INTERNATIONAL CIVIL AVIATION ORGANIZATION

AFI PLANNING AND IMPLEMENTATION REGIONAL GROUP FIFTEENTH MEETING (APIRG/15)

(Nairobi, Kenya, 26 – 30 September 2005)

Agenda Item 4.2: Communications, Navigation and Surveillance

REVIEW OF THE REPORT OF THE AFI GNSS IMPLEMENTATION TASK FORCE

(Presented by the Secretariat)

SUMMARY

The Report of the AFI GNSS Implementation Task Force (GNSS/I/TF) is presented for consideration by APIRG.

Action by the Meeting is at paragraph 3.

References:
[1] - GNSS/I/TF/3 Summary Report (Lagos, 29-30 June 2005)*
[2] - GNSS/I/TF/2 Summary Report (Johannesburg, 22-23 June 2004)*
[3] - GNSS/I/TF/1 Summary Report (Dakar, 17-18 November 2003)*
[4] - APIRG/14 Report (Yaounde, 23-27 June 2003)*

*: Available on the ICAO/APIRG website

1. Introduction

1.1 At its Twelfth meeting (Tunis, 25-29 June 1999), the APIRG adopted the GNSS implementation strategy for the AFI Region.

1.2. At its Fourteenth meeting (Yaounde, 23-27 June 2003), APIRG adopted Conclusion 14/46 on the implementation of an operational satellite-based augmentation system (SBAS) in the AFI Region as an extension of the European geostationary navigation overlay service (EGNOS), which would allow the availability of approach with vertical guidance (APV-I). The APIRG/14 also established the AFI GNSS Implementation Task Force (Decision 14/47), whose tasks would include follow-up of Conclusion 14/16.

1.3. The GNSS/I/TF has held 3 meetings: Dakar (17-18 November 2003), Johannesburg (22-23 June 2004) and Lagos (29-30 June 2005). The present paper reports on the activities of the GNSS/I/TF and the implementation of the AFI GNSS strategy.

2. Discussion

2.1 Phase I of the AFI GNSS strategy comprises the implementation of basic GNSS, a test bed and a pre-operational test bed.

Basic GNSS

2.2 This item (APIRG/14 Conc. 14/44 refers) calls on States to publish approvals of the operational use of GPS from en-route to non-precision approach (NPA), develop, test and publish

non-precision approach and landing procedures. The status is as follows:

a) approval of operational use of GPS:

Cape Verde, Egypt, Ethiopia, Kenya, Malawi, Tunisia, South Africa and Sudan;

b) approval pending:

- Angola, Botswana, Democratic Republic of Congo, Lesotho, Mauritius, Mozambique, Namibia, Seychelles, Swaziland, Tanzania, Zambia and Zimbabwe: procedures tested but not yet published;

- Benin, Burkina Faso, Cameroon, Central African Republic, Congo, Cote d'Ivoire, Gambia, Gabon, Equatorial Guinea, Madagascar, Mali, Mauritania, Niger, Senegal, Chad and Togo: procedures published but regulatory texts not yet published.

Test Bed

23. Three EGNOS test beds have been implemented in the AFI Region. Ten (10) reference and integrity monitoring stations (RIMS) have been deployed in Central, Southern and Eastern Africa, referred to respectively as Zone A, Zone B and Zone C. The status of the test beds is as follows:

a) AFI Zone A:
- System managed by ASECNA;
- RIMS operated since May 2003 at Douala, Brazzaville, N'djamena and Lome (now moved to Bangui).

b) AFI Zone B:
- System managed by South Africa (ATNS), Namibia and Zambia;
- RIMS operated since October 2004 at East London, Johannesburg, Lusaka and Windhoek.

c) AFI Zone C:
- System operated in partnership with Central African Republic (ASECNA); Kenya (KCAA) and Ethiopia (ECAA);
- Coordination by ICAO ESAF Office;
- RIMS operational at Addis Ababa and Bangui since May 2005; and
- 1 RIMS in Nairobi, which is connected, but subject to RF interference in the L1 (GPS) frequency, thus is not used for the computation of the corrections broadcast over the AFI Region. The RIMS is being relocated to another site.

