International Civil Aviation Organization
CAR/SAM PLANNING AND IMPLEMENTATION REGIONAL GROUP (GREPECAS)
Fifteenth Meeting of the CAR/SAM Planning and Implementation Regional Group (GREPECAS/15)
(Rio de Janeiro, Brazil, 13 to 17 October 2008)

Agenda Item 2: **Global and inter-regional activities**

2.1 Inter-regional and intra-regional CNS/ATM activities and coordination

NATIONAL ATM OPERATIONAL CONCEPT

(Note presented by Brazil)

SUMMARY

This working paper aims at presenting the National ATM Operational Concept, document prepared by Airspace Control Department (DECEA), in order to establish a strategic planning document oriented to the gradual, coordinated, opportune and effective implementation of the Global ATM Operational Concept components.

References:

- Global ATM Operational Concept (Doc. 9854)
- Global Air Navigation Plan de (Doc. 9750)

1. Introduction

1.1 Further to the progress in the CNS/ATM System implementation, achieved by States and Planning and Implementation Regional Groups under the guidance of the Global Air Navigation Plan for CNS/ATM Systems (Doc. 9750), it was recognized that technology was not an end in itself and that a comprehensive concept of an integrated based on operational requirements clearly set. Such a concept, in turn, would form the basis for the coordinated implementation of CNS/ATM technologies based on clearly established requirements. To develop the concept, the ICAO Air Navigation Commission has created the Air Traffic Management Operational Concept Panel (ATMCP).

1.2 The Global ATM Operational Concept, developed by the above-mentioned Panel, was approved by the Eleventh Air Navigation Conference and published as Doc. 9854 AN/458 - through the recommendation 1/1 – and has pointed to the following:

a) ICAO, States and planning and implementation regional groups (PIRG) should consider the concept as the common global milestone to guiding the planning for the ATM implementation and focusing the work of ATM development;

b) The Global ATM Operational Concept should be used as high level guidance to designing ICAO provisions related to the CNS/ATM Systems;

c) States, with the support of other ATM community members, shall carry out the task of validating the seven components of the Global ATM Operational Concept;

d) ICAO, States and PIRG should design transition strategies for the implementation ATM systems based on the Global ATM Operational Concept; and

e) ICAO should align its technical program so as to facilitate future efforts related to the ATM Operational Concept.

1.3 In order to adapt global planning to the conclusions derived from the Eleventh Air Navigation Conference, mainly in relation to the Global ATM Operational Concept, as well as to the Industry Roadmap, ICAO has developed the new Global Air Navigation Plan. Besides including the Global ATM Operational Concept, the Global Air Navigation Plan is focused on a set of "Global Plan Initiatives" (GPI), providing the necessary conditions to the implementations meant to obtain short- and medium-term benefits to the ATM community.

2. Regional Planning within the new Global Air Navigation Plan environment

2.1 Regional Planning has always been based on the Air Navigation Regional Plan (Basic and FASID). However, after the publication of the Global ATM Operational Concept and the Air Navigation Global Plan, the basic portion of the CAR/SAM Air Navigation Plan needs to be updated, taking into account that it comprises concepts no longer applicable.

2.2 An attempt to update the regional planning was presented at the Fifth Meeting of the ATM/CNS Subgroup, by means of developing a draft document named as Transition Plan towards the ATM Operational Concept in the CAR/SAM Regions. That Plan has been developed taking into consideration the Global Air Navigation Plan and had as goal to apply the Global Plan Initiatives (GPI), aiming at starting the transition to the ATM Operational Concept.

2.3 Moreover, that Plan was addressed to establish an implementation strategy for obtaining short- and medium-term benefits to the ATM community based on infrastructure related to the ATM and to the available and foreseen aircraft capacities. The document contained, however, detailed information on the Air Navigation infrastructure (CNS, AIM, MET, AGA/AOP) and on the Institutional Aspects involved, necessary to make the follow-up of such evolution.

2.4 The Draft of the Transition Plan towards the ATM Operational Concept in the CAR/SAM Regions contained the ATM requirements and the specific chapters related to the above-mentioned navigation infrastructure and institutional aspects should be developed by the AGA/AOP, AIM, HRT and MET Subgroups, by the CNS Committee and by the Task Force on Institutional Aspects. Therefore, the different GREPECAS contributory bodies have not progressed as far as the development of such document is concerned.

3. The National ATM Operational Concept

3.1 Taking into account the need of developing a strategic planning document oriented to a gradual, coordinated, opportune and effective introduction of the Global ATM Operational Concept components, the Airspace Control Department (DECEA) has developed the National ATM Operational Concept based on the "Air Navigation Global Plan", specifically on the Global Plan Initiatives, and on the CAR/SAM Regions planning. (PBN CAR/SAM Road Map, ATFM CAR/SAM Operational Concept, etc). The ATM Operational Concept is attached as an **Appendix** to this working paper (**English only**).

3.2 In short, the benefits sought in this conception are:

- ✓ To ensure the transition to the Global ATM System;
- ✓ To make the increase of air traffic flow foreseen to Brazil and the Region feasible;
- ✓ To reduce the cost of air navigation infrastructure implementation, operation and maintenance;
- ✓ To enhance service availability, integrity, coverage and continuity within Brazil and, by extension, within the CAR/SAM Regions;
- ✓ To increase operations efficiency, introducing direct routes and services that allow the plan execution, according to the operators needs; and
- ✓ To ensure compliance with the required operational safety levels.

3.3 Initially, this conception considers the use of available procedures, processes and capacities, evolving, in the medium term, to the application of emerging procedures, processes and capacities. In the long term, it considers the migration to the "Global Operational ATM Concept" ATM system.

3.4 Its required updates will be implemented as new concepts and technologies are being approved by ICAO. The first upgrade is foreseen to be delivered as soon as 2010 based on the development of the NextGen and SESAR programs, and on the Brazilian ATM community experience and performed works.

3.5 The SISCEAB modernization was established through a modular planning, composed of three phases, duly provided for on budget planning.

- ✓ Phase 1, short-term: up to 2010;
- ✓ Phase 2, medium-term: from 2011 to 2015; and
- ✓ Phase 3, long-term: from 2016 to 2020.

3.6 Obviously, for making such upgrade feasible and granting that its cost-benefit relationship is favorable, it is important to consider as a fundamental requirement that the current system offer a solid base to receive and set new features, originated from the availability of new technologies and full use of existing means. Therefore, the most highly important requirement to have a safe and efficient system in the future is to seek maximum efficiency of systems that are currently operating.

The following factors have been considered as foundations to the transition process of Brazilian Airspace Control System (SISCEAB) to the targeted capacity:

1. To meet the required level of safety and service for all users;
2. To implement RNAV within Brazilian airspace, in all flight phases, and RNP wherever possible to obtain operational benefits, through Performance Based Navigation, using navigation systems including, but not limited to, GPS, Galileo and GLONASS;
3. To provide an adequate integrity level for air operations, in all flight phases;
4. To provide "gate to gate" operation within Brazilian airspace;
5. To provide operation surveillance in accordance with ATM requirements;
6. To perform transition to the ATN environment, applying integrated data communications;
7. To perform transition from ATS to ATM;
8. To perform transition from AIS to AIM with real-time digital capacity;
9. To minimize meteorological impact on aeronautical activities, aiming at keeping for IMC the same system capacities as those prevailing under VMC; and
10. To reduce operational costs and environmental impact.

