CNS/ATM/IC/SG/4 - WP/7
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International Civil Aviation Organization

Fourth Meeting of the AFI CNS/ATM Implementation Co-ordination Sub-group (CNS/ATM/IC/4) (Dakar, 10 - 14 March 2003)

Agenda Item 5: Review and update of the CNS/ATM Implementation Plan

Review and update of the CNS/ATM Implementation Plan (Doc 003)

(Presented by the Secretariat)

SUMMARY

This paper contains proposals for the updating of Doc 003

References: APIRG/13 Report
Doc 003, v. 5.0, January 2000 Edition*

**Principal reference*

1. **Introduction**

1.1 The AFI CNS/ATM Implementation Plan Doc 003 was developed to cover the period 1995 to 2005. The end period of the scope of the Plan is fast approaching. There is need to extend the planning period to beyond 2005.

2. **Discussion**

2.1 Under Agenda Item 3, the meeting has reviewed the status of implementation of the AFI CNS/ATM Plan. Many key objectives have not yet been completely implemented as the end period of the time scale of the plan is approaching.

2.2 After eight years, experience shows that many objectives were set with unrealistic target dates as the pace of CNS/ATM implementation world wide has not picked up as initially thought.

2.3 The APIRG has adopted a GNSS implementation strategy that covers from 2000 to 2017.

2.4 The number of routing areas in the AFI Plan needs to be reduced through consolidation.

2.5 ICAO has produced SARPs for keys elements of the CNS/ATM concept (ATN, GNSS, ADS, Data links, etc.).

2.6 In view of the preceding, the secretariat has developed proposals for the amendment of Doc 003, as shown at Appendix A to this paper.

3. Action by the Meeting

3.1 The meeting is invited to review Appendix A and adopt amendments for updating Doc 003.

AFI Doc 003

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AFI CNS/ATM IMPLEMENTATION PLAN

~~1995~~ 1999 — ~~2005~~ 2015

Edition 5.1
~~October~~ March 200~~2~~3 Prepared by the Eastern and Southern African Office

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DOCUMENT CHANGE RECORD

VERSION	DATE	REASON FOR CHANGE	SECTIONS PARAGRAPHS AFFECTED
5.0	15/11/99	Adoption by APIRG/12 of CNS/ATM/SG/2 Report and of the Initial AFI GNSS strategy.	Section II: 2.1.4, 2.2.1.6, 2.2.1.12 (new), 2.2.1.13 (new), 2.2.3.1.4 (new), 2.2.4.1.5 Section III: 3.3.4.2 Appendices A, B, F, G, H (new), I (new)
5.0	15/5/00	Amendment No. 1: Inclusion of Asmara FIR	Appendices A (pages A1, A2), B (pages B3, B9), G (pages G14-G22, G61-G66)
5.1	29/06/01	Adoption by APIRG/13 of CNS/ATM/IC/SG/3 Report	Section I: 1.1.1, 1.1.2 (new), 1.1.3, 1.2.1 b), 1.4.1 Section II: 2.1.2.2 (new), 2.1.2.4 (new), 2.1.2.5 (new), 2.1.4.1, 2.2.1.6 a), 2.2.1.7, 2.2.2.1.1, 2.2.3.1.4, 2.2.3.2.3 Section III: 3.3.3.2; Appendix A (pages A1 and A2); Appendix B (pages B1 to B10); Appendix C, Appendix F, Appendix G, and Appendix I

History of the versions

- Version 1 was drafted in October 1994 by the second meeting of the CNS/ATM Task Force. It contained Sections I and II.

- Version 2 was drafted in November 1995 by the first meeting of the CNS/ATM Sub-group. It contained Sections I, II and III.

- Version 3 was published in June 1996 consecutive to the adoption of Doc 003 by the Tenth meeting of the AFI Planning and Implementation Regional Group (APIRG) for presentation to the Seventh AFI Regional Air Navigation (AFI/7 RAN) Meeting.

- Version 4 was published in January 1998 following the review and adoption of Doc 003 by the AFI/7 RAN meeting.

- Version 5.0 was published in January 2000 following the adoption by the Twelfth Meeting of the APIRG (Tunis, 21 -25 June 1999) of amendments formulated by the Second meeting of the CNS/ATM/IC/SG.

- The current Version 5.1 ~~was~~ is published ~~in October 2002~~ following the adoption by the Thirteenth Meeting of the APIRG (Sal, 25 -29 June 2001) of amendments formulated by the Third meeting of the CNS/ATM/IC/SG.

TABLE OF CONTENTS

GLOSSARY

AAIM	Aircraft autonomous integrity monitoring
ACC	Area Control Centre
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance broadcast mode
ADSP	Automatic Dependent Surveillance Panel
AFI	Africa - Indian ocean area
AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunication Network
AIDC	ATS Inter-facility data communications
AIREP	Air Report
AIS	Aeronautical Information Service
AMCP	Aeronautical Mobile Communications Panel
AMS(R)S	Aeronautical Mobile-Satellite (R) Service
AMSS	Aeronautical Mobile-Satellite Service
APIRG	AFI Planning and Implementation Regional Group
APR	Automatic Position Reporting
APV	Approach with vertical guidance
AR	Area of routing
ASECNA	Agency for the Security of Aerial Navigation in Africa and Madagascar
ASM	Airspace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATS/DS	Air Traffic Services Direct Speech
CNS	Communications, Navigation, and Surveillance
CNS/ATM	Communications, Navigation, and Surveillance / Air Traffic Management
COM/MET/OPS	Communications/Meteorology/Operations
CPDLC	Controller pilot data link communications
DARPs	Dynamic user preferred re-routes
DCPC	Direct Controller Pilot Communications (voice/data)
DFIS	Data Link Flight Information Services
DGNSS	Differential Global Navigation Satellite System
DME	Distance Measuring Equipment
EUR	European Region
FIR	Flight Information Region
FDPS	Flight Data Processing System
FL	Flight Level
FMS	Flight Management System
GES	Ground Earth Station
GIC	GNSS Integrity Channel
GLONASS	Global Orbiting Navigation Satellite System (Russian Federation)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (United States)
HF	High Frequency
HFDL	High Frequency Data Link
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICG	Implementation Coordination Group
IFR	Instrument Flight Rules

