, as of yet, no action had been taken.

6.54 In this context and taking into consideration the aviation industry fuel crisis, the meeting was urged to implement in the near-term, an ATS route project in line with the above and at the same time, to take account of the introduction of PBN operations in the region, pursuant to Assembly Resolution A36-23. The meeting also agreed that the PBN Task Force was the most suitable body to address the ATS route structure in the region.

Global navigation satellite systems (GNSS) procedures

6.55 The meeting was informed by IATA of a project for the design of GNSS procedures with seventeen southern African States. The meeting was further apprised that only fourteen States had published the procedures. In this context, IATA had requested that States that had not done so, publish the procedures as soon as possible. When discussing this issue, the meeting was informed that regulatory and legal, rather than technical barriers, were keeping some States from publishing the procedures. In this context, the meeting agreed to the following recommendations:

Recommendation 6/13 – Publication of GNSS-based RNP approach procedures

That:

a) States having taken part in the IATA area navigation (RNAV) global navigation satellite systems (GNSS) procedures development and implementation programme and which had not yet done so, publish GNSS-based required navigation performance (RNP) approaches, and at the same time, remove any operational restrictions that may be in place; and

b) States that had not taken part in the IATA RNAV GNSS procedures development and implementation programme, seek assistance from appropriate organizations with the objective of designing and implementing GNSS-based RNP approach procedures.

Recommendation 6/14 – ICAO assistance with legal and regulatory issues associated with implementation of GNSS approach procedures

That ICAO provide assistance to States in overcoming legal and regulatory difficulties associated with implementation of global navigation satellite systems (GNSS) based approach procedures.

6.56 In the context of the above, the meeting was made aware that design and publication of a procedure was not an end in itself and that there were other considerations that had to be taken into account to ensure safety, such as training, equipage, implementation and maintenance of WGS-84, quality assurance, and regulatory issues.

6.57 In addition, it was noted that some States having implemented GNSS-based procedures were sometimes failing to maintain their conventional navigational ground aid infrastructure as required. The meeting agreed that States should continue to comply with their obligations to maintain their conventional navigational aids in accordance with their obligations as contained in the AFI ANP.

Measures to foster the implementation of SIGMET, the quality management system for the provision of MET Service to international air navigation, and other MET matters

6.58 The meeting recalled that the MET Divisional Meeting (2002) had formulated Recommendation 1/12 – *Implementation of SIGMET Requirements*, which called for the PIRGs to foster implementation of SIGMET information. However, information indicated non-compliance by most of the AFI States, to ICAO Annex 3 — *Meteorological Service for International Air Navigation* requirements on the issuance of SIGMET.

6.59 The meeting also noted that Amendment 72 to ICAO Annex 3, introduced the quality management system (QMS) for meteorological service to international air navigation, which became applicable on 1 November 2001 and that APIRG/14, Conclusion 14/40 recognized the new requirements of Annex 3, requested States in the AFI Region to give priority to the implementation of QMS and APIRG/16, Conclusion 16/59 called for support to AFI States to implement QMS. However, the level of implementation of QMS in the area of aeronautical meteorology in the AFI Region remained very low.

6.60 Other critical safety related aviation meteorology deficiencies identified through various ICAO missions to States and through APIRG, related to the lack of:

a) provision of information on volcanic activity to civil aviation units;

b) issuance and dissemination of SIGMETs; and

c) provision of QMS for meteorological information.

SP AFI/08-WP/84

Report on Agenda Item 6

6.61 The meeting also noted that QMS involved role players and stakeholders at all levels within the organization. QMS was intended to be cohesive by nature and therefore all owners and drivers of business and operational processes were responsible for ensuring that this remained the status quo. In this context the meeting also agreed that implementation of QMS come with a certain economic cost and these costs needed to be factored into the discussions with users when implementing QMS.

6.62 In this regard, the meeting noted progress made by the South African Weather Service towards the implementation of total quality management (TQM). The major objectives of this programme were ensure service delivery of international standard and ICAO compliancy by obtaining ISO 9001 certification as well as to align the relevant elements of its TQM programme with the World Meteorological Organization (WMO) Quality Framework. The fundamental constructs of its QMS were now in place. These formed the foundation upon which all outstanding elements would be built in order to deliver quality-assured products and services to all stakeholders.