3.7 So, the main undertakings foreseen in our planning are:

1. Phase 1 –until 2010:
   a. ATM:
      - ✓ To implement ATC modeling and simulation tools, aiming at validating new airspace structures;
      - ✓ To implement ATC and airport capacity calculation tools;
      - ✓ To implement approach and departure sequencing tools;
      - ✓ To consolidate capacity for the implementation of ATFM strategic measures; and
      - ✓ To implement the Flight Plan Initial Treatment.
   b. Communications:
      - ✓ To implement ATS Message Handling Services;
      - ✓ To implement VDL Mode 2;
      - ✓ To develop, implement and integrate a communications infrastructure to support the entire SISCEAB, with an open architecture that could absorb all current and future services required by the CNS/ATM transition program; and
      - ✓ To study and design technical/operational requirements for the CAR/SAM Regions, enabling ATM Automation among all ATC unities;
   c. Navigation:
      - ✓ To begin the implementation of GBAS CAT I stations in airports whose operational demand justify it;
      - ✓ To introduce RNAV-5 en-route;

- ✓ To implement SID/STAR RNAV-1 in Brasília, Recife and São Paulo TMA;
- ✓ To implement RNP APCH and APV Baro/VNAV approach in all IFR airports;
- ✓ To implement RNP AR approach procedures where there are consistent operational benefits;
- ✓ To implement an automated tool for air navigation procedures design, aiming at meeting the demand for new procedures, specially RNAV and RNP; and
- ✓ To adapt DME infrastructure to the ICAO requirements for RNAV (DME/DME) navigation in selected TMA.

d. Surveillance:

- ✓ To introduce Mode-S, ADS-B and/or Multilateration in the off-shore operations of Bacia de Campos and other similar air spaces;
- ✓ To introduce ADS-C service on the EuroSAM corridor;
- ✓ To install a test platform for the implementation of ADS-B within the continental air space; and
- ✓ To provide surface movement surveillance capacity in selected airports, using Multilateration and/or ADS-B.

2. Phase 2 - 2011 to 2015:

a. ATM:

- ✓ To implement tools for real-time airspace management; and
- ✓ To implement new ATM Automation tools, like conflict prediction, conflict resolution and warning, trajectory conformity control, functional integration of ground and aircraft systems, and others.

b. Communications:

- ✓ To plan gradual VHF AM deactivation, due to the VDL system implementation, considering, however, the required back-up infrastructure;
- ✓ To implement ATM Automation in the CAR/SAM Regions;
- ✓ To introduce the National ATN; and

c. Navigation:

- ✓ To introduce GBAS CAT II in selected airports;
- ✓ To begin the deactivation of ground-based air navigation aids, keeping only the back-up infrastructure;
- ✓ To implement RNP-2 for en-route operations;
- ✓ To implement SID/STAR RNAV-1 in other TMA; and
- ✓ To implement GLS approach procedures in the main airports.

d. Surveillance:

- ✓ To introduce ADS-B coverage in the entire Brazilian airspace;
- ✓ To plan the interruption of Primary Radar use for civil aviation where there is no operational requirement; and
- ✓ To plan the interruption of Secondary Radar overlapping coverage for en-route operations (assuming the users are appropriately equipped with ADS-B).

3. Phase 3 – 2016 to 2020:

a. ATM:

- ✓ To assess the implementation of other Global ATM Operational Concept components.
- ✓ To extend the offer of services to regional partners.

b. Communications:

- ✓ To begin VHF AM gradual deactivation, due to the introduction of VDL systems, considering, however, the necessary backup infrastructure; and
- ✓ To conclude the SISCEAB's Communications Digital Network and its integration into the CAR/SAM Regions through REDDIG and MEVA II Networks, acting as a basis for ATM Automation and Integration in the Region.

c. Navigation:

- ✓ To implement GBAS CAT III in selected airports.
- ✓ To implement CAT I approaches in other Brazilian airports; and
- ✓ To make Brazilian navigation architecture available for South America in order to develop a regional capacity.

d. Surveillance:

- ✓ To plan the interruption of Primary Radar use for civil aviation where there is no operational requirement;
- ✓ To plan the interruption of Secondary Radar overlapping coverage for en-route operations (assuming the users are appropriately equipped with ADS-B).
- ✓ To make services available to regional partners.

4. Actions for the GREPECAS

4.1 The meeting is invited to:

a) Discuss the modernization strategy for the regional planning documentation, based on the Global ATM Operational Concept and on the Global Air Navigation Plan; and

b) Consider the need of harmonizing the Regional Planning with the Brazilian ATM Operational Concept.

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APÉNDICE / APPENDIX

(Solamente en Inglés / Only in English)

THE ATM OPERATIONAL CONCEPT

MINISTRY OF DEFENSE

AERONAUTICAL COMMAND

AIRSPACE CONTROL

DCA 351-2

BRAZIL ATM CONCEPT OF OPERATIONS

2008

MINISTRY OF DEFENSE

AERONAUTICAL COMMAND

AIRSPACE CONTROL DEPARTMENT - DECEA

AIRSPACE CONTROL

DCA 351-2

BRAZIL ATM CONCEPT OF OPERATIONS

2008

MINISTRY OF DEFENSE

AERONAUTICAL COMMAND

PORTARIA # 299/GC3, 5^{TH} MAY 2008.

Brazil ATM Concept of Operations edition approval

The **Air Force Commander**, in accordance with the inciso XIV of article 23 of the Aeronautical Command Regimental Structure, approved by Decree # 5.196, 26^{th} August 2004, and considering Process # 67050.001449/2008-36, decides:

Art.1^{st}. Approve this DCA 351-2 “Brazil ATM Concept of Operations” edition,

Art. 2^{nd} This document will be valid in its publication data.

Ten Brig Ar (General) JUNITI SAITO

Brazilian Air Force Commander

(Published: BCA # 088, 12^{th} May 2008)

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PREFACE

In 1991, the 10th ICAO Air Navigation Conference (ANC 10) developed the new CNS/ATM System Concept, after work completed in 1998 by the FANS – Future Air Navigation Committee.

In 1998, after analyzing the revisions of the institutional, legal, economical and technical aspects proposed to the *CNS/ATM System Global Transition Plan* (document developed after the ANC10), the *CNS/ATM System Air Navigation Global Plan,* known as Doc. 9750, was announced.

The aeronautical community has been working to meet the objectives defined in the Global Plan.

After the important evolution in the ANC 10, the 11th Air Navigation Conference, in 2003, considering the progress and difficulties faced by the Implementation and Planning Regional Groups and States, approved the *Global ATM Operational Concept*, with the aim of making it the basic planning reference to conduct the implementation process of an integrated Global ATM.

In November, 2006 the Doc. 9750 New Version, know as ***CNS/ATM System Air Navigation Global Plan***, was approved after being updated with the parameters of the *Global ATM Operational Concept*, providing the aeronautical community with the components and the necessary methodology to allow a strategic plan to meet the world, regional and national objectives.

