INTERNATIONAL CIVIL AVIATION ORGANIZATION

SECOND MEETING OF THE APIRG COMMUNICATIONS, NAVIGATION AND SURVEILLANCE SUB-GROUP (CNS/SG/2)

(Dakar, 22-25 May 2007)

Agenda Item 7: Regional strategies for the implementation of CNS systems

(Presented by the Secretariat)

SUMMARY

This paper reviews AFI implementation strategies for CNS systems for consideration by CNS/SG.

Action by the meeting is at paragraph 3.

References :

- APIRG/15 – Report.
- CNS/SG/1 – Report.

1. Introduction

1.1 The First Meeting of APIRG Communications Sub–group (CNS/SG/1, Dakar, 7-8 April 2005) noted very low progress in the implementation of AFTN circuits since APIRG/14 meeting (Yaounde, Cameroon, 23-27 June 2003). This paper reviews the current implementation status and the performance of the AFTN in the AFI Region, and identifies deficiencies and remedial measures for their elimination.

2. Discussion

2.1 **Attachment** to this paper contains the implementation strategies adopted by AFI Region for CNS systems, as defined in Doc 003 – AFI CNS/ATM Implementation Plan. The CNS Sub-group may wish to review the outlined strategies in light of its deliberations under Agenda items 4, 5 and 6.

3. Action by the CNS Sub-group

3.1 The CNS Sub-group is invited to :

a) review the regional strategies for the implementation of CNS systems in the AFI Region as developed in **Attachement** hereto;
b) agree on the need to amend these strategies based on its discussions under Agenda items 4, 5 and 6;
c) identifies those areas where amendment proposals are required;
d) accordingly provide the necessary guidance to AFI ATN Planning Task Force and GNSS Implementation Task Force; and
e) formulate any comments/suggestions for consideration by APIRG.

IMPLEMENTATION STRATEGY AND SYSTEM CONFIGURATION

1. IMPLEMENTATION STRATEGY

1.1 INTRODUCTION

a) The provider, user States and Organizations concerned acknowledge that the AFI Region stands to derive great benefits from the introduction of the new integrated ICAO CNS/ATM System. It is recognized that it is only with the full coordination of implementation activities that the complete benefits of CNS/ATM will be realized.

b) Consequently, and in order to ensure a coherent, timely, co-ordinated, cost-effective,
operationally oriented implementation of the integrated ICAO CNS/ATM system in the AFI Region, the approach and strategy contained in this document are adopted at the AFI Regional level for use and compliance by provider and user States and Organizations concerned.

c) In deciding the possible introduction at regional level of new elements of the integrated CNS/ATM system requiring the carriage of additional equipment on-board aircraft, APIRG will take into consideration the need of airspace users to be given adequate advance notice for major new equipment fittings.

1.2 General Principles

1.2.1 The AFI Region shall aim at taking advantage in a timely manner, of those individual elements of the CNS/ATM systems for which positive benefit in relation to overall cost has been demonstrated or recognized by those concerned.

1.2.2 It is recognized that the full implementation of all ATM objectives with their CNS requirements will take time. The AFI Region, therefore, will adopt a step by step approach starting with the ATM objectives which can be achieved within the short term with minimum CNS requirements or relatively low cost.

1.2.3 The introduction of individual elements of the new integrated CNS/ATM concept in the AFI Region shall be carried out in a co-ordinated and coherent manner, under the aegis of the AFI Planning and Implementation Regional Group (APIRG). In this context it is essential to ensure that:

a) adjacent systems shall interface in such a way that airspace boundaries between control sectors, Flight Information Regions, or Air Navigation Regions, are transparent.

b) systems must remain responsive to operational requirements at every step of development, avoiding to the extent possible, discontinuities in evolution likely to cause disturbances to the operational environment.

1.2.4 At least in the short and medium term, the difference in equipage between the domestic and regional operators on the one hand, and the transcontinental operators on the other hand, will be significant. The transcontinental operators will be fully equipped to operate in regions such as Europe and will certainly value taking advantage of their capabilities to obtain more economic flight profiles. As far as the domestic and regional operators are concerned, because they would not operate in other regions with the new CNS/ATM requirements for equipage/approval, they may not derive a positive cost/benefit from equipping.
In light of the foregoing, long haul operators which are adequately certified and/or approved should be given timely full benefit and the domestic and regional operators be allowed to choose either to equip (approved or certified) or to fly segregated airspace.