6.63 On the basis of the above, the meeting agreed to a set of projects to foster the implementation of SIGMET and QMS for the provision of meteorological service to international air navigation. It was also agreed that a number of seminars and workshops should be requested using the special implementation projects (SIPs) mechanism, the AFI Comprehensive Implementation Programme (ACIP) and the International Financial Facility for Aviation Safety (IFFAS) cooperative development projects, to assist in updating and preparing action plans to remove existing deficiencies in the area of SIGMET and QMS. To eliminate the safety-related MET deficiencies, the meeting agreed to the following recommendation:

Recommendation 6/15 — Foster the implementation of SIGMET and QMS in the AFI Region

That APIRG adopt the MET Performance Objective: Foster the Implementation of SIGMET and QMS in the AFI Region as contained in the performance framework form in Appendix F to the Report on Agenda Item 6.

6.64 The meeting was informed that aviation cost recovery mechanisms in the region were not fully and effectively implemented in most African States and that African States would therefore, find it difficult to fund the implementation of QMS. In this regard, the meeting agreed that alternative means of funding for this effort should be investigated. On this basis, the meeting agreed to the following recommendation:

Recommendation 6/16 — Technical and financial support for implementation of Quality Management Systems in the AFI Region

That ICAO identify potential sources of technical and financial support for States for the implementation of quality management systems (QMS) in the field of Meteorology.

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SP AFI/08-WP/84

APPENDIX D

REGIONAL PERFORMANCE OBJECTIVES/NATIONAL PERFORMANCE OBJECTIVES FOR PBN

REGIONAL PERFORMANCE OBJECTIVES/NATIONAL PERFORMANCE OBJECTIVES OPTIMIZATION OF THE ATS ROUTE STRUCTURE IN EN-ROUTE AIRSPACE				
Benefits				
Environment **Efficiency**	• reduction in gas emissions • ability of aircraft to conduct flight more closely to preferred trajectories • increase in airspace capacity • facilitate utilization of advanced technologies (e.g., FMS-based arrivals) and ATC decision support tools (e.g., metering and sequencing), thereby increasing efficiency			
Strategy				
ATM OC COMPONENTS	**TASKS**	**TIMEFRAME START-END**	**RESPONSIBILITY**	**STATUS**
AOM	***Terminal airspace***	2008		
	• develop regional implementation plan	1Q 2008 – 1Q 2009	PBN TF	In progress
	• develop regional action plan	1Q 2009	PBN TF	In progress
	• develop airspace concept based on AFI PBN regional implementation plan, in order to design and implement a trunk route network, connecting major city pairs in the upper airspace and for transit to/from aerodromes, on the basis of PBN, e.g. RNAV 10 and RNAV 5, and taking into account interregional harmonization		"	
	• harmonize State and PBN implementation plans with regional plan		"	
	• develop performance measurement plan		"	
	• formulate safety plan		"	
	• establish collaborative decision making (CDM) process		"	
	• publish national regulations for aircraft and operators approval using PBN manual as guidance material		State	
	• identify training needs and develop corresponding guidelines		PBN	
	• formulate system performance monitoring plan		PBN	
	• implementation of ATS routes enroute		Region/States	In progress

	• monitor implementation progress in accordance with AFI PBN implementation plan and State implementation plan		PBN	
linkage to GPIs	GPI/5: performance-based navigation; GPI/7: dynamic and flexible ATS route management; GPI/8: collaborative airspace design and management			
REGIONAL PERFORMANCE OBJECTIVES/NATIONAL PERFORMANCE OBJECTIVES OPTIMIZATION OF THE ATS ROUTE STRUCTURE IN TERMINAL AIRSPACE				
Benefits				
Environment **Efficiency**	• reduction in gas emissions • ability of aircraft to conduct flight more closely to preferred trajectories • increase in airspace capacity • improved availability of procedures • facilitate utilization of advanced technologies (e.g., FMS based arrivals) and ATC decision support tools (e.g., metering and sequencing), thereby increasing efficiency			
Strategy				
ATM OC COMPONENTS	**TASKS**	**TIMEFRAME START-END**	**RESPONSIBILITY**	**STATUS**
AOM	***Terminal airspace***	2008		
	• develop regional implementation plan	1Q 2008 – 1Q 2009	PBN TF	In progress
	• develop regional action plan	1Q 2009	PBN TF	Not started
	• develop State PBN implementation	1Q 2009 – 4Q 2009	State	
	• develop airspace concept based on AFI PBN roadmap, in order to design and implement a optimized standard instrument departures (SIDs), standard instrument arrivals (STARs), holding and associated instrument flight procedures, on the basis of PBN and, in particular RNAV 1 and Basic-RNP 1			
	• develop performance measurement plan			
	• formulate safety plan			
	• establish collaborative decision making (CDM) process			
	• publish national regulations for aircraft and operators approval using PBN manual as guidance material			
	• identify training needs and develop corresponding guidelines			
	• formulate system performance monitoring plan			