24. The performance level of the AFI Zone A, Zone B, Zone C areas is APV-I. The availability is about 98.5% (between 97% and 100%). The position accuracy is typically 1m in the horizontal plane (95%) and 2m in the vertical plane (95%). Regarding integrity, no misleading information has been detected.

25. **Appendix A** shows an APV-I availability chart over the AFI area on 23 June 2005. The chart can be checked daily on the Internet at:
http://ravel.esrin.esa.it/docs/egnos/estb/IMAGEtech/avail_120_ESTB.jpg .

26. During APIRG/14 flight demonstrations of APV-I were performed at Yaounde. Similar tests were conducted in Nairobi on 19 May 2005.

Pre-operational test bed: AFI System Test Bed (ASTB)

27. In accordance with APIRG/14 Conclusion 14/46, an operational satellite-based augmentation system is to be implemented in the AFI Region as an extension of EGNOS, starting with a pre-operational test bed. The pre-operational test bed, known as the AFI System Test Bed (ASTB), is to be built from the existing Zones A, B and C test beds with the addition of 4 RIMS to be located at Accra, Cape Town, Jeddah and Mahajanga. The objective of the ASTB is to provide APV-I signal over the AFI landmasses. The operation of the Cape Town and Mahajanga RIMS is planned during the fourth quarter 2005. It is planned to operate the ASTB until mid 2006.

Studies and Planning for the operational SBAS

28. Several studies and planning activities are being conducted, in cooperation with the European Commission and the European Space Agency, toward the implementation of the AFI operational SBAS, known as the *Inter-regional SBAS over AFI* (ISA). The work covers technical studies, institutional arrangements, cost benefit analysis and funding options. It should be noted that the development of ISA is included in the EGNOS evolution programme. The ISA will be composed of RIMS installed in the Mediterranean Development Area (MEDA) and RIMS installed south of the Sahara.

Technical studies for ISA

29. The European Space Agency (ESA) has completed internally work on the ISA mission requirements, analysis of ionospheric effects over AFI (which is continuing) and documentation for consultation of the industry.

210. ESA has contracted an industrial group to conduct detailed feasibility studies of the ISA, including ionosphere, communications network, central processing facility extension, ISA architecture and cost assessment, etc. The report is planned to be available during the first quarter 2006.

Institutional framework for the ISA

211. The Task Force, in view of the progress of the technical studies for the ISA, was aware of the urgency for the AFI Region to establish organizational structures capable of oversight, administration, operating and maintaining the Inter-regional SBAS over AFI (ISA). The Task Force developed an institutional model described in Appendix G to Reference [1]. The following institutional set-up was developed for ISA.

a) Three sub-regional ISA service providers to be established:

   i. AFI West and Central area, corresponding to FIRs of ASECNA States and FIRs Accra, Kano, Roberts et Sal;
   ii. AFI South, which corresponds to the SADC States; and
   iii. AFI East, which covers FIRs Addis Ababa, Asmara, Entebbe, Khartoum, Mogadishu, Nairobi and Seychelles.

b) Each sub-regional ISA service provider to be appointed and supervised by a Management Board composed of the concerned States/ANSPs and users; and

c) An AFI-wide ISA Supervisory Board, composed of ATS providers, users and ISA sub-regional providers, to coordinate with the three sub-regional management boards in b) above and with the Mediterranean Development Area (MEDA).

212. The proposed structure is shown at **Appendix B**. An example of composition of a sub-regional management board is also shown in Appendix B.