1.2.5 The seamless airspace, which is indispensable for total benefit, will not be achieved without close co-ordination among providers and between providers and users. It is then more and more necessary and important that providers and users agree before any decision on implementation is taken. In this regard the following should be kept in mind:

- **Communications**

  The objective of the region is full deployment of an ATN environment with the possibility to accommodate FANS1/A and the highest degree of functionality possible.

- **Navigation**

  The ultimate objective of the Region is a navigation system based on satellite as a sole means of navigation for all phases of flight. As far as augmentation is concerned, any deployment should be in line with the regional policy as defined and approved by APIRG.

- **Surveillance**

Even if the Region is recognized as a valid candidate for ADS, enough caution is necessary at all levels in order to avoid ground equipage with prototypes and/or systems without perational benefits.

1.2.6 All planned operations, including domestic, civil and military operations to the extent that they may influence the ATS system, should be taken into account when system capacity is defined to meet the requirements.

1.3 The objectives

1.3.1 The future system must evolve from the present system so as to meet user needs to the maximum extent possible while taking the potential benefits from the application of new system technologies.
This evolution should be guided by the principle of maintaining an optimum separation assurance.

1.3.2 Of the overall goals of the future ATM system, the following are specially of relevance in the AFI context:

a) maintenance of, or increase in, the existing level of safety;

b) increased system capacity and full utilization of capacity resources as required to meet traffic demand;

c) dynamic accommodation of user-preferred three-dimensional and four-dimensional flight trajectories;

d) accommodation of full range of aircraft types and airborne capabilities;

e) improved provision of information to the users such as weather conditions, traffic situation, availability of facilities;

f) improved navigation and landing capabilities to support advanced approach and departure procedures;

g) increased user involvement in ATM decision making including air-ground computer dialogue for flight negotiation;

h) create, to the maximum extent possible, a single continuum of airspace, where boundaries are transparent to users; and

i) organize airspace in accordance with ATM provision and procedures.

1.3.3 Priority should be given to the implementation of systems or functions specifically aimed at the attainment of any of these stated objectives.

1.4 Planning Targets

1.4.1 Under Section III the Implementation Plan identifies target dates, by which individual tasks are required to be accomplished. These are in line with the following milestones:

- 1999 Uniform application of 10 minutes longitudinal separation in the upper airspace;
- 1999 Provision of area control service in upper airspaces;
- 1999 Pursue the implementation of fixed RNAV routes contained in the AFI ANP;
- 1999 Implementation of WGS-84;
- 1999 Data exchange between Flight Data Processing Systems (FDPS) in selected Air Traffic Control Centres;
- 1999 Progressive introduction of Controller pilot data link communications (CPDLC) with full capacity in 2005;
- 1999 Complete implementation of all AFTN and ATS/DS circuits;
- 1999 Extension of VHF coverage at all operationally significant altitudes;
- 1999 Progressive provision of SSR in selected airspaces;
- 2000 Progressive reduction of lateral separation minima in selected airspaces from 100 NM to 50 NM (in RNP 10 environment) and eventually to 30 NM (in RNP 5 environment) as dictated by operational requirements;
- 2000 Progressive introduction of Automatic Dependent Surveillance (ADS) Service with full ground capability by 2005;
- 2000 Continuation of introduction of Random RNAV routes in oceanic airspaces;
- 2000 Progressive introduction of random RNAV routes above FL 350 in continental airspaces;
- 2000 Progressive introduction of GNSS-based procedures;
- 2000 Progressive introduction of RNP 5 in selected upper airspaces;
- 2001 Progressive introduction of Longitudinal RNAV/RNP separation minima of 10
- minutes and / or 80NM RNAV derived distance in selected airspaces;
- 2005 Progressive introduction of AIDC with completion by 2008;
- 2002 Progressive Implementation of 1000 FT Vertical Separation Minima (RVSM) between FL290 and FL410 in selected airspaces.

2 SYSTEM CONFIGURATION : STAGE 1995 - 2015

2.1 COMMUNICATIONS

2.1.1 Mobile voice communications

2.1.1.1 Aeronautical mobile voice communications should provide for static-free, direct pilot-controller communications throughout the Region, at least at operationally significant altitudes.
2.1.1.2 Voice, will remain the main form of pilot-controller communications throughout the region within the time-frame encompassed by this Plan. Meanwhile, the early introduction of data links is supported and encouraged with the initial main objective of reducing R/T workload.
2.1.1.3 In view of the remoteness of large areas of the AFI region, aeronautical mobile satellite service (AMSS) voice offers one of the best methods of achieving the above objectives. However, the number of users equipped for this type of communications may not be significant for several years, and therefore efforts should continue on the implementation of remote and extended range VHF.
2.1.1.4 HF voice stations could be phased out as VHF and AMSS voice communications become available in a given FIR or in a given portion of the airspace; for the time being, however, increased traffic on HF will have to be accommodated and it will be necessary to ensure the integrity, reliability and availability of the ground HF facilities.