ILS	Instrument Landing System
INS	Inertial navigation system
ITU	International Telecommunication Union
MASPS	Minimum Aviation System Performance Standards
MET	Meteorological services for air navigation
METAR	Aviation routine weather report
MLS	Microwave Landing System
MMR	Multimode receiver
MNPS	Minimum Navigation Performance Specifications
MNT	Mach Number Technique
MODE S	Mode S - SSR Data Link
MSAW	Minimum Safe Altitude Warning System
NDB	Non-directional beacon
NPA	Non-precision approach
PANS-OPS	Procedures for Air Navigation Services C Aircraft Operations
RAIM	Receiver Autonomous Integrity Monitoring
RNAV	Area Navigation
RNP	Required Navigation Performance
R/T	Radiotelephony
RVR	Runway visual range
RVSM	Reduced Vertical Separation Minimum
SAM	South American Region
SARPs	Standards and Recommended Practices
SAT	South Atlantic
SATCOM	Satellite Communication
SBAS	Satellite-based augmentation system
SIGMET	Information concerning en-route phenomena which may affect the safety of aircraft operations
SIGWX	Significant weather
SITA	Société Internationale de Télécommunications Aéronautiques
SSR	Secondary Surveillance Radar
TAF	Terminal area forecast
TBD	To be determined
TMA	Terminal Control Area
VFR	Visual flight rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
WGS-84	World Geodetic Reference System 1984

SECTION I : INTRODUCTION

1.1 GENERAL

1.1.1 The AFI Plan for the implementation of the new ICAO Communications Navigation and Surveillance and Air Traffic Management (CNS/ATM) Concept was initially contained in three documents, namely:

Doc 001	-	Executive Summary
Doc 002	-	System Concept Description
Doc 003	-	AFI CNS/ATM Implementation Plan

1.1.2 Doc 001 and Doc 002 are no longer in publication. The reader should refer to ICAO Global Air Navigation Plan for CNS/ATM Systems (Doc 9750) for a complete description of the CNS/ATM concept.

1.1.3 The present document, Doc.003 - AFI CNS/ATM Implementation Plan, specifies implementation time-frames for the various systems and concepts, gives an operational overview of systems configuration during the transition, and lists activities required for an evolutionary and co-ordinated implementation towards the final objectives as contained in Doc 9750.

1.2 DOCUMENT OVERVIEW

1.2.1 The scope of this document is:

a) To present the implementation strategy for the Future AFI CNS/ATM concept~~. This consists of overlapping terms~~ during the time-frame ~~1995~~ 1999 to 2015~~. namely: mid-term (1995-2005) and long-term (2000 to 2015).~~

b) To present the implementation plan which will enable the national administrations and airspace users to develop their plans so as to meet the conditions and pre-requisites laid down in the ICAO Global Air Navigation Plan for CNS/ATM Systems (Doc 9750), and which takes account of the need to harmonize with plans currently being developed by the regions which interface with the AFI Region. The implementation plan takes into account present facilities that meet the reliability expected in the future CNS/ATM systems.

c) This implementation plan will at the direction of the AFI Planning and Implementation Regional Group (APIRG) progressively address the planning process into long term.

1.2.2 Document 003 is organized in three distinctive sections:

Section I: Introduction

Section II: Implementation Strategy and System Configuration
Details the objectives to be achieved during the planning time-frame; For each system (Communications, Navigation and Surveillance and ATM), specifies which system

components (both of the old and of the new concept) must be in place to support the required level of service in each phase.

Section III: Implementation Plan:
Contains Implementation Sheets detailing:

- objectives;
- actions required to achieve implementation;
- required ground and airborne capabilities;
- provider and user States and Organizations concerned; and
- the target dates for implementation.

1.3 PLANNING CONCEPT

1.3.1 The AFI Implementation Plan is conceived as a rolling ~~ten~~ fifteen-year~~s~~ ~~Plan~~ plan towards the full implementation of the ICAO CNS/ATM Concept throughout the AFI Region and in the interface with adjacent regions, in order to achieve a coherent regional Air Traffic Management (ATM) system fully responsive to the regional needs in a timely and cost-effective manner and adequately integrated with the world-wide air navigation system.

1.3.2 The AFI Implementation Plan will be reviewed and updated periodically by APIRG, based on input from States and International Organizations concerned, in order to ensure it is kept responsive to changing requirements and abreast with worldwide developments.

1.3.3 The implementation, monitoring and co-ordination methodology contained in this document has been adopted by the AFI States.

1.4 GUIDING PRINCIPLES

1.4.1 In defining time-frames in the systems' evolution Tables and for the implementation activities due account was taken of the following general guidelines on transition :

"a) *Careful planning will be necessary to ensure that aircraft of the future are not unnecessarily required to carry a multiplicity of existing and new CNS equipment~~. In addition, as already referred to,~~ T~~t~~here is a close relationship between the required CNS services and the desired level of ATM and, finally, there is, for reasons of both economy and efficiency, a need to ensure that differences in the pace of development around the world do not lead to incompatibility between elements of the system. Particularly, because of the wide coverage of satellite CNS systems, the above considerations call for conscientious worldwide co-ordination of the planning and implementation if such systems are to be optimized.*

b) In developing guidelines for the transition it is useful to consider the type of system (C, N, or S), and the specific problems, or issues affecting its transition to full operational use in a particular type of airspace or phase of flight."

c) Ideally, the transition to new CNS systems should be based in improvements in ATM and accompanied by procedural and structural changes that will provide benefits to ATM and to users. The transition should be carefully planned so as to avoid degradation in system performance."

d) The priority structure of system elements and areas of applicability with regard to implementation has to be established. The priorities in terms of time-scales are then established in response to identified

constraints and the perceived view of States as to the systems and areas of applicability providing the most immediate benefits, or for which early implementation may be most likely."

SECTION II - IMPLEMENTATION STRATEGY AND SYSTEM CONFIGURATION

2.1 IMPLEMENTATION STRATEGY

2.1.1 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.

2.1.2 General Principles

2.1.2.1 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.

2.1.2.2 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.

2.1.2.3 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.

2.1.2.4 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.

2.1.2.5 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 operational benefits.

2.1.2.6 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.

2.1.3 The objectives

2.1.3.1 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.

2.1.3.2 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.

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

2.1.4 Planning Targets

2.1.4.1 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 or 25 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;
2001 Progressive introduction of AIDC with completion by 2005;
2002 Progressive Implementation of 1000 FT Vertical Separation Minima (RVSM) between FL290 and FL410 in selected airspaces[1].

Note 1: In accordance with para. 2.2.1.9 of this Document, implementation of RVSM should be pursued within APIRG. In areas of routing adjacent to the EUR Region, the planning target date should be harmonized with the selected date in that Region (i.e. 2002).

2.1.5 Institutional Arrangements

2.1.5.1 Many of the technical and operational aspects of the implementation of the integrated CNS/ATM system are still under development. It is not possible, or probably even wise, at this stage to

establish detailed institutional arrangements which, in many ways, will be strongly influenced by the options to be retained.

2.1.5.2 APIRG will closely monitor world-wide developments relating to Global Communications and Navigation Satellite systems and address the issue in due course.