Cost benefit analysis

213. The Task Force reviewed a study on the benefits of the Inter-regional SBAS over AFI (ISA). The study indicates that the benefits are most likely to arise from safety-of-life applications. The study estimates benefits of around €5M– €10M in the early years, increasing to around €30M per year once all aircraft are equipped with SBAS receivers. The estimated costs of implementing and operating the ground infrastructure of SBAS would be around €10-12M per year. Ffurther studies are required to accurately determine both implementation and operating costs. Potentially significant benefits, such as avoiding the costs of replacing conventional navigation aids and the safety benefits have not yet been quantified in economic terms. It should be noted that the study did not take into account the cost of aircraft equipage, but indicated that they should be included in an update. One member of the Task Force does not agree with the results of the study. Nonetheless, cost/benefit analysis is still a task on the work programme of the Task Force.

Funding options for ISA

214. The Task Force has studied the funding options for the ISA and has concluded that they could comprise a combination of the following:

a) Direct input from the designated sub-regional service providers;
b) Input from the European Commission regional programmes, for the preparatory activities; and
c) Loan from the European Investment Bank (EIB) for ISA infrastructure.

215. With regard to a) above, the Task Force agreed on the need for commitment by ATS providers to invest in ISA implementation. In this regard, it was proposed that a meeting for parties interested in ISA investment and management be organized during the last quarter of 2005.

216. With regard to b), the Task Force considered valid APIRG Conclusion 14/45 on the need to get the support and inclusion of ISA into the priority EDF programmes of regional economic organizations (CEMAC, COMESA, ECOWAS and SADC)[1]. The definition of these programmes is to be done in 2005-2006.

The next steps for ISA

217. The Task Force has identified the following priorities:

a) Convene a meeting of potential investors in the ISA. A tentative period/venue was the week 5 to 9 December 2005, in Cairo, subject to confirmation;

b) Study of the legal aspects and contractual framework of the proposed institutional arrangements; and

c) Establish the institutional structures as soon as possible.

Amendment of the AFI GNSS strategy

218. The Task Force amended the AFI GNSS strategy as shown in **Appendix C.** The Secretariat has introduced in Appendix C the new ICAO terminology for approach with GNSS vertical guidance:

[1] CEMAC: Economic and Monetary Community of Central African States
COMESA: Common Market for Eastern and Southern Africa
ECOWAS: Economic Community of West African States
SADC: Southern Africa Development Community

localizer performance with vertical guidance (LPV). This terminology applies to the two types of approaches with GNSS vertical guidance (APV-I and APV-II).