2.1.2 Fixed Communications

Data communications

2.1.2.1 The aeronautical fixed service must provide for the exchange of messages between end-users with a very high degree of reliability within the specified transit times; in case this cannot be achieved within the current configuration of the AFTN Plan or the ATS/DS network plan, these must be re-planned as necessary and without delay in order to meet those objectives.
2.1.2.2 As a step towards the ATN the mutual support between aeronautical networks should be reinforced by the automatic interchange of messages, at least at the level of AFTN main centres, and ideally at the level of all tributary centres.

2.1.2.1 The aeronautical fixed service must provide for the exchange of messages between end-users with a very high degree of reliability within the specified transit times; in case this cannot be achieved within the current configuration of the AFTN Plan or the ATS/DS network plan, these must be re-planned as necessary and without delay in order to meet those objectives.

2.1.2.2 As a step towards the ATN the mutual support between aeronautical networks should be reinforced by the automatic interchange of messages, at least at the level of AFTN main centres, and ideally at the level of all tributary centres.

2.1.2.3 The goal of the AFI Region is the implementation of the ATN for ground-to-ground and air-to-ground data communications. It is anticipated that the mobile element of the integrated ATN may be developed at a slower pace than the end-user requirements for fixed communications; it is essential to ensure that the implementation of the necessary improvements to the ground network does not suffer delays as it is a pre-requisite for the development of the air-ground network as well.

2.1.2.4 In those circumstances in AFI, where only satellite links will be capable of supporting the implementation of the ground elements of the ATN with the required degree of reliability, considerations concerning costs of circuits, should not therefore delay the implementation of specific links by satellite whenever such requirement has been identified.

2.1.2.5 Notwithstanding the above, and considering the regional objective of inter-operability between sub-networks, the decision on which carrier to use to connect specific centres must be taken based on cost-benefit and operational efficiency only. The final aim is for a global ATN ensuring that the routing over the various sub-networks is predominantly based on choice.

Data link communication services

2.1.2.6 In oceanic and low/medium air traffic density areas where ground-based communication infrastructure cannot be deployed, AMSS and HF data links will be progressively introduced. Where a ground-based infrastructure can be deployed, VHF data link to be specified by regional agreement, will be introduced to support air-ground ATN-compatible applications.

Data link surveillance services

2.1.2.7 Surveillance data link services will be progressively introduced, using either the SSR Mode S extended squitter, or the universal access transceiver (UAT) or the VDL Mode 4, based on regional agreement.

2.1.2.8 There will be a progressive introduction of Gate data-links at the busiest airports in the Region. This consists of a physical link between aircraft on the apron and ATC. The main purpose of this type of data-link, in so far as ATC is concerned, is to allow for ATC clearance delivery by data instead of voice, thus reducing communications work-load and the risk of misinterpretation.

2.1.2.9 Data link flight information services (DFIS), ADS and CPDLC have been standardized. DFIS services will make it possible to improve both aeronautical and meteorological air-ground communications as well as the availability of meteorological information (METAR, WINDSHEAR, RVR, TAF, SIGMET, AIREP, SIGWX, etc.). In particular, DFIS will make it possible for aircraft to obtain meteorological and aeronautical information by a reliable and relatively un-congested data link.

2.2 NAVIGATION

2.2.1 Approach and landing

2.2.1.1 The AFI strategy for transition from ILS to new precision approach and landing systems is based on the worldwide strategy developed by the Special Communications/Operations Divisional Meeting (1995) (SP COM/OPS/95) for the introduction and application of non-visual aids to approach and landing which enables each region to develop an implementation plan for future systems. The AFI strategy, which will be kept under constant review states as follows:

a) continue ILS operations to the highest level of service as long as operationally acceptable and economically beneficial.

Note: To co-ordinate with the users any withdrawal of ILS and provide at least a five-year notice for the withdrawal of any ILS ground-based equipment.

b) promote the use of multimode receiver (MMR) or equivalent airborne capability to maintain aircraft interoperability;

c) validate the use of and implement GNSS, with such augmentations as required, to support approach and departure operations, including Category I operations; and

d) complete feasibility studies for Category II and III operations, based on GNSS technology, with such augmentations as required. If feasible, implement GNSS for Category II and III operations where operationally acceptable and economically beneficial.