As its main focus, the Doc. 9750 new version was developed in partnership with the States and Industry, and instead of setting objectives to be reached in all world, in a centered planning, it gives 23 operational initiatives to be considered in the CNS/ATM system planning development and implementation process, aiming at meeting the "performance goals" identified by the regions and states.

Also, environment protection is one of ICAO's strategic goals and it was subject to ample debate during ICAO's 36th Assembly, since it can impact future implementations. Therefore, this is one of the main goals of this concept of operations, that will be accomplished by means of air navigation efficiency improvements, which will result in more rational fuel consumption and, consequently, in less environment-hostile emissions.

In this way, and with the lessons learned from all the DECEA work and the new directions given by the ICAO, the ***Brazil ATM Concept of Operations Plan*** was developed. It was presented to the national aeronautical community, and after important inputs, it became the main planning reference to define the objectives for the CNS/ATM system implementation for the SISCEAB.

1. INTRODUCTION

1.1 PURPOSE

To present the Brazil ATM Concept of Operations plan, including the transition strategy that will bring benefits to the ATM community, in short and medium term, based on the air navigation infrastructure related to ATM (CNS, AIS, MET, etc) and based on the current and future aircraft capacities, and to analyze the aspects that will allow a seamless and secure/safe implementation, with a favorable cost/benefit relation.

1.2 CONCEPTS

The concepts of the terms and expressions with aeronautical use contained in this publication can be found in the Brazilian Air Force Glossary.

1.2.1 DEFINITIONS

a) ATM Community – Set of organizations, agencies or entities that can participate, collaborate and cooperate in the ATM System planning, development, use, regulation, operation and maintenance.

b) Development – Stage in the SISCEAB evolution process where problem analysis, studies, research, tests and evaluations will be performed, aiming at the Concept of Operations plan elaboration and directions for its implementation. These directions will be established by DECEA.

c) Implementation - Stage in the SISCEAB evolution process where all the planning for the project execution, including the scope, implementation justification, expected results, time chart, technical directions, budget, implementation phases and goal definition will be performed. These directions will be established by DECEA.

d) Implantation - Stage in the SISCEAB evolution process where all the investments for the project execution and implementation will be performed, including the work program, technical configuration, basic and executive project, acquisition process, ending with the delivery to the DECEA

e) Air Traffic Management – Generic expression that describes airspace and traffic management in a secure/safe, economic and efficient way, through the CNS/ATM system and seamless services, with contributions from all participants.

f) Human Performance – human capacities and limitations that could implicate the secure/safe and efficient aeronautical operation.

g) Human Factor Principles – Principles applied to the aeronautics systems operation, maintenance, training, specification and certification, aiming at establishing a secure/safe interface between the human being and system components.

h) "Gate-to-Gate" operation – Set of procedures required to meet all the user's needs, including all the aircraft operations, from take-off, flight in TMA, en-route and approach, until its arrival in the final destiny, including the aircraft parking.

i) ATM System – Air traffic management executed through a set of cooperative efforts among human resources, information, technology, facilities and services, supported by communications systems, navigation and surveillance, based in ground and satellite systems and other systems located inside the aircraft.

j) ATS Surveillance service – Service provided using an ATS surveillance system.

l) ATS Surveillance system – Generic term meaning ADS-B, PSR, SSR or any other similar system located in the ground that allows aircraft identification. Note: – A similar system is one that presents, through a comparative evaluation or another methodology, a performance and security/safety level equal to or better than that of a secondary monopulse radar system.

1.3 ABBREVIATIONS AND ACRONYMS

The abbreviations and acronyms listed can be found in this document, and their meanings are listed below:

ABAS	Aircraft Based Augmentation System
ACARS	Aircraft Communication Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ACC	Area Control Center
ACP	Aeronautical Communication Panel
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
AFTN	Aeronautical Fixed Telecommunication Network

AIP	Aeronautical Information Publication
AIM	Aeronautical Information Management
AIS	Aeronautical Information Services
AMHS	Air Traffic Services (ATS) Message Handling Services
AMSS	Aeronautical Mobile Satellite Service
AO	Aerodrome Operations
AOM	Airspace Organization and Management
APV	Approach with Vertical Guidance
ASP	Aeronautical Surveillance Panel
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATMSDM	ATM Service Delivery Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
AUO	Airspace User Operations
BARO	Barometric Vertical Navigation (Baro-VNAV)
BVHF MC CDMA	Broadband VHF Multi-Carrier Code Division Multiple Access
CAR/SAM	Caribbean and South American Region
CAT-I	Category I Precision Approach
CAT-II	Category II Precision Approach
CAT-III	Category III Precision Approach
CCAM	Message Automatic Commutation Center
CFIT	Controlled Flight Into Terrain
CGNA	Air Navigation Management Center
CM	Conflict Management
CNS/ATM	Communications Navigations Surveillance/Air Traffic Management

COFDM	Coded Orthogonal Frequency Division Multiplex
CPDLC	Controller-Pilot Data Link Communications
CDMA	Code Division Multiple Access
DAMA	Demand-Assigned Multiple Access
DCB	Demand Capacity Balancing
DME	Distance Measuring Equipment
E1	European Digitazed Telephone Hierarchy
EAC	Restricted Airspace
EGNOS	European Geostationary Navigation Overlay Service
FAA	Federal Aviation Administration - USA
FANS–1	Future Air Navigation System - 1
FDMA	Frequency Division Multiple Access
FIR	Flight Information Region
FMS	Flight Management System
FR	Frame Relay
GAGAN	GPS and Geostationary Earth Orbit Augmented Navigation
Galileo	Europe's own global navigation satellite system
GBAS	Ground Based Augmentation System
G-GNM	Gate-to-Gate Network Management
GLONASS	GLObal NAvigation Satellite System - Russia
GNSS	Global Navigation Satellite System
GPMS	GNSS Performance Monitoring System
GPS	Global Positioning System
GRAS	Ground Based Regional Augmentation System
GREPECAS	Caribbean and South American (CAR/SAM) Regional Planning and Implementation Group
HF	High Frequency

HFDL High Frequency Data Link

ICAO International Civil Aviation Organization

IFR Instrument Flight Rules

ILS Instrument Landing System

IMC Instrument Meteorological Conditions

IP Internet Protocol

IRS Inertial Referential System

LAAS Local Area Augmentation System (USA)

LAN Local Area Network

MAN Metropolitan Area Network

MET Meteorology

METAR Aerodrome Routine Meteorological Report

Modes A, C, S Secondary radar transponder Modes

Mode A: provide identification code for the aircraft

Mode C: provide aircraft's pressure altitude

Mode S: provide multiple information formats to a selective interrogation

MPLS Multi Protocol Label Switching

MSAS Multi-functional Satellite Augmentation System - Japan

MSSR Monopulse Secondary Surveillance Radar

MTSAT Multi-functional Transport Satellite (MSAS GEO satellite)

NADIN II National Airspace Data Interchange Network

NAVAID Navigational Aid

NAVP Navigation Panel

NDB Non-Directional radio Beacon

NOTAM Notice to Airmen - A notice distributed by means of telecommunication containing information concerning the establishment condition or change in any aeronautical facility service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operation.