3. **Action by APIRG**

3.1 The APIRG is invited to:

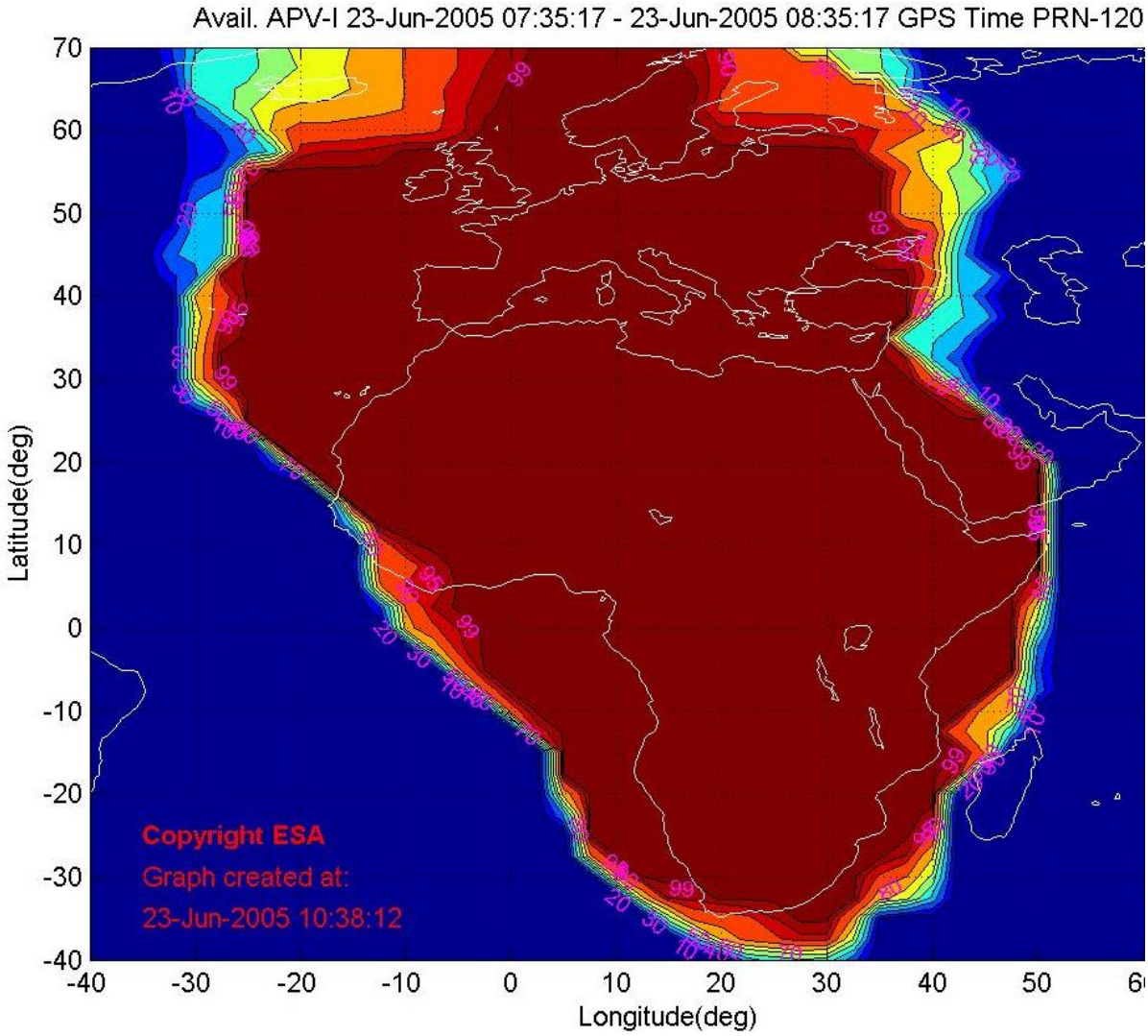
a) note the information provided in the paper;

b) endorse the proposed institutional framework for the ISA;