2.2.1.2 The initial AFI GNSS implementation strategy was adopted by the APIRG/12 Meeting (Tunis, 21 - 25 June 1999). It details an evolutionary path from existing constellations through a minimal satellite-based augmentation system (SBAS) providing over the whole AFI Region an approach capability with vertical guidance at 20 m accuracy (APV-I). The updated AFI GNSS strategy is shown at Appendix xxx to this document.

2.2.1.3 It is anticipated that Global Navigation Satellite System (GNSS) will provide the capability for precision approaches, these shall be taken into consideration in the formulation of the requirements of the regional air navigation plan .
2.2.1.4 GNSS may be used as an approach and landing guidance system initially as an overlay to conventional systems or as a stand-alone sysem.

2.2.2 Terminal areas (TMAs)

2.2.2.1. As a general principle, navigation facilities in TMAs must allow for navigation during departure, holding and approach with the required degree of accuracy. For the time-frame encompassed by this Stage, the standard navigation aid in TMAs is envisaged to remain the VOR/DME.
2.2.2.2. Whenever feasible, VORs must be so located as to serve both terminal and en-route requirements.
2.2.2. Installation of new NDBs is discouraged.
2.2.2.4. Global Navigation Satellite systems may initially be used as supplemental navigation means in the TMAs.

2.2.3. En-route

2.2.3.1 Area Navigation (RNAV) will progressively be extended throughout the AFI Region, based on the criteria contained in the ICAO Manual on Required Navigation Performance (RNP) (Doc 9613 - AN/937) and within the terms and conditions defined by the AFI Planning and Implementation Regional Group (APIRG).

2.2.3.2 VOR/DME will continue to be the agreed en-route navigation aid in the AFI Region along conventional ATS routes, as long as GNSS has not been approved as a sole means system for en route in accordance with Phase II of the AFI GNSS strategy. In case a requirement exists for a new route or for a higher level of navigation performance along an existing route, primary consideration should be given to meet the requirement by the implementation of an RNAV route.
2.2.3.3 NDBs will not normally be provided for en-route navigation unless there is an operational requirement which cannot be satisfied by any other means, this will be confirmed through APIRG.
2.2.3.4 Global Navigation Satellite Systems will be used as supplemental en-route navigation means and as primary en-route means in designated airspaces.

2.2.3.5 It is foreseen that GNSS will eventually become the sole means of radio navigation and that the present radionavigation systems will be progressively withdrawn. The timing of such withdrawal will depend on many factors, among which the level of implementation and the quality of the new systems will be prominent. Withdrawal will only be undertaken in line with a plan to be developed by APIRG.

2.3 SURVEILLANCE

2.3.1 In accordance with Annex 6, Part I, paragraph 6.1.19, carriage and operation of pressure-altitude reporting transponders is mandatory throughout the AFI Region.

2.3.2 Terminal areas (TMAs)

2.3.2.1 Secondary Surveillance Radar (SSR) should be used to provide surveillance within busy TMAs meeting criteria to be defined by APIRG; SSR Mode S will gradually be introduced in selected busy TMAs to be confirmed by APIRG.

2.3.2.2 Where available and when necessary in the interest of safety, existing primary radars may continue to be used in those TMA environments where there still exists a mix of transponder-equipped and non transponder-equipped aircraft until there is sufficient equipage in pressure altitude reporting transponders.
Note: The intent of this paragraph is to discourage the installation of new primary radar. Equipage in pressure altitude reporting transponders should be promoted by States in accordance with ICAO provisions in Annex 6, Part I on international air transport, and Part II on general aviation.

2.3.2.3 ADS may be introduced, initially on a trial basis and eventually in broadcast mode (ADS-B) .
The AFI Region recognizes the advantages to be derived from ADS-B in terms of reduced costs and operational benefits.

2.3.3 En-route

2.3.3.1 En-route surveillance will mostly continue to be based on present procedural methods, but with improved pilot-controller communications in terms of reliability and transit times. This improvement will come about mostly as a result of enhanced mobile communications and of fixed communications between adjacent ACCs.

2.3.3.2 Where a requirement for en-route surveillance has been identified, this shall rely essentially on SSR, and on ADS, including ADS-B, particularly for low density, remote and oceanic airspaces outside SSR coverage.