2.1.5.3 Meanwhile, it would appear to be in the best interest of cost-effectiveness and efficiency of the overall system if an open, competitive environment was finally retained for the provision of individual elements of the new concept.

2.1.6 Trials and Demonstrations

2.1.6.1 It is anticipated that many contenders for the provision of individual elements of the integrated CNS/ATM system will emerge. It is also to be anticipated that such contenders will need partners at the level of provider and user States and Organizations, so that technical solutions can be tested in the operational environment.

2.1.6.2 As a matter of priority for the AFI Region, trials and demonstrations should be:

a) operationally oriented;

b) aimed at providing familiarization with the new technologies and concepts;

c) aimed at assisting States with the transition; and

d) aimed at demonstrating cost-effectiveness.

2.1.6.3 It is also anticipated that the results of trials are also likely to provide useful information to assist the regional planning bodies in their work. In this context trials are encouraged and supported.

2.1.6.4 Providers and User States and Organizations are encouraged to co-operate in the conduct of trials. In order to minimize redundancy, the objectives and scope for specific trials and the results of such trials should be co-ordinated and disseminated through APIRG or its designated subsidiary body.

2.2 SYSTEM CONFIGURATION

~~STAGE A (1995/2005)~~ 1999 - 2015

2.2.1 Airspace and Air Traffic Management

2.2.1.1 Airspace planning is to be carried out in close co-ordination between civil and military users, with a view to achieving an efficient joint utilization of available airspace to the greatest benefit of all users.

2.2.1.2 The ideal objective of airspace management should be to maximize the utilization of available airspace, by dynamic accommodation of all short-term requirements within a single system.

2.2.1.3 Where a single system is not established, a dynamic time-sharing of specific volumes of airspace should be considered; permanent segregation of airspace among various categories of users should be avoided. In this case airspace management should be oriented by the following principles:

a) airspaces reserved for individual classes of users shall be released as soon as the respective operational need ceases;

b) specific reserved airspace should be released for limited periods or at specific altitudes;

c) alternative routes should be established in order to facilitate traffic management when specific airspaces are intended for alternative civil and military use;

d) specific reserved airspaces may be relocated when required and possible.

2.2.1.4 Air traffic management in AFI should evolve progressively from the present route system to a system of area navigation (RNAV) routes.

2.2.1.5 Random RNAV areas should be established whenever feasible. Where implementation of random RNAV areas may not be feasible due to traffic densities or constraints of the present CNS/ATM system, priority should be given to the implementation of those elements of the new CNS/ATM concept aimed at eliminating such constraints.

2.2.1.6 The RNP values to be used in the AFI Region should be selected from the following ones:

a) RNP 5, with consequential route spacing of 25NM or 30NM as appropriate, on continental RNAV routes or RNAV areas, and in those non-RNAV ATS routes where ground-based navigation aids permit frequent determination of position and the requirement for full VHF coverage is satisfied;

b) RNP 10, with consequential route spacing of 50 NM, on oceanic RNAV routes where there is limited navaids coverage and in continental airspaces.

Note: Transition areas, namely between continental and oceanic airspaces, between pure RNAV and VOR/DME environments will be assessed case by case.

2.2.1.7 Optimum longitudinal separation minima must be applied on an internationally co-ordinated manner. The aim will be to apply not more than 10 minutes longitudinal separation progressively in the Region. However, in selected airspaces where navigation aids are not available to permit frequent

determination of aircraft's position, use of Mach Number Technique (MNT) shall be applied. Lower minima may be required in specific areas of the Region, and in this case will be based upon the availability of positive surveillance to ATC. The introduction of longitudinal separation minima based on RNAV Route criteria of 10 minutes/80NM should be pursued through APIRG.

2.2.1.8 In order to increase airspace capacity, implementation of Reduced Vertical Separation ~~minima~~ minimum (RVSM 1000ft) for subsonic aircraft between FL290 and FL410 inclusive, should be pursued through APIRG.

2.2.1.9 There will be a progressive introduction of automated flight data processing systems (FDPS) by Air Traffic Control Units. The main objectives of ATC automation should be, by priority:

a) assistance to ATC co-ordination, especially between adjacent FIRs and between control sectors within busy ATS units;

b) code-call sign correlation in radar units;

c) assistance in monitoring adherence to flight plan;

d) computer assisted conflict prediction;

e) computer assisted conflict resolution.

2.2.1.10 Automated preparation of flight progress strips is a desirable by-product of automated flight plan processing, but not an objective in itself in most of the ATS units in the Region.

2.2.1.11 ATC automation should also aim at simplifying the interface between the air traffic controller and the communication and information systems, namely AFTN, AIS, MET.

2.2.1.12 In view of the recognized potential of the Minimum Safe Altitude Warning System (MSAW) to enhance flight safety, States are encouraged to implement this system as soon as possible. APIRG will monitor the progress of implementation.

2.2.1.13 In order to enhance ATM benefits in an RNP/RNAV environment, States are advised to refer to the material in Appendix H relating to ATM operational requirements in an RNP/RNAV environment.

2.2.2 Surveillance

2.2.2.1 Terminal areas (TMAs)

2.2.2.1.1 Secondary Surveillance Radar (SSR) should be used to provide surveillance within busy TMAs meeting criteria to be defined by APIRG; SSR Mode S ~~data link~~ will gradually be introduced in selected busy TMAs to be confirmed by APIRG. ~~Introduction of VDL Mode 4 will be considered in due course.~~

2.2.2.1.2 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.

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

2.2.2.2 En-route

2.2.2.2.1 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.

2.2.2.2.2 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.

2.2.2.2.3 ~~Automatic Position Reporting will be initiated on a cooperative basis in selected airspaces.~~

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

2.2.2.2.5 There is no requirement for primary radars for en route surveillance in the Region. Those already in place should be progressively phased-out.

2.2.3 Navigation

2.2.3.1 Approach and landing

2.2.3.1.1 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 GNSS, with such augmentations as required, to support approach and departure operations, including Category I operations, and implement GNSS for such operations as appropriate; 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.

2.2.3.1.2 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 a non-precision approach capability with vertical guidance at 20 m accuracy (APV-I). The updated AFI GNSS strategy is shown at Appendix I to this document.

~~2.2.3.1.2~~2.2.3.1.3 ~~Although i~~It is anticipated that Global Navigation Satellite System (GNSS) will provide the capability for precision approaches, these shall ~~not~~ be taken into consideration in the formulation of the requirements of the regional air navigation plan ~~for the time being~~ in due course.

~~2.2.3.1.3~~2.2.3.1.4 GNSS may be used as an approach and landing guidance system initially as an overlay to conventional systems or as a stand-alone sysem.