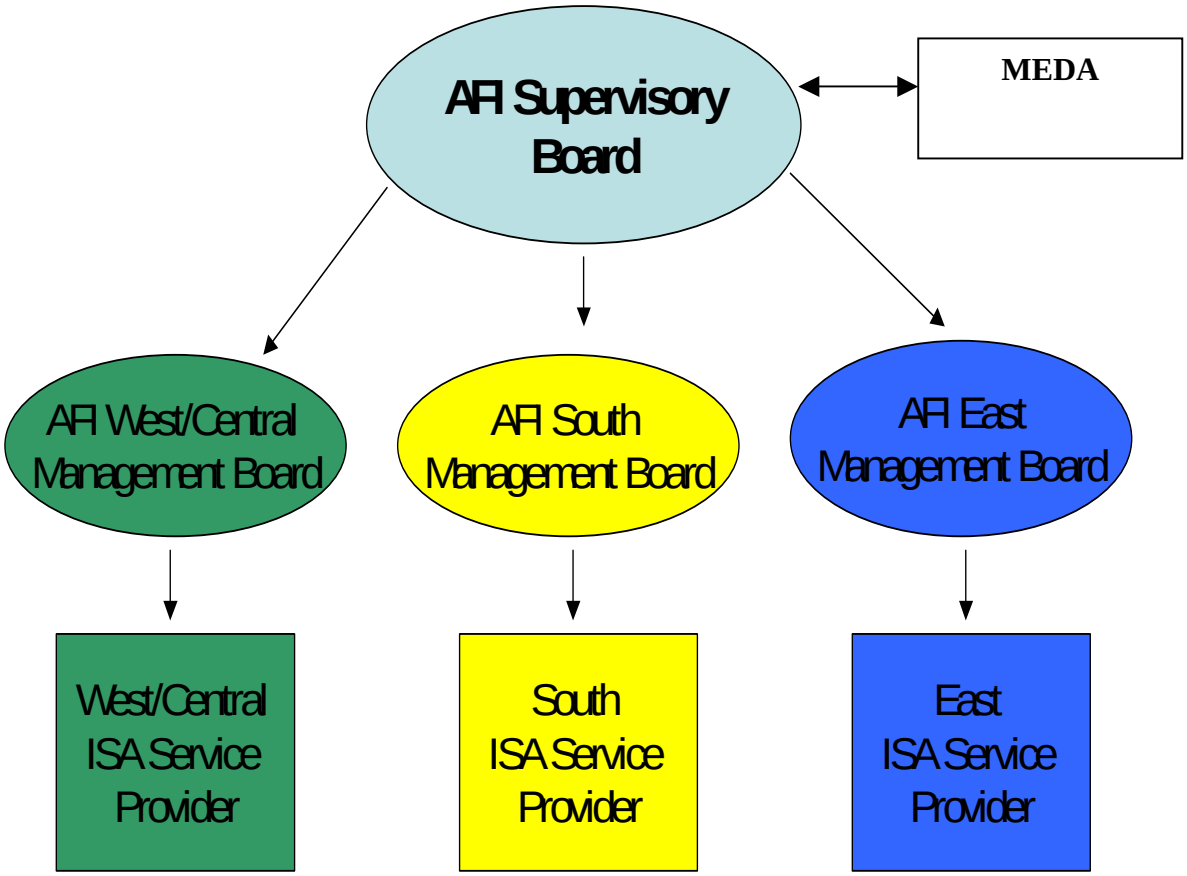
c) agree to the convening of a meeting of potential investors in the ISA; and

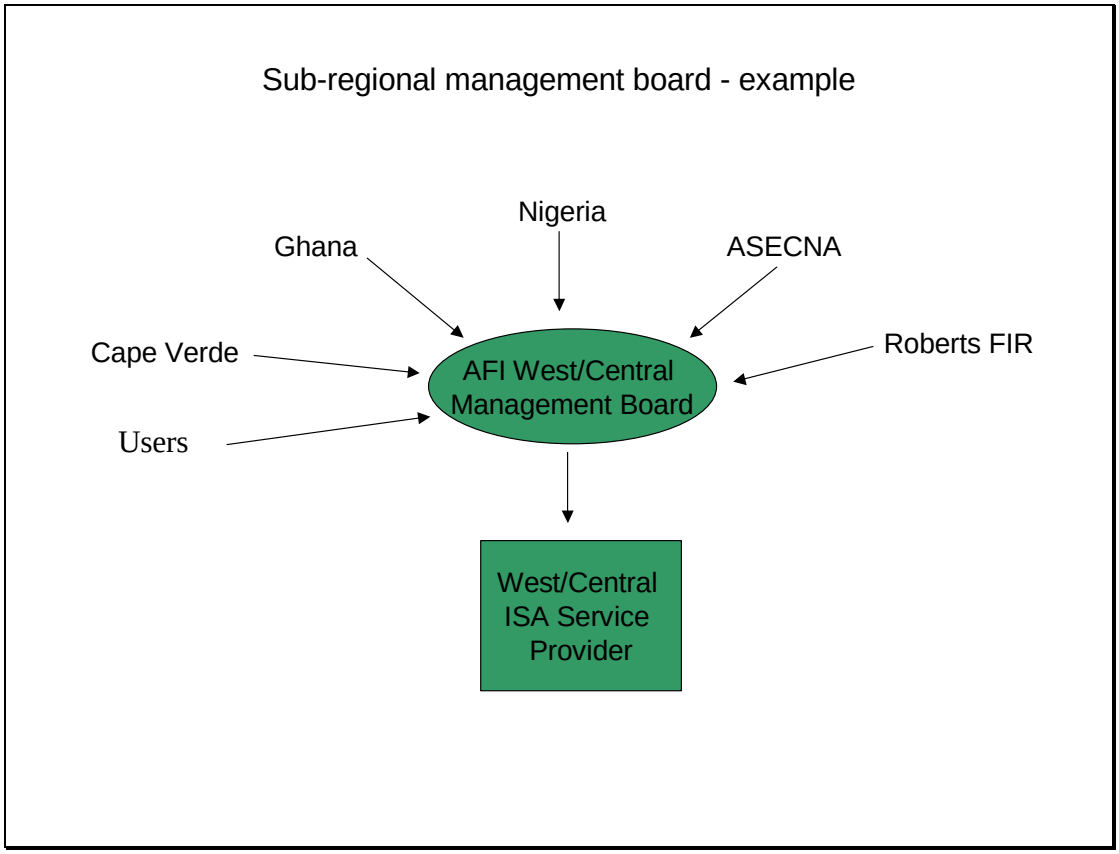
d) agree to the amendment of the AFI GNSS strategy as shown in Appendix C to this paper.