	• develop a regional strategy and work programme for implementation of SIDs and STARs		State	
	• monitor implementation progress in accordance with AFI PBN implementation roadmap and State implementation plan			
linkage to GPIs	GPI/5: performance-based navigation; GPI/7: dynamic and flexible ATS route management; GPI/8: collaborative airspace design and management; GPI/10: terminal area design and management; GPI/11: RNP and RNAV SIDs and STARs; GPI/12: FMS-based arrival procedures			
REGIONAL PERFORMANCE OBJECTIVES/NATIONAL PERFORMANCE OBJECTIVES OPTIMIZATION OF VERTICALLY GUIDED RNP APPROACHES				
Benefits				
Environment **Efficiency**	• reduction in gas emissions • increased accessibility to aerodromes, including continuity of access • increased runway capacity • reduced pilot workload • availability of reliable lateral and vertical navigation capability			
Strategy				
ATM OC COMPONENTS	**TASKS**	**TIMEFRAME START-END**	**RESPONSIBILITY**	**STATUS**
AOM	***En-route airspace***	2008		
	• develop regional implementation plan	1Q 2008 – 1Q 2009	PBN TF	In progress
	• develop regional action plan	1Q 2009	PBN TF	Not started
	• develop State PBN implementation	1Q 2009 – 4Q 2009	State	
	• develop airspace concept based on AFI PBN implementation plan, in order to design and implement RNP APCH with Baro-VNAV in accordance with Assembly resolution A36-23, and RNP AR APCH where beneficial			
	• develop performance measurement plan			
	• formulate safety plan			
	• establish collaborative decision making (CDM) process			
	• publish national regulations for aircraft and operators approval using PBN manual as guidance material			
	• identify training needs and develop corresponding guidelines			
	• identify training needs and develop corresponding guidelines			
	• implementation of APV procedures	present - 2016	State	

	• Formulate system performance monitoring plan			
linkage to GPIs	GPI/5: performance-based navigation; GPI/7: dynamic and flexible ATS route management; GPI/8: collaborative airspace design and management; GPI/10: terminal area design and management; GPI/11: RNP and RNAV SIDs and STARs; GPI/12: FMS-based arrival procedures			

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SP AFI/08-WP/84

APPENDIX E

AIM PERFORMANCE OBJECTIVES

NATIONAL PERFORMANCE OBJECTIVE – IMPLEMENTATION OF WGS-84 AND eTOD				
Benefits				
Environment	• none			
Efficiency	• WGS-84 is a prerequisite for performance-based navigation, benefits described in performance objectives for PBN. • support approach and departure procedure design and implementation • improve aircraft operating limitations analysis • support aeronautical chart production and on-board databases			
Safety	• improve situational awareness • support determination of emergency contingency procedures • support technologies such as ground proximity and minimum safe altitude warning systems • see benefits described in performance objectives for PBN			
Strategy *Short term (2010)* *Medium term (2011 - 2015)*				
ATM OC COMPONENTS	**TASKS**	**TIMEFRAME START-END**	**RESPONSIBILITY**	**STATUS**
ATM CM	***Electronic terrain and obstacle data (eTOD)***			
	• share experience and resources in the implementation of eTOD through the establishment of an eTOD working group.	2008-2011	APIRG States	
	• report requirements and monitor implementation status of eTOD using a new AIS Table of the AFI FASID (Ref. Appendix B).	2009-ongoing	APIRG States	
	• develop a high level policy for the management of a national eTOD programme.	2008-2009	States	
ATM AUO	***WGS-84***			
	• establish WGS-84 implementation goals in coordination with the national PBN implementation plan.	2008-2009	States	
	• report requirements and monitor implementation status of WGS-84 using the AIS-5 Table of the AFI FASID and take remedial action if required.	Ongoing	APIRG States	

