INTERNATIONAL CIVIL AVIATION ORGANIZATION

CAR/SAM REGIONAL PLAN FOR THE IMPLEMENTATION OF THE CNS/ATM SYSTEMS

DOCUMENT I

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Chapter 1: Background

1.1 Objective

1.1.1 This document is the Caribbean/South American (CAR/SAM) Regional Plan for the Implementation of the Communications, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems. The complementary document, corresponding to the Action Plan, contains the evolution of ATM in the CAR/SAM Regions both en route and in terminal areas, as well the necessary CNS requirements accompanying this evolution.

1.1.2 This Regional Plan has been developed taking into consideration the Global Air Navigation Plan for CNS/ATM Systems. This document does not repeat the concepts found in the Global Plan; therefore, States should count with a copy of it.

1.2 Scope

1.2.1 The scope of this CNS/ATM implementation plan, comprehends up to the limits of the CAR/SAM Regions, which are shown in Figure 1-1.

1.3 Introduction

1.3.1 In the early 1980's, civil aviation recognized the increasing limitations of the present communication, navigation, surveillance (CNS) and air traffic management (ATM) systems and the need to make improvements to overcome the present limitations and also meet the future needs. Thus the Council of ICAO established the Special Committee on Future Air Navigation Systems (FANS) in 1983 to study new concepts and new technologies and to recommend a system that would overcome the present and foreseen problems and take aviation into the 21st century.

1.3.2 The FANS Committee made an extensive study of existing systems and the applications of new technologies. It concluded that the limitations of the existing systems are intrinsic to the systems themselves and were so restrictive to effective Air Traffic Management that the problems could not be overcome on a global scale except by new concepts and new CNS systems which would in turn support more efficient ATM. The FANS Committee concluded that the exploitation of satellite technology was the only viable solution to overcome the limitations of the present system and meet future needs on a cost-effective global basis.

1.3.3 The first Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS), held in Caracas, Venezuela in April 1991 took action on the new CNS/ATM systems and requested that members attending the FANS(Phase II) Committee Meeting to report accordingly at the Second Meeting of the Group.

1.3.4 The system concept developed by the FANS Committee was endorsed by the ICAO 10th Air Navigation Conference in September 1991. This Conference recommended that ICAO complete and maintain a global co-ordinated plan and accomplish tha planning for implementation of future CNS/ATM systems through ICAO regional planning and implementation groups. The FANS Committe completed the global co-ordinated plan in October 1993. At the Second Meeting of GREPECAS, held in Fort Lauderdale, USA, when this matter was examined, the Group agreed to create a Subgroup responsible for the CNS/ATM Implementation Planning in the CAR/SAM Regions. Under Decision 2/30, the GREPECAS created the Communications, Navigation, Surveillance (CNS), and Air Traffic Management (ATM) Subgroup, with the following Terms of Reference:

Terms of Reference

a) In pursuance of Recommendation 8/1 of the Tenth Air Navigation Conference, accomplish the inter and intra regional co-ordinated planning for implementation of the CNS/ATM system in the CAR/SAM Regions;

b) Develop for the CAR/SAM Regions a strategy of implementation of the different elements of the CNS/ATM system in conformity with the ICAO Global Implementation Plan;

c) The period planned should extend to the year 2010 taking into account the following three periods:

Near term	1993 - 1996
Middle term	1996 - 2000
Long term	2000 - 2010

1.3.5 GREPECAS considered the task of the CNS/ATM Subgroup to have ended in 1995, upon approving a first version of this CAR/SAM regional plan for the implementation of CNS/ATM systems during its fifth meeting, and immediately after, established the CNS/ATM Implementation and Coordination Subgroup (CNS/ATM/IC/SG), with the following Terms of Reference:

a) Study and propose the inter and intra regional coordination in order to begin the implementation of the different elements of the CNS/ATM systems in the CAR/SAM Regions, to ensure their conformity with the Regional Plan for the implementation of the new CNS/ATM systems and the necessary strategy compliant with the ICAO Global Plan for the Transition to the new CNS/ATM systems.

b) Maintain permanent co-ordination with the various contributory bodies of GREPECAS, to ensure appropriate integration of all tasks contributing to CNS/ATM implementation, in keeping with the CAR/SAM Regional Plan for the implementation of the new CNS/ATM systems.

c) Develop periodical proposals of amendment related to the CAR/SAM Regional Implementation Plan for the new CNS/ATM systems and improve elements of a coordinated inter and intra regional planning for the implementation of the CNS/ATM systems in the CAR/SAM Regions, taking into consideration the implementation plans of the States' CNS/ATM systems, based on ICAO's regional basic operational requirements and planning criteria in the light of the development of the ICAO CNS/ATM systems.

1.3.6 The CNS/ATM/IC Subgroup has elaborated the Action Plan as a complementary document to this CNS/ATM Plan, which provides additional text and is linked to the structure of the Facilities and Services Implementation Document (FASID) used in the regional planning process. The Action Plan has been developed on the basis of identifying Homogeneous Areas and Main Traffic Flows.

1.4 Shortcomings of the Present CNS/ATM Systems in the CAR/SAM Regions

1.4 Oceanic CNS

1.4.1.1 Over the oceanic areas, the systems which can currently be used in the CAR/SAM Regions have limitations. Thus, in most cases, the air ground communications are limited to partial VHF coverage provided from offshore Continental zones and from some islands. HF communications often require the need for intermediate communicators. While "on-board" navigation systems such as INS/IRS are available for the larger aircraft, long range radio navigation has been limited to VLF/Omega and LORAN C. Surveillance has been limited to pilot position reports via HF communications. These limitations have resulted in extensive separation standards, which apply in oceanic airspace.

1.4.2 Continental CNS

1.4.2.1 Because of the presence of mountains and extended jungles in the CAR/SAM Regions, it is difficult and in many cases impossible to implement the present communication, navigation and surveillance systems. Even when the implementation is greater than in the oceanic area, the performance achieved often limits air traffic management.

1.4.2.2 The present ground communications system, the Aeronautical Fixed Telecommunications Network (AFTN) is limited in its reliability, throughput, data integrity, and the ability to handle bit oriented message and data exchanges.

1.4.3 Air Traffic Management (ATM)

1.4.3.1 Present day ATM applied in the CAR/SAM Regions suffers shortcomings which include:

a) Lack of radar coverage over large areas of the region does not permit the reduction of aircraft separation standards;

b) Direct and/or parallel ATS route availability is constrained due to ground based navigation aids;

c) Dissimilar separation criteria applied at FIR boundaries does not permit the use of optimum flight profiles;

d) The lack of coordination in the provision of the current CNS/ATM services occasionally gives rise to a duplication in resources and services;

e) Poor quality of communications systems and language difficulties cause problems in the provision of Air Traffic Services.

1.4.3.2 What is required to overcome the present limitations and cope with growth are overall surveillance and appropriate parallel route structures. Language difficulties and coordination procedure problems can be largely resolved by exchanging and processing automated data. Efficient coordination between adjacent FIRs and common navigation standards and procedures are also essential to ensure that a transparent transfer of ATS responsibility is provided. The satellite technology can efficiently provide the necessary seamless and flexible regional interface.

1.5 Description of the New CNS/ATM Systems

1.5.1 The main features of the global concept of the new CNS systems can be summarized as follows:

1.5.2 Communications

1.5.2.1 Communications with aircraft for both voice and data will be by direct satellite to aircraft links. Initially, high frequency (HF) may have to be maintained in the transition period and over polar regions until such time as satellite communications are available. Very high frequency (VHF) data will be used along with VHF voice in many continental and terminal areas. The secondary surveillance radar (SRR) Mode S data link will be used for air traffic service purposes in high density airspace.

1.5.2.2 The aeronautical telecommunication network (ATN) will provide for the interchange of digital data between end-users (aircrew, air traffic controllers, aircraft operators, etc) over dissimilar air-ground and ground-ground communication links. User access to the ATN is via one or more subnetworks which are connected by ATN routers. ATN routers may be either mobile (aircraft) or fixed (ground-based). The ATN router selects a path via aeronautical subnetworks based on user-specified communication parameters and subnetwork availability. This action is transparent to the user who, therefore, does not need to know the area of coverage of particular subnetworks nor the change communications procedures depending upon the subnetworks that are in use.

1.5.3 Navigation

1.5.3.1 Area navigation (RNAV) capability will be progressively introduced in compliance with the ICAO Required Navigation Performance (RNP) Standards. Global navigation satellite system(s) (GNSS) will provide world-wide coverage and will be used for aircraft navigation and for precision approaches. Additionally, GNSS will be used for providing surface movement guidance. Non-directional radio beacon (NDB) and VHF omnidirectional radio range/distance measuring equipment (VOR) (VOR/DME) will be progressively withdrawn.

1.5.3.2 The Special COM/OPS Divisional Meeting, April 1995 has proposed an ICAO global strategy for the implementation and application of the non-visual aids for approach and landing; and the Plan is consistent with such a global strategy, in which no change or addition is prescribed to the standards of ICAO's Annex 10 regarding the ILS system which would require the replacement of such equipment before the year 2010. In this regard, it is estimated that the CAR/SAM States/Territories would carry out a transition plan for the current precision systems for approach and landing aimed at using the augmented GNSS with differential techniques instead of implementing the microwave landing system (MLS).

1.5.3.3 Modern aircraft are increasingly equipped to utilize newer techniques, generally referred to as area navigation (RNAV), the use of which is appropriate and inevitable because they facilitate the flexibility of the route network. Therefore, the ICAO CNS/ATM systems are based on the availability of airborne RNAV capability. A new concept, primarily for use in airspace where adequate surveillance is available to ATC, has been developed and called required navigation performance (RNP). RNP is broadly defined as the maximum deviation from assigned track within which the aircraft can be expected to remain with a given degree of probability. This concept avoids the need for ICAO selection between competing systems from the outset; however, it will not prevent ICAO from dealing with navigation techniques which are in wide use internationally.

1.5.3.4 GNSS systems providing independent navigation, where the user performs on-board position determination from information received from broadcast transmissions by a number of satellites, will provide highly reliable, highly accurate and high integrity global coverage independently. Although the RNP concept allows for more than one satellite navigation system to be in use simultaneously, from an aircraft equipment point of view, maximum interoperability is essential as it would significantly simplify avionics and thereby reduce cost. It would also be attractive if one system could serve as a complement to and/or in a back-up role for each other.

1.5.4 **Surveillance**

1.5.4.1 Automatic dependent surveillance (ADS) will be used extensively. In continental airspace and in some terminal areas, it may eventually become a supplement to SSR, diminishing, therefore, the use of primary radar.

1.5.4.2 The introduction of air-ground data links, together with sufficiently accurate and reliable aircraft navigation systems, present the opportunity to provide surveillance services in areas which lack such services in the present infrastructure, in particular oceanic areas and other areas where the current systems prove difficult, uneconomic, or even impossible, to implement. ADS is an application for use by ATS in which aircraft automatically transmit, via a data link, data derived from on-board navigation systems. As a minimum, the data include the four-dimensional position. Additional data may be provided as appropriate. The ADS data would be used by the automated ATC system to present information to the controller. In addition to areas which are at present devoid of traffic position information other than pilot-provided position reports, ADS will find beneficial application in other areas, including high-density areas, where ADS may serve as an adjunct and/or back-up for secondary surveillance radar and thereby reduce the need for primary radar. Also, in some circumstances, it may even replace secondary radar. As with current surveillance systems, the full benefit of ADS requires supporting complementary two-way pilot/controller data and/or voice communication (voice for at least emergency and non-routine communication).

1.5.5 Current Situation of CNS Elements

1.5.5.1 The systems have now been defined, the technology is mature, the ICAO standards are being developed to complete its inclusion in the Annexs to the Convention on International Civil Aviation by 1998. The revised ICAO planning processes is going on and the States/Territories have the choice of implementing specific ATM elements in order to obtain the benefits of the new technology. The complete future CNS systems are presented in a condensed form in the CNS Evolution Table (Table 1-1).

1.5.6 Air Traffic Management (ATM)

1.5.6.1 The general objective of ATM is to enable aircraft operators to meet their planned times of departure and arrival and adhere to their preferred flight profiles with minimum constraints without compromising agreed levels of safety.

1.5.6.2 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 technologies. This evolution should be guided by the principle of maintaining an optimum separation assurance.

1.5.6.3 The development of the ATM system must be evolutionary. There is often the temptation to design on a "clean sheet of paper" to take full advantage of new capabilities which new technology offers. The reality is that transition and integration are the most difficult institutional problems facing ATM system designers. It is simply impractical to evolve from one system to another in time-frames less than several years in duration.

1.5.6.4 In the design of the future airspace structure, airspace boundaries and divisions should not prevent the efficient use of automated conflict detection and resolution techniques nor the utilization of advanced avionics in modern aircraft.

1.5.6.5 The implementation of the global CNS concept will greatly influence the future development in the field of air traffic management (ATM). However, the provision of ATM has to also be considered on a regional basis. The ATM concept is intended to be applied world-wide but achieved through variable phases of regional implementation.

1.5.6.6 Planning and implementation of improved ATM capabilities must include consideration of human factors.

1.5.6.7 Some of the benefits to be expected from implementation of these capabilities are enhanced safety, reduced fuel cost, reduced delays, and increased system capacity.

1.6 Benefits and costs

1.6.1 CNS/ATM systems will improve the handling and transfer of information, extend surveillance using ADS and improve navigational accuracy. This will lead, among other things, to reductions in separation between aircraft, allowing for an increase in airspace capacity.

1.6.2 Advanced CNS/ATM systems will also see the implementation of ground-based cumputerized systems to support the management of a higher traffic volume. These ground-based systems will exchange data directly with flight management systems (FMSs) aboard aircraft through data link. This will benefit the ATM provider and airspace user by: enabling improved conflict detection and resolution through intelligent processing, providing for the automatic generation and transmission of conflict free clearances, as well as offering the means to adapt quickly to changing traffic requirements. As a result, the ATM system will be better able to accommodate an aircraft=s preferred flight profile and help aircraft operators to achieve reduced flight operating costs and delays. Table 1-2 describes CNS/ATM systems objectives and resulting benefits.

1.6.3 Benefits for Airlines

1.6.3.1 Benefits of CNS/ATM systems will come to providers and users of the air navigation system through formation of a more close-knit relationship allowing rapid and reliable transmission between ground and airborne system elements. More accurate and reliable navigation systems will also allow aircraft to navigate in all types of airspace and operate more closely together, therefore, increasing the capacity of the airspace.

1.6.4 Benefits for General Aviation

1.6.4.1 General aviation and utility aircraft will find increasing access to avionics equipment that will allow them to operate in flight conditions, as well as into and out of airports, that they would normally have been prohibited from using because of the operating cost and associated requirements. Furthermore, as a result of implementing CNS/ATM systems, many remote areas that are currently inaccessible to most general aviation aircraft because of their inability to communicate or safely navigate over them, would become accessible.

1.6.5 The benefits of CNS/ATM can be summarized as:

a) maintain or enhance the existing level of safety;

b) the provision of an ATM system to make more efficient use of airspace and airport capacity and to permit the harmonious treatment of flights transitting all airspace;

c) the provision of CNS in a more cost effective manner; and

d) the provision of CNS systems in a more homogeneous manner.

1.7 Planning Considerations

1.7.1 With the benefits from the new CNS/ATM systems, there is need and enthusiasm for its implementation, but there are many hard decisions to be made, particularly on timing. Global and regional cooperation on an unprecedented scale will be required.

1.7.2 The regional planning process is the principal engine of ICAO=s planning and implementation work. It is here that the top-down approach, comprising global guidance and regional-harmonization measures, converges with the bottom-up approach constituted by States/Territories and aircraft operators and their proposals for implementation options.

1.7.3 In its most basic form, the output from the regional planning process should be a listing of air navigation facilities and services together with their achievable time frames, necessary for CNS/ATM systems implementation. These listings will be included in the CAR/SAM regional air navigation plan (ANP) and maintained updated by the ICAO CAR/SAM regional planning and implementation regional group (GREPECAS) with the assistance of ICAO=s regional offices.

1.7.4 The objective of the global plan is to guide a progressive and coordinated world-wide implementation of the elements of the future air navigation system in a timely and cost-beneficial manner. To this end, the plan fulfills two principal functions:

a) it provides guidelines for use by regional planning bodies, States/Territories, service providers and users, for transitions from the current ground-based air navigation system to the future satellite-based system; and

b) it functions as a benchmark for the evaluation of implementation progress.

1.7.5 The implementation of the current CNS/ATM systems has basically been a regional responsibility, i.e. States/Territories or groups of States/Territories working together within the framework of the concept and implementation strategy developed for the respective region by the corresponding regional planning group. ICAO air navigation planning should continue to be conducted through the established regional planning process.

1.7.6 States/Territories have the responsibility for implementation of the new CNS/ATM system within their areas of responsibility. It will however be necessary for each State within the CAR/SAM Region to develop and publish its own CNS/ATM implementation plan. These State Plans should be coordinated within the Flight Information Regions and with adjacent Flight Information Regions to ensure that optimum use is made of all aspects of CNS/ATM.

1.8 Evolution and Implementation

1.8.1 In considering the overall system concept, the questions of evolution and transition are most important. For instance, 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, there 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 CNS/ATM system. Particularly, because of the wide coverage of satellite CNS systems, the above considerations call for conscientious world-wide and regional co-ordination of the planning and implementation if such systems are to be optimized.