~~2.2.3.1.4~~2.2.3.1.5 ~~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 a non-precision approach capability with vertical guidance at 20 m accuracy (APV-I). The updated AFI GNSS strategy is shown at Appendix I to this document.~~

2.2.3.2 Terminal areas (TMAs)

2.2.3.2.1. 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 first Stage, the standard navigation aid in TMAs is envisaged to remain the VOR/DME.

2.2.3.2.2. Whenever feasible, VORs must be so located as to serve both terminal and en-route requirements.

2.2.3.2.3. NDBs may continue to be used on a case by case basis when there is an agreed requirement to be confirmed by APIRG. Installation of new NDBs is discouraged.

2.2.3.2.4. Global Navigation Satellite systems may initially be used as supplemental navigation means in the TMAs.

2.2.3.3. En-route

2.2.3.3.1 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).

2.2.3.3.2 VOR 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.

2.2.3.3.3 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.

2.2.3.3.4 Global Navigation Satellite Systems will be used as supplemental en-route navigation means and as primary en-route means in designated airspaces.

2.2.3.3.5 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.

2.2.4 Communications

2.2.4.1 Mobile voice communications

2.2.4.1.1 Aeronautical mobile voice communications should provide for static-free, direct pilot-controller communications throughout the Region, at least at operationally significant altitudes.

2.2.4.1.2 Voice, will remain the main form of pilot-controller communications throughout the region within the time-frame encompassed by this ~~first Stage~~Plan. Meanwhile, the early introduction of data links is supported and encouraged with the initial main objective of reducing R/T workload.

2.2.4.1.3 In view of the remoteness of large areas of the AFI region, aeronautical mobile satellite service (AMSS) voice ~~links~~ 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.

2.2.4.1.4 HF voice stations could be phased out as VHF and ~~satellite~~ 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 ~~system~~ ground HF facilities.

~~2.2.4.1.5Although high frequency (HF) data link was not addressed in the original CNS/ATM concept, ICAO has adopted SARPs for HF data link (HFDL). HF data link is ATN compliant. APIRG will closely monitor these developments.~~

2.2.4.2 Fixed Communications

2.2.4.2.1 The aeronautical fixed ~~telecommunications system~~ 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 ~~switched~~ network plan, these must be re-planned as necessary and without delay in order to meet those objectives.

2.2.4.2.2 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.

2.2.4.3 Data communications

2.2.4.3.1 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.

2.2.4.3.2 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.

2.2.4.3.3 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

2.2.4.3.4 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

2.2.4.3.5 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.

~~2.2.4.3.4~~2.2.4.3.6 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.

~~2.2.4.3.5~~2.2.4.3.7 Data link flight information services (DFIS) ~~applications~~, ~~like the two other ATM data link applications~~ (ADS, CPDLC~~)~~ have been standardized and validated by the Automatic Dependent Surveillance Panel (ADSP). ~~These~~ 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 ~~operating on Europe-Africa and Gulf of Guinea routes~~ to obtain meteorological and aeronautical information by a reliable and relatively un-congested data link.

Note: This Document may eventually include the AGA, AIS/MAP, MET and SAR elements of the CNS/ATM system.

SECTION III - AFI CNS/ATM IMPLEMENTATION PLAN

3.1 INTRODUCTION

3.1.1 The present section gives a detailed presentation of the implementation activities of the AFI CNS/ATM Implementation Plan and information on the programme of activities to be carried out by concerned States and users to implement specific system components of the Plan.

3.2 PLANNING METHODOLOGY

3.2.1 En route airspace

3.2.1.1 Taking into account the global nature of the CNS/ATM Systems, the AFI Region has been divided into ~~ten~~ seven homogeneous areas of routing corresponding to the major traffic flow patterns of the Region. The ~~ten~~ seven areas of routing (AR) are:

AR-1: the Europe - South Atlantic (EUR/SAT) oceanic routes;

AR-2: the Atlantic Ocean interface between the AFI, NAT and SAM Regions (AFI/NAT/SAM interface);

AR-3: the Europe to Eastern Africa routes including the area of the Indian Ocean (EUR/AFI-East);

AR-4: the Europe to Southern Africa routes (EUR/AFI-South);

AR-5: the ~~coastal routes over the Gulf of Guinea~~ Continental Western Africa routes (combine western parts of AR5 and AR-9);

~~AR-6: the Iberian peninsula to Canaries routes;~~ (to be combined with AR-1)

~~AR-7: the North AFI coastal area (EUR/AFI interface);~~ (FIRs to be distributed in AR-1 (Morocco), AR-3 (Egypt and Libya) and AR-4 (Algeria, Tunisia)

AR-~~8~~6: the Continental Southern Africa routes;

~~AR-9: the Trans-Sahelian routes~~; and

AR-~~10~~7: the Trans-Indian Ocean area interfacing with the ASIA/PAC Region.

3.2.1.2 Chart CNS/ATM-1 in **Appendix A** shows the areas of routing.

3.2.1.3 For each area of routing a set of air traffic management (ATM) objectives has been defined. Then the required communications, navigation, surveillance (CNS) systems are derived taking into account the nature (oceanic, continental) of the area, the existing CNS systems and the improvements which could be introduced during the time frame of the plan ~~(1995 - 2005)~~.

3.2.2 Terminal airspace and Aerodromes

3.2.2.1 The AFI CNS/ATM Plan defines three types of terminal airspaces based on the traffic density and the complexity of the traffic pattern. The three types of TMAs are:

a) TMA Type 1: characterized by multiple airports within the single TMA, a complex traffic pattern and a high density traffic;

b) TMA Type 2: characterized by multiple airports within the TMA, a complex traffic pattern and a medium density traffic; and

c) TMA Type 3: low density traffic TMAs.

3.2.2.2 Likewise, three types of aerodromes are defined based on traffic density (high, medium and low).

3.2.2.3 The TMAs and aerodromes of the AFI Region will be type-designated by the AFI Planning and Implementation Regional Group (APIRG) based on the proposals by provider and user States and organizations concerned.

3.3 AFI CNS/ATM IMPLEMENTATION PLAN ~~(1995 - 2005)~~

3.3.1 The first phase of the AFI CNS/ATM Implementation Plan is intended to cover the 199~~5~~9 - ~~2005~~ 2010 time period.

3.3.2 En route

3.3.2.1 The major en route ATM objectives are:

- extension of random routing in oceanic areas;
- reduction of separation minima in oceanic and high traffic density continental areas;
- progressive extension of fixed and random RNAV routes; and
- definition of Required Navigation Performance (RNP) values for specific itineraries.

3.3.2.2 To support the above ATM objectives, it is proposed in the plan to:

- improve and extend VHF coverage in continental area;
- introduce data links progressively;
- improve the AFTN network and implement ATS/DS circuits;
- improve SSR surveillance in certain continental areas;
- introduce automatic position reporting as a first step toward automatic dependent surveillance (ADS); and
- introduce ATC automation gradually.