2.3.3.3 ADS, including ADS-B, will be introduced, initially on a trial basis.

2.3.3.4 There is no requirement for primary radars for en route surveillance in the Region. Those already

in place should be progressively phased-out.

AFI CNS/ATM Implementation Plan – Table I : En route

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Europe - South Atlantic (Oceanic routes) **AR-1**	Atlantico[1] Canarias Casablanca Dakar Oceanic Lisboa[1] Sal	Fixed RNAV routes (1995); Progressive evolution towards a random RNAV environment from West to East (Nov. 2005); Reduction of longitudinal separation to 10 minutes using Mach Number Technique (1998); In selected airspaces: Longitudinal separation 30 NM (2001). Lateral separation 25 NM (2001) both with radar surveillance; Distance based separation 80 NM (1998 - 2002) 50NM (2002 - onwards); Reduction of lateral separation to 50 NM (1999- 2004). Further reduction of lateral separation to 30NM (2004 - onwards); RVSM (2002):	DCPC (data) by participating aircraft (Bpa) (2004); Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000)	Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (2004-onwards)	RNP 5: Casablanca and Canarias FIRs (1998); RNP 10: Other FIRs (2001); RNP 5: (2005 - onwards) Other FIRs GNSS as primary-means	Automatic Dependent Surveillance (ADS) on RNP airspace Bpa (from 2004)

Note: 1: Outside AFI. Indicated for coordination.

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Atlantic Ocean (AFI-NAT/SAM interface) **AR-2**	Accra Dakar Oceanic Johannesburg Oceanic Luanda	Random routing (2005); Reduction of longitudinal separation to 10 minutes (2000) RVSM (Jan. 2005)	DCPC (data) by participating aircraft (Bpa) (1998); HF (voice)	Gradual introduction of ATN compatible bit-oriented procedures (BOP) between main AFTN Centres (1998-onwards); AFTN and ATS/DS (1999)	RNP 10 (2000) GNSS as primary-means	ADS (2000)

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Europe - Eastern Africa (including oceanic areas) **AR-3**	Addis Ababa Antananarivo Asmara Cairo Dar es Salaam Entebbe Khartoum Mauritius Mogadishu Nairobi Seychelles Tripoli	Fixed RNAV routes coexisting with conventional routes (1999); Longitudinal separation 10 minutes (2000); Lateral separation: progressive introduction of 30 NM in line with RNP 5 in the upper airspace (2001); Vertical Separation: introduction of RVSM initially between FL 350 and FL 390 (2003-onwards) and extension to FL 290 - FL 410 by 2005; Full ATC service on all ATS routes above FL 245 and 150NM from international airports (1999); RNAV: Gradual implementation of Random RNAV initially above FL 350 from 2001.	Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000) DCPC (data) Bpa (2000).	Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (1999-onwards); AFTN and ATS/DS (1999); Introduction of ATS inter-facility data communications (AIDC) starting in 2005 to be completed by 2008	RNP 10: (2000); RNP 5: from 2001 onwards GNSS as primary-means	Procedural; ADS 2001 onwards with full ground capability in 2005; SSR in selected airspaces (1999); Automation: progressive introduction of computer assisted conflict detection and resolution from 2000

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Europe - Southern Africa including Continental Southern Africa routes **AR-4**	Algiers Beira Brazzaville Cape Town Gaborone Harare Johannesburg Kano Kinshasa Lilongwe Luanda Lusaka N'Djamena Niamey Tunis Tripoli Windhoek	Fixed RNAV routes coexisting with conventional routes from 1995; Longitudinal separation 10 minutes from (2000) Lateral separation minima; Gradual introduction of 30 NM in line with RNP 5 in the upper airspace (2001); RVSM: Introduction initially between FL 350 and 390 (2003-onwards), evolving towards FL 290/410 by 2005; Full ATC service on all ATS routes above FL 245 and 150NM from international airports (1999). Random RNAV initially above FL350 from 2001	Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000) DCPC (data) Bpa (From 2001)	Implementation of all ATS/DS circuits. AFTN and ATS/DS links upgraded; Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (1999 - onwards); Gradual introduction of AIDC from 2005 to be completed by (2008)	RNP 5: from 2001 onwards GNSS as primary-means	Procedural (on account of traffic diversity); ADS (2001 onwards with full ground capability in 2005; SSR at Brazzaville, Kinshasa, Luanda and N'Djamena from (2000);