Link to GPIs	GPI-5: Performance-based navigation; GPI-9: Situational awareness; GPI-11: RNP and RNAV SIDs and STARs; GPI-18: Aeronautical Information; GPI-20: WGS-84; GPI-21: Navigation systems

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MATERIAL FOR THE DEVELOPMENT OF THE AFI PBN IMPLEMENTATION PLAN – CONTENTS OF THE AFI PBN REGIONAL PLAN

- Table of Contents
- Executive Summary
- Explanation of Terms
- Acronyms
- Introduction
  - o Need for the Road Map
  - o Navigation roles in supporting operations
  - o Benefits of performance-based navigation
  - o Goals & Objectives of PBN Implementation
  - o Principles
- PBN Operational requirements & Implementation Strategy
  - o Route
    - Remote oceanic
    - Oceanic
    - Remote continental
    - Continental en-route
  - o TMA
    - Arrival
    - Departure
  - o Approach
- Current Status & Forecast
  - o AFI traffic forecast
  - o Aircraft fleet readiness status
  - o CNS Infrastructure
    - Existing navigation capabilities
    - • GPS Assessment
    - • Other PBN navigation infrastructure
    - Existing surveillance capabilities (Note: as related to PBN)
    - • Surveillance requirements
    - • Surveillance coverage maps
  - o RADAR coverage map above 29000 ft
  - o ADS-B coverage map above 29000 ft
    - Existing communication capabilities (Note: as related to PBN)
    - • Communication requirements
- Implementation Roadmap of Performance Based Navigation
  - o ATM Operational Requirements
  - o Short Term
    - Route
    - • Remote oceanic
    - • Oceanic
    - • Remote continental
    - • Continental en-route

TMA
• Arrival
• Departure
Approach
Summary table & Implementation targets
Regional Plan
Short Term (2008-2012)
Airspace Navigation Specification
Route - Remote oceanic
Route – Oceanic
Route - Remote continental
Route - Continental en-route
TMA – Arrival
TMA – Departure
Approach
o Medium Term
Route
• Remote oceanic
• Oceanic
• Remote continental
• Continental en-route
TMA
• Arrival
• Departure
Approach
Summary table & Implementation targets
Medium Term (2013-2016)
Airspace Navigation Specification
Route - Remote oceanic
Route – Oceanic
Route - Remote continental
Route - Continental en-route
TMA – Arrival
TMA – Departure
Approach
o Long Term (2016 and beyond)
Implementation strategies
- Transitional Strategies
- Safety Assessments & Monitors
o Methodology
o Roles & Responsibilities
- Post-implementation activities
o Implementations status
o Challenges
Appendix A -Reference documentation for developing operational and airworthiness approval
Appendix B – Practical Example of tangible benefits
Appendix C – Procedure to modify the regional plan.

LIST OF PBN IMPLEMENTATION ISSUES

Preliminary
Senior Management (up to DG and Minister level)
Education/Knowledge
Commitment
Timeline
Safety Assessments
Gap analysis
Equipage
Personnel / Capability
Shortage of procedure designers
Legislation
WGS 84
Benefits:
Safety (CFIT)
Access
Airspace capacity
Efficiency
Environment
Cost/Benefit Analysis
All stakeholders
RNP vs. RNAV

PBN implementation plan (short and medium term)
CNS/ATM considerations integrated in PBN implementation plan
Integration with Regional Plan
Pans Ops criteria
Regulations/Legislation

Navigation infrastructure plan
Backup navigation strategy/plan
Regional basis
WGS 84
Operations
Approach
Terminal
STARs
SIDs
Enroute
Oceanic/Remote
Aircraft Ops Spec Issues

Training
Regulator
Controller
Procedure Designer
Pilots
Regulators
Dispatcher
Aircraft Maintenance
Flight and Ground validation
Flight Inspection