Table 1-1. CNS Systems Evolution

	Function	Current System	Future System
Oceanic/Continental en-route airspace with low density traffic (Note 6)	Navigation	LORAN-C NDB VOR/DME Barometric altitude INS/IRS	RNAV/RNP GNSS Barometric altitude High altitude GNSS (Note 2) INS/IRS
	Air-ground communications Ground-ground communications	VHF and HF communication voice system AFTN and ATS speech circuits	VHF and AMSS voice/data communications via ATN (Note 5) HF voice poles only (Note 4) HFDL Data communications via the ATN
	Surveillance	Primary radar/SSR Voice position reports	ADS via the ATN
Continental airspace with high density traffic	Navigation	LORAN-C NDB VOR/DME Barometric altitude INS/IRS	RNAV/RNP GNSS Barometric altitude High altitude GNSS altimetry (Note 2) INS/IRS
	Air-ground communications Ground-ground communications	VHF communications voice systems AFTN and ATS speech circuits	VHF and AMSS voice/data Communications and SSR Mode S data link via the ATN Data communications via the ATN
	Surveillance	Primary radar SSR Mode A/C	SSR Mode A/C or SSR Mode S ADS via the ATN
Oceanic airspace with high-density traffic	Navigation	MNPS LORAN-C Barometric altitude INS/IRS	RNAV/RNP GNSS Barometric altitude High altitude GNSS altimetry (Note 2) INS/IRS
	Air-ground communications Ground-ground communications	HF voice systems AFTN and ATS speech circuits	AMSS voice/data communications via the ATN Data communications via the ATN
	Surveillance	Voice positions reports via HF speech circuits	ADS via the ATN
Terminal areas with high-density traffic	Navigation	NDB VOR/DME ILS Barometric altitude INS/IRS	RNAV/RNP GNSS ILS, NDB (Note 3) VOR/DME (Note 3) Barometric altitude INS/IRS
	Air-ground communications Ground-ground communications	VHF voice systems AFTN and ATS speech circuits	VHF and AMSS voice/data Communications and SSR Mode S data link via the ATN (Note 6) Data communications via the ATN
	Surveillance	PSR SSR Mode A/C	PSR (Note 3) SSR Mode A/C or SSR Mode S ADS via the ATN (Note 1)

Note 1 - The need for primary radar is reduced
Note 2 - To be used where barometric altimetry is not functional especially at high altitudes
Note 3 - Will be progressively withdrawn
Note 4 - Until such time as satellite communications are available
Note 5 - Includes low-altitude, off shore and remote areas
Note 6 - Depends on outcome of feasible studies

Table 1-2. Objectives of CNS/ATM Systems

	AIR TRAFFIC MANAGEMENT	FLIGHT OPERATIONS

General	$ ensure that all necessary information including information needed for dynamic flight planning is available to all ground and airborne systems
	$ enhance functional integration of ground systems with airborne systems and the ATM-related aspects of flight operations
	$ enhance the accuracy of conflict prediction and resolution and the provision of real time information to controllers and operators
		$ enhance the accuracy of information related to flight progress
		$ enhance functional integration of airborne systems and flight operations with ground systems
		$ ensure the provision of accurate information between airborne system elements with ground system elements necessary for dynamic flight planning

Air Operations Safety	$ ensure the provision of well adapted and harmonized safe procedures on a global basis
	$ ensure that separation between aircraft is maintained
	$ ensure that clearance between aircraft and obstacles is maintained
	$ provide for enhanced contingency planning
	$ ensure that rapid alerting service is available
	$ ensure that safety levels are maintained as the use of automation increases
		$ improve pilot situational awareness*
		$ ensure adequate clearance from terrain
		$ enable aircraft to maintain their own separation under specific circumstances*
		$ ensure that safety levels are maintained as the use of automation increases
		$ ensure integrity of database information

Regularity and Efficiency of Air Operations	$ provide for the application of global ATM under all operational conditions
	$ improve the application of tactical airspace management through dynamic user involvement, leading to more efficient airspace utilization
	$ improve strategic airspace management while increasing tactical airspace flexibility
	$ ensure the provision of information necessary for tactical and strategic ATFM
	$ enhance over-all tactical and strategic ATFM so that demand does not exceed capacity
	$ increase available capacity without increasing controller workload
		$ ensure that aircraft can operate under all types of weather conditions
		$ provide for the application of user-preferred flight profiles
		$ ensure that the necessary infrastructure is available to support gate-to-gate operations
		$ improve user capability to optimize flight planning dynamically, in order to improve airspace capacity through more flexible operations
		$ minimize aircraft operating cost penalties
		$ minimize differing equipment carriage requirements between regions

COMMUNICATIONS, NAVIGATION AND SURVEILLANCE		
Communications	$ to enhance coverage, accessibility, capability, integrity, security and performance of aeronautical communication systems in accordance with ATM requirements	
Navigation	$ to enhance coverage and allow for all weather navigation capability in all airspace, including approach and landing, while maintaining or improving integrity, accuracy and performance in accordance with ATM requirements	
Surveillance	$ to enhance and extend effective surveillance to oceanic and remote areas while improving air traffic situational awareness* in the cockpit in accordance with ATM requirements	

* Emerging concept or technology-concensus still to be reached.

ATTACHMENT A

STATEMENT OF ICAO POLICY ON CNS/ATM SYSTEMS IMPLEMENTATION AND OPERATION
Approved by Council (C 141/13) on 9 March 1994

In continuing to fulfill its mandate under Article 44 of the Convention on International Civil Aviation by, inter alia, developing the principles and techniques of international air navigation and fostering the planning and development of international air transport so as to ensure the safe and orderly growth of international civil aviation throughout the world, the International Civil Aviation Organization (ICAO), recognizing the limitations of the present terrestrial-based system, developed the ICAO communications, navigation and surveillance/air traffic management (CNS/ATM) systems concept, utilizing satellite technology. ICAO considers an early introduction of the new systems to be in the interest of healthy growth of international civil aviation.

The implementation and operation of the new CNS/ATM systems shall adhere to the following precepts:

1. UNIVERSAL ACCESSIBILITY

The principle of universal accessibility without discrimination shall govern the provision of all air navigation services provided by way of the CNS/ATM systems.

2. SOVEREIGNTY, AUTHORITY AND RESPONSIBILITY OF CONTRACTING STATES

Implementation and operation of CNS/ATM systems which States have undertaken to provide in accordance with Article 28 of the Convention shall neither infringe nor impose restrictions upon States' sovereignty, authority or responsibility in the control of air navigation and the promulgation and enforcement of safety regulations. States' authority shall be preserved in the co-ordination and control of communications and in the augmentation, as necessary, of satellite navigation services.

3. RESPONSIBILITY AND ROLE OF ICAO

In accordance with Article 37 of the Convention, ICAO shall continue to discharge the responsibility for the adoption and amendment of Standards, Recommended Practices and Procedures governing the CNS/ATM systems. In order to secure the highest practicable degree of uniformity in all matters concerned with the safety, regularity and efficiency of air navigation, ICAO shall co-ordinate and monitor the implementation of the CNS/ATM systems on a global basis, in accordance with ICAO's regional air navigation plans and global co-ordinated CNS/ATM systems plan. In addition, ICAO shall facilitate the provision of assistance to States with regard to the technical, financial, managerial, legal and co-operative aspects of implementation. ICAO's role in the co-ordination and use of frequency spectrum in respect of communications and navigation in support of international civil aviation shall continue to be recognized.

4. TECHNICAL COOPERATION

In the interest of globally co-ordinated, harmonious implementation and early realization of benefits to States, users and providers, ICAO recognizes the need for technical co-operation in the implementation and efficient operation of CNS/ATM systems. Towards this end, ICAO shall play its central role in co-ordinating technical co-operation arrangements for CNS/ATM systems implementation. ICAO also invites States in a position to do so to provide assistance with respect to technical, financial, managerial, legal and co-operative aspects of implementation.

5. INSTITUTIONAL ARRANGEMENTS AND IMPLEMENTATION

The CNS/ATM systems shall, as far as practicable, make optimum use of existing organizational structure, modified if necessary, and shall be operated in accordance with existing institutional arrangements and legal regulations. In the implementation of CNS/ATM systems, advantage shall be taken, where appropriate, of rationalization, integration and harmonization of systems. Implementation should be sufficiently flexible to accommodate existing and future services in an evolutionary manner. It is recognized that a globally co-ordinated implementation, with full involvement of States, users and service providers through, inter alia, regional air navigation planning and implementation groups, is the key to the realization of full benefits from the CNS/ATM systems. The associated institutional arrangements shall not inhibit competition among service providers complying with relevant ICAO Standards, Recommended Practices and Procedures.

6. GLOBAL NAVIGATION SATELLITE SYSTEM

The global navigation satellite system (GNSS) should be implemented as an evolutionary progression from existing global navigation satellite systems, including the United States' global positioning system (GPS) and the Russian Federation's global orbiting navigation satellite system (GLONASS), towards an integrated GNSS over which Contracting States exercise a sufficient level of control on aspects related to its use by civil aviation. ICAO shall continue to explore, in consultation with Contracting States, airspace users and service providers, the feasibility of achieving a civil, internationally controlled GNSS.

7. AIRSPACE ORGANIZATION AND UTILIZATION

The airspace shall be organized so as to provide for efficiency of service. CNS/ATM systems shall be implemented so as to overcome the limitations of the current systems and to cater for evolving global air traffic demand and user requirements for efficiency and economy while maintaining or improving the existing levels of safety. While no changes to the current flight information region organization are required for implementation of the CNS/ATM systems, States may achieve further efficiency and economy through consolidation of facilities and services.

8. CONTINUITY AND QUALITY OF SERVICE

Continuous availability of service from the CNS/ATM systems, including effective arrangements to minimize the operational impact of unavoidable system malfunctions or failure and achieve expeditious service recovery, shall be assured. Quality of system service shall comply with ICAO Standards of system integrity and be accorded the required priority, security and protection from interference.

9. COST RECOVERY

In order to achieve a reasonable cost allocation between all users, any recovery of costs incurred in the provision of CNS/ATM services shall be in accordance with Article 15 of the Convention and shall be based on the principles set forth in the Statements by the Council to Contracting States on Charges for Airports and Air Navigation Services (Doc 9082), including the principle that it shall neither inhibit nor discourage the use of the satellite-based safety services.

Chapter 2: Air Traffic in CAR/SAM Regions

2.1 Traffic Forecasts in CAR/SAM Regions

2.1.1 During the period between 1960 and 1995, world -wide economical activities, measured in terms of the Gross Domestic Product (GDP), have increased at an annual average growth rate of 3.7%.

2.1.2 For years, air transport growth has been considerably higher than economical growth, but have always maintained close interrelationship. During the same period referred to above, world-wide passenger traffic (domestic and international) measured in terms of passenger-kilometer, has increased at an annual average growth rate of 8.9%, while in terms of air cargo, measured in tons-kilometers, flows have increased at an annual average growth rate of 11.1%.

2.1.3 Future air transport growth will fundamentally depend on economical growth and on trade exchange, as well as on the evolution of airlines= operations costs, which, in turn, greatly depend on the behaviour of fuel costs. Nevertheless, it is also subject to the degree in which the industry faces problems related to airport and airspace congestion, as well as to environment protection and the increasing need of capital investment.

2.1.4 It is foreseen that until 2005, world-wide GDP will increase at an annual average growth rate of 2.5%, in real terms. Likewise, it has been forecasted that world-wide regular air traffic shall increase at a Aprobable@ annual average growth rate of 5.5%, while air cargo traffic would grow at an annual average growth rate of 7%.

2.1.5 With regard to the CAR/SAM Region, through the observance of States/Territories increasing economy trend and the GDP behaviour, an annual average growth rate slightly higher to the current annual average growth rate (2.9%) is estimated. With respect to air transport, an annual average growth rate of 4.5% is expected in terms of passengers, and 6.5% in air cargo.

2.2 Air Traffic Forecasting Task Force

2.2.1 In order to elaborate air traffic forecasts for the CAR/SAM Regions, GREPECAS established a Task Force with the following Work Programme:

Work Programme

a) Identify the data source (area control centres or ATS units) and the data requirements for preparation of oceanic and regional air traffic forecasts for the medium- (3 to 5 years) and long- term (6 to 20 years).

b) Develop medium- and long- term passenger, freight and total aircraft movement forecasts for the CAR and SAM Regions, aimed at planning air navigation systems, taking into consideration that:

i) the forecasts should be developed using a methodology which links passenger and freight demand with aircraft movement forecasts directly and in a consistent manner;

ii) the forecasts should, in the first instance, cover primary inter-continental traffic flows between the CAR and SAM Regions and points in the United States, as well as the traffic flows in the Mid and South Atlantic.

iii) at a later stage, the forecasts should also cover other East-West inter-continental traffic flows, as well as other intra-regional flows.

c) Carry out a statistical survey in the CAR/SAM Regions, defining where and when it is not possible to use the optimum flight level requested by users, taking into account the following parameters:

i) ATS routes used;

ii) flight level requested by the user;

iii) level assigned by ATS units; and

iv) longitudinal separation applied between aircraft in the route concerned.

2.2.2 It is expected that the forecasts which this Task Force elaborates can be used to make future amendments to the Action Plan, in such a manner that the temporary evolution of ATM is based on the air traffic services demand.

2.3 Forecasts by the International Air Transport Association (IATA)

2.3.1 The statistics presented by IATA correspond to a period of traffic from 1985 to 1996 and to a forecast from 1997 to 2011. IATA will review and provide a more complete statistical report in the near future. The data presented cover international regular and charter flights. They do not include General Aviation nor Military Aviation.

International Passenger Traffic
(In thousands)

Within each Subregion*	1985	1996	Annual rate of growth1985 - 1996	Year 2001 forecast	Annual rate of growth1996 - 2001	Year 2011 forecast	Annual rate of growth from2001 - 2011
Caribbean	2178,2	3855,9	5.3%	4625,2	3.7%	6442,2	3.4%
Central America	3355	7102	7.1%	9149	5.2%	1296,4	3.5%
South America	1396,8	3707,2	9.3%	5225,1	7.1%	9404,2	6.1%
North America	3002	7705	8.9%	9441	4.1%	1943,7	7.5%

Between Subregions	1985	1996	Annual rate of growth1985 - 1996	Year 2001 Forecast	Annual rate of growth1996 - 2001	Year 2011 Forecast	Annual rate of growth2001 - 2011
Caribbean/Central America	2090	2911	3.1%	4036	6.5%	6588	5.0%
Caribbean/Lower South America	413	2546	18.0%	3903	8.9%	8107	7.6%
Caribbean/Upper South America	6109	8710	3.3%	1143,4	5.6%	1896,8	5.2%
Central America/Lower South America	565	3539	18.2%	5925	10.9%	1237	7.6%
Central America/Upper South America	4442	6899	4.1%	8809	5.0%	1493,4	5.4%
Lower South America/Upper South America	5150	1059,8	6.8%	15277	7.6%	3054,9	7.2%

* Caribbean: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Bermuda, Britanicas, Cayman Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadalupe, Haití, Jamaica, Martinica, Montserrat, Netherland Antilles, Puerto Rico, St. Kitts y Nevis, Saint Lucia and the Grenadines, Trinidad and Tobago, Turks and Caicos, Virgin Islands and Virgin Islands of the Unites States of America.
Central Americal: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama
Within lower South America: Argentina, Brazil, Chile, Paraguay and Uruguay.
Within upper South America: Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname and Venezuela.

International Passenger Traffic from/to the LAT/CAR Region to/from other Regions

		1985 actual passenger traffic in thousands	1996 actual passenger traffic in thousands	Annual rate of growth from 1985 to 1996	Year 2001 forecast passenger traffic in thousands	Annual rate of growth from 1996 to 2001	Year 2011 forecast passenger traffic in thousands	Annual rate of growth from 2001 to 2011
From/to each Subregion to a Region								
Caribbean	Asia/Pacific	0	0		0		0	
Caribbean	EUR/AFI/Middle East	1474	5765	13.2%	8296	7.6%	15176	6.2%
Caribbean	North America	12580	18495	3.6%	23364	4.8%	33688	3.7%
Central America	Asia/Pacific	170	300	5.3%	810	22.0%	2380	11.4%
Central America	EUR/AFI/Middle East	4250	1295	10.7%	1863	7.5%	3201	5.6%
Central America	North America	7218	14780	6.7%	21224	7.5%	36005	5.4%
Lower South America	Asia/Pacific	760	3960	16.2%	8020	15.2%	1997	9.6%
Lower South America	EUR/AFI/Middle East	1299	3131	8.3%	4582	7.9%	8711	6.6%
Lower South America	North America	1019	3911	13.0%	6286	10.0%	11918	6.6%
Upper South America	Asia/Pacific	30	110	12.5%	340	25.3%	1930	19.0%
Upper South America	EUR/AFI/Middle East	8310	1743	7.0%	2277	5.5%	4035	5.9%
Upper South America	North America	1502	3807	8.8%	5245	6.6%	8406	4.8%
	Total	26444	53364	6.6%	74054	6.8%	123568	5.3%

Aircraft Movement from the LAT/CAR Region to other Regions outside the Americas

		Total movement in 1985	Total movement in 1989	Annual rate of growth from 1985 to 1989	Total movement in 1997	Annual rate of growth from 1989 to 1997
Caribbean	Asia Pacific	n/a	n/a	n/a	n/a	n/a
Central America	Asia Pacific	n/a	n/a	n/a	n/a	n/a
Lower South America	Asia Pacific	1,159	196	-35.9%	315	6.3%
Upper South America	Asia Pacific	n/a	n/a	n/a	n/a	n/a
Caribbean	EUR/AFI/Middle East	3,033	4,139	8.1%	9,195	10.5%
Central America	EUR/AFI/Middle East	81	36	-18.4%	2,254	67.7%
Lower South America	EUR/AFI/Middle East	3,467	4,176	4.7%	7,984	8.5%
Upper South America	EUR/AFI/Middle East	1,386	2,05	10.3%	2,986	4.8%
	Total	9126	10597		22734	

Aircraft movement from/to the LAT/CAR from/to USA/Canada

		Total movement in 1985	Total movement in 1989	Annual rate of growth from 1985 to 1989	Total movement in 1997	Annual rate of growth from 1989 to 1997
Upper and lower SAM North	USA* - Atlantic	5,03	7,697	11.2%	21,861	13.9%
Upper and lower SAM	USA - East Central	0	0		182	
Upper and lower SAM	USA - Northeast	1,765	2,802	12.2%	7,334	12.8%
Upper and lower SAM	USA - Pacific	313	349	2.8%	1,347	18.4%
Upper and lower SAM	USA - West Central	10	82	69.2%	2,169	50.6%
Upper and lower SAM	Canada	188	390	20.0%	269	-4.5%
Caribbean	USA - Atlantic	59,507	71,142	4.6%	65,56	-1.0%
Caribbean	USA - Deep South	0	119		44	-11.7%
Caribbean	USA - East Central	291	333	3.4%	1,267	18.2%
Caribbean	USA - Mid West	20	270	91.7%	123	-9.4%
Caribbean	USA - New England	744	1,768	24.2%	1,127	-5.5%
Caribbean	USA - Northeast	9,768	13,532	8.5%	12,635	-0.9%
Caribbean	USA - Pacific	98	214	21.6%	59	-14.9%
Caribbean	USA -West Central	677	593	-3.3%	292	-8.5%
Caribbean	Canada	1,993	2,142	1.8%	2,555	2.2%
Mexico	USA - Atlantic	3,416	4,4	6.5%	8,841	9.1%
Mexico	USA - Deep South	5	180	144.9%	145	-2.7%
Mexico	USA - East Central	2,164	3,035	8.8%	3,604	2.2%
Mexico	USA - Mid West	0	0		532	

* United States of America is subdivided as follows:

New England: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont.
Northeast: New Jersey, New York and Pennsylvania.
Atlantic: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia y West Virginia.
East Central: Illinois, Indiana, Michigan, Ohio and Wisconsin.
Deep South: Alabama, Kentucky, Mississippi and Tennessee.
Mid West: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota.
West Central: Arkansas, Louisiana, Oklahoma and Texas.
Mountain States: Arizona, Colorado, Idaho, Montana, Nevada, New México Utah and Wyoming.
Pacific: California, Oregon and Washington.