OCP	Obstacle Clearance Panel
PABX	Digital Telephone Central
PAMA	Pre-Assigned Multiple Access
PBN	Performance Based Navigation
PIREP	Pilot Report (Meteorology)
PIRG	Planning and Implementation Regional Groups (ICAO)
QPSK	Quadrature Phase Shift Keying
8PSK	Phase-Shift Keying - 8
RAIM	Receiver Autonomous Integrity Monitoring
RCP	Required Communications Performance
RDCS	SISCEAB Communications Digital Network
RFI	Radio Frequency Interference
RFP	Request For Proposal
RMMS	Remote Maintenance Monitoring System
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP APCH	Approach RNP
RNP AR	Approach RNP, with Authorization
RSP	Required Surveillance Performance
RVSM	Reduced Vertical Separation Minima or Minimum
SASP	Separation and Airspace Safety Panel
SBAS	Satellite Based Augmentation System
SCPC	Single Carrier Per Channel
SID	Standard Instrument Departure
SISCEAB	Brazilian Airspace Control System
SMGCS	Surface Movement Guidance and Control System
SSR	Secondary Surveillance Radar

STAR	Standard Instrument Arrival
TAF	Terminal Aerodrome Forecast
TDMA	Time Division Multiple Access
TMA	Terminal Control Area
TS	Traffic Synchronization
TSO	Technical Standard Order
UAT	Universal Access Transceiver
VDL	VHF Digital Link
VFR	Visual Flights Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
VSAT	Very Small Aperture Terminal
WAAS	Wide Area Augmentation System
WAN	Wide Area Network
WGS-84	World Geodetic System -1984
WiMAX	Worldwide Interoperability for Microwave Access

1.4 SCOPE

The presented plan applies to all organizations and agencies involved in the planned activities.

2. GENERAL PRINCIPLES

2.1 INITIAL TOPICS

2.1.1 The goals of this document are:

a) To meet the ICAO requirements established in the DOC 9854 – Global ATM Operational Concept and in the DOC 9750 – Air Navigation Global Plan; and

b) To develop an ATM Concept of Operations applied to the Brazilian airspace that increases its security/safety and efficiency, and associates its cost to the aeronautical operations.

c) To establish the basis for elaborating the National ATM Implementation Program, that will be constituted by the Global Plan Initiatives (GPI) application projects; in addition, the Program will be harmonized with the documents related to the Aviation Security/Safety Global Plan Initiatives, aiming to meeting the airspace security/safety requirements.

2.1.2 The document is not intended to replace or supersede specific guidance concerning airspace operations. It simply provides a high level definition of the capabilities, infrastructure, and procedures possible with the implementation of the CNS/ATM technologies.

2.1.3 The capacities introduced in this Plan must be validated using the Airspace Modeling, Real Time and Accelerated Time Simulation, Flight Evaluation, to make sure they are attainable. In addition to this document DECEA will develop the following documentation:

a) Implementation Program – This document will define the actions, schedule and priorities to be met by DECEA, aiming to ensure a secure/safe transition during the SISCEAB update, respecting the limits set in ICAO's global and regional plans.

b) Cost/benefit Analysis – This document will define the cost/benefit relation associate to the implementation of each technology envisioned to support future operations in Brazilian Airspace. The projects in the Implementation Program can also be subject to specific cost-benefit analysis, depending on their complexity.

c) Investment Plan – This document will describe a specific acquisition strategy and approach for acquiring the equipment and resources needed to achieve full CNS/ATM capability.

2.1.4 The decision criteria used to develop this document were:

a) Mission success: to what extent the capability improves mission performance for the external and internal customers;

b) Investment return: the capability global value, in economic terms, to the ATM community;

c) Risk: what is the involved risk, in terms of uncertainties and possible consequences; and

d) Strategic alignment: definition of the system capability limit to support the organizational strategic objectives, such as DECEA Global Architecture System and

International Commitments.

2.2 SITUATION SUMMARY

2.2.1 The CNS/ATM concept, developed by the FANS Committee was approved by the ICAO at the 10th ICAO Air Navigation Conference, in September 1991. This Conference recommended to the ICAO the development of a Global Plan, to allow the planning and implementation of the CNS/ATM future systems, through the Implementation and Planning Regional Groups. In this direction, the ICAO developed the Air Navigation Global Plan for the CNS/ATM System, document 9750. In this document, the ICAO recommended that the CNS/ATM system were implemented based in the coordination of the Regional Implementation and Planning Groups (PIRG), although the implementation of CNS/ATM System was a unique responsibility of each State.

2.2.2 In reply to the ICAO Plan, the CAR/SAM Region developed, supported by its PIRG named GREPECAS, a CNS/ATM Regional Plan to help other State-Members to develop their own Implementation Plan, to ensure a seamless and successful transition of these systems.

2.2.3 After the advance in the CNS/ATM System implementation, reached by the States and the Regional Implementation and Planning Groups, it was acknowledged the necessity of a complete concept for the Integrated Global ATM System, based in operational requirements clearly established. This concept would form the foundation for a coordinated implementation of CNS/ATM technology, also based in requirements clearly established.

2.2.4 The Global ATM Operational Concept, developed by the ICAO, in reply to the above-mentioned needs, was approved by the 11th Air Navigation Conference and published as Doc. 9854 AN/458.

2.2.5 It is important to say that the new CNS technologies and the mentioned Global ATM Operational Concept bring important modifications in the traditional form of providing air navigation services. The transition and implementation of a new system, aiming at the operational security/safety and efficiency, require some concern about the human factors.

2.2.6 In order to adjust the world-wide planning to the Global ATM Operational Concept, the ICAO developed the new Air Navigation Global Plan, which gives the necessary conditions for the Implementation to reach the benefits for the ATM community, in short and medium term. In this way, it is essential to have an adequate infrastructure for the ATM, to reach the established operational requirements.

2.2.7 As the Global ATM Operational Concept, the objective of the National ATM is to provide an Air Traffic Management System to the ATM community, during all flights phases, to satisfy the required level of operational security/safety, to be sustainable in relation to the environment, and to satisfy the national requirements for aviation security/safety.

2.3 AIR NAVIGATION SERVICES PLANNING

2.3.1 This Concept of Operations provides a path to a gradual, coordinated, opportune and effective implementation of the Global ATM Operational Concept components, based on the Air Navigation Global Plan and CAR/SAM Regions Planning, and in the Global Plan Initiatives (GPI), that could be implanted in short and medium term.

2.3.2 The National ATM Planning considers the characteristics of the Global ATM Operational Concept components, whose facilities and services make possible its application beyond the national borders. These characteristics make necessary the implementation of multinational facilities and services, in order to prevent duplicity of resources and services for the States.

2.3.3 The institutional aspects related to operation, maintenance, control and property of the CNS/ATM system in the multinational facilities and services must be considered, due the legal, economic, and financial aspects of its implementation.

2.3.4 Considering the aspects mentioned in the previous paragraph, and the necessity to establish an implementation and planning structure of multinational facilities and services, it is observed that there is a tendency to create Regional Multinational Organizations, formed by State groups, that will make sure that the necessary investments for the implementation and maintenance of the air navigation service will be optimized.