Fleet Equipage/Capability
Domestic operators
Intl operators operating to your airspace
Navaid infrastructure
Transition issues
Mixed fleet/mixed mode operations
Separation standards
AIS integrity
Coordination and cooperation with other States, Regions, FIRs
Regional Supp Procedures
User charges

Attachment A to Appendix E

Material for the development of the AFI PBN strategy/ Action Plan
GPI 1, 12, 16, 21, 23

PBN AFI Action Plan GPI 1, 12, 16, 21, 23			
1 Airspace Concept	Start	End	Remarks
1.1 Establish and prioritize Strategic Objectives (Safety, Capacity, Environment, etc)			
1.2 Analyse aircraft fleet navigation capacity operating in the Airport			
1.3 Analyse communication, ground navigation (VOR, DME) and surveillance for navigation specification and reversionary mode compliance			
1.4 Design Instrument Approach Procedure (RNP APCH/APV Baro-VNAV or RNP AR), based on the strategic objective of the airspace concept. Consider Airspace Modelling, ATC simulations (fast time and/or real time), Live Trials, etc.			
2 Develop Performance Measurement Plan			
2.1 Prepare Performance Measurement Plan, including gas emission, safety, efficiency, etc.			
2.2 Conduct Performance Measurement Plan			
3 Procedure safety assessment			
3.1 Determine which methodology shall be used to evaluate procedure safety, depending on the navigation specification. Consider Airspace Modelling, ATC simulations (fast time and/or real time), Live Trials, etc.			
3.2 Prepare a data collection programme for airspace safety assessment			
3.3 Prepare preliminary procedure (s) safety assessment			
3.4 Prepare final procedure (s) safety assessment			
4 Establish collaboration decision making (CDM) process			
4.1 Coordinate planning and implementation needs with Air			

PBN AFI Action Plan GPI 1, 12, 16, 21, 23			
Navigation Service Providers, Regulators, Users, aircraft operators and military authorities			
4.2 Establish implementation date			
4.3 Establish the documentation format of the AFI PBN website (www.icao.int/esaf/ PBN			
4.4 Report planning and implementation progress to the corresponding ICAO Regional Office			
5 ATC Automated Systems			
5.1 Evaluate the PBN implementation in the ATC Automated Systems, considering the Amendment 1 to the PANS/ATM (FPLSG).			
5.2 Implement the necessary changes in the ATC Automated Systems			
6 Aircraft and operator approval			
6.1 Be aware of the national implementation programme and of the required navigation specifications			
6.2 Analyse aircraft approval requirements, aircrew and operator approval requirements for the navigation specifications to be implemented, as contained in the ICAO PBN Manual			
6.3 Publish the national regulations to implement the required ICAO navigation specifications			
6.4 Approval of aircraft and operators for each type of procedure and navigation specification			
6.5 Establish and keep updated a record of approved aircraft and operators			
6.6 Verify operations with a continuing monitoring programme			
7 Standards and procedures 8			
7.1 Evaluate regulations for GNSS use, and if such were the case, proceed to its publication.			
7.2 Develop and publish AIC notifying PBN implementation planning			
7.3 Publish AIP Supplement including applicable standards and procedures			
7.4 Review Procedural Manuals of the ATS units involved			

PBN AFI Action Plan GPI 1, 12, 16, 21, 23			
7.5 Update Letters of Agreement between ATS units, if necessary			
7.6 Provide procedures to accommodate non-approved RNAV/RNP aircraft, when applicable			
7.7 Conduct ATC simulations to identify the workload/operational factors, if necessary.			
8 Training			
8.1 Develop a training programme and documentation for operators (pilots, dispatchers and maintenance)			
8.2 Develop training programme and documentation for Air Traffic Controllers and AIS Operators			
8.3 Develop training programme to regulators (aviation safety inspectors)			
8.4 Conduct training programmes			
8.5 Hold seminars oriented to operators, indicating the plans and the operational and financial benefits expected			
9 Decision for implementation			
9.1 Evaluate operational documentation availability (ATS, OPS/AIR)			
9.2 Evaluate the percentage of approved aircraft and operations (mixed equipage concerns)			
9.3 Review safety assessment results			
10 System Performance Monitoring			
10.1 Develop post-implementation APP operations monitoring programme			
10.2 Execute post-implementation APP operations monitoring programme			
10.3 Pre operational implementation date			
10.4 Definitive implementation date			