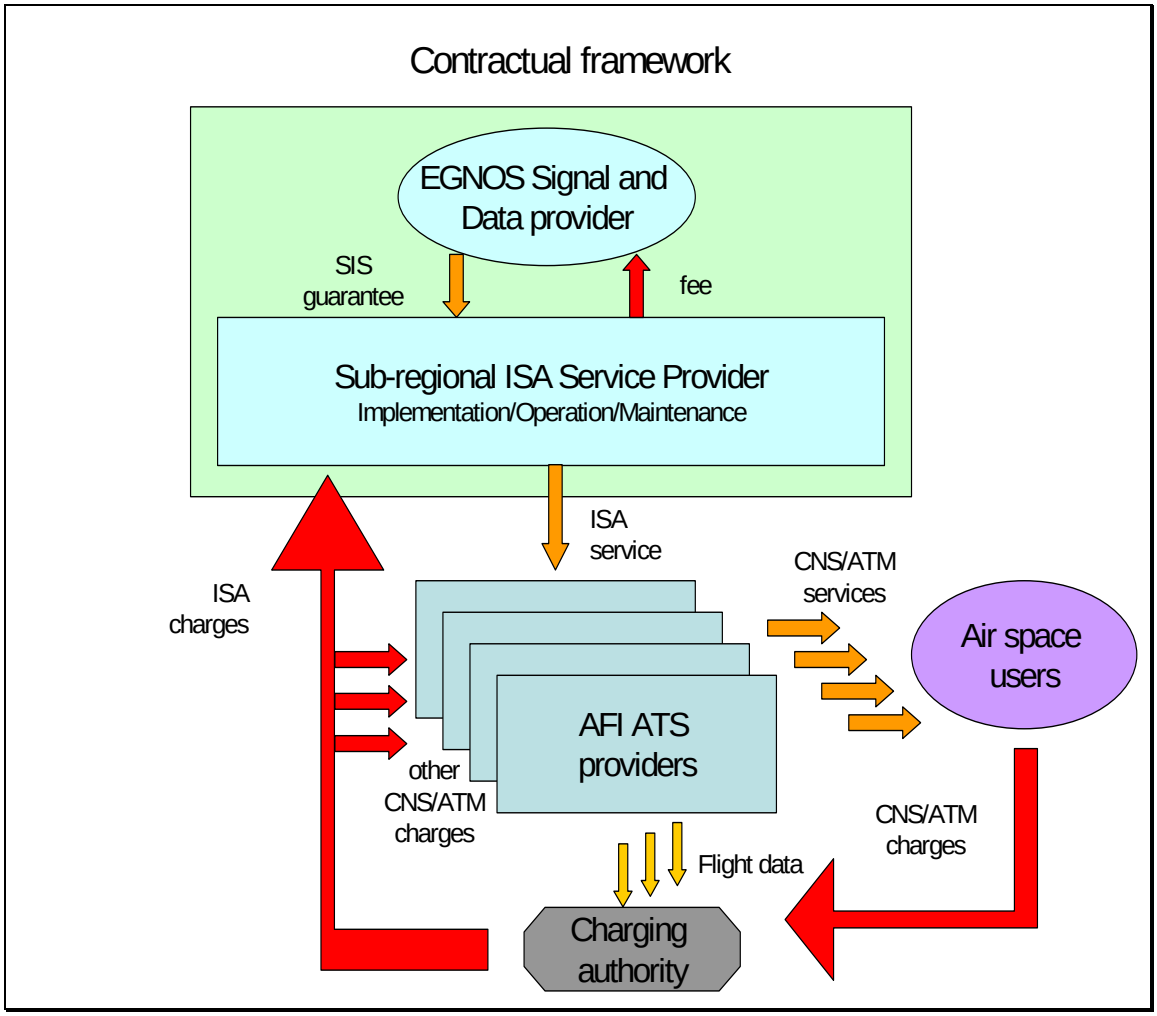
APV-I availability over AFI Region 23 June 2005



