INTERNATIONAL CIVIL AVIATION ORGANIZATION
WESTERN AND CENTRAL AFRICA OFFICE

Second Meeting of the AFI Performance Based Navigation/Global Navigation Satellite System AFI Task Force (PBN/GNSS TF/2)

(Dakar, Sénégal, 13 - 15 Juin 2011)

Agenda Item 5: Review of GNSS implementation strategy

Status of implementation of GNSS in other Regions

(Presented by the Secretariat)

SUMMARY

This Working Paper presents the status of implementation of GNSS in other Regions Action by the meeting is at **paragraph 3.**

REFERENCE(S)

- **ICAO Doc 9849**
- **Results of NSP Meetings Discussions**

This Working Paper is related to Strategic Objectives: **A &C** and is linked to **GPI-1; GPI-2; GPI-5; GPI-6; GPI-1 ;GPI-7 ;GPI-11; GPI-21**

1. Introduction

1.1. The Global Air Navigation Plan (Doc 9750) describes a set of initiatives that, when implemented, will result in performance enhancements ensuring the availability of a safe, secure, efficient and environmentally sustainable air navigation system and calls for the implementation of an air traffic management system that makes optimal use of technical advances.

1.2. Many of these initiatives in particular Performance Based Navigation rely on the Global Navigation Satellite System (GNSS) as the enabling technology. GNSS is defined in Annex 10 as "*a worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation*."

1.3. In order to ensure a continuous safe, secure, efficient and environmentally sustainable air navigation service operation the implementation of PBN within the AFI Region should take into consideration the worldwide ongoing projects for GNSS implementation in order to identify and properly address the harmonization requirements between neighbouring State/ANSPs.

2. Discussion

Implementation of GNSS in APAC Region

2.1. The implementation of GNSS in APAC Region is conducted through the Navigation Strategy for the Asia/Pacific Region. This strategy was reviewed, revised and adopted by APANPIRG 20th meeting on September 12009. The Strategy considers:

a) Material contained in the ICAO Performance Based Navigation Manual (Doc 9613) for enroute, approach, landing and departures operations;

b) Fleet equipments by Airlines to support PBN;

c) GNSS as the future predominant sensor and APV to be conducted by Baro-VNAV or augmented GNSS that should support Category I operations by end 2009 and Category II and III operations by 2015;

d) ILS capable of meeting the majority of requirements for precision approach and landing, MLS CAT III current operational status;

e) Needs to ***maintain aircraft interoperability both within the Region and between the Asia/Pacific Region and other ICAO regions*** and to provide **flexibility for future aircraft equipage.**

The Navigation Strategy for the Asia/Pacific Region is attached in **Appendix A.**

2.2. The Asia/Pacific Regional PBN Implementation Plan is the basic document for the implementation of GNSS in APAC Region. This document was drafted on September 2008 adopted by APANPIRG 20th meeting on September 2009 and revised by APANPIRG 21th meeting on September 2010.

Based on current status and forecast on traffic, Aircraft fleet readiness status, Global Navigation Satellite System (GNSS), other PBN Navigation Infrastructure, Surveillance and Communications Infrastructures within APAC Region, the Regional Plan built an implementation Road Map of Performance Based Navigation including GNSS covering the **2008 to 2016** period and beyond.

2.3 The transition strategies recommend *inter alia* that during transition to PBN (Full GNSS):

a) Sufficient ground infrastructure for conventional navigation systems must remain available to serve non-equipped flights;

b) Before existing ground infrastructure is considered for removal, users should be given reasonable transition time to allow them to equip appropriately to attain equivalent PBN-based navigation performance;

c) States should approach removal of existing ground infrastructure with caution to ensure that safety is not compromised.

d) States should encourage operators and other airspace users to equip with PBN-capable avionics. This can be achieved through early introductions of RNP approaches, preferably those with vertical guidance.

The regional Plan also addressed the issue of Safety assessment of PBN monitoring requirements.