Attachment to B Appendix E

PBN AFI strategy/action Plan

Task No.	Task Description	Start	End	Remarks/Status
	Working Methods and Resources			
1	Agree on structure of TF to enable efficient handling of specialist technical tasks			
2	Identify resources for performing specialist technical tasks			
3	Investigate methods of funding any outside assistance required			
4	Identify clear goals and objectives			
5	Develop a questionnaire to determine the State implementation status of PBN instrument procedures and Approaches			
6	Develop the AFI PBN strategy/action Plan			
7	Develop the AFI PBN implementation Plan			
8	Develop training guidance material for Controllers, Pilots, airspace designers, dispatchers ,Ops/Air, operators etc			
9	Nomination of PBN National Programme Managers (Focal Point of Contact- (FPOC)			
	Safety Assessment and Monitoring			
10	Conduct preliminary data collection and readiness assessment			
11	Evaluate options for carrying out the safety analysis			
12	Develop detailed program for safety analysis			

Task No.	Task Description	Start	End	Remarks/Status
13	Establish requirements for pre and post-implementation monitoring			
14	Undertake initial safety analysis			
15	Carry out pre-implementation safety analysis			
16	Carry out pre-implementation readiness assessment			
17	Carry out post-implementation safety analysis during verification phase			
18	Ensure transferability of aircraft data from other Regions			
19	Devise methodologies for incorporating the effects of projected traffic growth and system changes on occupancy & collision risk in the future environment			
20	Perform periodically other data collections (eg. ASE stability) in order to ensure that the parameter values used remain current			
	ATM Operational Issues			
21	Establish/identify airspace categorization for en-route and areas.			
22	Develop and Harmonize ATS Operational procedures			
23	Identify transition areas and transition procedures			
24	States assess the impact of PBN implementation on controller automation systems and plan for upgrades/modifications			
25	Restructuring of airspace as appropriate			

Task No.	Task Description	Start	End	Remarks/Status
26	Develop procedures for integration of general aviation handling non-compliant civil aircraft (inc ferry & maintenance)			
27	Develop procedures for suspension of PBN			
28	Evaluate the need for simulations to assess ATC workload and possible need for airspace/air route/Sector changes (SIDs & STARs, environmental issues etc)			
29	Sharing of resources and experience			
30	Develop ATC regional training guidance material			
31	Identify issues to be addressed in Letters of Agreement			
32	Aeronautical Information management (AIM) issues i.e WGS 84 , AIP Suppliments, NOTAMs .etc			
33	**CNS infrastructure issues**			
	OPS/AIR Issues			
34	States to examine existing legislation and regulations to identify any changes required for PBN			
35	Develop and promulgate information on the operational approval process			
36	Develop procedures for aircraft found to be non-compliant through monitoring			
37	Evaluate the need for chart amendments related to PBN			

Task No.	Task Description	Start	End	Remarks/Status
38	Monitor progress with operator approvals			
	Joint Tasks			
39	Review preliminary readiness assessment			
40	Set target proportion of PBN approved aircraft for full PBN implementation			
41	Prepare/maintain regional status report detailing PBN implementation plans			
42	Develop a regional PBN informational campaign			
43	Develop regional PBN Guidance Material			
44	Review weather and contingency procedures for applicability under PBN			
45	Undertake coordination and harmonization of procedures with adjacent Regions			
46	PBN Meetings			
47	Develop monitoring and evaluation program for the verification phase			
48	Seminars and Workshops			
49	Determine implementation date			
50	Post implementation analysis			

Attachment C Appendix E

AFI PBN TASK LIST

No	ICAO Performance Objectives	ICAO Strategic Objectives	Associated GPIs	Tasks/strategy	Benefits	Deliverables	Target Date	Members	Status
1	**PBN Planning**	**A:Safety: D:Effciency C:Enviromment**	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Introduction** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft documnent	**15 Aug. 2008**	**ICAO, ASECNA**	**Ongoing**
2	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **PBN Operational requirements & Implementation Strategy** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document			
3	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: AFI traffic forecast** Section for Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document			Ongoing
4	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: Aircraft fleet readiness status** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document			
5	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: CNS Infrastructure** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document			