2.3.5 HOMOGENEOUS ATM AREA

2.3.5.1 Homogeneous ATM area is an airspace portion with a common ATM interest, based in similar characteristics of density and air traffic complexity, air navigation system infrastructure requirements, where a detailed planning will foster the application of an interfunctional ATM system. The homogeneous ATM areas can include a specific part from one State or from a group of States, including large parts of continental or oceanic airspace.

2.3.5.2 Based on the Global ATM Operational Concept, the homogeneous ATM areas must be reduced, considering the junction of adjacent areas, in order to guarantee the interoperability and operational integration.

2.3.5.3 In Brazil, the main homogeneous ATM areas are:

a) The oceanic airspace, concentrated in the Atlantic FIR, which have specific ATM requirements, because its low density and air traffic complexity; also, the current available technology demands application of a CNS infrastructure based on satellites, in order to guarantee an adequate air navigation service.

b) The low density and complexity continental airspace located above the Amazon, inside the Amazon FIR, which makes possible the application of specific and differentiated ATM procedures, if compared with the other parts of the national continental airspace; and

c) The average and high density continental airspace, formed by the Brazilian continental airspace part, that keep the regions peculiarities where they are inserted, resulting in the current configuration of the Brasília, Curitiba and Recife FIR.

2.3.6 TRAFFIC MAIN FLOW

2.3.6.1 Air Traffic Main Flow is the concentration of significant volume of air traffic in the same trajectory or in a near flight trajectory. The air traffic flow can cross several homogeneous ATM areas with different characteristics. The main traffic flows must be considered in the airspace structure planning, in order to be prioritized, in terms of route definition and optimized air navigation procedures.

2.3.6.2 In Brazil the main air traffic flows identified are:

a) Rio de Janeiro / São Paulo

b) Rio de Janeiro / Northeast Region / Europe

c) São Paulo / Belo Horizonte / Northeast Region / Europe

d) Buenos Aires / Porto Alegre / Florianópolis / Curitiba / São Paulo

e) São Paulo / Brasília / Manaus / USA

f) Rio de Janeiro / Brasília / USA

2.3.7 The homogeneous ATM areas and the Air Traffic Main Flow are related specially with the airspace en-route. So, improving the capacity and efficiency of the terminal control area (TMA) and the aerodrome, based in a set of initiatives that allow the service continuity, will be the way to obtain a seamless ATM system.

2.3.8 PLANNING METHODOLOGY

2.3.8.1 After the identification of the homogeneous ATM areas, in this case the Brazilian FIR, and the air traffic main flow, it will be essential to define the national airspace user profile, including the aircraft fleet study and its current and future capacities. Also, the analysis of the air traffic increase and the infrastructure related to the ATM will allow the identification of "gaps" in the system performance, and consequently, the choice of the Global Plan Initiatives that are better adjusted to the national airspace specific needs.

2.3.8.2 This planning process will have continuity with the following activities:

a) Analysis of the different options to execute the initiative mentioned;

b) Cost/Benefit analysis for the selected options;

c) Development of the operational concept for each project, stemming from this Concept of Operations, in order to meet every national airspace necessity;

d) Preliminary development of infrastructure requirements associated to the ATM;

e) Elaboration of the Implementation plans specific to each project in this Concept of Operations, observing the necessary conditions to the harmonization of the implementation process between users and service providers.

2.3.8.3 Figure 1 below is an illustration of a planning flow chart:

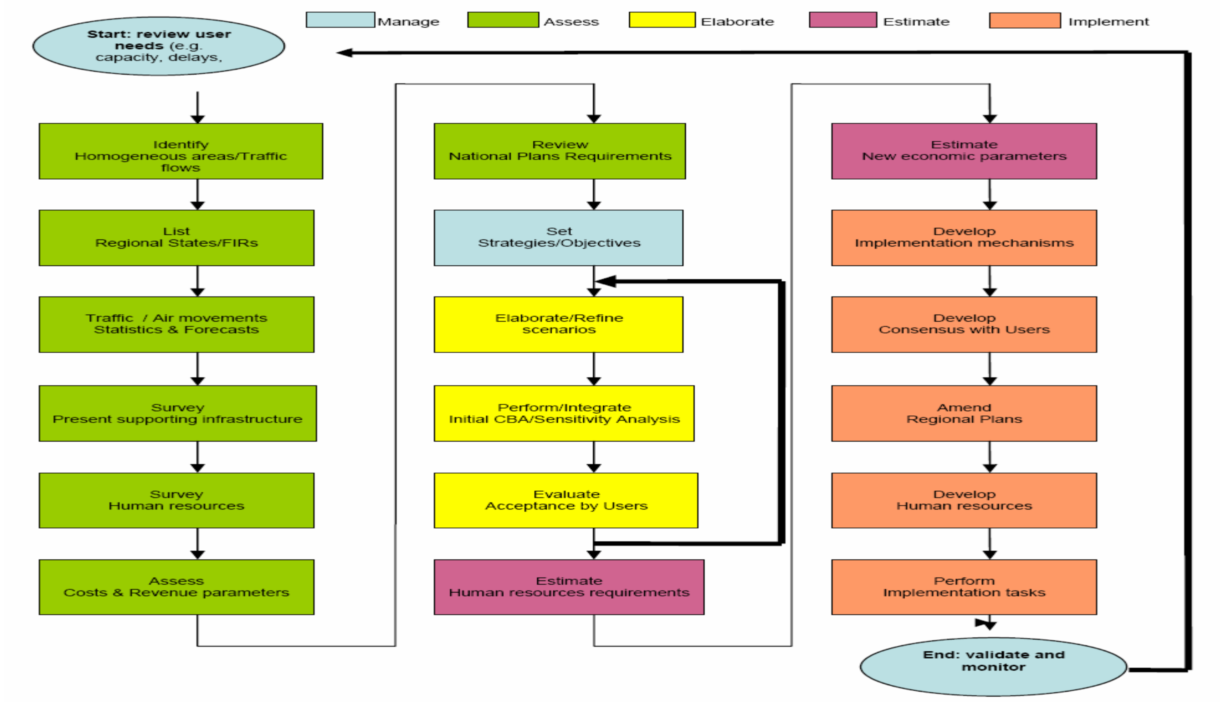

Figure 1 Planning flow chart

2.3.9 EVOLUTION

2.3.9.1 To reach the intended ATM system, several initiatives will be executed, in constant evolution, throughout the years. The set of initiatives that integrate this Concept of Operations have the objective to facilitate and to harmonize the work that has been done, at the regional and national level, and to give the aircraft operators the necessary benefits in short and medium terms.

2.3.9.2 The initiatives presented in this Concept of Operations fulfill the world-wide, regional and nationals objectives, based on the Global ATM operational concept. On this base, the execution and planning activities will begin with the application of available procedures, process and capacities. The evolution will advance, in medium term, to the application of emergent procedures, process and capacities. After that, in a long term, the migration to the ATM system planned in the Global ATM Operational Concept will be made. The figure 2 presents the evolution planned.

2.3.9.3 This Concept of Operations will be updated when new concepts and technologies are approved by ICAO. The first update should be performed in 2010, based on the European and US future air navigation systems implementation programs (SESAR and NextGen), which will be fully applied after 2025, and on Brazilian ATM community experience and performed works.