2.4 APAC Region organized with Eurocontrol a PBN Workshop from 9 to 12 May 2011 back to back with the PBN Implementation Seminar, held from 10 to 11 May 2011.

The eighteenth meeting of the APAC Performance Base Navigation Task force PBN/TF/8 was held in New Delhi India from 12 to 13 May 2011.

Barriers to PBN GNSS implementation were identified as presented in **Appendix B.**

2.5 IATA provided the meeting with key aspects aiming to contributing to the implementation of PBN/GNSS in the Region. These key aspects are summarized in **Appendix C**.

Based on the above different provisions the APAC PBN Regional Plan and the strategy were revised and the PBN implementation Task List updated accordingly.

Implementation of GNSS in NACC Region

2.6 The implementation of GNSS in NACC Region is being conducted through the document on CAR/SAM strategy for the evolution of navigation systems developed by the first meeting of the CAR/SAM CNS/ATM Sub Group.

Based on the evolution of the operational scenario according to CAR/SAM PBN implementation Road Map a strategy of evolution of navigation infrastructure has been developed comprising short, mid and long term phases from **2010 to 2025** and beyond.

2.7 A tentative Action Plan for the implementation of this strategy has been established and covers the same period. The guidelines for the preparation of a GNSS Training Programme were developed as well as the guidelines for the implementation of GNSS for Enroute, Approach Landing and Departure phases of flight.

Implementation of GNSS in SAM Region

2.8 The implementation of PBN/GNSS within SAM Region is conducted through a PBN Implementation Plan for SAM Region. This Plan is a comprehensive document that analyses all the components of ATM operation and support services and infrastructures including MET and AIM and Search and Rescue issues;

2.9 The Human Resources and Competence Management was developed to enhance human factors capacities as well as a Safety Assessment of the system based on the implementation of QMs linked to each component.

2.10 The last activity conducted in the matter was a Seminar/Workshop on the Implementation of the Performance Based Air Navigation Plan for the South American Region held in Lima, Peru, 9 to 13 May 2011.

The meeting addressed Analysis of the current CNS systems situation and the implementation strategy of the performance objectives.

In the Region**, ABAS** is being implemented in selected airspaces of the Region for en-route, terminal a rea and for NPA operations; **GBAS** implementation trials are conducted in Brazil and Chile.

Implementation of GNSS in MID Region

2.11 The implementation of PBN/GNSS in the MID Region is developed through then Regional PBN Implementation Plan MID Region conducted Workshops with the collaboration of experts from EUROCONTROL and the FAA.

The regional strategy that supports the regional PBN Implementation Plan process covers period from **2008 to 2016** and beyond.

2.12 A transitional strategy was developed taking into consideration the safety assessment and the need for a periodic review of the implementation activities.

Focal points have been nominated for each MID State while the national PBN implementation timeframe is developed as presented in **Appendix E**.

Implementation of GNSS in EUR/NAT Region

2.13 The implementation of PBN/GNSS in EUR NAT is based on the ICAO EUR/NAT Navigation Plan that provides guidance on the expected evolution of the regional navigation system to allow coordinated and harmonised planning of airspace changes, ATM systems and aircraft equipage.

This regional plan is strongly linked with sub-regional programmes, e.g. SESAR. An implementation roadmap has been developed to cover the period from 2010 to 2020 and beyond.

2.14 Augmentation systems (**ABAS**, **GBAS, SBAS**) under development and trials by many EUR States (France, Russia, Germany...).

EGNOS, the European Satellite Based Augmentation System **Safety-of-Life Service** was made available, on 2nd March 2011 after having been certified by French National Supervisory Authority (NSA) on 12 July 2010.

Air Navigation Service Providers in the EGNOS service area may now proceed with the publication of SBAS precision approach procedures (LPV) based on EGNOS, once they have established working agreements with ESSP as required by the Single European Sky (SES) regulation.

2.15 It is therefore advisable for AFI Stats to take the opportunity of the existing experience gained by the other ICAO regions to update th AFI PBN/GNSS implementation scheme.