3.3.2.3 The en-route AFI CNS/ATM Plan is shown at **Appendix B**.

3.3.3 TMAs and Aerodromes

3.3.3.1 In terminal airspace and aerodromes, VHF coverage will be extended to at least 150 NM, while VHF data link is to progressively be introduced in high and medium traffic density areas.

3.3.3.2 For navigation in terminal areas, GNSS is to be introduced during the planning period.

3.3.3.3 For approach and landing at aerodromes, ILS will remain the standard aid. GNSS based approach procedures will be progressively introduced as follows:

a) overlay to ILS procedures;

b) non-instrument runways; and

c) non-precision runways.

3.3.3.4 For surveillance, voice position reports will remain the dominant procedure. However in high and medium traffic density terminal and approach area, SSR will be required while ADS will be progressively introduced.

3.3.3.5 The AFI CNS/ATM Plan for TMAs and aerodromes is at **Appendix C**. The list of TMAs and Aerodromes is at **Appendix D**.

3.3.4 GNSS Applications

3.3.4.1 For en route navigation, GNSS will be used, initially as a supplemental-means of navigation. States are recommended to make use of the guidance material contained in ICAO Circular 267 - AN/159 - *Guidelines for the introduction and operational use of the Global Navigation Satellite System (GNSS)* when drafting their GNSS Plan. Particular attention should be given to the following:

a) procedures development;

b) aeronautical coordinates referenced to the WGS-84 coordinate system;

c) data base creation and maintenance;

d) certification and operational approvals;

e) ground and flight inspection;

f) trials and demonstrations;

g) GNSS planning and organization;

h) GNSS training;

i) information of users by NOTAM and Aeronautical Information Circular;

j) legal issues; and

k) implementation assistance through ICAO.

3.3.4.2 A sample Aeronautical Information Circular (AIC) for the approval of GPS as a supplemental means of navigation for en route and terminal operations and overlay non-precision approaches (NPA) was adopted by the AFI/7 RAN Meeting and is shown as Appendix E. In due course, a similar AIC for approval of GNSS-based precision approach and landing applications shall be developed and included in this document.

3.4 IMPLEMENTATION PROGRAMME ~~(1995 - 2005)~~

3.4.1 This part of Section III defines in more detail, the actions to be undertaken by States and users in each area of routings or in the terminal and approach areas for the actual co-ordinated implementation of the Plan.

3.4.2 Timelines Reference Sheets (TRS)

3.4.2.1 The Timelines Reference Sheets (TRS) which reflect the actual plans of States, the status of implementation is at **Appendix F**.

3.4.3 Implementation worksheets

3.4.4.1 The implementation worksheets have been developed for each operational and technical element. The area concerned, the FIRs involved, the specific activity that must be carried out, the system that must be in place, by whom, and in which time-frames are identified. The implementation worksheets are aimed at providing to all concerned clear guidance to ensure uniformity of approach, compatibility of implemented systems and procedures and training. They will be used by Implementation Co-ordination Groups (ICGs) which are recommended to be set-up for each area of routing.

3.4.4.2 The implementation worksheets are at **Appendix G**.

3.4.4 Implementation Co-ordination Groups (ICGs)

3.4.4.1 The achievement of the intended benefits along each routing or within each area of affinity is entirely dependent on the coordinated implementation of the required elements by all concerned, provider and users alike. This section introduces the three pillars on which the attainment of that objective will rely: the Implementation Worksheets (IWS), the Implementation Co-ordination Groups (ICG's), and the Time-lines Reference Sheets (TRS).

3.4.4.2 The Implementation Worksheets (IWS) detail, for each traffic flow and for each area of affinity, and for every CNS element, the systems that must be put in place, by whom, and within which time-frames. Thus, the IWS will provide to all concerned a clear indication of what is required from each one of them, and will provide the basis to ensure coordinated and harmonized systems deployment.

3.4.4.3 Implementation Coordination Groups (ICGs) should be established for each routing and for each area of affinity. Members will be all those providers and users alike, required to implement systems either on the ground or airborne on the area of routing concerned, i.e., States and or Organizations responsible for the provision of services in the FIRs concerned, and the Users Organizations.

3.4.4.4 On their implementation role, the ICGs are independent of the Regional Planning machinery. They will nevertheless be guided by the IWS, on which they are free to improve and detail as necessary. However, any substantive modification either of objectives or time frames must be submitted to APIRG through the CNS/ATM Sub-Group in order to ensure overall conformity at the Regional level. The ICGs will, in their work, give due regard to the maintenance of, or increase in, the existing level of safety.

3.4.4.5 The ICAO Secretariat will co-ordinate the establishment and activities of ICGs. The ICGs will appoint a coordinator for each element (i.e. for each IWS). The coordinator will be responsible to initiate and

co-ordinate actions required to carry out implementation and among all concerned. The coordinator will also be responsible to report to the CNS/ATM Sub-group on progress, on eventual constraints being experienced, or on any other matters of concern. These will be mostly reflected in the TRS as detailed below.

3.4.4.6 The Timelines Reference Sheets at Appendix F are intended to ensure timeliness of implementation and to identify deviations so that corrective action can be initiated on a timely manner. They show, again for each element and for each area of affinity, the planned date of implementation and the FIRs and States concerned. Against each FIR, they will show the date on which the responsible authority has declared it can meet the requirement. This will allow for immediate identification of any significant deviation where corrective action may be required.