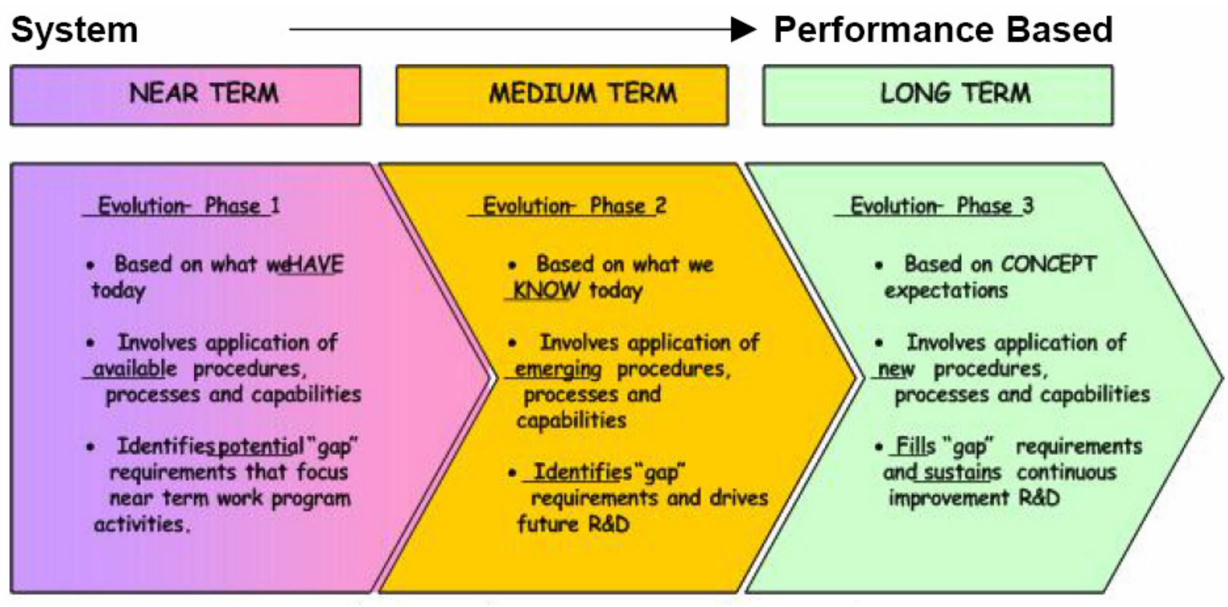

Figure 2 Global Plan Evolution

2.3.10 Global Plan Initiatives (GPI)

2.3.10.1 The table below presents the Global Plan Initiatives (GPI), that can be considered to the ATM system implementation, in short and medium term. In this Concept of Operations, the chosen initiatives will be inserted in specifics chapters, divided in ATM and its related infrastructure (CNS, AIS e MET).

2.3.10.2 The GPI objective is to facilitate the planning process and will not be considered as independent tasks, and in most cases they will be interrelated. In this way, the initiatives must integrate and support each other.

GPI		En-Route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-1	Flexible use of airspace	X	X			AOM, AUO
GPI-2	Reduced Vertical Separation Minima	X				AOM, CM
GPI-3	Harmonization of level systems	X				AOM, CM, AUO
GPI-4	Alignment of upper airspace classifications	X				AOM, CM, AUO
GPI-5	RNAV and RNP (Performance-Based Navigation)	X	X	X		AOM, AO, TS, CM, AUO
GPI-6	Air Traffic Flow Management	X	X	X		AOM, AO, DCB, TS, CM, AUO
GPI-7	Dynamic and Flexible ATS Route Management	X	X			AOM, AUO

GPI		En-Route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-8	Collaborative Airspace Design and Management	X	X			AOM, AUO
GPI-9	Situational Awareness	X	X	X	X	AO, TS, CM, AUO
GPI-10	Terminal Area Design and Management		X			AOM, AO, TS, CM, AUO
GPI-11	RNP and RNAV SIDs and STARs		X			AOM, AO, TS, CM, AUO
GPI-12	Functional integration of ground systems with airborne systems		X		X	AOM, AO, TS, CM, AUO
GPI-13	Aerodrome Design and Management			X		AO, CM, AUO
GPI-14	Runway Operations			X		AO, TS, CM, AUO
GPI-15	Match IMC and VMC Operating Capacity		X	X	X	AO, CM, AUO
GPI-16	Decision Support Systems and Alerting Systems	X	X	X	X	DCB, TS, CM, AUO

GPI		En-Route	Terminal Area	Aerodrome	Supporting Infrastructure	Related Operational Concept Components
GPI-17	Data link applications	X	X	X	X	DCB, AO, TS, CM, AUO, ATMSDM
GPI-18	Aeronautical Information	X	X	X	X	AOM, DCB, AO, TS, CM, AUO, ATMSDM
GPI-19	Meteorological systems	X	X	X	X	AOM, DCB, AO, AUO
GPI-20	WGS-84	X	X	X	X	AO, CM, AUO
GPI-21	Navigation Systems	X	X	X	X	AO, TS, CM, AUO
GPI-22	Communication infrastructure	X	X	X	X	AO, TS, CM, AUO
GPI-23	Aeronautical radio spectrum	X	X	X	X	AO, TS, CM, AUO, ATMSDM

Table 1 Global Plan Initiatives (GPI)

2.4 SISCEAB MODERNIZATION

2.4.1 The SISCEAB modernization will be established by a modular planning with 3 different phases. Each phase will enclose a specific period, considering the system total capacity, and each period will be considered in the budget. These phases are:

a) Phase 1 – Short Term – Today up to 2010

b) Phase 2 – Medium Term – from 2011 up to 2015

c) Phase 3 – Long Term – from 2016 up to 2020

2.4.2 The planning goal is to complete the investment and the implementation of the Brazilian airspace transition in 2020, based in the use of procedures, process and available and emergent capacities. To summarize, the benefits and risks of this implementation are:

a) Benefits:

- To ensure the transition to the Global ATM System;
- To make possible the increase in the air traffic of Brazil and Region, with the additional resources coming from the tourism and from the air transportation industry;
- To reduce the cost of implantation, operation, maintenance and air navigation infrastructure;
- To increase the services availability, integrity, coverage and continuity in Brazil and in the CAR/SAM Region;
- To increase the operational efficiency, with the implementation of direct routes and services that allow the plan execution, according to the operator needs; and
- To ensure the required operational security/safety levels are met.

b) Risks:

- Phased implementation without synchronizing with the demand real growth;
- Difficulties in planning and in budgetary execution;
- Unexpected difficulties with the emergent technologies;
- Unavailability of the required human resources, in adequate quantity and qualification.

2.4.3 For the modernization to be viable and with a balanced cost/efficiency, it is important to consider, as a fundamental requirement, the current system to be a solid base that will receive and support the new features that will be derived from the availability of new technologies and from the full use of existing means. Therefore, striving for an efficient operation of the current systems constitutes a requirement of the utmost importance in order to have a future system that is efficient and secure/safe.