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Continental Western Africa routes including coastal areas **AR-5**	Accra Dakar Kano Niamey Ndjamena Roberts	Fixed RNAV routes coexisting with conventional routes from 1999; Longitudinal separation 10 minutes (2000); Full ATC service on all ATS routes above FL 245 and 150NM from international airports (1999). Lateral separation 30 NM in an RNP 5 environment (2001 - onwards); RVSM initially between (FL 350-FL 390) (2003 -onwards); Random routing initially above FL350 (2001 - onwards)	Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000) Progressive introduction of DCPC (data) from 2000 onwards	AFTN and ATS/DS links upgraded (1999); Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main Centres (1999-onwards); Gradual introduction of AIDC from 2005 to be completed by (2008)	RNP 5 environment (2001) GNSS as primary-means	SSR along itinerary Abidjan/Accra/Lagos (2000); ADS/CPDLC from 2001 with full ground capability by 2005

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Trans-Indian Ocean **AR-6**	Antananarivo Bombay[1] Johannesburg Oceanic Male[1] Mauritius Melbourne[1] Seychelles	Reduction of longitudinal separation to 10 minutes (2000); Random routing in selected portions of the airspace (1999); RNP itineraries (2000); Full ATC service on all ATS routes above FL 245 and 150NM from international airports; Reduction of lateral separation to 50 NM coinciding with RNP 10 from 2000 onwards; RVSM along selected itineraries initially between FL 350-FL390 (2001-onwards) evolving towards FL 290-FL 410 from 2005 onwards.	DCPC (data) from 1999); Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000)	AFTN and ATS/DS links upgraded (1999); AIDC (2005) with full capability in 2008	RNP 10: (2000) GNSS as primary-means	ADS Bpa (2000)

Note: 1: Outside AFI. Indicated for coordination.

Table 2 - TMAs and/et Aerodromes

Type of TMA or Aerodrome (See Note 1)	Characterisation	Systems evolution 1995-2005			
		Communications		Navigation	Surveillance
		Voice	Data		
1	2	3	4	5	6
TMA Type 1	Multiple airports within TMA; Complex traffic patterns; High density traffic.	VHF voice coverage up to 150 NM from all international airports at operationally significant altitudes	VHF data-link by participating aircraft	VOR/DME; fixed RNAV routes; GNSS overlay NPA GNSS	Voice position reports plus: - SSR; Mode S (See Note 2) - Automatic Dependent Surveillance (ADS) by participating aircraft.
TMA Type 2	Multiple airports within TMA with complex traffic patterns, or TMAs with medium density traffic.		VHF data-link by participating aircraft (the ground element of the system where justified only)		Voice position reports plus: - SSR Mode A/C (where justified) - ADS (where justified)
TMA Type 3	TMAs with low density traffic.		N/A		Voice position reports.
Aerodrome Type 1	High density traffic.	Independent ground and Tower high reliability VHF voice frequencies	VHF data-link by participating aircraft; Gate data-link by participating aircraft.	ILS; GNSS based approach procedures: – overlay to ILS procedures; – non-instrument runways; – non-precision runways.	Voice position reports. Visual surveillance plus: - Surface Movement Radar (where justified) - ADS by participating aircraft.
Aerodrome Type 2	Medium density traffic.		VHF data-link by participating aircraft; (the ground element of the system where justified only)		Voice position reports; Visual surveillance plus: - ADS by participating aircraft (where justified).
Aerodrome Type 3	Low density traffic.	Single ground/Tower high reliability VHF voice frequency	N/A		Voice position reports. Visual surveillance.

Note 1: Those Airports and TMAs falling within each type will be designated by the AFI Planning and Implementation Regional Group (APIRG) based on suitable proposals by provider and user States and organizations concerned.

Note 2: Primary radars may continue to be used in those TMAs where there is a mix of transponder equipped and non-transponder equipped aircraft and the number of non-transponder equipped aircraft is sufficiently large to justify the requirement.

APPENDIX B

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 2005: Additional ranging and health information on GPS constellation provided via GEO satellites

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

3.2 Phase II (Medium term) 2006-2011: APV-I -I, 20m vertical accuracy, will be available everywhere in the AFI Region

• This phase will include the following:

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.
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.
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.
d) Terminal area VOR/DME/NDB, and Locators not associated with ILS, will be progressively withdrawn in consultation with users during Phase II.
e) Approach and landing phase: sufficient capability for APV-1 in the whole AFI Region. ILS will continue to be provided at aerodromes1.

Note 1: Where the requirements for approach and landing can be met by 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. 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.