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LIST OF APPENDICES

APPENDIX A

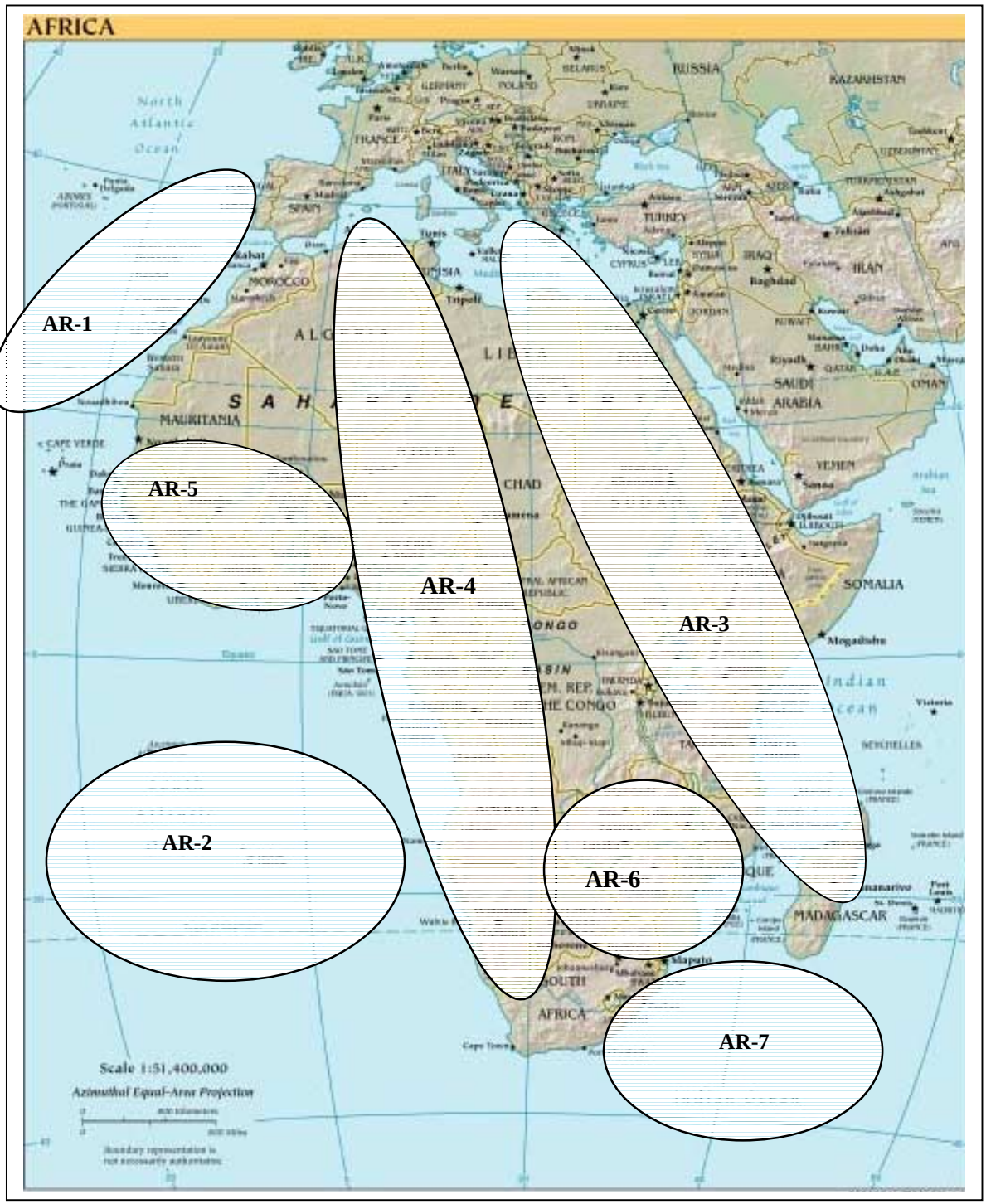
Areas of routing

Area of routing (AR)	Traffic flows	FIRs involved	Type of area covered	Remarks
AR-1	Europe - South Atlantic (EUR/SAT)	Canarias* Casablanca* Dakar Oceanic Lisboa[1*] Recife[1] Sal	Oceanic en-route low density in southern part and oceanic high density in northern part	Major traffic flow EUR/AFI/SAM *: FIRs northern part
AR-2	Atlantic Ocean (AFI-NAT/SAM interface)	Accra Dakar Oceanic Johannesburg-Oceanic Luanda Sal	Oceanic en-route low density	Homogeneous area AFI/NAT/SAM
AR-3	Europe - Eastern Africa (including oceanic areas)	Addis Ababa Antananarivo Asmara Cairo Dar es Salaam Entebbe Khartoum Mauritius Mogadishu Nairobi Seychelles Tripoli	Continental en-route / oceanic low density	Major traffic flow AFI/EUR
AR-4	Europe - Southern Africa	Algiers Brazzaville Gaborone Johannesburg Kano Kinshasa Luanda Lusaka N'Djamena Niamey Tripoli Tunis Windhoek	Continental en-route low density	Major traffic flow AFI/EUR
AR-5	~~Gulf of Guinea~~Continental Western africa ~~(Coastal routes)~~	Accra ~~Brazzaville~~ Dakar Kano Niamey Roberts	Continental/oceanic low density	Homogeneous area AFI
~~AR-6~~	~~Iberian Peninsula-Canaries~~	~~Canarias~~ ~~Casablanca~~ ~~Lisbon[1]~~	~~Oceanic high density~~	~~Major traffic flow AFI/EUR~~
~~AR-7~~	~~North AFI/Coastal and EUR/AFI Interface routes~~	~~Algiers~~ ~~Cairo~~ ~~Casablanca~~ ~~Tripoli~~ ~~Tunis~~	~~Continental / Oceanic low density~~	~~Homogeneous area AFI/EUR~~

Area of routing (AR)	Traffic flows	FIRs involved	Type of area covered	Remarks
AR-~~8~~6	Continental Southern Africa	Beira Gaborone Harare Cape Town Dar es Salaam Johannesburg Lilongwe Luanda Lusaka Windhoek	Continental low density	Homogeneous area AFI
~~AR-9~~	~~Trans-Sahelian~~	~~Asmara~~ ~~Dakar~~ ~~Kano~~ ~~Khartoum~~ ~~N'Djamena~~ ~~Niamey~~	~~Continental low density~~	~~Homogeneous area AFI~~
AR-~~10~~7	Trans-Indian Ocean	Antananarivo Bombay[1] Johannesburg-Oceanic Male[1] Mauritius Perth[1] Seychelles	Oceanic low density	Homogeneous area AFI/ASIA

Note: 1: Outside AFI. Indicated for completeness.

APPENDIX A


AFRICA
AR-1
AR-2
AR-3
AR-4
AR-5
AR-6
AR-7
Scale 1:51,400,000
Azimuthal Equal-Area Projection

APPENDIX B

CNS/ATM Plan by Area of routing

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		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**	Canarias Casablanca Dakar Oceanic Lisboa[1] Recife[1] Sal	Progressive evolution towards a random RNAV environment from West to East (2000 - 2005; Reduction of longitudinal separation to 10 minutes using Mach Number Technique (1998); extension to route UA302 (1999); 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 25 NM/30NM (2004 - onwards); RVSM (2000 -2005): progressive evolution towards RVSM FL290/410	DCPC (data) by participating aircraft (Bpa) (2000); 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 (1999-onwards)	RNP 5: Casablanca and Canarias FIRs (1998); RNP 10: Other FIRs (1999-2004); RNP 5: (2004 - onwards) Other FIRs GNSS as primary-means	~~Automatic Position Reporting (APR) Bpa trials (2000);~~ Automatic Dependent Surveillance (ADS) on RNP airspace Bpa (from 2000)

Note: 1: Outside AFI. Indicated for coordination.