2.5 PLANNING FACTORS

2.5.1 The following planning factors must be considered in the SISCEAB transition process:

a) To meet the required level of security/safety and service for all users

b) To develop the RNAV within Brazilian airspace, in all flight phases (route, TMA, approach) and RNP, where it is possible to have operational benefits, using the Performance Based Navigation (PBN) and navigation systems including, but not limited to, GPS, Galileo and GLONASS;

c) To provide the adequate integrity level to the air operation, in all flight phases;

d) To provide the "gate to gate" operation within Brazilian airspace;

e) To provide the operation surveillance in accordance with the ATM requirements;

f) To make the transition to the ATN environment, applying integrated data communication;

g) To make the transition from ATS to ATM;

h) To make the transition from AIS to AIM, with real time digital capacity;

i) To minimize the meteorological impact in the aeronautical activities with the goal to have, under IMC, system capacities identical to those under VMC;

j) To reduce the operational cost and the environmental impact.

l) To ensure that the Implementation Program establishes the planning for each Project, including the measures required for mitigating or eliminating the assessed risks.

2.6 SERVICE LEVEL

2.6.1 The required services for the airport operation and airspace in Brazil are:

a) Air Traffic Management:
   - Air Traffic Service;
   - Flow management and aeronautical infrastructure capacity management (ATC and Airport);
   - Real time airspace management and organization.

b) Communications:
   - En-route – Oceanic airspace:
     1. Basic: Data;
     2. Emergency or non-routine situation: Voice.
   - En-route – Continental airspace:
     1. Basic: Data/Voice;
     2. Emergency or non-routine situation: Voice.

- In Terminal Control Area (TMA):
  1. Basic: Data/Voice;
  2. Emergency or non-routine situation: Voice.
- In Aerodrome control:
  1. "Clearance": Data;
  2. Ground: Data/Voice;
  3. Control tower: Voice.

c) Navigation:

- En-route:
  1. Basic: GNSS Services and Inertial System;
  2. Secondary: NAVAIDS based in ground, in the continental airspace, to support contingency procedures.
- In Terminal Control Area (TMA) and Approach phase:
  1. Basic: GNSS Services and Inertial System;
  2. Secondary: NAVAIDS based in ground, in selected airports;
  3. Approach phase: 3-D orientation in all runway ends (Baro-VNAV); 3-D accuracy in selected airports (GBAS), with positive glide path guide.
- Ground navigation (airports):
  1. Basic: GNSS Services in selected airports, with GBAS;
  2. Secondary: Visual references.

d) Surveillance:

- En-route – Oceanic airspace:
  1. Basic: ADS-C;
  2. Emergency or non-routine situation: Voice.
- En-route – Continental airspace:
  1. ADS-B and/or Secondary radar for selected airspace.
- In Terminal Control Area (TMA):
  1. ADS-B and/or Primary/Secondary radar for selected airspace.
- In Aerodrome control:
  1. ADS-B and Multilateration in selected airports;
  2. Voice/Visual for airports with low operational complexity.

e) Aeronautical Information Management (AIM):

- Management of the National Aeronautical Information Database;
- On-line access to AIP, to ROTAER, to land digital data and NOTAM;
- Service to Client by internet;

- Lack of errors in critical and/or essential information;
- AIXM model application;
- Delivery of information in critical situations with priority;
- Real time aeronautical information, through datalink between on-board system and AIS system;
- GNSS Performance Monitoring System (GPMS);
- Information generation and dissemination of NOTAM and Flight Information Service (FIS).

f) Meteorological services:

- TAF, METAR and PIREP:
  1. Basic: Data communication;
  2. Back-up: Vital information by voice.
- En-route prediction:
  1. Basic: Data communication;
  2. Back-up: Voice.

3. AIR TRAFFIC MANAGEMENT

3.1 <u>GENERAL ASPECTS</u>

3.1.1 As the air traffic volume increases in the world, the demands on the air navigation services supplier intensify, and the air traffic management becomes more complex. With the increase in the air traffic density, the amount of flights that cannot have its best flight trajectory will increase, as well as the total system delay (landing and take-off), if the necessary actions to increase the system capacity are not taken. To face this problem, the 11th Conference approved the Global ATM Operational Concept.

3.1.2 The Global ATM Operational Concept resulted in the modification of the ATM traditional division in ATS, ATFM and ASM, initially used for the application of a Global ATM system based in 7 main components: Airspace Organization and Management (AOM), Aerodrome Operations (AO); Demand Capacity Balancing (DCB), Traffic Synchronization (TS), Airspace User Operations (AUO), Conflict Management (CM), and ATM Service Delivery Management (ATMSDM).

3.1.3 The Global ATM Operational Concept presents two essential characteristics, represented by the information management and the collaborative decision, which will decisively influence the concept implementation.

3.1.4 The ATM basis is the global information management, integrated and with guaranteed quality, which will provide essential information for the development of the 7 Global ATM main components.

3.1.5 The concept replaces the unilateral concept of decision, where the user is just a passive part in the process, with a method of collaborative decision making with ample participation of all interested parts, including the operation and planning stages. In this way, it is guaranteed that the flight will be performed close to the best profile, through the negotiation among the ATM community members.

3.1.6 The implementation of the ATM operational concept components will allow sufficient capacity to satisfy the increasing demand, bringing benefits as more efficient flight profiles and improvements in the operational security/safety. However, the new technologies potential to reduce the service cost to the users and to the air navigation service supplier, makes necessary to establish clear operational requirements, object of this document, which must be validated by a cost/benefit analysis.

3.1.7 Considering the ATM operational concept benefits, it will be necessary to make the decisions in the right moment, so that its implementation will provide the required increase in the system capacity, in order to prevent undesired gaps in air traffic services. As the ATM operational concept elements go beyond the States border, it will require cooperation in a regional and world–wide level.

3.1.8 The airspace structure will not be limited by the airspace traditional divisions. The planning will be coordinated among adjacent areas, aiming at a continuous airspace, seamless to the users. The airspace must be free of operational discontinuities and incoherence, and must be organized to meet the needs of the airspace users.

3.1.9 The transition between areas must be clear to the users. The planning and implementation of the ATM operational concept components must include its impacts and requirements, in terms of human factors.

3.1.10 The Brazilian ATM evolution will be carefully planned, in order to prevent the performance degradation of the current system. In this way, it is necessary that the transition ensure the desired security/safety levels, at least equal to the current level, in a gradual evolution to the improvement in the air operations efficiency. During the transition phase the CNS avionics on board aircraft will only be mandated when there are clearly established operational requirements.

3.2 ATM GLOBAL OPERATIONAL CONCEPT COMPONENTS

3.2.1 AIRSPACE ORGANIZATION AND MANAGEMENT

3.2.1.1 It substitutes the old "Airspace Management" (ASM), including the tactical phase of airspace flexible utilization and the airspace organization in the strategic phase, and procedures and rules in which the airspace is structured to accommodate different types of activities and air traffic volume.

3.2.1.2 The airspace will be globally organized, and the air traffic will not be affected by national borders or by FIR and/or control sector limits. These limits will be transparent for the airspace users ("seamless airspace"). It is important to remember that the airspace globalization must not affect the sovereignty of the involved States.