		Total movement in 1985	Total movement in 1989	Annual rate of growth from 1985 to 1989	Total movement in 1997	Annual rate of growth from 1989 to 1997
Mexico	USA - Mountain States	1,652	1,966	4.4%	7,601	18.4%
Mexico	USA - New England	0	0		4	
Mexico	USA - Northeast	1,682	2,245	7.5%	3,374	5.2%
Mexico	USA - Pacific	9,118	13,295	9.9%	19,875	5.2%
Mexico	USA - West Central	11,827	16,545	8.8%	26,951	6.3%
	Total	110,268	143,099		187,751	

2.4 Airport Development in the CAR/SAM Regions

2.4.1 The expansion and development of existing airports with restricted capacity will resolve the current and expected problems of airport congestion and also could increase air traffic movement in the CAR/SAM Regions. The following airport development projects have been approved and some have already been executed by the aviation authorities:

1.	Oranjestad/Reina Beatrix New taxiway Extension of passenger terminal Platform expansion	Aruba
2.	Bridgetown/Grantley Adams Intl. New air terminal Runway and taxiway improvements	Barbados
3.	Cochabamba/J Wilsterman Intl. Passenger terminal building Operating building Control tower taxiways and apron	Bolivia
4.	La Paz/J. F. Kennedy Intl. Passenger terminal building expansion Operating building - Executed Control tower - Executed	Bolivia
5.	Brasilia/Intl. Airport expansion - Executed Construction of new runway	Brazil
6.	Campinas/Viracopos Cargo Terminal	Brazil
7.	Curitiba/Intl. New passenger terminal - Executed	Brazil
8.	Fortaleza/Pinto Martins New passenger terminal	Brazil
9.	Porto Alegre/Salgado Filho New passenger terminal	Brazil
10.	Rio Branco New international airport	Brazil
11.	Rio de Janeiro/Intl. Passenger terminal 2 - Executed Cargo terminal	Brazil

12.	Sao Paulo/Guarulhos Intl. Passenger terminal 3 Cargo terminal Construction of new runway	Brazil
13.	Santiago/Arturo Merino Benítez Passenger terminal, second stage	Chile
14.	Bogota/Eldorado Second runway - Executed passenger terminal building second stage cargo terminal second stage Platform and taxiways expansion Construction of new runway	Colombia
15.	Cartagena/Rafael Nuñez Platform expansion	Colombia
16.	Liberia/Tomas Guardia Intl. Runway extension New passengers terminal	Costa Rica
17.	Habana/Jose Marti Passenger terminal 3	Cuba
18.	Camaguey/Ignacio Agramonte International passengers terminal	Cuba
19.	Varadero/Varadero Intl. Air terminal expansion	Cuba
20.	Barahona/Intl. Airport construction	Dominican Republic
21.	La Romana/De la Romana Intl. Runway expansion	Dominican Republic
22.	Puerto Plata/La Union Intl. New passengers terminal Platform expansion	Dominican Republic
23.	Quito/Mariscal Sucre New international airport	Ecuador
24.	Guayaquil/Simón Bolivar Runway expansion Passenger terminal	Ecuador
25.	San Salvador/El Salvador Intl. Expansion of passenger terminal	El Salvador

26.	Fort-de-France/Le Lamentin, Martinique New passengers terminal New cargo terminal	France
27.	Pointe-a-Pitre/Le Raizet, Guadaloupe New passenger terminal New cargo terminal Platform expansion	France
28.	Cayenne/Rochambeau Passenger terminal building expansion	France
29.	Guatemala/La Aurora Expansion of the passenger terminal	Guatemala
30.	San Pedro Sula/La Mesa Intl. Runway extension Radar installation	Honduras
31.	Mexico/Lic. Benito Juárez Intl. International terminal	Mexico
32.	Albrook/Marcos A. Gelabert Runway improvement New passenger	Panama
33.	Ciudad del Este New airport - Executed	Paraguay
34.	Lima-Callao/Jorge Chavez Intl. Expansion and improvement of the passenger terminal - Executed	Peru
35.	Port-of-Spain/Piarco Intl. New passenger terminal Runway extension	Trinidad & Tobago
36.	Maracaibo/La Chinita New international terminal	Venezuela

2.4.2 In the CAR/SAM Regions some national airports are expanding and developing into international airports, which would allow an increase in the air traffic.

Chapter 3: Planning considerations

3.1 Introduction

3.1.1 As traffic volumes grow world-wide, the demands on the ATS provider in a given airspace increase, as do the complexities of air traffic management. The number of flights unable to follow optimum flight paths also increases with an increase in traffic density. This creates pressure to upgrade the level of ATS by, *inter alia*, reducing separation standards.

3.1.2 Implementation of CNS/ATM systems are expected to be able to provide sufficient capacity to meet the increasing demand, while producing additional benefits in the way of more efficient flight profiles and increased levels of safety. The potential of new technologies to significantly reduce service costs, however, will require new arrangements in the provision of services and changes in air traffic management procedures.

3.1.3 Chapter 3 of the Global Plan provides the means to begin the process of identification of ATM requirements, on the basis of identified homogeneous ATM areas and major international traffic flows, followed by the determination of the regional and global CNS system elements needed to meet the ATM requirements.

3.2 Homogeneous ATM Areas and Major International Traffic Flows

Homogeneous ATM area

3.2.1 The method of identifying homogeneous ATM areas involves consideration of the varying degrees of complexity and diversity of the world-wide air navigation infrastructure. Based on these considerations, it is considered that planning could best be achieved, at the global level, if it were organized based on ATM areas of common requirements and interest, taking into account traffic density and level of sophistication required.

Major International Traffic Flows

3.2.2 Major international traffic flows consist of areas which include groupings of routes wherein it is specified a detailed plan for the implementation of CNS/ATM systems and procedures, where the objective is to attain a seamless system throughout the area concerned. These are defined by origin and destination geographic areas which could be States/Territories, specific portions of States/Territories, or groupings of smaller States/Territories. They may also include Oceanic and Continental en-route areas.

3.2.3 The basic planning parameter is the number of aircraft movements which must be provided with ATM services along a particular international flow. Estimates and forecasts of annual aircraft movements over the planning period are required for high level planning. Forecasts of aircraft movements in peak periods, such as during a particularly busy hour, are needed for detailed planning. Additionally, the establishment of major international traffic flows will require appropriate civil/military co-ordination and consideration of special use airspace (SUA).

3.3 Regional Plan

3.3.1 The objective of global planning is to provide general guidelines for regional planning activities, in order to ensure the interoperability and harmonization of the future regional air traffic management, communications, navigation, and surveillance systems. The global coordinated plan shall serve as a basis, not as a substitute, for the detailed implementation plans that were the responsibility of the regional planning bodies. The implementation of the future global CNS systems would not occur at the same time and at the same pace in all regions.

3.3.2 The ICAO Council, based on the results of the 10th Air Navigation Conference was of the view that each ICAO region should be responsible for the development of its strategy for the planning and implementation of CNS/ATM systems elements, in accordance with the global transition plan. This work has been included in the on-going work of regional planning groups.

3.3.3 Thus the implementation of the CNS/ATM systems was basically a regional responsibility, i.e. States/Territories or groups of States/Territories working together within the framework of the concept and implementation strategy developed for the respective region by the corresponding regional planning group. ICAO air navigation planning should continue to be conducted through the established regional planning process.

3.3.4 There is a vital need for effective coordination of global and regional planning, as well as for inter-regional coordination. To achieve this last objective, the ICAO Council established the ICAO CNS/ATM Implementation Advisory Group (ALLPIRG), which is composed by the Chairmen and Secretaries of all planning and implementation groups (PIRGs), by the Chairmen of the CNS/ATM/IC Subgroups and by representatives of bodies interested in the CNS/ATM systems. The Terms of Reference of this Group are the following:

Advise the Council on:

1) the type and role of the ICAO inter-regional co-ordination mechanisms for CNS/ATM systems and recommendations on inter-regional harmonization;

2) major implementation problems and their possible solutions;

3) the status of the Global Co-ordinated Plan, and recommending necessary updates and additions;

4) ideas for a mechanism to identify sources of technical assistance from Member States, industry, etc., recommending actions to facilitate assistance for CNS/ATM projects;

5) ways to assist regions and States/Territories in obtaining the required funding for CNS/ATM projects from Bretton Woods Institutions, regional development banks, commercial banks, donor countries, international organizations and industry;

6) ways to promulgate the benefits of CNS/ATM systems among governments, airlines and financial institutions.

3.3.5 Considering the global guidelines described in the preceding paragraphs, the CAR/SAM Regions should take into account the need to coordinate their regional plan with the adjacent Regions, especially with the NAM Region, since air traffic density between this Region and the CAR/SAM Regions is quite high. Coordination of the regional CAR/SAM planning for the CNS/ATM transition with the indicated regions will be necessary. Finally, in the long-term there would be a continuing need for coordination after the completion of the Global Transition Plan.

3.4 States/Territories Plans

3.4.1 States/Territories have the responsibility for implementation of the new CNS/ATM system within their areas of responsibility. It will however be necessary for each State within the CAR/SAM Region to develop and publish its own CNS/ATM implementation plan. These State Plans should be coordinated within the Flight Information Regions and with adjacent Flight Information Regions to ensure the optimum use is made of all aspects of CNS/ATM.

3.5 Airlines Plans

3.5.1 The airlines use data link systems such as ACARS of ARINC and Air Com of SITA for managing the operational movement of aircraft; in some scenarios such as the North Atlantic and the Pacific, these data systems have been used, to provide surveillance through ADS technique. Utilizing these present data link systems for air traffic services, within the evolving implementation process of the CNS/ATM system, will permit the use of the available technology to obtain prompt benefits within the CNS/ATM concept; nevertheless, the final data linking systems, as considered by ICAO, will be in compliance and shall form part of ATN.

3.5.2 The airlines agree to incorporate the future CNS/ATM system on an evolutionary basis. A consensus paper from 13 major airlines has been developed as a method of transition planning.

Chapter 4: Air Traffic Management (ATM)

4.1 ATM Objectives

4.1.1 The term Air Traffic Management is used to describe the activities connected with airspace administration and air traffic management that are carried out in an integrated manner by the aeronautical authorities of each State. It is related to the planning, organisation and effective use of airspace, as well as the safe and orderly flow of aircraft in the corresponding airspaces.

4.1.2 The general purpose of an ATM system is to allow aircraft operators to comply with foreseen departure and arrival schedules and to use their preferred flight profiles with a minimum of limitations and without jeopardising the agreed level of safety. To do this, the future system must evolve from the present system in such a way that user needs are met as fully as possible. At the same time, it must take advantage of the potential benefits to be gained from the application of the new technologies offered by CNS systems through international harmonisation of ATM standards and procedures.

4.1.3 The 10th Air Navigation Conference (September 1991) not only approved the aforementioned general objective put forward by the FANS Committee, but also stated that the main goal of ATM was to expedite and effectively maintain a safe and orderly traffic flow, duly taking into account the implementation and operation costs of the system.

4.1.4 The goals for the future ATM system can be summarized as follows:

1) maintain or increase the existing level of safety;

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

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

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

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

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

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

8) creation, to the maximum extent possible, of a single continuum of airspace, where boundaries are transparent to users;

9) organization of airspace in accordance with ATM provision and procedures;

10) minimization of airborne delays and holding, coupled with adjustment of flight-track schedules to achieve efficient traffic flows as well as efficient airspace and airport usage; and

11) improved ATS strategic planning to minimize future aircraft conflict and tactical conflict-resolution maneuvering by the ATS system.

4.2 Limitations of the Current ATM in the CAR/SAM Regions

4.2.1 The general conclusion to be reached from an evaluation of ATM in the CAR/SAM Regions is that its main limitations are related to deficiencies in the infrastructure supporting ATM parts or subsystems. Those to be emphasized in this case are the limitations inherent in the current communication, navigation and surveillance (CNS) systems, deficiencies in the operation of those systems in certain States/Territories or Flight Information Regions and also the deficiencies that affect the ATS, ASM and ATFM in greater or lesser degree. The most salient aspects of ATM limitation in the region are the following:

1) Obsolete ATS infrastructure in many cases;

2) Failures in the professional updating process of ATC personnel;

c) Limited implementation of RNAV routes in the ATS route network;

4) Lack of adequate civil/military co-ordination;

5) Insufficient operational supervision in ATS units;

6) Shortcomings of (AMS/AFS) communication systems;

7) Limited radar surveillance; and

8) Little use of automated functions in the ATS.

4.2.2 Shortcomings of En-route Operations

4.2.2.1 The most obvious indications of ATM shortcomings in en-route operations in the CAR/SAM Regions have to do with safety aspects, given the occurrence of ATS incidents and failure to meet to a large degree international civil aviation efficiency and economic requirements. With respect to the latter, mention could be made of the lack of optimum path routes (RNAV) and the impossibility of using preferential flight levels, due mainly to the difficulty of using smaller longitudinal separations and lack of uniformity in the application of the separation.

4.2.2.2 With regard to the above, it should be noted that an analysis of these limitations has made it possible to determine that their most relevant causes are connected with difficulties inherent in the current CNS system, resulting from natural limitations of the system, deficiencies in its operation, and a lack of implementation in some specific cases. These CNS limitations could be summarized as follows:

Air-ground Communications (AMS)

4.2.2.3 VHF adequately covers air-ground communication over continental areas with the heaviest traffic density in the CAR/SAM Regions. However, there is only partial VHF coverage, for the most part, in oceanic and remote continental areas, where air-ground communication tends to be based on HF systems, whose precision and reliability are affected by problems inherent in the nature of those systems.

4.2.2.4 Consequently, large portions of CAR/SAM FIRs do not enjoy air-ground communication at the level of efficiency established in Annex 11 to the Convention. The deficiencies noted in the AMS are instrumental in reducing the level of ATS supplied in the airspaces in question, with the resulting impact on navigation safety and efficiency.

Ground-to-ground Communications (AFS) for ATS Co-ordination

4.2.2.5 Switched network systems and point-to-point links cover voice ground-to-ground communication for ATS co-ordination between ACC pairs in the CAR/SAM Regions (ATS speech circuits). Although it meets the operational requirements of a large number of ACCs, the ATS speech circuit network suffers from technical problems and, in some cases, from lack of implementation. For this reason, the affected ACCs frequently have to resort to AMS HF frequencies and commercial telephone for ATS co-ordination. The result is higher costs for Administrations and inappropriate use of the AMS.

4.2.2.6 Consequently, several ACC pairs in the CAR/SAM Regions still have no speech communication at the level of reliability required for ATS co-ordination. These deficiencies, just like AMS deficiencies, have a negative impact on the quality of the ATS supplied, in addition to hindering or preventing an increase in airspace capacity because of the impossibility of reducing and standardising the existing aircraft separations in the two Regions. This means that aircraft, in several segments of the ATS routes, because of the separation applied, are forced to operate at flight levels that are not preferential, seriously harming users and creating a series of operational problems for the ACCs involved.

4.2.2.7 The deficiencies of the communication system, combined with other operational deficiencies that affect the ATS, generate ATM limitations for en-route operations, thus making it impossible to reduce separations. The end result is the impairment of air navigation efficiency and the contribution, to a certain extent, to the occurrence of ATS incidents.

Navigation

4.2.2.8 En-route navigation in the CAR/SAM Regions rests basically on conventional radio aid systems with limited coverage. The regional ATS route network is, consequently, a system of fixed tracks whose very structure keeps it from adjusting to user needs. The present navigation system is a limiting factor for ATM and requires improvement both in terms of eliminating inadequate paths on some of its routes and implementing a larger number of fixed and random RNAV routes to link up pairs of airports or TMAs with heavy traffic densities. This would make it possible to take advantage of both the RNAV capacity of the most modern aircraft, and the new (GNSS) navigation methods connected with the RNP concept to achieve optimum traffic circulation, with the consequent benefit to users.

Surveillance

4.2.2.9 Although recent years have seen substantial improvements in en-route surveillance, with the implementation and modernisation of radar systems in a large part of the airspace of the CAR/SAM Regions, surveillance has been restricted to position reports sent by pilots via air-ground communications. These limitations, added to those in communications, have given rise to the wide separations that are applied in some parts of the airspace, thereby limiting its capacity and, thus, affecting air navigation efficiency.

4.2.3 Limitations of Terminal Area Operations

4.2.3.1 Although ATM normally has more CNS elements available in terminal areas than those used for managing en-route operations, it should be noted that the type of airspace differs substantially. This is particularly true with regard to the heavier traffic densities that must be handled, traffic complexity, topographical difficulties, different aircraft performances, etc. In most cases, the ATC does not have automated systems to handle departures and arrivals more efficiently, thereby under-using the airborne avionics capacity. Standard departure and arrival routes (SID and STARS) are inflexible and are based on conventional navigation systems, making it necessary to adopt paths that are not optimum and, in many cases, affecting the regularity and efficiency of air operations. Furthermore, noise abatement and environmental protection procedures that are becoming increasingly demanding impose more restrictions on operations in the terminal area and near the airports. And lastly, the separation criteria applied in many terminal areas have impeded optimum use of the respective airspace.

4.2.4 Limitations of Aerodrome Surface Operations

4.2.4.1 The surveillance and control of aerodrome surface operations in the CAR/SAM Regions, with a few exceptions in which the ASDE system is employed, is carried out using visual means and conventional communications, without the support of automated systems for guiding and controlling the movement of aircraft and vehicles on the surface. This ATM limitation is already affecting some airports in the CAR/SAM Regions which are operating at the limit of their capacity, especially during periods of peak demand. In order to increase the capacity of these airports without reducing their safety margins, some enhanced surveillance functions are required. Furthermore, the ATC does not have the proper means for verifying whether flight crews do as authorised during their movements at the airport. In many cases, there is already some congestion in air-ground communications, which can cause errors or confusion resulting from voice communications.

4.3 ATM Evolution in the CAR/SAM Regions

4.3.1 Homogeneous Areas

4.3.1.1 Although changes in the ATM system will be evolutionary, the design for the future system should offer a series of well-pondered, feasible improvements with a good cost-benefit ratio, that will meet user needs and culminate in a system that meets safety, capacity, efficiency, regularity and environmental protection requirements. Said design should envision a system implementation at various degrees of improvement, so that the services provided are appropriate to given applications and regions, thereby ensuring homogeneous, continuous and effective service from the pre-flight stage until its conclusion. It is also essential to guarantee an interface between adjacent systems so that boundaries remain transparent to airspace users.

4.3.1.2 Therefore, the evolution of ATM in the CAR/SAM Regions has been planned on the basis of an integrated regional ATM system, considering that the most advantageous approach would be the implementation of CNS/ATM systems through homogenous areas and major air traffic flows that operate in or through the CAR/SAM Regions.

4.3.1.3 Consequently, eight homogenous areas within the CAR/SAM Regions were defined considering the various degrees of complexity and diversity of the air navigation infrastructure, as well as the type of airspace in question, whether oceanic or continental areas with more or less traffic density. These homogenous areas not only cover CNS/ATM planning and implementation needs at the regional level, but also take into account the planning for adjacent regions.

4.3.2 **Main Air Traffic Flows**

4.3.2.1 The main air traffic flows, which include groups of ATS routes and are contained within the cited homogenous areas, have been defined as those important international air traffic currents between the airports or terminal areas with the heaviest traffic density in the CAR/SAM Regions and between these regions and adjacent ones. It should be recalled that the main traffic flows do not necessarily present all of the pairs of international airports and corresponding ATS routes, which were considered, however, as elements for defining said flows and homogenous areas.

4.3.2.2 Eighteen main air traffic flows were identified in the CAR/SAM Regions. Based on that, ATM evolution was planned and minimum communication, navigation and surveillance requirements were established for said evolution, both on board and for ground air navigation services.