3 Conclusion

3.1 The meeting is invited to:

3.2 Take note of the Information given above

3.3 Identify from the experience gained in ICAO regions in the area of PBN/GNSS planning, strategy, capacity building and safety assessment, the guidance materials from which, can be driven additional provision to update the current AFI PBN/GNSS Implementation Plan and strategy.

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Appendix A

REVISED NAVIGATION STRATEGY FOR THE ASIA/PACIFIC REGION

Considering:

a) The material contained in the Performance Based Navigation Manual (Doc 9613) for enroute, approach, landing and departures operations;

b) Operators will equip aircraft to support PBN operations;

c) GNSS will be the predominant navigation sensor;

d) APV operations may be conducted with BARO-VNAV or augmented GNSS;

e) Augmented GNSS will support Category I operations by end 2009 and Category II and III operations by 2015;

f) In the Asia/Pacific Region, ILS is capable of meeting the majority of requirements for precision approach and landing;

g) MLS CAT III is operational;

h) The need to maintain aircraft interoperability both within the Region and between the Asia/Pacific Region and other ICAO regions and to provide flexibility for future aircraft equipage.

Strategy

a) Transit to PBN operations as follows:

i) RNP10/RNP4 for Oceanic and Remote Continental routes;

ii) RNAV5/RNAV2 for Continental En-route;

iii) RNAV1, RNAV2 and Basic RNP1 based arrivals and departure;

iv) APV **

v) Precision approaches at selected runways,

with respective end states as follows:

vi) RNP4 for Oceanic and Remote Continental routes;

vii) RNP1/RNP2 for Continental En-route;

viii) RNP1 and RNP0.3 based arrivals and departure;

ix) APV **

x) Precision approaches at selected runways,

Note: Ideally, end-state should follow the above process but may be achieved directly without transiting through the immediate phases (i.e. (i) to (v)), if considered safe to do so.

b) Retain ILS as an ICAO standard system for as long as it is operationally acceptable & economically beneficial;

c) Implement GNSS with augmentation as required for APV and precision approach operations where operationally required and economically beneficial;

d) Implement the use of APV operation in accordance with ICAO's requirement;

e) Protect all the Aeronautical Radio Navigation Service (ARNS) frequencies; and

f) Ensure civil-military interoperability.

*****APV includes BARO-VNAV, RNP, RNP-AR, APV 1 & 2***

Appendix B

Some barriers to effective PBN implementation identified in APAC Region

I Insufficient PBN Knowledge:

I.1 PBN remains a foreign topic and encounter opposition or diversions;

1.2 Lack of Awareness/Knowledge;

1.3 Lack of Expertise to develop Regulations

1.4 ICAO Model PBN Plan resources unclear;

1.5 Insufficient flow-on Information between stakeholders;

I.6 Indifferent management will and commitment;

1.7 Noncommittal stance by key stakeholders;

I.8 Confusion in navigation aid and airspace planning, Operations Approval process, Goal setting;

1.9 Leadership unclear – due structural reforms;

1.10 Contact Point for ICAO Not Identified due Bureaucratic Channels

II Funding - PBN Team

II.1 Scarce funding for Regulator/ANSP/Airline to attend forums;

II.2 Regulatory Operations Approval and RNP AR Training;

III Mixed Fleet Equipage

III.1 Legacy aircraft equipage without any plans for upgrades until after 2013;

III.2 Domestic re-fleeting without considering PBN initiatives;

IV Maps and Charts Updates

IV.1 Lack of local charting equipment and PBN expertise to update AIP;

V Government Policy Conflicts

V.1 Influence and divergence of funding; and

V.2 Opponents to Safety Assessments.