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1999-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Europe - South Atlantic (Oceanic routes) (Norhtern part) **AR-1**	Canarias Casablanca Lisbon[1]	Fixed RNAV routes (1995); Longitudinal separation 30 NM (2001). Lateral separation 25 NM (2001) both with radar surveillance; RVSM (2002 - onwards)	DCPC 2005 - onwards	Gradual introduction of ATN compatible bit-oriented procedures (BOP) between main AFTN centres (2002)	RNP 5 (1998) GNSS as primary-means	Mode S (2000); ADS Bpa - 1999 onwards

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		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 Sal	Random routing; Reduction of longitudinal separation to 10 minutes (2000)	DCPC (data) by participating aircraft (Bpa) (1998); 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 main AFTN Centres (1998-onwards); AFTN and ATS/DS (1999)	RNP 10 (2000) GNSS as primary-means	~~Automatic Position Reporting (APR) Bpa trials (2000);~~ ADS (2000)

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		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 25 NM or 30 NM in line with RNP 5 in the upper airspace (2001); Vertical Separation: introduction of RVSM initially between FL 350 and FL 390 (2001-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; 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); ~~Full interface between aeronautical networks (2001);~~ AFTN and ATS/DS (1999); Introduction of ATS inter-facility data communications (AIDC) starting in 2002 to be completed by 2005	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 ~~1995-2005~~1999-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Europe - Southern Africa **AR-4**	Algiers Brazzaville Gaborone Johannesburg Kano Kinshasa Luanda Lusaka N'Djamena Niamey Tunis Tripoli Windhoek	Fixed RNAV routes coexisting with conventional routes from 1995 to 2000; Longitudinal separation 10 minutes from (2000) Lateral separation minima; Gradual introduction of 25 NM or 30 NM (2000); RVSM: Introduction initially between FL 350 and 390 (2002-onwards), evolving towards FL 290/410 from 2005; Full ATC service on all ATS routes above FL 245 and 150NM from international airports. Random RNAV initially above FL350	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; ~~full interface between aeronautical networks (from,2001);~~ Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (1999 - onwards); Gradual introduction of AIDC to be completed by (2005)	RNP 5: Initially above FL350 (from 2000) WGS 84 GNSS as primary-means	Procedural (on account of traffic diversity); ADS (2000 onwards); SSR at Brazzaville, Kinshasa, Luanda and N'Djamena from (2000); RADAR and ADS integration from (2000)

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
~~Gulf of Guinea (Coastal routes)~~ Continental Western Africa routes **AR-5**	Accra ~~Brazzaville~~ Dakar Kano Niamey Roberts	Longitudinal separation 10 minutes (2000); Full ATC service on all ATS routes above FL 245 and 150NM from international airports. Lateral separation 25NM or 30 NM in an RNP 5 environment (2001 - onwards); RVSM initially between (FL 350-FL 390) (2002 -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 ~~1999~~ 20xx onwards	AFTN and ATS/DS links upgraded (1999); Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main Centres (1999-onwards); ~~Full interface between aeronautical networks 2001 - onwards~~	VOR/DME (TMAs); 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 1995-2005				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Iberian Peninsula-Canaries AR-6	Canarias Casablanca Lisbon[1]	Fixed RNAV routes (1995); Longitudinal separation 30 NM (2001). Lateral separation 25 NM (2001) both with radar surveillance; RVSM (2002 - onwards)	DCPC 2005 - onwards	Gradual introduction of ATN compatible bit-oriented procedures (BOP) between main AFTN centres (2002)	RNP 5 (1998) GNSS as primary means	APR Bpa (1998); Mode S (2000); ADS Bpa - 1999 onwards

Note: 1: Outside AFI. Indicated for coordination.

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2005				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
North AFI/Coastal and EUR/AFI Interface routes AR 7	Algiers Cairo Casablanca Tripoli Tunis	Reduction of longitudinal separation to 10 minutes along specific itineraries (2000) ; Fixed RNAV coexisting with conventional routes (1999); RVSM (2002 - onwards)	DCPC 2005 onwards; Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000)	Gradual introduction of ATN between selected ACCs (1999); ATS/DS (1999)	VOR/DME (TMAs); RNP 5 2000 onwards in selected upper airspaces GNSS as primary means	SSR (high density airspaces) (2000); Mode S (where justified) (2000).

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Continental Southern Africa **AR-~~6~~8**	Beira Gaborone Harare Cape Town Dar es Salaam Johannesburg Lilongwe Luanda Lusaka Windhoek	Fixed RNAV routes coexisting with conventional routes (2000); Longitudinal separation 10 minutes (2000); Full ATC on all ATS routes above FL 245 and 150NM from international airports.(2000); Lateral separation (TBD); Random routing initially above FL 350 (TBD); RVSM initially between FL350 and FL390 (TBD)	Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000) DCPC (data) from 2000	AFTN implemented (1999); Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (1999); ATS/DS (1999); AIDC (2001-2005)	VOR/DME (TMAs); RNP 10 (2000); RNP 5: (from 2000), and evolution to RNP 4 in selected airspaces GNSS as primary-means	SSR (high density airspaces) (1996); ADS/CPDLC Bpa (2000); SSR (Luanda, 2000)

Table 1- En-route

Area of Routing	FIRs	Systems Evolution 1995-2005				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Trans-Sahelian AR 9	Asmara Dakar Kano Khartoum N'Djamena Niamey	Fixed RNAV routes co-existing with conventional routes (1999) evolving to random routing; Full ATC service on all ATS routes above FL 245 and 150NM from international airports. Longitudinal separation of 10 minutes (2000); Lateral separation 25 NM or 30 NM in an RNP 5 environment (2001 - onwards); RVSM initially between FL350 - 390 (2001- 2005) Random routing initially above FL350	Full VHF coverage on all ATS routes above FL300, and 150 NM from international airports (2000) DCPC (data) (2000 - 2005).	AFTN and ATS/DS links upgraded (1999); Full Interface between aeronautical networks 2001 - onwards; Gradual introduction of ATN compatible bit-oriented procedures (BOP) between AFTN main centres (1999-onwards)	RNP 10: (2000); RNP 5: 2000- onwards evolving towards RNP5 GNSS as primary means	APR Bpa (1998); ADS/DCPC (2001 - onwards) with full ground capability by 2005; SSR coverage at N'Djamena sector

Table 1- En-route

Area of Routing	FIRs	Systems Evolution ~~1995-2005~~1999-2010				
		Airspace and Traffic Management	Communications		Navigation	Surveillance
			Mobile Service	Fixed Service		
1	2	3	4	5	6	7
Trans-Indian Ocean **AR-~~10~~7**	Antananarivo Bombay[1] Johannesburg Oceanic Male[1] Mauritius Perth[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 310-FL370 (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); ~~Interface between aeronautical networks (1999);~~ AIDC (2002) with full capability in 2005	RNP 10: (2000) GNSS as primary-means	~~APR Bpa (1999);~~ ADS Bpa (2000)

Note: 1: Outside AFI. Indicated for coordination.

