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

Hurdles to the implementation of GNSS in AFI Region

(Presented by the Secretariat)

SUMMARY

This Working Paper presents the hurdles to the implementation of GNSS in AFI region

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 implementation of GNSS to support PBN in AFI region is governed by the AFI GNSS implementation strategy that should take into consideration both technical, institutional and economic aspects.

1.2. GNSS will also supports ABS-B and ADS-C operation by providing the precise position reports required to ensure the safe separation of aircraft based on aircraft broadcasting position, velocity and other on-board data as well as precise time information that is used in many aviation systems to synchronize their local clocks to a global time standard such as Coordinated Universal Time (UTC).

1.3. In the AFI Region the implementation of PBN, ADS-B and ADS-C relies on GNSS provision in term of accuracy, integrity, availability, continuity and functionality. Therefore it is important that the barriers to the implementation of GNSS be identified and properly addressed.

2. Discussion

2.1. As part of the review of the GNSS Manual (ICAO Doc 9849), the Secretary of the Navigation System Panel (NSP) asked ICAO regional offices to identify perceived hurdles or barriers to the implementation of GNSS.

This exercise was conducted in order to address as many of these hurdles as possible in the revised GNSS Manual. In many cases it was possible to address specific hurdles by adding guidance material to the draft GNSS Manual. Some hurdles, however, require action by other ICAO bodies, by States or by equipment manufacturers.

2.2. At the May 2010 meeting, NSP/WG2 also identified hurdles and on May 2011, the NSP meeting categorized these hurdles as **OPEN** or **CLOSED** with explanations.

The list of hurdles is attached in **Appendix** to this Working Paper.

There were a total of **49** hurdles; **33** were **CLOSED** and **16** are **OPEN.** The meeting deemed hurdles were CLOSED when: they were directly addressed by text in the GNSS Manual; other action has been taken to close them; or, when no action is possible.

2.3. Between the 16 OPEN hurdles, 8 require States to provide material on the ICAO web site or via links to their web sites, including safety and business cases, approval documentation and training material. There were 5 hurdles identified that require ICAO to coordinate documentation. There were 3 that require more text in the Manual and ICAO is currently working to address these.

2.4. When reviewing the strategy of implementation of GNSS within AFI Region it should be advisable, based on the list of hurdles identified, that AFI states identify the critical current hurdles encountered and develop an action plan to address them.

3. Conclusion

3.1. The meeting is invited to:

3.2. Take the Information given above

3.3. Identify from the list of hurdles provided, those who should be critical in AFI region and develop an adequate Action Plan aiming to overcoming them.

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APPENDIX

Navigation Systems Panel (NSP)

Working Group of the Whole – 10th Meeting

(Montreal, 9-20 May 2011)

Implementation Hurdles (re ICAO Doc 9849)

	Topic	**Hurdle**	**Comments**
1	Airspace	Full operational capability of GNSS for area navigation has not been realised. Refinement of separation standards and airspace management has not occurred to take advantage of the technology.	Various ICAO Panels, Study Groups and PIRGs are developing separation and airspace standards. GNSS performance must be linked to the broader concept of PBN in order to address total system error. Separation standards cannot be based on a single sensor performance. - OPEN (ICAO) -
2	APV	APV implementation issue: PBN RNP APCH with Baro-VNAV would be the easiest APV operation. Lack of Baro-VNAV capability for regional aircraft is the hurdle for implementation of APV. SBAS or GBAS based APV need to be matured both in documentation, equipage level and implementation.	The ICAO resolution calling for APV to all runways was amended to allow for straight-in LNAV procedures where aircraft equipage is an issue. Please see 1.4.2.4 in the draft GNSS Manual. – CLOSED –
3	APV	Some States perceive there is a barrier to APV implementation because of the lack of currency and consistency among ICAO publications. The meeting agreed that the manual should clearly show that APV is possible despite these issues, perhaps including documentation map and that the NSP should work within ICAO to resolve inconsistencies.	Please see 7.10.2.5 in the draft GNSS Manual. More consistency among ICAO documents is required. - OPEN (ICAO) -
4	Augmentation	More detailed guidance may be included for the GNSS implementation team differentiating GBAS and SBAS implementation issues.	GBAS and SBAS issues are addressed in technical, business case and safety case sections. – CLOSED –