APPENDIX C

The IATA PBN Experience in APAC

A. States must recognize the benefits in order for decision makers to invest;

B. Stakeholder buy-in must be at the working level (working groups);

C. Coordination and collaboration between Stakeholders is required;

D. Cost-Benefit Analysis can be important;

E. States need to understand internal limitations and be willing to accept assistance;

F. There was a need to transition from planning to implementation (GO Teams, etc);

G. APAC stands at risk of not meeting ICAO implementation targets;

H. Prompt action is required to accelerate the pace of implementation; and

I. A comprehensive Regional Support Strategy was required (REDI Initiatives).

J. Airworthiness certification & Ops Approval process considered a weak link;

1. *Limited understanding of the requirements*
2. *Lack of a useful approvals process;*

K. Common regulator responses to PBN approvals

3. *Lack of oversight – "Rubber Stamp";*
4. *Unreasonable oversight – require more than the minimum; and*
5. *Impeding oversight – refuse approval due to lack of confidence.*

Appendix D.1

EVOLUTION OF AIR NAVIGATION INFRASTRUCTURE IN CAR/SAM REGION

Short term (**up to 2010**)

a) Initial deactivation of NDBs.

b) Definition of the GNSS backup infrastructure.

c) Changes to DME infrastructure to meet ICAO RNAV (DME/DME) requirements at selected TMAs.

d) Initial implementation of ABAS for en-route, TMA, and NPA operations.

Medium term (2011-2015)

a) The implementation of GBAS CAT I stations at airports with sufficient operational demand will improve en-route and TMA operations (SIDs and STARs) on paths similar to those of the ILS.

b) At some airports, ILS systems will be maintained as GNSS/GBAS backup.

c) Initial deactivation of VOR for en-route operations.

Long term (2016-2025)

a) Continue deactivating conventional aids, maintaining the backup structure, if necessary;

b) Implementation of GBAS Cat II/III at selected airports.

c) Implementation of GBAS CAT I approach at other CAR/SAM airports with sufficient operational demand.

d) Possible implementation of SBAS, depending on feasibility studies already carried out and underway under ICAO projects, taking into account current mono-frequency systems and the evolution of ionosphere algorithms, as well as the future availability of a multi-frequency, multi-constellation satellite structure.

Appendix D.2

TENTATIVE ACTION PLAN FOR THE IMPLEMENTATION OF PBN/GNSS IN CAR/SAM REGION

Short term (up to 2010)

a) The implementation of an automatic tool for the development of procedures should be established in order to meet the new demand for procedures such as RNAV and RNP.

b) Analysis of DME/DME coverage and DME implementation to support operations, and introduction of improvements.

Medium term (2011-2015)

a) In order to determine which airports are suitable for the installation of GBAS CAT I stations, each State must make a cost-benefit analysis based on its own operational demand.

b) For each eligible airport, a GBAS ionosphere threat model will be required for certification and commissioning purposes.

c) Complete and conclude the SACCSA project to see the possibility of implementing an SBAS system in the CAR/SAM Regions.

d) Assess the technical, operational, and financial feasibility of SBAS systems, based on the development of new mono-frequency system models, the future implementation of GPS operations, and the commissioning of the GALILEO constellation.

Long term (2016-2025)

a) In order to determine which airports are suitable for the installation of GBAS

CAT II/III stations, each State must conduct a cost-benefit analysis, based on its own operational demand.

b) SBAS operations with a self-owned or leased GEO satellite, which could enable SBAS operations independently from WAAS and/or EGNOS.

APPENDIX E

Example of National Time Frame for the implementation of PBN in MID Region

Bahrain PBN Implementation time frame

Navigation Specification	Airspace Application	Short Term				Medium Term				Long Term	
		2009	2010	2011	2012	2013	2014	2015	2016	2017….	2025
RNAV10	NA	Will not be used									
RNP4	NA	Will not be used									
RNAV2	NA	Will not be used									
RNP5 into RNAV5	Enroute										
RNAV1	Enrout										
RNAV1	TMA Dep. and Arr. Sur										
Basic RNP1	TMA Dep. and Arr. Non sur										
RNP APCH	Approach										
RNP AR APCH	Approach KHIA										
RNAV1	SIDs / STARs										
Basic RNP1	Enrout										
advanced-RNP-1	en-route										
advanced-RNP-1	terminal airspace										
Use of NDB	Approach operations					Stop using the NDB for approach operations					
Conventional NPA procedures										Stop the conventional NPA procedures	