APPENDIX C

TMAs and Aerodromes

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 D

Tentative Categorization of TMAs and Aerodromes
Classification provisoire des TMA et Aérodromes

State/Etat	TMA	Type	Aerodromes	Type
Algeria/Algérie	Alger	1	Alger	1
	Constantine	1	Constantine Bejaia* Jijel*	1 3 3
	Annaba	1	Annaba Tebessa	1 3
	Oran	1	Oran Tlemcen Tiaret Mascara*	1 3 3 3
	Other TMAs	1/2	Other Aerodromes	2/3
Angola	Luanda		Luanda Huambo	
Benin/Bénin	Cotonou	2	Cotonou	2
Botswana	Francistown Gaborone Maun Kasane	3 2 3 3	Gaborone Others	2 3
Burkina Faso	Bobo Dioulasso Ouagadougou	3 2	Bobo Dioulasso Ouagadougou	3 2
Burundi	Bujumbura		Bujumbura	
Cameroon/Cameroun	Douala Yaounde	2 3	Douala Yaounde/Nsimalen	2 3
Cape Verde/Cap-Vert	Sal	2	Amilcar Cabral Francisco Mendes	2 3
Central A.Rep./R.C.A.	Bangui	2	Bangui	2
Chad/Tchad	Ndjamena	2	Ndjamena	2
Comoros/Comores	Moroni			
Congo	Brazzaville Pointe Noire	2 3	Brazzaville Point Noire	2 3
Côte d'Ivoire	Abidjan Bouake	2 3	Abidjan/F.H. Boigny Bouake	2 3
Dem. Rep. Of Congo Rep. Dém. Du Congo	Kinshasa Other TMA's	2 3	Kinshasa Other aerodromes	2 3
Djibouti	Djibouti		Djibouti	

State/Etat	TMA	Type	Aerodromes	Type
Egypt/Égypte	Alexandria Aswan Cairo Hurgadah Luxor	2 2 1 2 2	Abu Simbel Alexandria Aswan El Arish* Cairo Hurghada Luxor Mers Matruh Sharm El Sheikh St. Catherine Taba	2 2 2 3 1 2 2 3 3
Equat. Guinea/Guinée Equat.	Malabo	2	Malabo Bata*	3 3
Eritrea/Érythrée	Asmara	3	Asmara Assab	3
Ethiopia/Éthiopie	Addis Ababa	3	Addis Ababa Dire Dawa	3
France (Réunion)	St. Denis	2	St. Denis	2
Gabon	Libreville Port Gentil	2 3	Libreville Port Gentil	2 3
Gambia/Gambie	Banjul		Banjul	
Ghana	Accra Kumasi	2 3	Accra/KIA Kumasi/Kumasi	2 3
Guinea/Liberia/Sierra Leone	Roberts	2	Conakry Freetown Monrovia	2 2 2
Guinea Bissau/Guninée Bissau	Bissau		Bissau	
Kenya	Nairobi	1	Nairobi Eldoret Mombasa	1
Lesotho	Maseru	2	Maseru	2
Libyan Arab Jamahiria	Benghazi Tripoli		Benghazi Tripoli Sebha	
Madagascar	Ivato	2	Ivato Mahajanga Toamasina	2 3 3
Malawi	Lilongwe	3	Lilongwe	3
Mali	Bamako	2	Bamako	2
Mauritania/Mauritanie	Nouakchott Nouadhibou	2 3	Nouakchott Nouadhibou	3 3
Mauritius	Mauritius		S.S. Ramgoolam	
Morocco/Maroc	Casablanca Agadir Fes Marrakech Ouarzazate Oujda Rabat-Sale Tangiers	1 2 2 2 2 2 2 2	Casablanca Agadir Fes Marrakech Ouarzazate Oujda Rabat-Sale Tangiers	1 2 2 2 2 2 2 2

State/Etat	TMA	Type	Aerodromes	Type
Mozambique	Beira Maputo	3 2	Beira Maputo	3 2
Namibia	Windhoek		Windhoek	
Niger	Niamey	2	Niamey	2
Nigeria/Nigéria	Abuja Calabar Ilorin Kaduna Kano Lagos Maiduguri Port Harcourt Sokoto	2 3 3 2 1 1 2 2 3	Abuja Calabar Ilorin Kaduna Kano Lagos/Murtala Mhmd. Maiduguri Port Harcourt Sokoto	2 3 3 2 2 1 3 2 3
Rwanda	Kigali		Kigali	
Sao Tome	Sao Tome	3	Sao Tome	3
Senegal/Sénégal	Dakar	2	Dakar/L.S. Senghor	2
Seychelles	Seychelles	2	Seychelles Int.	2
Somalia/Somalie	Mogadishu		Mogadishu	
South Africa/Afrique du Sud	Bloemfontein Cape Town Durban East London George Johannesburg Lanseria Port Elizabeth	3 2 2 3 3 1 1 3	Bloemfontein Cape Town Durban East London George Johannesburg Lanseria Port Elizabeth	3 2 2 3 3 1 1 3
Spain (Canary Islands) Espagne (îles Canaries)	Canarias	1	Gran Canaria Tenerife Sur Tenerife Norte Lanzarote Fuerteventura La Palma El Hierro	1 1 2 2 2 3 3
Sudan	Khartoum		Khartoum	
Swaziland	Manzini		Manzini	
Togo	Lome Niamtougou	2 3	Lome Niamtougou	2 3
Tunisia/Tunisie	Tunis Djerba Monastir Sfax Tabarka Tozeur	1 1 2 2 2 2	Tunis Djerba Monastir Sfax Tabarka Tozeur	1 1 1 2 2 2
Uganda/Ouganda	Entebbe	3	Entebbe	3
United Rep. of Tanzania/Tanzanie	Dar es Salaam	3	Dar es Salaam	3
Zambia/Zambie	Lusaka	2	Lusaka	2

State/Etat	TMA	Type	Aerodromes	Type
Zimbabwe	Harare		Harare	

9

Note: * means aerodrome not part of the AFI Plan / * signifie aérodrome ne faisant pas partie du Plan AFI.

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**: *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.

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) 2005-2011**: *APV-I -I, 20m vertical accuracy, will be available everywhere in the AFI Region*

- This phase will allow for:

a) 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) 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) Terminal area VOR/DME/NDB, and Locators not associated with ILS, will be progressively withdrawn in consultation with users during Phase II.

d) Approach and landing phase: sufficient capability for 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 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 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		2005 - 2011	2012 - 2017
Certification	Supplemental	Primary	Sole-means from en route to 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		APV-1 SBAS	SBAS CAT I CAT I GBAS CAT II/III GBAS