	Topic	Hurdle	Comments
5	Augmentation	Information of system certification guidance such as GBAS/SBAS system certification is also required.	Please see section 7.7.4 in the draft GNSS Manual. – CLOSED –
6	Avionics	A major hurdle to full implementation in most States is avionics equipage. Aircraft operators face major costs to equip their fleets, and to equip a large fleet can take five years or more. At the same time, different mandates, different airspace requirements and different mandate deadlines in different areas make it difficult to decide when to equip. As an example, in Europe there is a mandate for ADS-B that can be supported by C129 avionics, and a mandate for APV that requires more advanced avionics. There is a requirement for a vision developed among ANSPs and aircraft operators.	International coordination is always a challenge. States will have different demands based on their operational environment (ground based nav aids, surveillance and comm infrastructure) as well as traffic density and equipage. What is needed is a standard that is associated with each performance level for applied separation requirements. This is being done in part through the PBN work but needs to be accelerated to encompass surveillance applications as well. Example, differences in Canada and Australia for the same ADS-B separation standard. – OPEN (ICAO) –
7	Avionics	Available avionics are generally limited to the GPS constellation. A small number are developed to utilise both GPS and GLONASS however these have not seen widespread adoption by European or North American aircraft manufacturers. There is no apparent effort by RTCA or EUROCAE to write standards for multi-constellations avionics or the development of TSOs and ETSOs.	Chapter 6 in the draft GNSS Manual discusses the issues surrounding the use of multiple constellations and signals. Aircraft operators equipped with GPS avionics because benefits were well defined and the business case was positive. Until these new elements are available and they provide clear incremental benefits, progress will be slow. – CLOSED –

	Topic	Hurdle	Comments
8	Avionics	There are very few aircraft equipped to take advantage of all GNSS services. The services considered are ABAS, SBAS (WAAS, MSAS, EGNOS, GAGAN), GBAS (Cat I, GRAS and future GAST D /Cat III) and multiple constellations.	Please see comment in 7 above. Equipage levels are high in States where there is a regulatory framework and where there are clear benefits. ABAS use and equipage is widespread. SBAS use and equipage is widespread in the United States and to a lesser degree in Canada and Mexico. GRAS is no longer viable. (Section 7.5 in the draft GNSS Manual.) – CLOSED –
9	Avionics	TSO C-129 receivers do not have certified implementation of fault detection and exclusion and do not account for the zeroing of SA. Small operators do not have the financial resources to upgrade serviceable avionics.	Many operators obtain significant benefits from TSO C-129 avionics and have no business case to upgrade to SA-aware SBAS avionics with FDE until the incremental benefits are significant and until their current avionics are near the end of their life cycle. (Section 7.5 in the draft GNSS Manual) – CLOSED –
10	Avionics	Major manufacturers (Airbus and Boeing) have not employed SBAS although there is an offering with the A350 for SBAS. Some new airliners are being offered with GBAS Cat I capability and ABAS solutions to support RNP (APV-I) and RNP-AR.	The business case determines equipage. Please see 7.5.4.3 in the draft GNSS Manual.re airline equipage with SBAS avionics. – CLOSED –
11	Avionics	Many older aircraft are not equipped with GPS. Example aircraft in Australia are B737-3/400, B767-300, F100, B737-200, B727 and DC9. Retrofits involve complex interfaces with the implemented flight management system, significant HMI issues and significant cost.	The business case determines equipage. (Section 7.5 of the draft manual.) – CLOSED –

	Topic	Hurdle	Comments
12	Avionics	TSO C129 seems to be acceptable and does not require a high cost of reequipping since most airlines already have C129. Any more advanced TSO requirement, such as TSO C145/146 can create major cost for operators for near term implementation.	Please see comment in 11 above. – CLOSED –
13	Business Case	States require a business case analysis to support implementation, and the Manual does not provide enough information to support identification and quantification of benefits. The meeting agreed that examples would be useful and might obviate the necessity for States to complete their own business cases for simple applications like Basic GNSS non-precision approach operations.	Business case analysis is discussed in general terms in section 7.5. of the draft manual States need to provide examples. - OPEN (STATES) -
14	Business Case	On the business case analysis, you may include cost recovery guidance as stated in ICAO Circular Information of system.	Please see 7.5.1.4 of the draft manual in which there is a caution re cost recovery. Section 7.5.1.5 in the draft GNSS Manual provides ICAO references. – CLOSED –
15	Business Case	A major contributor to the benefit equation is the potential retirement of conventional navaids – that is mainly VOR, NDB (replaced functionally with GPS). Delayed transition and the perceived need to maintain an alternative capability erode the benefits.	Please see section 7.16.3 of the draft manual for a discussion of issues surrounding the decommissioning of VOR and NDB. – CLOSED –
16	Business Case	Good examples of Business Case Study of introducing GNSS operations, including how some States handle environmental assessment can be helpful.	States need to provide examples. - OPEN (STATES) -
17	Certification	Certification guidance such as GBAS/SBAS system certification is also required.	Please see section 7.7.4. in the draft GNSS Manual. – CLOSED –
18	Certification	Some States do not know how to address aircraft certification, in part because there are currently different standards applied globally.	Please see section 7.7.2 in the draft GNSS Manual. – CLOSED –