Institutional structures- proposal




Sub-regional management board - example
Nigeria
Ghana
ASECNA
Cape Verde
Roberts FIR
AFI West/Central Management Board
Users
West/Central ISA Service Provider


Contractual framework
EGNOS Signal and Data provider
SIS guarantee
fee
Sub-regional ISA Service Provider
Implementation/Operation/Maintenance
ISA service
ISA charges
CNS/ATM services
Air space users
AFI ATS providers
other CNS/ATM charges
CNS/ATM charges
Flight data
Charging authority

CONCEPT OF THE GNSS STRATEGY FOR THE AFI REGION

1. Introduction

1.1 The purpose of the AFI GNSS strategy is to define an evolution path for replacement of ground-based navigation aids, i.e. VOR/DME/ILS/NDB, ensuring that operational and other concerns such as positive cost-benefit are fully taken into account.
1.2 The AFI GNSS strategy assumes availability of a GNSS meeting the specified parameters at every phase of deployment. It does not analyze GNSS systems configuration per se nor the advantages and disadvantages of various deployment strategies.

~~2.~~General Considerations

2.1 By necessity, satellite-based and ground-based navigation systems will co-exist for a period of time. Considering that the operation of a dual system is detrimental to a positive cost-benefit, users and providers will co-operate with the view of reducing the duration of the transition period as much as possible, having due regard for the following principles:

- The level of safety will not be downgraded during the transition
- GNSS-based service must, before the end of the transition period, fully meet the required parameters of accuracy, availability, integrity and continuity for all phases of flight;
- During the transition, gradually evolving levels of functionality will be available.
- Operational advantage shall be taken of the available capabilities at every step of deployment.
- Methods of application will take into full consideration safety considerations of any functional limitations;
- Users must be given sufficient advance notice to re-equip before ground-based systems are decommissioned.

3. Evolving functionality

3.1 **Phase I (Short term), up to ~~2004~~2005**: *Additional ranging and health information on GPS constellation provided via GEO satellites*

- This phase will allow the use of Basic GNSS ~~as a primary means of navigation~~ for en-route, approach down to ~~for~~ NPA ~~and as a supplemental means navigation system for TMA~~. Existing ground infrastructure remains intact.

~~Phase I A (up to 2003)~~

- An AFI GNSS test bed will be implemented to validate the objectives and differential correction algorithms of the operational EGNOS system to be implemented during Phase I.