4.3.3 **Evolution of En-route ATM**

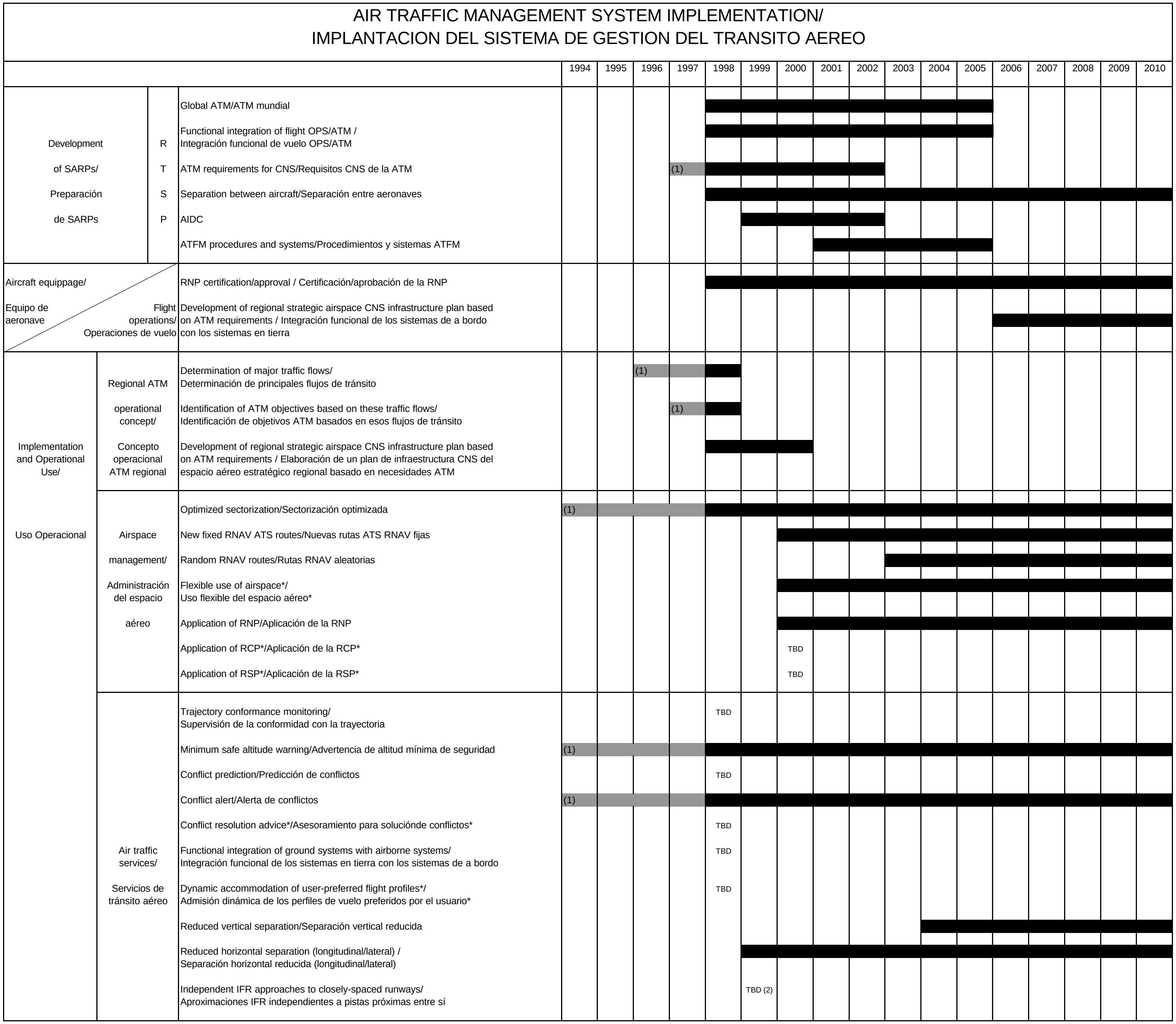
4.3.3.1 The evolution of en-route ATM for the CAR/SAM Regions has been planned considering first those improvements that may be implemented on the basis of the current systems such as, for example, the homogenous implementation in the two regions of the 10-minute longitudinal separation, continuing with the implementation of improved ATM functions, considering the new ICAO CNS/ATM systems. These improvements will be obtained to the extent that the current system operates with the necessary efficiency. The ATM Evolution Tables define, not only the necessary CNS requirements for implementing ATM improvements, but also the implementation dates of the planned improvements in the Flight Information Regions affected by the respective traffic flow.

4.3.4 **ATM Evolution in Terminal Areas and Airports**

4.3.4.1 ATM evolution in terminal areas of the CAR/SAM Regions, like that en route, will start with those improvements that may be applied on the basis of the existing systems. The evolution has been planned in such a way that the administrations themselves will identify their level of demand/density in each of the terminal areas and main airports that constitute their air navigation system. Based on that information, they will examine ATM improvements applicable to each specific TMA/airport, also bearing in mind, in addition to traffic density, aspects such as airspace type and organisation, total capacity of the system, geographic and weather conditions, etc., so as to adjust to user needs and avoid excessive delays in air operations. Furthermore, it is obvious that any ATM improvement must be accompanied by an evolution in the infrastructure of the major airports of the region, like, for instance, runways that will meet international air transportation needs, rapid exit taxiways, sufficient parking areas, etc. The implementation of state-of-the-art CNS elements to improve ATM in terminal areas would follow a natural course, taking into account the practical availability of those elements and cost-benefit aspects.

ATTACHMENT A / ADJUNTO A

AIR TRAFFIC MANAGEMENT EVOLUTION IN THE CAR / SAM REGIONS / EVOLUCION DE LA GESTION DE TRANSITO AEREO EN LAS REGIONES CAR / SAM



Chapter 5: Communications

5.1 Introduction

5.1.1 The communications element of CNS/ATM systems provides for the exchange of aeronautical data and messages between aeronautical users and/or automated systems. Communication systems are also used in support of specific navigation and surveillance functions.

5.2 Flexibility

5.2.1 The communications element of the ICAO CNS/ATM systems concept is very flexible, because some or all of the various system elements can be used to implement a complete system. Although satellites are an essential element (AMSS), the communications element also comprises other data link technologies such as VHF data link (VDL) in its different modes, SSR Mode S data link, HF data link (HFDL) and the ground ATS segment of the Aeronautical telecommunications Network (ATN). The air-ground communication element can be implemented using any or all or any combination of these data link technologies, all capable of interconnection to any ground system via services provided by the ATN. In this regard, States/Territories will be able to plan and implement in their airspaces data link technologies providing the communications means to satisfy ATM operational requirements. In many cases, for example, small States/Territories with continental airspace will be able to implement ATM functions with VDL data transmission, while in oceanic areas AMSS data link will have to be implemented if the VDL coverage or other ground based data link is unsatisfactory.

5.3 Communications services envisaged

5.3.1 Aeronautical communications include:

a) safety communications requiring high integrity and rapid response:

   1) safety-related communications carried out by ATS for ATC, flight information and alerting;

   2) aeronautical operational control (AOC) communications carried out by aircraft operators, which also affect air transport safety, regularity and efficiency (aeronautical operational control); and

b) non-safety related communications:

   1) private correspondence of aircraft operators (aeronautical administrative communications (AAC)); and

   2) public correspondence (aeronautical passenger communications (APC)).

5.3.2 In general, communication systems used in CNS/ATM systems are capable of carrying both of the above-mentioned categories. However, safety-related communications shall always have priority over non-safety ones.

5.4 Main Features of New Communication Systems

5.4.1 There are fundamental differences between conventional aeronautical communication systems and those which form parts of new CNS/ATM systems. The main difference between one and other system is that the communications systems supporting the CNS/ATM concept will make ATM automation and data transmission between ground systems possible, as well as between these and the aircraft systems, making optimal use of the automation functions implemented within the aircraft as in the ground ATM units. Even though air-ground and ground speech communications capacity will be taken into account in the CAR/SAM CNS/ATM systems plan, it would only be utilized in non-routine communications situations and in emergency cases, once there is an extensive implementation of the data link systems. Routine communications would be normally established through data link. The structure of the ATN inter-network to be progressively implemented, will permit a global inter-functioning of ATM applications. Figure 5-1 presents the ATN architecture.

Figure 5-1.- ATN Architecture

5.5 Implementation of Communications Systems in the CAR/SAM Regions

5.5.1 Implementation of data communications in the CAR/SAM Regions through air-ground and/or ground links will be progressively carried out, and as States/Territories can apply the new data communications technology within the timescale to be regionally determined. In this regard, States/Territories, upon planning data links, should take due note of the need to foresee the human resources necessary to support the implementation of ATM applications such as ADS-C, CPDLC, AIDC, etc., which will require of a proper management of the communications systems through which these ATM applications are to be established.

5.5.2 As a first step, States/Territories of the CAR/SAM Regions should employ new digital technology communications structures able to support the improvement of conventional systems, and provide the platform necessary to establish air-ground and ground data network permitting the evolutionary development towards ATN and its interface with current data systems, such as AFTN. This will substantially improve the current air navigation services and obtain a technology transfer that will permit the establishment and operation of data links.

5.5.3 As commercial systems become available and capable of implementing ICAO Annex 10 SARPs for an initial use of ATN, in correspondence to the CNS/ATM-1 SARPs package, sub-networks with WAN and/or LAN architecture, such as X.25, Frame Relay, ISDN, Ethernet, etc., would be established in the CAR/SAM States/Territories. Based on these network structures, the States/Territories may implement the ground segment of ATN. Applications such as the ATS message service (AMHS) and AIDC will progressively be implemented, while AFTN and ATS speech coordination communications for en-route air operations would be maintained in sites deemed necessary during the transition period. States/Territories initial plans for the evolutionary development of the CAR/SAM ATN show this trend. The use of AFTN/AMHS gateways as a strategy for a progressive migration from AFTN to ATN has been taken into consideration.

5.5.4 With regard to the ground-ground data links, an extensive use of VDL for CPDLC and ADS-C ATM applications is foreseen. VDL would be, in principle, implemented in Mode 2, in correspondence to the plans of the industry and of the ATS provider States. The voice communications capacity would be maintained through the current systems. Once SARPs for VDL in Mode 3 are available, the implementation of voice and data channels in the same VHF frequency carrier would be carried out. The industry is building VDL equipment with multimode capacity adjustable by software, which will facilitate the implementation of the various VDL modes. The VDL data links will inter-operate with the ground part through the ATN inter-network, expected to be available in 2004 in some FIRs of the CAR/SAM Regions.

5.5.4.1 For the remote and oceanic areas without VHF coverage, satellite air-ground data links for the AMSS should be planned, using the current geostationary satellite systems. Note should be taken that the HF data link (HFDL) can be a complement to AMSS and also provide a sub-network compatible with the ATN. On the other hand, in the planning of satellite links, note should be taken of the feasibility to aviation safety which the non-geostationary new generation of satellite systems (NGSS), such as the low and medium earth orbit (LEOs and MEOs) may provide in the future to aviation. ICAO considers feasible the use of services for the AMSS to be provided by this new generation of satellites.

5.5.5 SSR Mode S data links have not been planned since no surveillance requirement with this Secondary Surveillance Radar has been foreseen.

5.6 Implementation Timescale

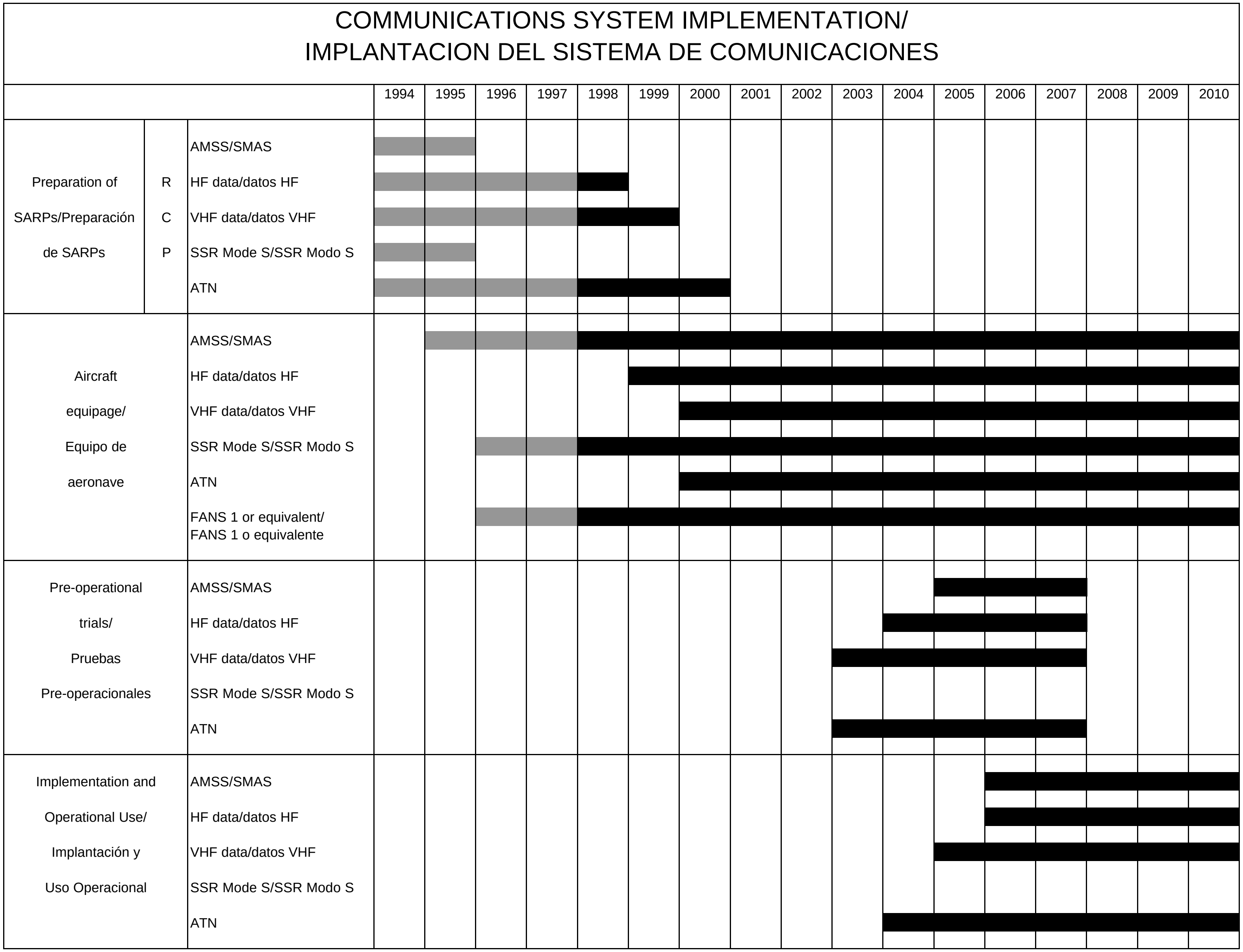
5.6.1 The main events for the implementation of the new communications system are shown in **Attachment A,** in keeping with the guidelines in the Global Plan and the activities being carried out on a worldwide basis. This programming will be modified as necessary to harmonize with any changes which can occur during the implementation period.

5.6.2 **Attachment A** maintains the information provided in the Global Plan regarding avionics and standards and procedures. The Global Plan shows trials and demonstrations events; nevertheless, in the Regional Plan they have been named pre-operational trials since in the CAR/SAM Regions there has not been real trial and demonstration programmes, except in isolated cases, and it is highly probable that in the future the trials and demonstrations to be carried out in air-ground and ground data communication be those necessary to test the systems within a specific period of time, while States/Territories absorb the technology for the later use of these systems in ATM operational environments.

5.6.3 The timescales with regard to implementation and operational use mean that the new communication systems will be executed in co-existence with the current system up to the year 2010. It is probable that, if the planning carried out by FIR which appears in the Action Plan were to be put into practice, by the year 2010 many of the current systems will be de-activated and the new communications systems will be servicing most of ATM operational requirements.

ATTACHMENT A / ADJUNTO A

REGIONAL COMMUNICATION SYSTEM IMPLEMENTATION / IMPLANTACION REGIONAL DEL SISTEMA DE COMUNICACIONES



Chapter 6: Navigation

6.1 Introduction

6.1.1 The navigation element of the CNS/ATM systems is the GNSS, which is a system to determine precise, trustworthy and continuous position and time throughout the world, through the introduction of satellite-based aeronautical navigation.

6.2 WGS-84 Coordinate System

6.2.1 In support of evolving satellite-based technology, ICAO adopted WGS-84 as the common geodetic reference datum for civil aviation with an applicability date of 1 January 1998 (Annex 15). Implementation of WGS-84 involves, among other things, the transformation of existing coordinates and reference data to WGS-84.

6.2.2 It is expected that in the CAR/SAM States/Territories the implementation of this new geodetic system be implemented by the end of 1998, thanks to an ICAO Special Implementation Project and to a LACAC Project backed by the United States Trade Development Agency (TDA). Both projects objective is to survey the WGS-84 geodetic data at States/Territories which have had difficulties in its establishment.

6.3 Operational GNSS Framework for the CAR/SAM Regions

6.3.1 GREPECAS established a regional strategy for the introduction and application of non visual aids for approach, landing and departure. **Attachment A** contains the regional strategy.

6.3.2 GREPECAS recognized that the GLONASS constellation is still in a trial phase, and that GPS is being widely used. In this sense, it was agreed to consider as a first step of the GNSS operational evolution only the GPS and, when GLONASS is ready for operational utilization, include it with GPS as second phase. In accord with the above, the following GNSS operational evolution was adopted:

a) GPS

b) GPS and GLONASS

c) GPS/GLONASS + AUGMENTATION

d) GPS + GLONASS + CIVIL GNSS

e) CIVIL GNSS

Short Term: (including the present stage) use of GPS.

Medium Term: use of the GPS and GLONASS for the purpose of receiving broadcasts from the 48 satellites of both constellations, thus enhancing service integrity, precision, availability and continuity. Also during this period, complementary civil satellites will be gradually incorporated.

Long Term: civil GNSS systems.

GNSS Applications

6.3.3 GNSS applications in the CAR/SAM Region have been developed taking into account the scenarios defined in the first version of the CAR/SAM Regional Plan for the Implementation of the CNS/ATM systems and in ICAO Circular 267, A*Guidelines for the introduction and operational uses of the global navigation satellite system*@. Taking this into consideration, GREPECAS adopted the following GNSS applications for the CAR/SAM Regions:

GNSS APPLICATIONS IN THE CAR/SAM REGIONS, BY AIRSPACE

AIRSPACE	SUPPLEMENTARY MEANS (NOTE 2)	PRIMARY MEANS
Low-density en route oceanic/ continental airspace (Note 1)	Not applicable	GNSS + On board augmentation (Note 2)
High-density continental airspace	GNSS + On board augmentation	GNSS + On board augmentation + SBAS (Note 3)
High-density oceanic airspace	GNSS + On board augmentation	GNSS + On board augmentation + SBAS (Note 3)
High-density terminal areas	GNSS + On board augmentation	GNSS + On board augmentation + SBAS/GBAS (Note 4)

Note 1: Covers low-altitude, off-shore and remote areas.

Note 2: GNSS + on board augmentation will permit non-precision approaches.

Note 3: SBAS + on board augmentation will permit the use of GNSS as primary navigation method for non-precision and precision approaches up to Category I*.

Note 4: GBAS + on board augmentation will permit precision approaches of Category I*, II* and III*.

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* In accordance with the development and approval of ICAO SARPs.

6.3.4 **Operational Performance Requirements**

6.3.4.1 In order to meet the operational performance requirements (precision, integrity, availability and continuity) in all flight phases, the GNSS needs to have different levels of augmentation and to achieve this, the establishment of operational performance requirements will be needed, parameters which shall be defined by ICAO.

6.3.4.2 GREPECAS agreed that while the operational performance requirements are not defined in ICAO Annex 10, CAR/SAM States/Territories could provisionally use the performance requirements for en-route through non-precision approach and the performance requirements for precision approach, as a guide for early GNSS introduction, which are contained in Table 6-1. The combination of GNSS elements and a fault-free GNSS user receiver shall meet the signal-in-space requirements defined in this Table.

6.3.4.3 On the other hand, note should be taken that the GNSS Augmentation Plan is being developed by a Task Force of the CNS/ATM/IC Subgroup. Once the Regional Augmentation Plan is concluded and approved by the corresponding bodies, it should be included in this Regional Plan.

Note.-The concept of a fault-free user receiver is applied only as a means of defining the performance of combinations of different GNSS elements. The fault-free receiver is assumed to be a receiver with nominal accuracy and time-to-alert performance. Such a receiver is assumed to have no failures that affect the integrity, availability and continuity performance.