	Topic	Hurdle	Comments
19	Data Recording	GNSS data recording: AFI ANSPs have not implemented this Annex 10 requirement. Related guidance material should be included in the GNSS Manual.	Please see section 7.9 in the draft GNSS Manual. – CLOSED –
20	Environmental Assessment	The implementation of GNSS-based terminal area operations in some States faces the requirement for an environmental assessment including extensive public consultation, all at great cost. This is a difficult institutional issue that has no easy solution.	This is not addressed in the manual. States have different requirements re environmental assessment and public consultation – CLOSED –
21	ICAO Pubs	The meeting noted that States do not always use the GNSS Manual as a reference to support implementation.	ICAO needs to promote the GNSS Manual as a key reference supporting the implementation of GNSS-based services. - OPEN (ICAO) -
22	ICAO Pubs	ICAO has published numerous publications over the last decade and many overlap in the guidance provided. Confusion is also generated by description in manuals of what may be achieved and what must be achieved (pseudo standards). Revision and coordination between manuals must be achieved on a regular basis. The updated Manual should be a single source of harmonised ICAO documentation and requirements on GNSS Ops. Doc 8071 and Doc 9906 should be harmonized and compatible.	ICAO needs to address coordination of guidance material among groups. - OPEN (ICAO) -
23	Institutional	Some States feel that there is an institutional problem because the current core satellite constellations are operated by the military. The manual needs to stress the commitments to civil aviation by Russia and the United States of America.	The commitments are described in the Executive Summary and in sections 3.2.1 and 3.3.1 in the draft GNSS Manual. – CLOSED –

	Topic	Hurdle	Comments
24	Institutional	Sovereignty of the core constellations and augmentations provided outside the States' control is often quoted as a reason for distrust of GNSS. Removal of services or degradation of service without regard to the non-provider User State is the major concern/fear. GNSS is effectively based on the GPS constellation. The availability of the GLONASS, Galileo and Compass would reduce this dependence into the future. GLONASS has been around as long as GPS however due to system management issues it has not achieved the same operational respect as GPS. Galileo and Compass are yet to achieve operational capability. The risk of total loss of navigation capability for a State reliant solely on GNSS (GPS) is considered unacceptable. States are maintaining back-up networks of conventional navigation aids. This risk mitigation behaviour is detracting from the cost benefits that can be achieved by GNSS transition. Loss of GNSS could be attributed to: constellation failures; interference (single L1 frequency); ionosphere and troposphere abnormalities; intentional denial of service.	Current service providers have given service guarantees to ICAO. It is expected that future service providers will do the same. It is up to each State to assess these institutional issues and adopt a position. In many cases State aircraft operators will demand GNSS-based services because there are clear benefits. States will see that GNSS-based services reduce fuel use and emissions. – CLOSED –
25	Institutional	Legal uncertainty about liability for the certification and performance of GNSS between the provider and user States.	This issue must be addressed by each State. – CLOSED –
26	Ionosphere	In the update document should be included an explanation or a reference of the ionosphere effects on the GNSS performance (accuracy, integrity, continuity and availability) and their limitation on the implementation of ABAS, GBAS and SBAS augmentation system.	Please see section 5.4. - CLOSED -
27	Ionosphere	SBAS performance in equatorial regions: AN/Conf/11 recommended trials along the equatorial line to assess SBAS performance. Accordingly and EGNOS Test Bed was conducted in the AFI Region but so far no technical report has been submitted to ICAO and AFI States to validate the system performance and make informed decisions in respect of SBAS implementation. There is a need for a comprehensive report based on regional inputs as a follow-up to AN/Conf/11 recommendation.	Please see section 5.4. It has been concluded that single-frequency SBAS cannot provide reliable APV service in equatorial regions. The NSP will monitor the results of efforts in the GAGAN project. - OPEN (MANUAL) -