~~Phase I B (up to 2004)~~

~~This phase will be achieved by the deployment of a network of RIM stations through the AFI Region.~~

~~To prepare EGNOS implementation, numerous activities must be carried out: final system definition, specifications development, cost/benefit analysis (CBA) and funding, preparation of the institutional and operational~~

~~framework and programmatic issues will be carried out.~~

- ~~This phase will end with EGNOS validation in the AFI Region.~~

3.2 **Phase II (Medium term) 2005~~5~~6-2011**: *LPV (APV-I) ~~I~~,i.e localizer performance with 20m vertical accuracy, will be available everywhere in the AFI Region*

- This phase will ~~allow~~ include~~for~~:
  - a) To prepare EGNOS implementation, numerous activities must be carried out: final system definition, specifications development, cost/benefit analysis (CBA) and funding, preparation of the institutional and operational framework and programmatic issues will be carried out, with EGNOS validation in the AFI Region.
  - ~~a)~~b) En-route phase: sufficient capability to meet en-route navigation requirements everywhere in the AFI Region; GNSS is approved ~~as a sole means system~~ for en-route navigation, taking into account technical and legal developments, and institutional aspects. En-route navigation aids will be progressively withdrawn accordingly in consultation with users.
  - ~~b)~~c) Terminal areas: sufficient capability to meet TMA navigation requirements everywhere in the AFI region; GNSS is approved ~~as sole means~~ for TMAs, taking into account technical and legal developments, and institutional aspects.
  - ~~c)~~d) Terminal area VOR/ ~~DME~~/NDB, and Locators not associated with ILS, will be progressively withdrawn in consultation with users during Phase II.
  - ~~d)~~e) Approach and landing phase: sufficient capability for LPV (APV-1) in the whole AFI Region. ILS will continue to be provided at aerodromes[1].

  Note 1: Where the requirements for approach and landing can be met by LPV (APV-1), the withdrawal of ILS CAT I should be considered.
- During Phase II, the implementation of Long term GNSS will be developed.

3.3 **Phase III (Long term) 2012 onwards**: *It is assumed that at least two constellations of navigation satellites will be available. ~~Sole means~~GNSS is approved for navigation services from en-route to CAT I operations. CAT I by SBAS or GBAS will be available in those locations where analysis of historical MET data or traffic characteristics justifies the requirement. Other requirements will be met by ground-based augmentation system (GBAS).*

- During Phase III, ILS CAT I will be withdrawn in consultation with users.

- Where CAT II/III ILS requirements have been confirmed, these facilities will remain unless technical evolution then demonstrates that the requirement can be supported by GBAS or SBAS.

4. Institutional issues

4.1 Phases II and III of the AFI GNSS strategy will require the deployment of AFI specific GNSS components. In order to minimize costs associated with the deployment and operation of these components, AFI should seek cooperation agreements with systems providers in adjacent regions with a view to the joint use of GNSS components where feasible and cost-effective.

4.2 Meanwhile the modalities of installation and cost-recovery of multinational facilities, essentially RIMS, in some AFI States, must be addressed without delay so that deployment can be initiated as soon as technically possible.

5. Synopsis of the AFI GNSS strategy

AFI GNSS Strategy				
	Phase I		**Phase II**	**Phase III**
Time scale	2000 - 2004~~4~~5		~~2005~~ 2006 - 2011	2012 - 2017
Certification	~~Supplemental~~ Basic GNSS	~~Primary~~Basic GNSS	~~Sole means~~ from en route to LPV (APV-1)	~~Sole means~~ from en route to CAT I
Oceanic/En route		GPS	GPS with EGNOS	Long term GNSS
Continental/En route		GPS	GPS with EGNOS	Long term GNSS
Terminal	GPS		GPS with EGNOS	Long term GNSS
Approach and landing	(GPS/Baro) NPA		LPV (APV-1) SBAS	SBAS CAT I CAT I GBAS CAT II/III GBAS

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