Table 6-1 Signal-in-space performance requirements

Typical operation(s)	**Accuracy lateral 95% (1)(3)**	**Accuracy vertical 95% (1)(3)**	**Integrity (2)**	**Time to alert (3)**	**Continuity (4)**	**Avail-ability (5)**	**Associated RNP type(s)**
En-route	2.0 NM (6)	N/A	$1\text{-}10^{-7}$/h	5 min.	$1\text{-}10^{-4}$/h to $1\text{-}10^{-8}$/h	0.99 to 0.99999	20 to 10
En-route, Terminal	0.4 NM	N/A	$1\text{-}10^{-7}$/h	15 s	$1\text{-}10^{-4}$/h to $1\text{-}10^{-8}$/h	0.999 to 0.99999	5 to 1
Initial approach, Non-precision approach, Departure	220 m	N/A	$1\text{-}10^{-7}$/h	10 s	$1\text{-}10^{-4}$/h to $1\text{-}10^{-8}$/h	0.99 to 0.99999	0.5 to 0.3
Instrument approach with vertical guidance (IPV)	220 m	9.1 m	$1\text{-}2\times10^{-7}$ per approach	10 s	$1\text{-}8\times10^{-6}$ in any 15 s	0.99 to 0.99999	0.3/125
Category I precision approach (8)	16.0 m	7.7 m to 4.0 m (7)	$1\text{-}2\times10^{-7}$ per approach	6 s	$1\text{-}8\times10^{-6}$ in any 15 s	0.99 to 0.99999	0.03/50 to 0.02/40

Notes:

1) The 95 percentile values for GNSS position errors are those required for the intended operation at the lowest height above threshold (HAT), if applicable.

2) The definition of the integrity requirement includes an alert limit against which the requirement can be assessed. These alert limits are:

Typical operation	Horizontal alert limit	Verticalale rt limit	Associated RNP type(s)
En-route	4 NM	N/A	20 to 10
En-route	2 NM	N/A	2 to 5
En-route, Terminal	1 NM	N/A	1
NPA	0.3 NM	N/A	0.5 to 0.3
IPV	0.3 NM	22.8 m	0.3/125
Category I precision approach	40.0 m	20.0 m to 10.0 m	0.03/50 to 0.02/40

A range of vertical limits for Category I precision approach relates to the range of vertical accuracy requirements.
3) The accuracy and time-to-alert requirements include the nominal performance of a fault-free receiver.
4) Ranges of values are given for the continuity requirement for en-route, terminal, initial approach, NPA and departure operations, as this requirement is dependent upon several factors including the intended operation, traffic density, complexity of airspace and availability of alternative navigation aids. The lower value given is the minimum requirement for areas with low traffic density and airspace complexity. The higher value given is appropriate for areas with high traffic density and airspace complexity.
5) A range of values is given for the availability requirements as these requirements are dependent upon the operational need which is based on factors that include: the frequency of operations, weather environments, the size and duration of the outages, availability of alternate navigation aids, radar coverage, traffic density, reversionary operational procedures. The lower values given are the minimum availabilities for which a system is considered to be practical but are not adequate to replace non-GNSS navigation aids. For en-route navigation, the higher values given are adequate for GNSS to be the only navigation aid provided in an area. For approach and departure, the higher values given are based upon the availability requirements at airports with a large amount of traffic assuming that operations to or from multiple runways are affected but reversionary operational procedures ensure the safety of the operation.
6) This requirement is more stringent than the accuracy needed for the associated RNP types, but it is well within the accuracy performance achievable by GNSS.
7) A range of values is specified for Category I precision approach. The 4.0 m (13ft) requirement is based upon ILS specifications. For performance which is not consistent with ILS specifications, appropriate operational procedures or restrictions may apply.
8) GNSS performance requirements for Category II and III precision approach operations are under review and will be included at a later date.

Note: This table is in process of approval, in accordance with ICAO procedures.

6.4 Implementation Timescale

Implementation Strategy

6.4.1 The global navigation satellite system (GNSS) is being introduced in the CAR/SAM Regions in an evolutionary manner. Most States/Territories in both Regions are using the GPS system as a supplementary aid, and some States/Territories have already established it as a primary aid in low density air traffic oceanic and remote continental areas. The following table shows the States of the CAR/SAM Regions which are using GPS as a supplementary and primary aid.

State	Suppl.	Prim.	State	Suppl.	Prim.	State	Suppl.	Prim.
Argentina	X		Colombia	X		Peru	X	
Bolivia	X		Costa Rica	X		United States	X	X
Brazil	X		Dominican Republic	X		Uruguay	x	X
Canada	X		Mexico	X		Venezuela	X	
Chile	X	X	Panama	X				

6.4.2 The main events for the transition to the new navigation system are shown in **Attachment B**. These events are in agreement with the guidelines established in the Global Plan and to worldwide and regional activities being carried out. This schedule will be modified as necessary for it to harmonize with changes which may arise during the implementation period.

6.4.3 **Attachment B** maintains the information provided in the Global Plan regarding avionics and standards and procedures. The Global Plan shows trials and demonstrations events; nevertheless, in the Regional Plan they have been named pre-operational trials since after a trial period States/Territories have been progressively implementing satellite navigation as a supplementary system. In the future and with respect to GBAS and SBAS augmentations, the trials and demonstrations to be carried out in air-ground and ground data communication, as well as those corresponding to aircraft operational performance on the basis of these augmentations, would be those necessary to test the systems within a specific period of time, while States/Territories absorb the technology for the later use of these systems in ATM operational environments.

6.4.4 The timescales with regard to implementation and operational use mean that the new navigation system and its augmentations will be executed in co-existence with the current system up to the year 2010. It is probable that, if the planning carried out by FIR which appears in the Action Plan were to be put into practice, by the year 2010 many of the current systems will be de-activated and the new navigation system will be servicing most of ATM operational requirements.

6.5 Guidelines for the Transition to the Navigation Systems

$ The global navigation satellite system (GNSS) is being introduced in an evolutionary way, first for its use in a supplementary route and later, as an only means radioelectric navigation system.

$ The ground infrastructure of the current air navigation systems should continue being available during the transition period.

$ States/Regions should consider the possibility of separating traffic according to navigation capacity and provide preferential routes to aircraft with better navigation performance.

$ States/Regions should coordinate their initiatives to guarantee that the standards and procedures with regard to separation applied to aircraft duly equipped are introduced practically simultaneously at each FIR through which a significant number of traffic circulates.

ATTACHMENT A

REGIONAL STRATEGY FOR THE INTRODUCTION AND APPLICATION OF NON-VISUAL AIDS FOR APPROACH, LANDING AND DEPARTURE

a) maintain the ILS as the ICAO standard precision approach and landing system as long as necessary and as long as it remains operationally acceptable and economically beneficial;

b) promote in the short term the use of GNSS in support of non-precision approach operations and the augmented GNSS for CAT I precision approaches and landing in accordance with the available SARPS and guidance material of ICAO;

c) promote and monitor the studies on the viability of CAT II and III GNSS operations with the corresponding necessary augmentations, to apply those capabilities in operationally acceptable and economically beneficial cases;

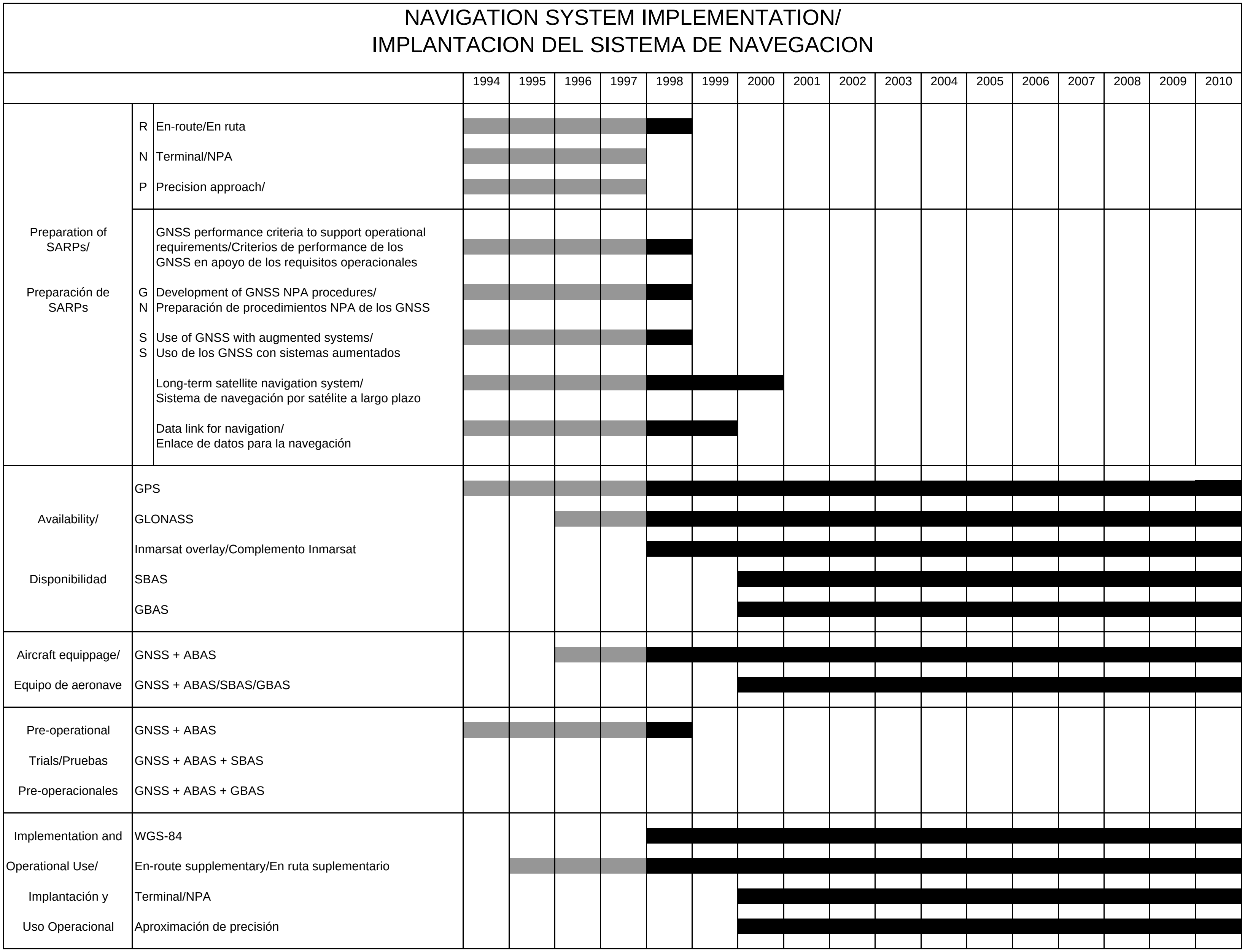
d) taking into consideration the projected availability of SARPS and guidance material of ICAO, in regard to GNSS operations, States/Territories requiring implementation of these systems for approach, landing and departure operations, conduct as soon as possible, studies for the implementation of local ground stations for complementary data link systems and for GNSS avionics equipment;

e) support the application of the required navigation performance (RNP) - for approach, landing and departure operations in accordance with ICAO provisions when applicable and

f) promote the development and validate the use of a multimode receiver (MMR) or the use of an on-board capability based on the operation, that allows the maximum transition flexibility in the future, in order to facilitate the transition and maintain the inter-functionability of air navigation systems and services.

ATTACHMENT B / ADJUNTO B

REGIONAL NAVIGATION SYSTEM IMPLEMENTATION / IMPLANTACION REGIONAL DEL SISTEMA DE NAVEGACION



Chapter 7: Surveillance

7.1 Introduction

7.1.1 Surveillance in the CAR/SAM Regions is currently based on the notification of position by voice or by primary (PSR) or secondary (SSR) surveillance radar.

7.2 Secondary Surveillance Radar (SSR)

7.2.1 SSR is in wide use in many parts of the world and in some zones of the CAR/SAM Regions where terrestrial line-of-sight surveillance systems are appropriate. In several States/Territories the accuracy and over-all performance of position information is improved by the application of monopulse techniques (including large vertical aperture antennas) and other advanced data processing techniques. In the CAR/SAM Regions, SSR Modes A/C surveillance will be widely used beyond the year 2010. SSR Mode S radar surveillance, which permits aircraft selective interrogation through a 24 bits unique direction, is not foreseen to be used before the year 2010. Therefore, plans related to surveillance within the CNS/ATM systems concept does not consider SSR Mode S requirements. This is also reflected in the communications plan, with regard to SSR Mode S data links. SSR Mode A/C will be able to be replaced by SSR Mode S when traffic in certain terminal areas which now currently have a trend to transform into high-density traffic areas is incremented.

7.3 Primary Radar Surveillance (PSR)

7.3.1 The use of primary radar for international civil aviation will diminish with the increasing use of more advanced surveillance systems being contemplated within the CNS/ATM systems concept. Even though its use is declining, its need will continue to exist in those airspaces where there is a mix of SSR-equipped aircraft with non-SSR-equipped aircraft, with compatible services provided to both categories.

7.4 Automatic Dependent Surveillance (ADS)

7.4.1 In the CAR/SAM Regions, two types of automatic dependent surveillance are being taken into account, one by contract (ADS-C) and the other, by broadcast (ADS-B). The first, simply known as ADS, has been taken as surveillance application for the planning period, up to the year 2010. This type of surveillance can be implemented by data links at sub-networks compatible with the ATN inter-network. The second, or ADS-B, is foreseen to be used in the future, at a date to be determined (TBD). This kind of surveillance is a non-ATN application and can be implemented through VHF data links and by SSR Mode S.

7.5 Implementation Timescale

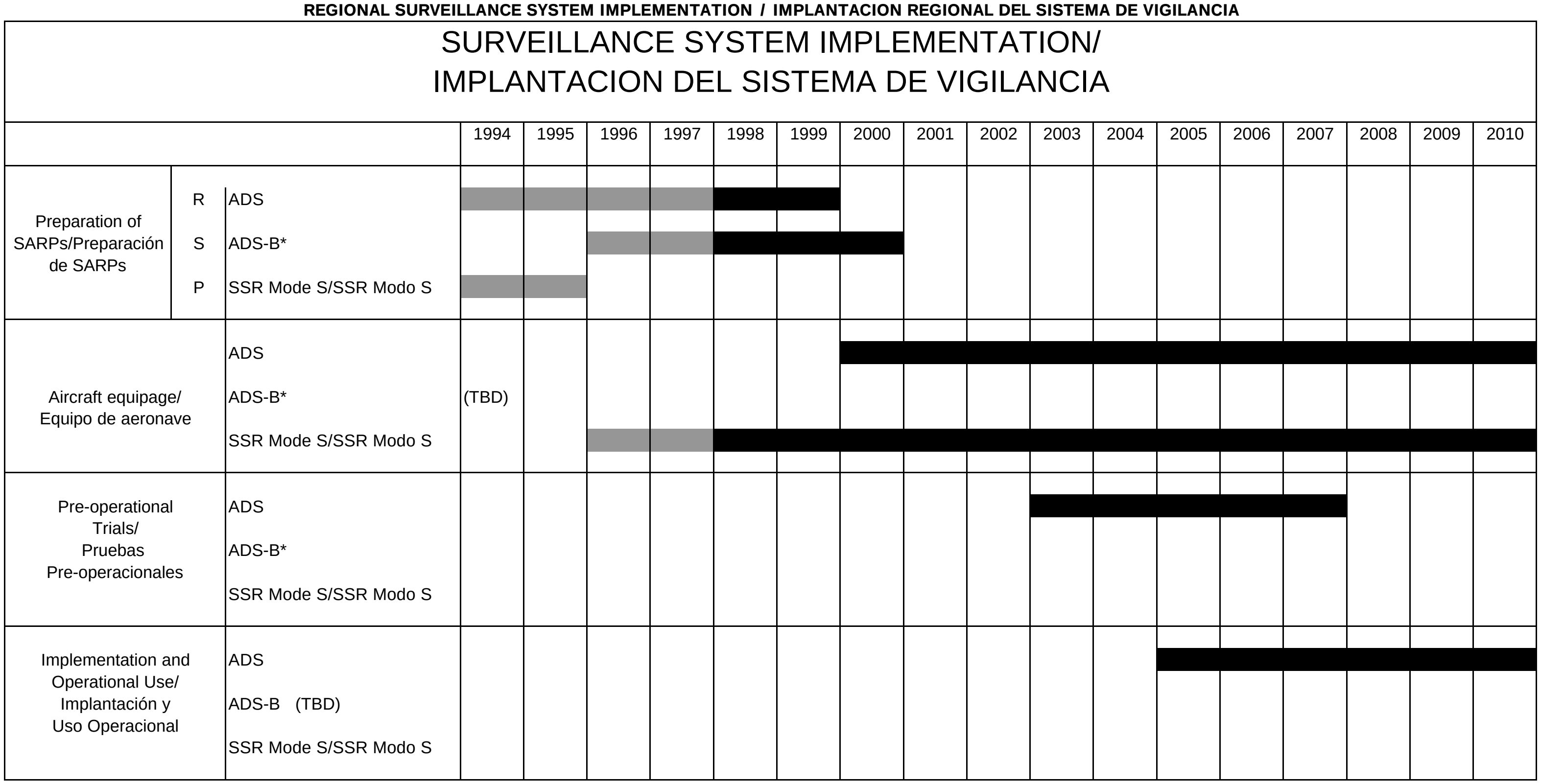
7.5.1 The benchmarks in the implementation of the new surveillance systems in the CAR/SAM Regions are shown in **Attachment A**. These events agree with the guidelines established in the Global Plan, and with the activities being carried out regionally and world-wide.

7.5.2 The timetable shown in **Attachment A** is in accordance with the requirements established in the evolution of ATM. Satellite capability, on-board equipment and the establishment of standards and procedures are those envisaged at a global level.

7.5.3 The time scales concerning implementation and operational use signifies that within those time scales, ADS-C surveillance functions will be implemented in correspondence with data link availability, co-existing as necessary with the current system until the year 2010. It is probable that, if the planning carried out by FIR which appears in the Action Plan were to be put into practice, by the year 2010, the current surveillance methods, mainly those notifying position by phone, will be de-activated, and the new surveillance techniques will be servicing most of ATM operational requirements.

ATTACHMENT A/ADJUNTO A

REGIONAL SURVEILLANCE SYSTEM IMPLEMENTATION / IMPLANTACION REGIONAL DEL SISTEMA DE VIGILANCIA



Chapter 8: Meteorology

8.1 Introduction

8.1.1 This chapter describes the ways in which the provision of meteorological information supports air traffic management and the technological developments in meteorological systems which will be required to facilitate the evolutionary transition to new ATM systems in the CAR/SAM Regions. It also addresses the co-ordinated national, regional and global planning of meteorological systems needed to realize the potential benefits from improved meteorological information in the new CNS/ATM systems.

8.2 Meteorological Support to International Civil Aviation

8.2.1 Traditionally, the provision of meteorological information to support international civil aviation was based primarily at the national level and organized hierarchically, with a specific meteorological office designated to be associated with each flight information centre (FIC)/area control centre (ACC), approach control unit and air traffic control tower. The associated meteorological offices supplied selected meteorological information necessary to enable each of the air traffic services units to meet its various obligations.