	Topic	Hurdle	Comments
28	Multi-constellation	Multi-constellation GNSS and SBAS: SBAS such as WAAS and EGNOS were developed as augmentations to the current GPS constellation signals. States do not clearly perceive the role of these augmentation systems in a multi-constellation environment with modernised and more robust constellations. The GNSS Manual should elaborate on this issue.	This is addressed in Chapter 6. In addition, the current draft manual urges States to take advantage of the current GNSS rather than wait for a future configuration. Text has been added to 6.10.1, and also see 7.16.4 in the draft GNSS Manual. - OPEN (MANUAL) -
29	NOTAM and Service Status Notification	There is uncertainty about NOTAM requirements. The meeting agreed that it was feasible to provide NOTAMs about potential service outages for Basic GNSS Receivers (GPS RAIM) and for SBAS and GBAS to be used as a tool by operators to make operational decisions. The meeting also agreed that the wide variety of avionics implementations that support RNP dictated that aircraft operators should use aircraft-specific tools to predict service outages for their fleets. To do this, operators need basic information about GNSS component planned and actual outages. The meeting went on to discuss ways to address this hurdle in the manual revision. The manual needs to demonstrate the link between NOTAM provision and safety.	Please see section 7.12 in the draft GNSS Manual. .– CLOSED –
30	NOTAM and Monitoring	About the NOTAM requirement, and mainly on the source of information to issue this communication, even though a monitoring system is not mandatory, maybe some recommendations on guidelines to share or use existing GPS receivers monitor networks may be included as a possible source of monitoring the status of the GPS Signal.	Please see section 7.9 re monitoring, the goal of which is to support incident and accident investigations rather than to support a real-time notification service. – CLOSED –
31	NOTAM	The current lack of clarity on RAIM NOTAM requirements have made it difficult for States to procure any system. Also, many States do not have the resource to obtain RAIM NOTAM system and use that as a reason why they are not implementing GNSS. Guidance material that explains what is necessary; then the regional ICAO bodies may try to work on a regional solution for this.	Please see section 7.12.7 in the draft GNSS Manual.. Note that additional text may be required in the draft to provide guidance on how to obtain a system to generate status notifications. – CLOSED –

	Topic	Hurdle	Comments
32	NOTAM	In the region exist doubts about how to obtain RAIM and FDE predictions and how to approve the RAIM and FDE predictions programs submitted by the operators to the Civil Aviation Authorities. We suggest to address in the update manual, the methods that may be used by the operators to comply with these requirements and the methods to approve the aforementioned programs by the authorities	Please see section 7.12.7 and note in item 31 above. Text has been added to 7.12.1.3 - OPEN (MANUAL) -
33	PBN	The meeting noted that the GNSS Manual was developed before PBN Manual development started, and that having these two manuals creates confusion. This can be resolved by ensuring compatibility between the two manuals.	The draft GNSS Manual identifies GNSS as an enabler of PBN and links performance requirements to the PBN Manual. – CLOSED –
34	PBN	The GNSS Manual shall be interrelated to the PBN Manual particularly for the medium to long-term navigation infrastructure. For the GNSS implementation the 9613 is the used document. In this respect it would be useful that 9849 document be well referenced by the 9613 and vice versa or the possibility to integrate both documents.	Please see comment in 33 above. – CLOSED –
35	Performance	Assessments of performance by aircraft manufacturers and regulators are conservative and based on the core constellation of 24 satellites and do not give credit for additional satellites to the maximum constellation of 32 satellites.	Please see section 3.2.4 in the draft GNSS Manual.. Regulators are required to use the published conservative performance standard (21 satellites). Aircraft operators benefit from improved availability of approach RAIM, as an example, associated with having more operational satellites. – CLOSED –
36	Resources	Some States still do not authorise GNSS based operations for the reasons that are already listed in your file or sometimes simply because they don't know or have no resources to catch up.	It is hoped that the GNSS manual and other ICAO documents, along with assistance by regional offices, will assist States to implement GNSS-based services. – CLOSED –