PBN TF 2 Meeting
Appendix E plus attachments a, b & c to WP/3

No	ICAO Performance Objectives	ICAO Strategic Objectives	Associated GPIs	Tasks/strategy	Benefits	Deliverables	Target Date	Members	Status
6	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Safety Assessments and Monitors** Section for PBN Regional Plan To facilitate the development of the Regional Plan					
7	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix A - Reference documentation for developing operational and airworthiness approvals** Section for PBN Regional Plan	To facilitate the development of the Regional Plan				
8	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix B – Practical Example of tangible benefits** Section for PBN Regional Plan	To facilitate the development of the Regional Plan				
9	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix C – Procedure to modify the regional plan** Section for PBN Regional Plan	To facilitate the development of the Regional Plan				
10	PBN Coordination & Implementation PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify the short falls preventing the implementation of PBN	To identify preventive measures and to support PBN implementation	Working Papers		**TF members**	

PBN TF 2 Meeting
Appendix E plus attachments a, b & c to WP/3

No	ICAO Performance Objectives	ICAO Strategic Objectives	Associated GPIs	Tasks/strategy	Benefits	Deliverables	Target Date	Members	Status
11	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify training requirements	To assist States in their planning and implementation	**Working Papers**		**TF members**	
12	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Assess possibilities of future PBN seminar	To assist States in their planning and implementations				
13	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify ways and means to share resources	To assist States in their planning and implementations				
14	PBN Certification Process	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Develop standard template for application & approval package	To harmonize PBN approval process within the region				
15	PBN Planning	15 A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	ICAO, via a State letter, to request States to update information on CNS infrastructure in the FASID table	To obtain information necessary for regional planning State letters	Updated FASID table		**ICAO**	

Terms of reference of National Performance-Based Navigation (PBN) Programme Managers

National PBN Programme Managers (NPPMs):

1) Are 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, 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, focussing 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 are 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.
   l) 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 defence; and
   h) other relevant bodies.

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

TERMS OF REFERENCE OF THE APIRG
PERFORMANCE-BASED NAVIGATION TASK FORCE (APIRG PBN/TF)
1. Develop as part of the goal of moving towards a performance-based Global ATM System, an AFI Regional PBN implementation plan, based on a gap analysis, in line with the ICAO PBN goals and milestones. This PBN implementation plan must be based on the following objectives and guiding principles.
Objectives:
a) to ensure that the implementation of the navigation item of the CNS/ATM system is based on clearly established operational requirements;
b) to avoid undue multiple equipment on the aircraft and/or multiple systems on ground;
c) to avoid the need for multiple airworthiness and operational approvals for intra- and inter-regional operations; and
d) to explain in detail the contents of the Regional Air Navigation Plan (ANP) and of the Regional CNS/ATM Plan, describing potential navigation applications.
Guiding principles:
a) pre- and post-implementation safety assessments will be conducted to ensure the application and maintenance of the established target levels of safety;
b) continued application of conventional air navigation procedures during the transition period, to guarantee the operations by users that are not RNAV- and/or RNP equipped;
c) the first regional PBN implementation plan should address the short term (2008-2012), medium term (2013-2016), and long term (2017 and beyond);
d) target date for completion of the first regional PBN implementation plan is December 2008; and
e) input will be considered from all stakeholders in the PBN implementation process.
2. Carry out specific studies, develop guidance material and facilitate training to assist States with RNAV/RNP implementation in the en-route, terminal, and approach flight phases, taking into account the performance-based navigation (PBN) concept, according to the ICAO Strategic Objectives A, C and D, and Global Plan Initiatives (GPI) on this matter (GPI 5, 7, 10, 11, 12, 20, 21).
3. Identify other issues/action items arising from the work of the RNP SORSG or for consideration by the RNP SORSG in order to facilitate regional and global harmonization of existing applications as well as future implementation of PBN operations.
4. Review the States' PBN implementation documentation to ensure regional harmonization and for possible inclusion in ICAO-developed model documentation.
5. Address other regional PBN implementation issues, as needed.
6. The task force should report to APIRG, through the ATS/AIS/SAR Sub-Group, and should brief the CNS Sub-Group.