8.2.2 The meteorological information provided was related to a flight information region (FIR) and particular aerodromes required as destinations and alternates in that FIR and in immediately adjacent FIRs. Communication of this information beyond the FIRs concerned was tightly controlled so as not to overload the AFTN unnecessarily. The meteorological information was provided to pilots, *inter alia*, in face-to-face briefing in an airport meteorological office, in controller/pilot voice communications and through the ATIS and HF/VHF VOLMET broadcasts.

8.2.3 However, the fundamental changes in international civil aviation in the 1980s, which essentially prompted the creation of CNS/ATM systems, would also drive a parallel need for changes in the provision of meteorological services for international civil aviation.

8.2.4 These changes to the provision of meteorological services which began in the early 1980s comprised two main elements. The first was the development of the ICAO world area forecast system (WAFS) which, initially and for the case of the CAR/SAM Regions, centralized the production of global upper wind and temperature forecasts in the Washington world area forecast centre (WAFC), and the production of significant weather (SIGWX) forecasts in the Brasilia, Buenos Aires and Washington regional area forecast centres (RAFCs). The second element concerned the gradual change in the content and format of the meteorological information provided to pilots and a relaxation of the rules governing the exchange of OPMET messages to permit a wider distribution.

8.3 Meteorological Systems to Support the Transition to New Global CNS/ATM Systems

8.3.1 In order to support and facilitate the transition to CNS/ATM systems, the meteorological systems described will have to be further developed and focused more towards global requirements, in addition to national and regional requirements. These developments must meet aeronautical requirements to improve safety and provide an identifiable cost benefit to users. The systems must converge, as far as possible, towards a seamless and transparent global meteorological system for the provision of meteorological service to international civil aviation.

8.3.2 In many respects the WAFS and the ICAO direct satellite broadcasts have already made the transition to such a seamless and transparent system which, moreover, is also converging with systems for the exchange of OPMET messages. The global ATM system will require access to global meteorological information on a far shorter time scale than has been customary in the past. In many cases virtual "instant" access, including real-time data, will be required. Such stringent requirements will dictate that as many of the processes as possible, which the systems comprise, must be automated. The meteorologists' input will be increasingly transferred to the beginning of the processes, even to the extent of transferring knowledge and experience through artificial intelligence to dedicated expert systems.

8.3.3 Development of the meteorological systems to support a global ATM system will be required specifically in the following areas:

1) rapid progress to the final phase of the WAFS to obtain automated global upper winds/temperatures and SIGWX forecasts which may be input directly into ATC and airline computers;

2) continued extension of the three ICAO direct satellite broadcasts to exchange global OPMET messages and, as necessary, other non-MET aeronautical information;

3) availability at ATC centres and airline centralized operational control of background upper wind fields for display, both in the form of WAFS global upper wind forecasts and "real-time" wind fields derived from the wind information reported automatically from aircraft in ADS messages; and reports and forecasts of hazardous weather, particularly volcanic ash, thunderstorms, clear air-turbulence and icing, to assist in tactical decision-making for aircraft surveillance, air traffic flow management, and updating flight plans for flexible/dynamic aircraft routing;

4) automatic uplink of aerodrome weather observations to aircraft on approach or departure, including D-ATIS data link runway meteorological information and METAR/TAF/SIGMET data link to replace HF and VHF VOLMET; and dedicated systems to detect hazardous weather, such as automated TDWR;

5) automatic downlink of meteorological information derived from aircraft sensors (wind, temperature, turbulence and humidity) to ATC computers to provide background upper wind fields as described above, and real-time descent wind profiles to assist in the automatic sequencing of aircraft on approach to maximize runway capacity; and relay of this information to the Washington WAFC for assimilation in global numerical weather prediction models thereby improving the overall quality of subsequent global forecasts;

6) use of meteorological sensors including Doppler radar, possibly providing input to specialized systems which will provide automated runway wake vortex reports and forecasts to assist in optimizing aircraft separation, thereby maximizing runway capacity;

7) reduction in time delay for volcanic ash reports and advisories and associated SIGMETs to reach area control centres and aircraft in-flight from volcano observatories, Buenos Aires and Washington volcanic ash advisory centres (VAACs) and meteorological watch offices (MWOs) by employing more direct routing; and

8) harmonization of AIS and MET information to support combined automated AIS/MET pre-flight briefing facilities.

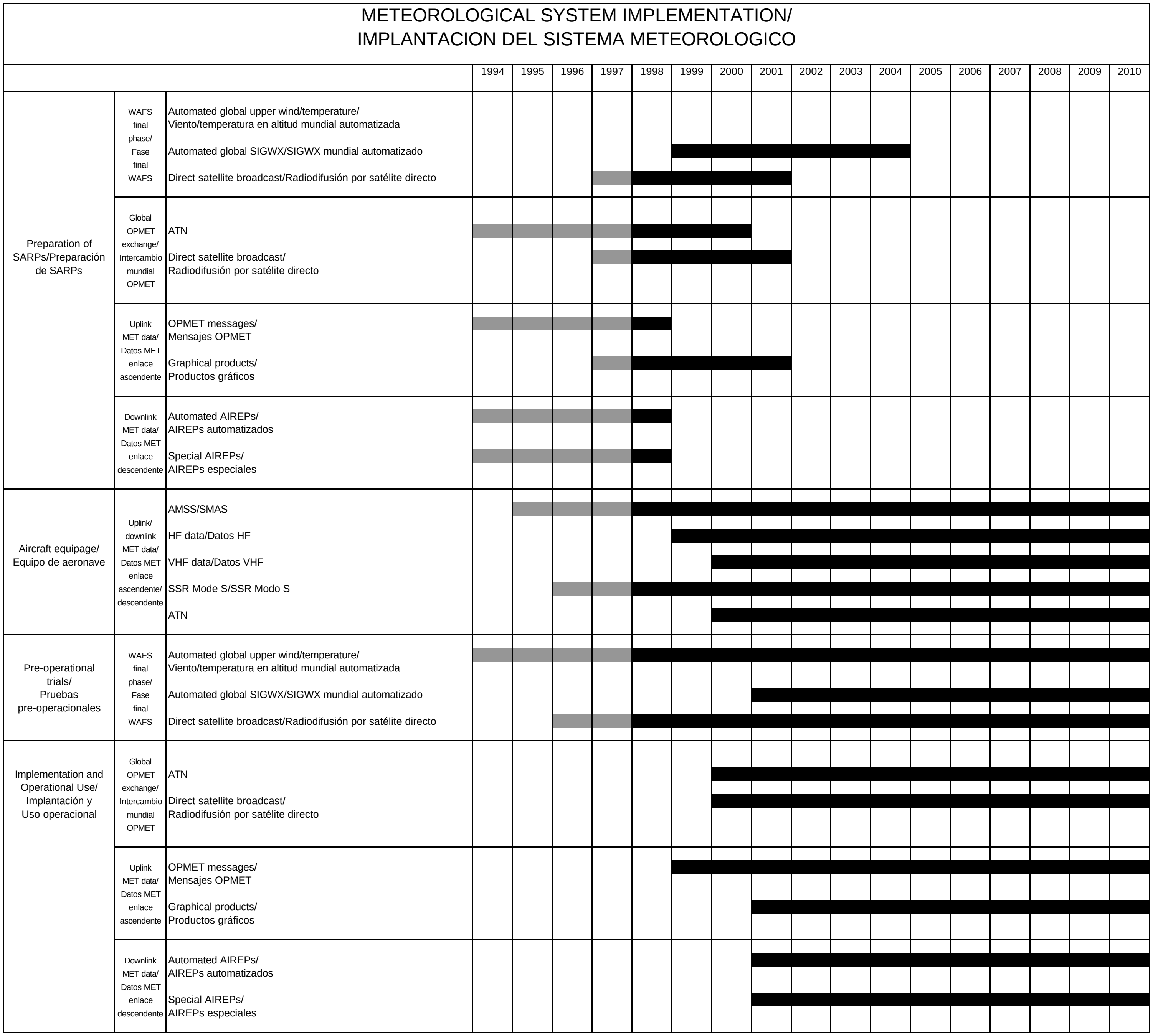
8.4 Planning and Implementation of Meteorological Systems

8.4.1 All of the elements necessary to satisfy the requirements referred to above are either currently in existence and others are being further developed, or are the subject of research and development by States/Territories. The implementation of these elements to form a seamless global system will proceed step by step as aeronautical requirements for the service are stated and reflected, as appropriate, in the relevant ICAO SARPs. This is critical in order to indicate clearly that the service is required by international civil aviation to contribute to the maintenance or improvement in air safety and/or provide a demonstrated cost benefit to users associated with global ATM. Once the requirements are firmly established, standardization of the relevant meteorological facilities and services will facilitate the planning of a seamless and transparent meteorological system to support the global ATM system.

8.4.2 In planning for the implementation of meteorological systems, account has to be taken of the existing national, regional and global meteorological and telecommunications infrastructures and a determination made as to which parts will be able to support the global ATM system and which will need to be upgraded or replaced.

ATTACHMENT A/ ADJUNTO A

REGIONAL METEOROLOGICAL SYSTEM IMPLEMENTATION / IMPLANTACION REGIONAL DEL SISTEMA METEOROLÓGICO



Chapter 9: Aeronautical Information Services

9.1 Introduction

9.1.1 This chapter, even though it briefly refers on the ways in which the provision of aeronautical information services (AIS) and aeronautical charts (MAP) has traditionally been provided, has the objective of presenting basic guidelines on the need for a new AIS/MAP approach oriented towards the support of global air traffic management systems and their associated automation systems. The chapter also outlines the developments which would be necessary in the AIS and MAP systems in support of air traffic management.

9.2 AIS and MAP Support to International Civil Aviation

9.2.1 The major objective of AIS is to ensure the flow of information necessary for the safety, regularity and efficiency of International Civil Aviation. In that respect each Contracting State is required to provide the service and is responsible for the information provided. Traditionally, aeronautical information has been provided as hard copy documents in the form of the Integrated Aeronautical Information Package which contains information for the entire territory and also areas outside the territory in which a State is responsible for the provision of air traffic services. The information must be provided in a suitable form and must be of high quality, be timely and include, as necessary, aeronautical information of other States/Territories. In addition, pre-flight and in-flight information service must be provided.

9.2.2 The current trend of the aeronautical information systems is oriented towards the automation of the aeronautical information/data, for their adequate, precise and in real-time provision, through a system guaranteeing the quality and integrity of the information provided.

9.3 AIS/MAP Systems to Support the Transition to the New Global CNS/ATM Systems

9.3.1 In order to support and facilitate the transition to new global CNS/ATM systems, the aeronautical information and charts systems will be redesigned and oriented towards the global requirements, in addition to national and regional requirements. These developments will be done in such a way that would improve safety and increase efficiency and cost-effectiveness to users. The goal, as far as possible, is the creation of a seamless and transparent global aeronautical information system.

9.3.2 It is envisaged that the global ATM system will require access to global aeronautical information that should be of a required quality. The ultimate goal would be to provide real time quality aeronautical information to users. To achieve this high-level requirement, aeronautical information must be provided in electronic form based on a commonly agreed and standardized data model. Strict quality principles will be put in place in order to ensure that aeronautical data is available, verified and validated in order to give the end user confidence in the correctness of the information.

9.3.3 Development of aeronautical information systems to support global ATM is specifically required in the following areas:

- implementation of the World Geodetic System -- 1984 (WGS-84) in support to the Global Navigation Satellite System (GNSS);

- introduction of a quality system in the origination, production, maintenance and distribution of aeronautical information;

- extension of the broadcast of aeronautical information through satellites to enable exchange of aeronautical data and messages associated with the status of ground-based databases;

- expedite development of the specifications required to implement direct up-link of aeronautical information (including charts) into aircraft along with the possibility for interrogation of aeronautical databases on the ground from the aircraft;

- harmonization of AIS, MET and flight plan (FPL) information to support combined automated AIS/MET/FPL pre-flight and in-flight briefing facilities.

Chapter 10: Human Resource Development and Training Needs

10.1 Introduction

10.1.1 The introduction to the new CNS/ATM systems will have a great impact on aeronautical personnel, not only with ground personnel, but also with flight crew. This is why training is one of the key elements for the success of this transition.

10.1.2 The evolution of aviation technologies has been gradual in the past, and trainers have, for the most part, been able to meet the challenges associated with change even though sophisticated training methodologies and tools have not always been at their disposal. However, the new CNS/ATM systems are based on many new concepts, which affect almost all air navigation services fields, therefore, their implementation presents a greater challenge to trainers.

10.1.3 ICAO undertook an initial study to assess the training implications of CNS/ATM systems. The objective of the study was to gain an early understanding of the amount of training that would be required by analysing the degree to which basic job disciplines in the aviation system will change with the introduction of the new technologies. While this was only a preliminary study, the results indicated that:

a) many aviation disciplines will change as a result of the introduction of CNS/ATM technologies, and it is likely that re-training will be required for a number of these disciplines. The most important changes seem to result from a higher use of computers, data communications and automation;

b) the change from ground to satellite-based technology will mean that several aviation disciplines will no longer be needed. At the same time, new aviation disciplines will emerge as a result of the introduction of CNS/ATM systems. From a human resource planning standpoint, there will be a need for re-deployment and training of personnel; and

c) the need for training and course development will be especially high during the transition phase. Not only will a large number of personnel have to be trained or re-trained on new technologies, equipment and procedures, but a sufficient number of qualified personnel will need to remain proficient in the skills necessary to operate and maintain the older systems.

10.1.4 CNS/ATM systems training needs can be seen as falling into three primary categories.

a) **Foundation training**. Early training in the fundamentals of automation, digital communications, satellite communications and computer networking is needed to provide all civil aviation personnel with the pre-requisite skills prior to receiving job specific training;

b) **Training for implementation planners**. Training is needed at a senior management level to provide decision makers with the basic information needed to begin planning for implementation of CNS/ATM systems. This type of training is needed for managers who will plan the implementation of CNS systems, as well as those managers who will be responsible for planning the ATM operational aspects of the systems; and

c) **Job specific training**. The third category of training needed is that necessary for personnel to manage, operate and maintain the systems on an ongoing basis. This category also represents the bulk of the training needed and the most complex to design, develop and implement. Taking this into consideration, ICAO has developed a strategy for the development of training programmes, as described in this chapter.

10.2 Foundation Training

10.2.1 In addition to the usual subjects covered in typical civil aviation training centres, some additional foundation or pre-requisite training will be necessary. This training will ensure that all personnel who will be involved with the planning, implementation, management, operation and maintenance of the new systems have an appropriate background in the base concepts and technologies. Such foundation training should be developed so that it addresses the specific needs of the technical and operational planners, as well as all personnel that will eventually be involved in the operation, maintenance and management of the new systems. The training needs include the following general areas:

a) CNS/ATM systems;

b) digital communications;

c) computer fundamentals;

d) computer communications, including local/wide area networks;

e) ISO's OSI reference model;

f) satellite communications systems used for fixed and mobile applications;

g) satellite navigation systems;

h) automation issues;

i) fundamentals of air traffic management; and

j) aeronautical databases.

10.3 CNS Systems Implementation Planning - Training Needs

10.3.1 The existing communication, navigation and surveillance systems have mostly been planned, implemented and operated by individual States/Territories. The new CNS/ATM systems, however, are global in nature and as such, are usually planned and implemented at a regional or global level. Regional implementation can be carried out by collective regional entities or commercial service suppliers. As a result, many States/Territories can simply buy CNS services with a minimum of local implementation of the systems.

10.3.2 Given the modality for the implementation of the technical systems, the technical management personnel of Civil Aviation Administrations (CAAs) will need to become familiar with the major functions and features of CNS systems, as well as the implementation, leasing and purchasing options available. They should then examine various options for systems implementation with their ATM colleagues and jointly decide upon their transition strategy. In this regard, training that provides an overview of the following CNS systems should be provided for senior technical management personnel:

a) Communication: AMSS, VDL, SSR Mode S datalink, HF datalink and ATN;

b) Navigation: GPS, GLONASS and various augmentation systems;

c) Surveillance: SSR Modes A, C and S, ADS and ADS-B*; and

d) relevant organizational, economic, certification and operational matters.

10.4 ATM Operational Implementation Planning -- Training Needs

10.4.1 Senior operational managers involved with transition planning to the new systems will need an overview of the topics listed above. In addition, operational managers should receive training in the following areas:

a) traffic forecasting and cost/benefit analysis techniques;

b) air traffic management;

   1) airspace planning;

   2) air traffic flow management (ATFM) systems and procedures;

   3) air traffic services (ATS) systems and procedures; and

   4) ATM-related aspects of flight operations;

c) CNS/ATM transition and implementation project planning;

d) human resource planning and training issues;

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* merging concept or technology-consensus still to be reached.

e) issues related to the increased use of automation in the new systems; and

f) operational and quality control issues associated with aeronautical databases.

10.4.2 As the existing systems will be operated in parallel with the new systems for a period of time, human resource planning and training will be a major challenge during the transition period.

10.4.3 CNS/ATM systems will result in a greater use of automation in many of the air traffic control functions that were previously performed manually. As a result, interactions between controllers and flight crews will take on a different dimension. Thus, it is important that the operational planners receive early training in these issues, including the full implications of automation, including backup procedures to be used in the event of system malfunctions. This area of training will also be important during the job specific training for anyone involved in operation of CNS/ATM systems.

10.5 Planning of Training

10.5.1 The planning of CNS/ATM training in the CAR/SAM Regions is being carried out through two bodies, adequately coordinated. The first of them corresponds to GREPECAS, through the Human Resources and Training Task Force established by the CNS/ATM/IC Subgroup, and the second, through the Civil Aviation Training Centres (CATC). A Guidance Manual for CNS/ATM Training has been established, and specific courses on the various elements composing the CNS/ATM systems have been identified, which are being developed by the various training centres for their later distribution to all CATCs of the CAR/SAM Regions.

Chapter 11: Legal Issues

11.1 Introduction

11.1.1 It has been generally agreed that there is no legal obstacle to the implementation of CNS/ATM systems and that there is nothing inherent in CNS/ATM systems which is inconsistent with the Chicago Convention. There is also a consensus that GNSS shall be compatible with the Chicago Convention, its Annexes and other principles of international law.

11.1.2 Presently, the legal aspects of CNS/ATM systems address mainly issues related the global navigation satellite system (GNSS), which is a key element of ICAO CNS/ATM systems.

11.1.3 The Council has been considering the question of a legal framework for GNSS, in the form of a new legal instrument, or several instruments of different types, for some time, with the assistance of the Legal Committee and a Panel of Legal and Technical Experts. Even though there is no consensus on the form of any new instrument, there has been much discussion on what features they might contain. The primary legal issue considered to require new law is how to secure accessibility and continuity of GNSS services. Corresponding to this issue, the institutional aspects mainly relate to the future operating structures for GNSS. Attention has been devoted both to legal considerations in respect of the existing systems and to the elaboration of a more complete and lasting legal framework for the long-term future.

11.1.4 The transitional arrangements with respect to the existing satellite navigation systems are governed by the Chicago Convention and relevant SARPs. In addition, aspects relating to the provision of the GNSS signal-in-space are the subject of the exchange of letters of ICAO respectively with the United States dated 14 and 27 October 1994 and the Russian Federation dated 4 June and 29 July 1996.The Panel of Legal and Technical Experts on the Establishment of a Legal Framework with Regard to GNSS (LTEP) was established by the ICAO Council on 6 December 1995, which has been given the mandate, inter alia, to consider the different types and forms of the long-term legal framework for GNSS and to elaborate the legal framework which would respond to certain fundamental principles. The consideration of the long-term legal framework has resulted in consensus on the text of a draft Charter on the Rights and Obligations of States Relating to GNSS Services (the “Draft Charter”, **Attachment A** to this chapter refers). Consideration of other legal issues has led to 16 Recommendations (**Attachment B** to this Chapter refers). The material in this Chapter is intended to assist States/Territories in identifying relevant legal issues which they may encounter in the planning and implementation of CNS/ATM systems.