	Topic	Hurdle	Comments
37	Resources	The global shortage of qualified and experienced instrument flight procedure designers is a limiting factor in the implementation of GNSS procedures.	Please see section 7.10.2.6 in the draft GNSS Manual.. This is a recognized problem; computer-aided design is offered as a potential solution to improve productivity. – CLOSED –
38	Safety Case	Guidelines or examples of Safety Risk Assessments for introduction of GNSS based operation are needed.	Please see section 7.6 in the draft GNSS Manual.. States need to provide examples for the NSP web site. - OPEN (STATES) -
39	Safety Case	While States believe it is ICAO requirements to conduct safety assessment, there is no specific ICAO guidance on how to do it.	Please see section 7.6 in the draft GNSS Manual.. ICAO Doc 9859 describes the safety analysis process. States need to provide examples and, if available, guidance re completing a safety analysis. - OPEN (STATES) -
40	Safety Case	GNSS related safety assessments: the guidelines in ICAO Circular 321 are limited to the implementation of GNSS longitudinal separation minima, whereas such guidance should be developed for the use of GNSS from en-route to approach an landing operations. As an example, use of SBAS for CAT-I operations is subjected to pre-implementation safety assessments. Assembly Resolution A36-23 on PBN states that ICAO should develop such guidance material to assist States in implementing safety assessment requirements.	Please see section 7.6 in the draft GNSS Manual.. – CLOSED –
41	Safety Case	Documentation does not support the requirement of some States to develop a safety assessment. The meeting recommended that the manual describe safety assessments that were used by States to support current operations and to encourage the acceptance of these assessments by other States, while noting any geographical or traffic-related issues that could dictate a differences analysis.	Please see section 7.6 in the draft GNSS Manual. States need to provide examples. - OPEN (STATES) -

	Topic	Hurdle	Comments
42	Survey	Some States have difficulties meeting survey requirements because responsibilities are split between ANS providers and airport operators.	This is a State issue that should be driven by business case analysis. – CLOSED –
43	Survey	In the EUR we have a conflict (though maybe only a perceived one) between some parts of GNSS reliant on WGS-84 and other parts on PZ90. It seems that ICAO SARPs recognise WGS-84 only whereas an ICAO SARPs compliant system is based on PZ90. It also seen sometime as a hurdle for APV in the eastern part of the EUR.	Please see section 7.11.3 in the draft GNSS Manual.. – CLOSED –
44	Survey	GNSS procedures require accurate and high integrity data sets referenced to WGS84 coordinate system. It has been observed that a number of States have not completed surveys to WGS84 and others that have completed surveys, have not managed data to preserve integrity.	Please see sections 7.11.3 and 7.11.4 in the draft GNSS Manual. The requirements are well defined. – CLOSED –
45	Terminology	Supplemental, Primary and Sole are terms associated with Satellite Navigation approvals that cause confusion, even among experts in the field. Despite the fact that ICAO has defined these terms, they still cause confusion. Confusion was observed between the terms sole-means and supplemental-means. Many persons think that supplemental-means must be used in conjunction with primary-means instead of sole-means. We suggest a detailed explanation of these terms, establishing when and how to use and the relationship within them. The definition could be illustrated with samples to improve the understanding.	These terms are avoided in the draft manual based on past experience with attempts to come to a common understanding. A PBN navigation specification provides the guidance required by aircraft operators. - CLOSED -
46	Training	The meeting noted that there is a lack of GNSS knowledge within some regulatory agencies, and that this is exacerbated by inconsistencies in ICAO documentation. The meeting agreed that the manual should be revised to support the education of regulators. Once the manual is revised there should be a program to provide material and support to regional offices to allow them to provide pertinent information to States.	The draft manual provides material that can be used to train regulatory and ANS provider staff. States need to provide training material for inclusion on the ICAO web site. - OPEN (STATES) -

	Topic	**Hurdle**	**Comments**
47	Training	For regulator and GNSS users, the inclusion of some training requirements may be useful for States guidance on developing their staff on GNSS supervision/regulation/operation-monitoring.	States need to provide examples of training programmes for the NSP web site. - OPEN (STATES) -
48	Training	Crew training and approvals. Practical experience demonstrates that the rate of operator's approval lags behind the progress of equipment implementation on board and on the ground.	This is an acknowledged problem. States need to provide examples of training programmes that have been approved for use in training and approving crews. - OPEN (STATES) -
49	Vulnerability	Some States are worried about vulnerability. The current manual addresses this issue and includes mitigation techniques, but this material needs to be emphasized. The manual needs to stress that availability is the issue, spoofing is not an issue for aviation.	Please see Chapter 5 in the draft GNSS Manual.. – CLOSED –