11.2 Fundamental Principles of the GNSS Legal Framework

11.2.1 The Panel of Experts has prepared the Draft Charter which embodies certain fundamental principles applicable to the implementation and operation of GNSS. Some of these principles have been incorporated in the Policy on CNS/ATM systems Implementation and Operation, adopted by the Council on 9 March 1994 ("Council Statement of 1994"), as well as in the exchange of letters of ICAO with the United States and the Russian Federation. Some of the principles are essentially restatements and elaboration of provisions of the Chicago Convention. The Draft Charter will be submitted to the 32nd Session of the Assembly (22 September - 2 October 1998) for adoption.

11.2.2 The Safety of International Civil Aviation

11.2.2.1 The safety of international civil aviation is a paramount principle embodied in the Preamble and Article 44 (h) of the Chicago Convention. The Draft Charter, described above, provides for a specific reference to this principle in its paragraph 1:

> "States recognize that in the provision and use of GNSS services, the safety of international civil aviation shall be the paramount principle".

Accordingly, the safety of international civil aviation should be fully safeguarded at all times in the operation of GNSS, including modification to the system.

11.2.3 Universal Accessibility without Discrimination

11.2.3.1 The principle of universal accessibility without discrimination, which is also embodied in the Chicago Convention and ICAO practice, is of particular importance with respect to navigation satellites as compared to communication satellites. In the case of the latter, the existence of multiple providers and commercial competition will provide a natural basis for guarantee of accessibility. In the event of the lack of access to the services of one provider, the users will simply switch to another provider. Furthermore, the major commercial providers of satellite communication services (e.g. Inmarsat) provide in their constitutional instruments the legal guarantees for accessibility to the services without discrimination.

11.2.3.2 The case of navigation satellites is somewhat different. In certain cases, aircraft operators and providers of air traffic services have in the past relied on navigational signals generated by navigation aids outside their territory and not under their direct control (e.g., Loran, Omega, or shorter range navigation aids). GNSS will intensify such reliance on foreign systems. For the majority of user States/Territories, the existing GNSS facilities are controlled and operated by one or several States/Territories. For the time being, multiplicity of system providers and commercial competition do not exist in this field. While some consider that the existing systems do not require a separate legal framework, there has been concern among some potential civil users of GNSS and States/Territories with respect to the guaranteed access to, and continuity of such services. Accordingly, the Council Statement of 1994 affirmed explicitly that the principle of universal accessibility without discrimination shall govern the provision of all air navigation services by way of CNS/ATM systems. The principle, which restates and elaborates principles already enshrined in the Chicago Convention, has also been incorporated into the exchange of letters of ICAO with the United States and the Russian Federation concerning the provision of GPS and GLONASS.

11.2.3.3 The Draft Charter mentioned above provides that every State/Territory and aircraft of all States shall have access on a non-discriminatory basis under uniform conditions to the use of GNSS services, including regional augmentation systems within the area of coverage of such systems. The term “aircraft” is included in order to ensure that the aircraft of all States will have such access.

11.2.3.4 It may be concluded that the principle of universal accessibility without discrimination is now well accepted. The remaining issue is how to render it generally applicable. States/Territories in the process of planning and implementation of CNS/ATM systems could, if necessary, provide additional assurances through bilateral agreements or other arrangements to safeguard their accessibility.

11.2.4 **Continuity of Services**

11.2.4.1 Closely related to the issue of non-discriminatory access is the issue of the continuity of services. When GNSS becomes the primary means of air navigation and the traditional terrestrial facilities for air navigation will have become obsolete, the discontinuation of GNSS services, if decided unilaterally by the provider State, could theoretically force users to rely on redundant and backup systems that might not be convenient or economical for an extended period. The provision of GNSS services will always follow the principle of redundancy. GNSS will consist of a menu of options. The options range from an automatic switch to a back-up system on “stand-by”, which will be part of the institutional arrangements, to an institutional guarantee by an international organization which may make alternative services available. In their exchange of letters with ICAO, the United States and the Russian Federation have respectively committed to take all necessary measures to maintain the integrity and reliability of the services and each of them expects that it will be able to provide at least 6 years notice prior to termination of its services.

11.2.4.2 The Draft Charter states that every State/Territory providing GNSS services shall ensure the continuity, availability, integrity, accuracy and reliability of its services, including effective arrangements to minimize the operational impact of system malfunctions or failure, and to achieve expeditious service recovery. States providing services shall ensure that the services are in accordance with ICAO Standards. States/Territories shall provide in due time aeronautical information on any modification of the GNSS services that may affect the provision of the services.

11.2.4.3 The concept of continuity may be understood in either a technical or a legal sense. In the narrower technical sense, continuity may refer to effective arrangements to minimize the operational impact of unavoidable system malfunctions or failure and achieve expeditious service recovery. In a wider legal sense, continuity may also mean the principle that the services are not to be interrupted, modified, altered or terminated for military, budgetary or other non-technical reasons. It is recommended that States/Territories provide adequate safeguards to the principle of continuity in both the technical and legal meaning in the implementation and operation of CNS/ATM systems.

11.2.4.4 The Chicago Convention and its Annexes already provide standards for the integrity and reliability of air traffic services, including navigation aids, and additional SARPs for GNSS are being developed.

11.2.5 Respect of State/Territory Sovereignty

11.2.5.1 The principle of complete and exclusive sovereignty of States/Territories over the airspace above their territory is a cornerstone of customary international air law, which has been recognized by the Chicago Convention, 1944. The Council Statement of 1994 affirmed that implementation and operation of CNS/ATM systems which States/Territories have undertaken to provide in accordance with Article 28 of the Chicago Convention shall neither infringe nor impose restrictions upon State/Territory sovereignty, authority or responsibility in the control of air navigation and the promulgation and enforcement of safety regulations. The same principle has also been respectively reiterated in the exchange of letters of ICAO respectively with the United States and the Russian Federation. In providing the GPS and GLONASS signals to other States/Territories and their operators, the United States and the Russian Federation will not be performing functions under Article 28 of the Chicago Convention, but will only provide navigation aid signals for use in aircraft positioning.

11.2.5.2 The implementation of CNS/ATM systems will favour the concept of “seamless airspace” as opposed to airspace divided by flight information regions (FIRs) or territorial State/Territory boundaries. For example, one ATM facility may cover an entire region, replacing the work of many existing facilities. From a pragmatic point of view, the implementation of GNSS requires that a balance be struck between the need to respect State/Territory sovereignty and the need to promote the use of advanced air navigation and ATM technology. A necessary compromise may involve a certain flexibility in the exercise of certain sovereign rights, in particular by entrusting tasks of signal provision and augmentation to foreign States/Territories and/or joint agencies or operating structures, in exchange for additional benefits flowing from the public utility services of GNSS. Regional air traffic management arrangements are already functioning, or are under development, in a number of places, and functioning well.

11.2.6 **Compatibility of Regional Arrangements with the Global Planning and Implementation**

11.2.6.1 The planning and implementation of CNS/ATM systems is a complex, multifaceted, progressive process which must be carefully monitored and co-ordinated at the international level. Such a planning and implementation process could not be successful without global co-ordination. The responsibility of ICAO in this respect has been affirmed in the Council Statement of 1994 and described in Chapter 2 of the Global Plan.

11.2.6.2 Paragraph 5, subparagraph 2 of the Draft Charter provides that States/Territories shall ensure that regional or sub-regional arrangements are compatible with the principles and rules set out in the Charter and with the global planning and implementation process for GNSS. Since the implementation of CNS/ATM systems is a complex and far-reaching project, it will require that two primary conditions be met: the first is to devise and implement the systems according to a very well prepared plan; and the second is for all members of the global community to co-operate fully in its realization. Financial resources are limited and should ideally be used to achieve optimum results. Duplication of efforts should be minimized and mutual interference prevented. Regional or sub-regional arrangements should therefore promote the global integration of the system.

11.2.7 **Co-operation and Mutual Assistance**

11.2.7.1 Paragraph 7 of the Draft Charter provides that with a view to facilitating global planning and implementation of GNSS, States/Territories shall be guided by the principle of co-operation and mutual assistance. Paragraph 8 provides that every State/Territory shall conduct its GNSS activities with due regard for the interests of other States/Territories.

11.2.7.2 These proposed broad principles appear necessary in view of ICAO's objective to achieve a single, integrated, global CNS/ATM system. Since the global system will be a seamless one with airspace boundaries transparent to users, it will require an unprecedented degree of co-operation between international organizations, States/Territories, service providers and users at all levels; local, national, regional and global.

11.2.7.3 In the event that the space segments of GNSS encounter technical failure or malfunction, it might be necessary for the owner or controlling entity of the segments to receive co-operation and assistance from other States/Territories. ICAO has repeatedly emphasized that States/Territories should be guided by the principle of co-operation and mutual assistance.

11.2.7.4 For the above reasons, co-operation and mutual assistance are essential in the planning, implementation and operation of CNS/ATM systems. The forms of co-operation may vary, depending upon the situation in particular States/Territories or regions.

11.3 Other Legal Issues

11.3.1 In addition to the fundamental principles to be incorporated into the Draft Charter, there are other legal issues under consideration, such as:

a) certification;
b) liability;
c) administration, financing and cost recovery; and
d) future operating structures.

In considering these issues, LTEP has put forward 16 Recommendations (**Attachment B** to this Chapter refers) which, along with the report on the work of the Panel, will be submitted to the 32nd Session of the Assembly of ICAO, through the Legal Commission, for further guidance. Some of these recommendations refer to the need for further studies on certain subjects.

11.3.2 Certification

11.3.2.1 GNSS, like other air navigation facilities, requires certification by the relevant authorities in order to ensure that it complies with standards related to safety of international civil aviation. Recommendations 1 to 8 adopted by LTEP address the issues related to certification (see Attachment B to this Chapter).

11.3.3 Liability

11.3.3.1 Similar to terrestrial air navigation facilities, GNSS may, due to technical failure, inaccuracy or other reasons, become a cause of damage to aircraft, persons or goods on the ground or in flight. Issues relating to liability have been the subject of detailed discussions in LTEP and are reflected in Recommendations 9 to 11 (see Attachment B to this Chapter).

11.3.4 Administration, Financing and Cost Recovery

11.3.4.1 Recommendations 12 to 14 put forward by LTEP are related to the legal aspects of administration, financing and cost recovery of GNSS services. These recommendations refer, inter alia, to GNSS services as an international service for public use, identify the possible options for administrative mechanisms for GNSS, and consider the possible methods of financing GNSS (see Attachment B to this Chapter).

11.3.5 Future Operating Structures for GNSS

11.3.5.1 The term “future operating structure” is related to long-term GNSS, rather than the existing systems. It is ICAO's established policy that GNSS should be implemented as an evolutionary progression from existing global navigation satellite systems, including the United States' GPS and the Russian Federation's GLONASS, toward an integrated GNSS over which Contracting States exercise a sufficient level of control on aspects related to its use by civil aviation. Recommendations 15 to 16 put forward by LTEP address the related issues and identify certain possible fields of international action (see Attachment B to this Chapter).

ATTACHMENT A

DRAFT CHARTER ON THE RIGHTS AND OBLIGATIONS OF STATES RELATING TO GNSS SERVICES

Whereas Article 44 of the Convention on International Civil Aviation, signed on 7 December 1944 (the “Chicago Convention”), mandates the International Civil Aviation Organization (ICAO) to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport;

Whereas the concept of the ICAO communications, navigation and surveillance/air traffic management (CNS/ATM) systems utilizing satellite-based technology was endorsed by States and international organizations at the ICAO Tenth Air Navigation Conference, and was approved by the 29th Session of the Assembly as the ICAO CNS/ATM systems;

Whereas the Global Navigation Satellite System (GNSS), as an important element of the CNS/ATM systems, is intended to provide worldwide coverage and is to be used for aircraft navigation;

Whereas GNSS shall be compatible with international law, including the Chicago Convention, its Annexes and the relevant rules applicable to outer space activities;

Whereas it is appropriate, taking into account current State practice, to establish and affirm the fundamental legal principles governing GNSS;

Whereas the integrity of any legal framework for the implementation and operation of GNSS requires observance of fundamental principles, which should be established in a Charter;

[The Assembly solemnly declares] [States Parties recognize] that the following principles of this Charter on the Rights and Obligations of States Relating to GNSS Services shall apply in the implementation and operation of GNSS:

1. States recognize that in the provision and use of GNSS services, the safety of international civil aviation shall be the paramount principle.

2. Every State and aircraft of all States shall have access, on a non-discriminatory basis under uniform conditions, to the use of GNSS services, including regional augmentation systems for aeronautical use within the area of coverage of such systems.

3. a) Every State preserves its authority and responsibility to control operations of aircraft and to enforce safety and other regulations within its sovereign airspace.

b) The implementation and operation of GNSS shall neither infringe nor impose restrictions upon States' sovereignty, authority or responsibility in the control of air navigation and the promulgation and enforcement of safety regulations. States' authority shall also be preserved in the co-ordination and control of communications and in the augmentation, as necessary, of satellite-based air navigation services.

4. Every State providing GNSS services, including signals, or under whose jurisdiction such services are provided, shall ensure the continuity, availability, integrity, accuracy and reliability of such services, including effective arrangements to minimize the operational impact of system malfunctions or failure, and to achieve expeditious service recovery. Such State shall ensure that the services are in accordance with ICAO Standards. States shall provide in due time aeronautical information on any modification of the GNSS services that may affect the provision of the services.

5. States shall co-operate to secure the highest practicable degree of uniformity in the provision and operation of GNSS services.

States shall ensure that regional or subregional arrangements are compatible with the principles and rules set out in this Charter and with the global planning and implementation process for GNSS.

6. States recognize that any charges for GNSS services shall be made in accordance with Article 15 of the Chicago Convention [and shall be based on] [and should be based on] [noting] the principles set forth in the Statements by the Council to Contracting States on Charges for Airports and Air Navigation Services[, including the principle that it shall neither inhibit nor discourage the use of GNSS services. Such charges shall be apportioned in an equitable manner among all users of GNSS].

7. With a view to facilitating global planning and implementation of GNSS, States shall be guided by the principle of co-operation and mutual assistance whether on a bilateral or multilateral basis.

8. Every State shall conduct its GNSS activities with due regard for the interests of other States.

9. Nothing in this Charter shall prevent two or more States from jointly providing GNSS services.

ATTACHMENT B

RECOMMENDATIONS OF LTEP

Certification

Recommendation 1

ICAO SARPs on GNSS should cover the system performance criteria of relevant satellite components, signal-in-space, avionics, ground facilities, training and licensing requirements, and the system as a whole.

Such ICAO SARPs should contain adequate system performance and failure mode information
to enable States to reasonably determine the safety impact on their air traffic service.

Recommendation 2

With respect to all ICAO SARPs on GNSS, signal-in-space provider States and provider international organizations should be involved in the proposed ICAO verification and validation process so that SARPs and supporting ICAO documentation will be of high integrity.

Recommendation 3

States providing signals-in-space, or under whose jurisdiction such signals are provided, shall certify the signal-in-space by attesting that it is in conformity with SARPs.

The State having jurisdiction under the Chicago Convention should ensure that avionics, ground facilities and training and licensing requirements comply with ICAO SARPs.

Recommendation 4

States providing signals-in-space, or under whose jurisdiction such signals are provided, should ensure application of ongoing safety management processes which demonstrate continued compliance with signal-in-space SARPs.

Recommendation 5

States providing signals-in-space, or under whose jurisdiction such signals are provided, should produce a safety management system document using the ICAO forum referred to in Recommendation 8 below. To the extent possible, such document should be consistent as regards format and content. ICAO should distribute such signal-in-space safety management system documentation.

Recommendation 6

Each State should define and ensure the application of safety regulations for the use of the signal-in-space as part of air traffic services in its own airspace.

Recommendation 7

For the purpose of authorization by a State of the use of the signal-in-space in its airspace, additional information which may be required for such authorization should be made available and distributed through ICAO. Other sources for obtaining such information may be used, including, inter alia, bilateral and multilateral arrangements, Safety Case and NOTAMs.

Recommendation 8

States recognize the central role of ICAO in co-ordinating the global implementation of GNSS and in particular:

a) establishing appropriate Standards, Recommended Practices and procedures in accordance with Article 37 of the Chicago Convention in the implementation and operation of GNSS;

b) co-ordinating and monitoring the implementation of GNSS on a global basis, in accordance with ICAO's regional air navigation plans and global co-ordinated CNS/ATM systems plan;

c) facilitating the provision of assistance to States with regard to the technical, financial, managerial, legal and co-operative aspects of the implementation of GNSS;

d) co-ordinating with other organizations in any matter related to GNSS, including the use of frequency spectrum bands in which GNSS constituent elements operate in support of international civil aviation; and

e) carrying out any other function related to GNSS within the framework of the Chicago Convention, including functions under Chapter XV of the Convention.

More specifically, the ICAO forum for exchange of information on GNSS certification could have the following functions:

a) to provide liaison between State ATS providers, regulatory authorities, and signal-in-space providers;

b) to provide liaison between signal-in-space providers and other States with respect to the format and contents of safety management system documents;

c) to identify the failure modes of the signal-in-space and their impact on the safety of air traffic services nationally, and to refer them to an appropriate body as determined by the Council;

d) to identify what States require from signal-in-space providers in order to be confident that performance and risks associated with the signal-in-space are adequately managed over the life cycle of the system;

e) to facilitate information-sharing between signal-in-space providers and other States as to the continued compliance with the relevant SARPs, in order to maintain confidence in the reliability of the system.

Liability

Recommendation 9

The following concepts, among other matters, should be considered in relation to the liability regime for GNSS which should be further studied:

a) Fair, prompt and adequate compensation;

b) Disclaimer of liability;

c) Sovereign immunity from jurisdiction;

d) Physical damage, economic loss, and mental injury;

e) Joint and several liability;

f) Recourse action mechanism;

g) Channelling of liability;

h) Creation of an international fund (as an additional possibility or an option);

i) The two-tier concept, namely strict liability up to a limit to be defined, and fault liability above the ceiling without numerical limits.

Recommendation 10

With regard to the fault liability portion, signals should be recorded for purposes of evidence in accordance with ICAO SARPs.

Recommendation 11

In conducting the studies on the liability regime for GNSS referred to in Recommendation 9, the following matters should, inter alia, be taken into account:

a) How liability provisions concerning the operation, provision and use of GNSS services should ensure that damage arising from such services will be compensated in an equitable manner;

b) The vital role of the signal transmitted by navigation satellites for the safety of international civil aviation could raise the question whether disclaimers of liability would be appropriate in the case of navigation satellites, particularly in cases involving accidental death or injury;

c) Having due regard to Principles 3 and 4 on the Draft Charter on the Rights and Obligations of States Relating to GNSS Services, whether the doctrine of sovereign immunity should be excluded in liability claims based on GNSS so as to ensure adequate allocation of liability;

d) The practical experience in the commercialization of GNSS services as they develop;

e) Appropriate methods of risk coverage should be utilized so as to prevent the frustration of legitimate claims;

f) Whether and to what extent liability provisions should reflect the joint liability of all parties involved in the operation, provision and use of GNSS services;

g) Liability provisions should have due regard to and, where necessary, should supplement existing principles and rules of international law, including air and space law.

Administration, Financing and Cost Recovery

Recommendation 12

GNSS services should be considered as an international service for public use with guarantees for accessibility, continuity and quality of the services.

The principle of co-operation and mutual assistance, as enunciated in the Draft Charter on the Rights and Obligations of States Relating to GNSS Services, should be applicable, a fortiori, to the cost recovery of GNSS.

Recommendation 13

In the absence of a competitive environment regarding the provision of GNSS services, consideration should be given as to whether mechanisms should be desirable to prevent abuse of monopoly power on the part of GNSS providers.

The administrative mechanisms for GNSS should be at multilateral, regional and national level. The Danish-Icelandic Joint Financing Agreement could be a model but this would not exclude the use of other types of mechanisms, including existing regional arrangements.

Cost recovery schemes, if any, should ensure the reasonable allocation of costs among civil aviation users themselves and among civil aviation users and other system users.

Recommendation 14

The aviation user charges which may be considered as possible methods for financing of GNSS include the following:

a) yearly subscription charges per using operator;

b) yearly subscription charges per using aircraft;

c) yearly/monthly licence fees;

d) charges per flight;

e) charges in respect of different phases of flight;

f) charges based on total passenger-kilometres and tonne-kilometres;

g) regular en-route charges; or

h) a combination of the above.

The principles recommended in the ANSEP Report and in the ICAO Guidelines should in any event be taken into account.

Future Operating Structures

Recommendation 15

The future operating structures should include a co-ordinating role for ICAO with respect to the future GNSS, including the system providing the primary navigation signals in space.

The future GNSS primary signals in space should be civilian-controlled, with user States exercising an appropriate level of control over the administration and regulation of those aspects that relate to civil aviation.

To the extent practicable, the future systems should make optimum use of existing organizational structures, modified if necessary, and should be operated in accordance with existing institutional arrangements and legal regulations.

Recommendation 16

National and/or regional operating structures for GNSS should be developed initially. A single centralized operating structure does not appear to be needed at this stage but may be the subject of future study.

International co-ordination can be achieved through regional organizations operating under the umbrella of ICAO.

Possible fields of international action include:

a) International audit;

b) Monitoring of a seamless and universally accessible worldwide GNSS network;

c) Monitoring of the stable provision of the international GNSS signals-in-space;

d) Signal monitoring of the availability, continuity, accuracy and integrity of the GNSS signals-in-space.

Text on 11 bis*

The Panel recommends to the Council that:

· it should encourage the study of the concept of addressing liability through a chain of contracts between GNSS actors as an approach, in particular, at regional level;

· a model for the future contractual arrangements should embody results of the work done in applying Recommendations 9 and 11;

· the study and development, in the appropriate ICAO forum, of an instrument of international law in the context of the long term legal and institutional framework for GNSS should be initiated.

* This text was put to an indicative vote during the Third Meeting of LTEP, resulting in fourteen in favour, seven against and one abstention.

Chapter 12: Organizational and International Co-operative Aspects

12.1 Introduction

12.1.1 Two important characteristics of major CNS/ATM components are their capacity to serve a large number of States/Territories, even regions of the world, and the major investments involved in their implementation. This has organizational implications because States/Territories will need to co-operate in order to benefit from the efficiency CNS/ATM systems offer. As established in the preceding chapters, the planning to introduce CNS/ATM systems in the CAR/SAM Regions has been developed on the basis of determining homogeneous areas and main air traffic flows. The determination of ATM requirements has been carried out in accordance with the evolution of air traffic services needs at each of the defined traffic flows. Even though the implementation of the CNS components in these flows will be made by FIRs, a close coordination will have to be established to implement the services all at once in a determined flow. It should be taken into account that the flows cross over various FIRs and, in many cases, different regions; in consequence, coordination should not only be intra-regional, but also inter-regional.

12.1.2 In accordance with the results from the CNS/ATM Conference held in Rio de Janeiro, Brazil, at the national level, implementation of CNS/ATM systems will be facilitated where financially-autonomous bodies have been established to operate air navigation services. Such authorities could also operate airports or be in the form of an autonomous civil aviation authority. Whether at the national or international level, financing of CNS/ATM systems components as well as other air navigation services infrastructure will be enhanced where such autonomous bodies are responsible for infrastructure provision and operation.

12.2 Specific Operational and Technical Organizational Aspects

General

12.2.1 Implementation of CNS/ATM systems will require considerable investment in the area of air traffic management (ATM) (e.g. automation and support systems) as well as in communications and navigation infrastructure. The latter involves space segment elements as well as associated ground-based elements (e.g. satellites or satellite transponders, ground earth stations, etc.). The magnitude of the investments involved and the capacity that will be provided are often of such an order that it will not be possible, feasible, nor practical for a State/Territory to implement such systems for its sole use.

12.2.2 When CNS/ATM systems are implemented on a global scale, the need for States/Territories to provide and operate conventional communication, navigation and surveillance systems will be significantly reduced. The regional air navigation plan (Doc 8733) should provide a schedule for the phase out of facilities made redundant for the provision of CNS/ATM systems services. From an organizational point of view, this will mean that some staff now required to operate conventional systems will become redundant, although some could be redirected towards work associated with the provision of the new CNS/ATM-related services. The extent of the redundancy would also be influenced by the technical solution and implementation option chosen, as described in the paragraphs below. Because of the centralization inherent in satellite operations, redundancies will occur in most States/Territories in staff and facilities previously devoted to serving the conventional systems, if the economies of CNS/ATM systems application are to be fully realized.

Aeronautical Mobile Satellite Services (AMSS) – implementation and option selection

12.2.3 The satellite-based system serving CNS/ATM systems communication needs will require an extensive network of ground-based facilities, including ground earth stations (GES) and associated communication links to air traffic facilities. As there are different means of system access, States/Territories will have different implementation options. Depending on requirements and circumstances, a State/Territory or a group of States/Territories may choose various options. Relevant to the selection of an implementation option and the resulting organizational structure, are such economic factors as achievable economies of scale, scope for competition and requirements for economic regulation. It should be stressed, however, that the specific framework a State/Territory or group of States/Territories selects cannot be established, nor can the appropriate legal instrument covering its establishment be written, until the States/Territories concerned have themselves determined which approach best meets their requirements. Once the Action Plan is approved, GREPECAS should concentrate in determining better implementation options for States/Territories and, preferably, for group of States/Territories, through the development of a business case.

Global Navigation Satellite Systems (GNSS)

12.2.4 The GNSS will initially be composed of a satellite system which provides standard positioning service. System augmentation is required for meeting certain performance criteria. Positioning signals are being offered free of charge by the two Provider States concerned at least up to the year 2010 by the Russian Federation (the GLONASS system), and for the foreseeable future with six years advance notice of any change to that policy by the United States (the GPS system). Both these systems are military systems, which have been made available for civilian use. Until these systems are replaced by (civilian) systems requiring financial commitments from the civil establishment world-wide, the provision, as opposed to the use, of the standard positioning service does not appear to be dependant on organizational issues needing to be addressed by States/Territories other than the two Provider States.

12.2.5 It should be taken into account that as of the date of elaboration of this Plan, the constellation of GLONASS satellites is not yet on operational phase, since the number of satellites in function is insufficient to provide the position determining service.

12.2.6 With regard to the augmentation of satellite signals, GREPECAS has developed the respective regional plan, which contemplates both satellite based augmentation (SBAS) and ground based augmentation (GBAS). Various alternatives are being explored, among these is the United States WAAS system, the European EGNOS system and the interoperability of both systems. In addition to the above, the new Extended LAAS or ELAAS network is being analyzed. Under this new concept, the use of local area augmentation stations with the wide area augmentation stations transmitting factor corrections through VHF data links would be proposed.

12.2.7 SBAS augmentation will necessarily require a regional arrangement, since the augmentation stations required cover great portions of airspace which in many cases exceed the limits of a State's airspace. Therefore, it is very difficult to justify a national SBAS system, due to the high costs its implementation involves.

Air Traffic Management (ATM)

12.2.6 With respect to the organizational aspects, the implementation of the CNS/ATM systems in the CAR/SAM Regions will be carried out according to the evolution of ATM determined for the 19 main traffic flows. All the selected flows encompass more than one State/Territory and some, more than one region. Since the implementation must be carried out by States/Territories and it should be made for each of the FIRs crossing a determined flow, coordination among all States/Territories part of one same flow will be important, since if a non homogeneous implementation is effected, the benefits expected will not achieved. Therefore, regional administrative arrangements are very important for its successful achievement.

12.3 International Cooperation

12.3.1 The Global Plan provides excellent guidelines to organize a regional working scheme of some or all of the air navigation services components. COCESNA is a good example of a multinational organization for the provision of air navigation services, which groups all Central American States. This type of organizations will enormously ease the implementation of the various components of the air navigation system. The Region must explore the need to establish similar organizations to facilitate the implementation of the CNS/ATM systems in other sectors of the region.

Chapter 13: Cost-Benefit and Economic Impacts

13.1 General

13.1.1 The decision by States as to whether and when to enter into the financial commitments necessary to implement CNS/ATM systems in the flight information regions (FIRs) for which they have the responsibility to provide ATM, should be preceded by appropriate cost/benefit analysis, taking into account the economic impacts on service providers, aircraft operators, passengers and freight consigners. User participation in cost/benefit analysis is encouraged. Additionally, each service provider or operator may carry out its own business case or financial evaluation, which will be closely related to the cost/benefit study. Finally, an understanding of the broader economic implications of new systems might be helpful in promoting their implementation.

13.1.2 Comprehensive guidance material to assist States/Territories to carry out cost-benefit studies of the implementation of CNS/ATM systems in their own airspace is available in the ICAO Circular 257, *Economics of Satellite-Based Air Navigation Services - Guidelines on Cost-Benefit Analysis of Communications, Navigation and Surveillance/Air Traffic Management (CNS/ATM) Systems*. The Circular focuses on the methodological approach of Net Present Value, which is widely recognized and used by financial institutions such as those potentially involved in funding CNS/ATM systems. The methodology is presented using a step-by-step tabular approach which may be applied manually or through a computer spreadsheet; formatted spreadsheets using Quattro Pro, Lotus or Excel software to apply the approach used in the present guidance material, are available for States/Territories on diskette from the ICAO Secretariat on request.

13.2 Business Case Evaluation

13.2.1 The development of a business case for the implementation of CNS/ATM systems by a service provider or an operator involves taking the financial cost-benefit analysis a step further. In particular, changes in revenues resulting from changes in the prices of the product sold must be taken into account. It is generally expected that CNS/ATM systems will facilitate reduced operating costs and a lower price for the service provided. From the point of view of a specific organization, assessment of the net financial impact, in present value terms, must include not only the implementation cost and operating cost savings, which are included in the cost-benefit analysis, but also consequent changes in revenues.

13.2.2 For a service provider, a business case evaluation must include the impact on revenues of changes in route charges associated with the implementation of CNS/ATM systems. Assuming that the ATM service provider is an autonomous organization operating on a commercial basis and is currently covering its costs with the present technology systems, the basic issue is for the service provider to be satisfied that the changes in revenues expected from the planned changes to en-route charges will match the net change in costs, measured by the cost-benefit analysis. However, if the relationship between costs and revenues is not being monitored (e.g. if costs are met from the government budget and revenues are treated independently as general government revenues), then the ATM services are not being provided on a commercial basis. Even in these circumstances it is recommended that a business case evaluation be conducted to assess the financial impact on the service provider of the new systems.

13.2.3 For an airline, a business case evaluation would include, among other factors, assumptions about the impact on its costs of expected changes in route charges and the impact on revenues of changes in airline fares and rates, where these changes are associated with the implementation of CNS/ATM systems. These impacts are in addition to the direct investment costs and operating cost savings attributable to the new systems and identified in the cost-benefit analysis described above. The impact of route charges will depend on the outcome of the policies and evaluations of the service providers. Assumptions about fares and rates will reflect competitive pressures in air travel and freight markets.

13.3 Other Economic Effects of CNS/ATM Systems Implementation

13.3.1 States/Territories may be interested in the broader economic and social impact of CNS/ATM systems as well as the financial viability of the new systems. For example, implementation of the new systems should produce passenger time savings, improve the safety of air operations, produce environmental benefits and may also lead to some industry restructuring and changes in skills required.

13.3.2 CNS improvements, which produce benefits to ATM such as more direct flight paths and less delay from airspace congestion, will reduce the passenger travel time for a given journey. If passengers value these time savings, they represent an additional benefit. The evaluation of this benefit is discussed in ICAO Circular 257.

13.3.3 CNS/ATM systems are expected to bring environmental benefits because of reductions of nitrous oxide and carbon emissions through more direct routing of aircraft. These benefits will accrue to the global community in general and are not limited to participants in the air transport industry. Recognition of these benefits provides a reason for subsidizing investment in CNS/ATM systems.

13.3.4 The increase in automation of ATM, the withdrawal of some ground-based navigation aids, and the possible relocation of some ATM facilities to fewer centralized locations should result in labour productivity improvements, and hence reductions in unit costs, over the long term. The labour released by this process should, in most regions, be absorbed by the requirement to service expanded traffic volumes generated by general economic growth. However, there may be situations where some redeployment of staff to other economic sectors is necessary, with further economic and social consequences.

13.3.5 The reduced costs and lower price of air transport made possible by CNS/ATM systems, and the resulting increased air traffic demand, could increase the viability of investment in activities closely related to air transport, not only accommodation and tourism but also those manufacturing and agricultural industries which ship materials and products by air. These indirect benefits are part of a dynamic process of economic growth and should not be attributed *entirely* to CNS/ATM systems. They will only be fully exploited provided the complementary investment in the associated industries is undertaken.

13.3.6 An understanding of the contribution of air transport to general economic activity can increase the political commitment to the process of transition to CNS/ATM systems. National accounting and industry data and employment surveys may be used to determine the share of air transport in total economic activity and its importance as an employer. The input/output tables of a State's national accounts can illustrate the inter-relationships between the various elements of the air transport industry and other industries and economic sectors. Other industries purchase air transport services or supply products and services to the air transport industry. From a national or regional economic planning perspective, it is especially important to appreciate the role of air transport in generating employment and incomes, and in supporting other non-aviation economic activities. This will put into perspective the value of supporting and investing in state-of-the-art national and regional air transport facilities.

Chapter 14: Financial Aspects

14.1 Introduction

14.1.1 Financing of CNS/ATM systems elements, in particular at the national level, would normally be approached in a manner similar to that applied to conventional air navigation systems. However, a characteristic of most CNS/ATM systems elements which differentiates them from most conventional air navigation systems is their multinational dimension. Consequently, and because of the magnitude of the investments involved, financing of basic systems elements may, in many cases, need to be a joint venture by the States/Territories involved at the regional or global level.

14.2 Determination, Cost Recovery and Financing

14.1.2 Chapter 14 of the Global Plan provides general guidelines which should be followed by States/Territories with regard to determination and cost recovery, as well as financing of the CNS/ATM systems implementation. As described in the preceding Chapters, and particularly in the Action Plan, implementation of the CNS/ATM systems would be effected using the main air traffic flow concept; therefore, it is very important that economical and financial analyses be carried out for each of the defined main air traffic flows. The Region would be in condition to start these analyses once the Action Plan is approved, since it will be the basis to obtain ATM requirements and CNS components to satisfy those requirements.

14.1.3 In addition to the analyses which can be developed at regional level, it will be necessary that States/Territories carry out their own particular studies at national level, to include all domestic aspects not considered in the regional analyses, as well as particular implementation financing potentials.

Chapter 15: Assistance Requirements and Technical Cooperation

15.1 Introduction

15.1.1 Planning and implementation of CNS/ATM systems requires cooperation among all partners that have a stake in its successful implementation. Chapter 15 of the Global Plan summarizes technical cooperation needs of the developing countries. The CAR/SAM Regions elaborated a Technical Cooperation Project whose objective is to support States/Territories of both Regions in the planning and implementation of CNS/ATM systems. It is expected that Regional Project RLA/98/003 will initiate its activities by the first quarter of 1999 at the latest.

15.1.2 It is important to highlight that the ICAO Council has recently approved the Recommendation of the Second Meeting of the ALLPIRG, which refers to a trial application of the changes proposed with regard to the focus given on CNS/ATM by the Regional Planning and Implementation Groups, through the execution of a Special Implementation Project.

15.2 Technical Cooperation Regional Project RLA/98/003 ATransition to the CNS/ATM Systems in the CAR and SAM Regions@

15.2.1 This Technical Cooperation Regional Project has the following immediate objectives:

1) Advise States/Territories in the planning of the transition to the CNS/ATM systems and in the definition of the most convenient implementation options, according to the implementation schedule agreed for the CAR and SAM Regions, including the specification s of the required systems and the analysis of the cost/benefit relationship of each option;

2) Advise States/Territories in the implementation of national plans for the transition to the CNS/ATM systems, including the requirements for human and financial resources and the applicable training programmes;

3) Assist States/Territories in the implementation of the World Geodetic System (WGS-84) and in improving their aeronautical information services; and

a) Assist States/Territories in the strategic planning of information systems for civil aviation, in such a way that they may conduct to a more efficient, profitable and economic administration of the aeronautical infrastructure, facilities and air navigation services.

15.2.2 End-of-project Situation

15.2.2.1 The steps foreseen in the CAR/SAM regional plan for the implementation of the CNS/ATM systems should have been taken to assist States/Territories in establishing a transition plan from the present air navigation ground based systems to the new CNS/ATM satellite based systems.

15.2.2.2 The States/Territories of CAR and SAM Regions that so require shold have received guidance and assistance to update their national air navigation plans, in such a way that would allow the review of the commitments assumed by each country for the provision of the facilities and services described in the regional plan, as well as the situation of the facilities and services utilized exclusive or partially for national purposes.

15.2.2.3 As required, the States/Territories of the CAR and SAM Regions should have received the necessary information and guidance for the air traffic forecasting with an adequate time frame for the planning of CNS/ATM systems.

15.2.2.4 Studies should have been carried out to assist States/Territories in establishing the cost/benefit relationship in the implementation of the systems, according to their requirements.

15.2.2.5 The civil aviation training centres of the CAR and SAM Regions that so require, should have received guidance to establish the training programmes in demand by the change of technology.

15.2.2.6 The managerial level officers of the civil aviation administration of participant States/Territories should have received the necessary training to face the institutional, administrative and financial aspects related to the transition to the new CNS/ATM systems, as per their requirements.

15.2.2.7 Participant States/Territories should have received orientation and advise for the implementation of the 1984 World Geodetic System (WGS-84) and to improve their aeronautical information services.

15.2.2.8 States/Territories interested in modernizing their management for the sub-sector, should have received orientation and assistance on the strategic planning of civil aviation information systems in a way conducting to a more efficient, profitable and economic administration of the aeronautical infrastructure, facilities and services.

15.3 CNS/ATM Special Implementation Project for the CAR/SAM Regions (CNS/ATM SIP)

15.3.1 The second meeting of ALLPIRG outlines a series of enhancements for the ICAO regional planning process. It agreed that this process needed to become more business-like and that the regional groups should play a broader role, in order to include:

1) intensified efforts to assist with implementation;

2) the preparation of cost/benefit analyses for implementation options; and

3) the development of comprehensive business cases for “competing” implementation for homogeneous ATM areas and/or major traffic flows.

15.3.2 The ALLPIRG meeting also concluded that this would bring about certain changes to the PIRGs working methods. To start applying these changes on a trial basis, the pilot project for the CAR/SAM Regions is being executed, whose results are expected to be seen during the first quarter of 1999.