3.2.2 AERODROME OPERATIONS

3.2.2.1 The ATM Global Operational Concept considers the aerodrome operations as an integrated part of the ATM system. The aerodrome operator must provide the ground infrastructure, including: take-off and landing runway, taxiing path, lights, surface movement precision guides, etc. These operations must have as main objectives the security/safety improvement and the capacity maximization, in any meteorological conditions. The ATM system must give the necessary conditions for the efficient use of the aerodrome capacity.

3.2.2.2 This component of the operational concept will remove any inefficiency in the previous concept, as it promotes the interrelationship between the aerodrome operation and the airspace operation, to guarantee the necessary capacity to meet the user needs

3.2.2.3 Although the Global ATM Operational Concept has focused in the "air" side of the airports and has made only reference to the "ground" side, the experience acquired during the process of capacity analysis presents that the "ground" side is as important as the "air" side. Capacity problems related to the check-in, departure and arrival waiting rooms, luggage inspection; immigration control, custom house and others have a fundamental role in the ATM system

3.2.3 DEMAND CAPACITY BALANCING

This component replaces the Air Traffic Flow Management (ATFM). The main reason for this change was that the balance between capacity and demand does not need to be done imposing restrictions to the air traffic demand, but could be implemented through the increase in the ATC and/or airport capacity. The European concept, for example, was modified for Air Traffic Capacity and Flow Management, more adaptable to the Brazilian characteristics.

3.2.4 TRAFFIC SYNCHRONIZATION

This component was established to guarantee an adequate "gate to gate" air traffic flow, through the use of automatic tools, that will indicate the optimum air traffic control sequence to the gates for the approach and landing, for the take-off and en-route. The traffic synchronization will be directly related to the capacity and demand balance, and to the conflict management, to guarantee a continuous and organized traffic flow, implying in the system and the controllers preparation for the use of the aircrafts navigation capacity in 4D.

3.2.5 AIRSPACE USER OPERATIONS

Airspace User Operations refers to the ATM aspects of flights operations. This component was established to indicate that all airspace users must be considered in Global ATM, including unmanned aircraft. The information proceeding from the user about their flights and the predicted changes will be a key element in the integrity of ATM components, such as: Airspace Organization and Management, Aerodrome Operations, Traffic Synchronization and Capacity and Demand Balance.

3.2.6 CONFLICT MANAGEMENT

3.2.6.1 The separation concept will be extended with the application of the Conflict Management component. The separation will be executed between the aircraft and the potential risks. The considered risks will be: another aircraft, the terrain, the meteorology, the turbulence map, incompatible activity in the airspace, vehicles in the surface and other obstacle located in the surface or in the maneuvering area. It can be observed that the separation concept is extended, including other risks beyond the traditional ones, as "another aircraft" and obstacles.

3.2.6.2 The conflict management will be executed in three main aspects:

a) Strategic conflict management;
b) Provision for detection and separation; and
c) Conflict resolution.

3.2.6.3 Normally the conflicts will be detected and decided in the ground, before the take-off, through the conflict strategic management, considering the planned profile of the flight.

3.2.6.4 The separation provision will be the conflict management tactical phase, and will guarantee the separation of the aircraft from the risks associated to its actual flight profile. In this phase, the necessary ATM automation will be applied, through adequate tools, aiming at the "alert", the "resolution" and the "conflict prediction".

3.2.6.5 The conflict detection and resolution in flight will be done through existing systems on board, similar to the ACAS.

3.2.7 ATM SERVICE DELIVERY MANAGEMENT

3.2.7.1 This component replaces the traditional Flight Plan filing, and suggests that a service delivery based in the components previously presented will correspond to the service request. To make this service possible, an interaction system between the user and ATM service provider will be developed, in which will be possible to establish an agreement, through a collaborative decision system, to make possible a flight profile close to the ideal.

3.2.7.2 It is important to say that after the agreement between the user and ATM service provider, a formal air traffic authorization will be necessary and must be complete, including all "gate to gate" flight phases.

3.3 PERFORMANCE-BASED AIR TRAFFIC MANAGEMENT

3.3.1 Performance-Based Air Traffic Management is based on the assumption that the ATM Community expectations can be best served by quantifying its needs. A set of performance goals and objectives that can justify, objectively, the projects that aim to improve the performance of the air traffic management system will be established.

3.3.2 In order to apply the performance-based ATM, it will be necessary to establish mechanisms for evaluating and measuring the performance goals. Figure 3 illustrates the process for transforming the expectations of the ATM Community into objectives and goals. The following Key Performance Areas (KPA) have to be taken into account when elaborating this process:

a) Access and equity;

b) Capacity;

c) Cost-effectiveness;

d) Efficiency;

e) Environment protection;

f) Flexibility;

g) Global interoperability;

h) ATM Community participation;

i) Previsibility;

j) Operational safety;

l) Aviation security.

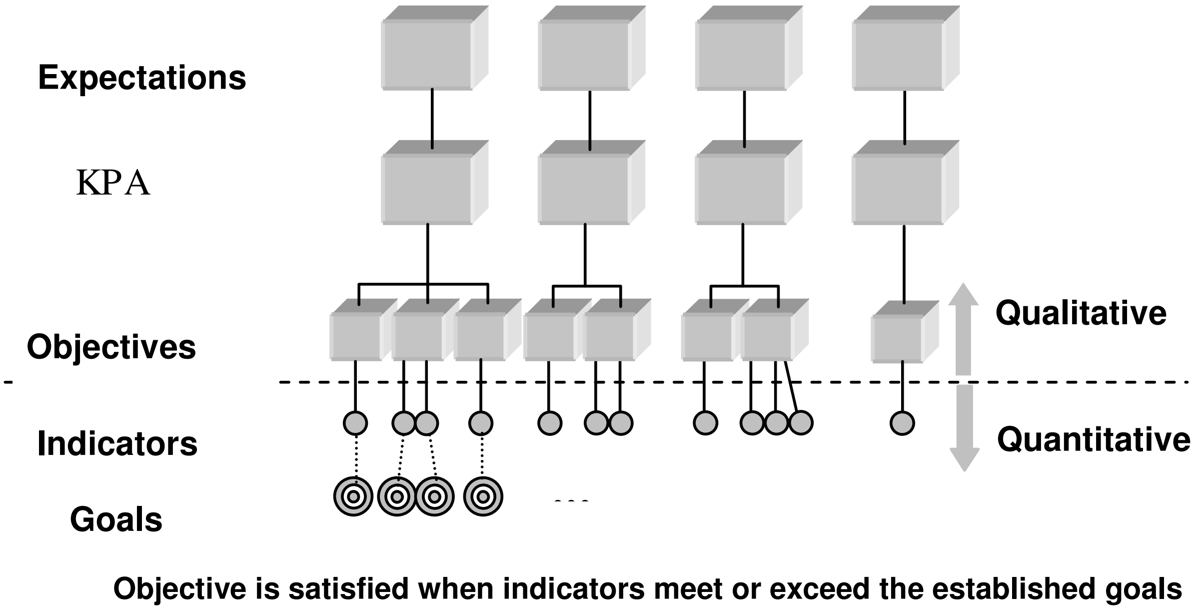

Figure 3 ATM Community Expectations Quantification Process

3.3.3 The KPA provide a general guidance for the classification of the performance improvement needs that will be met by establishing specific performance objectives that are adapted to the specific needs of each Region/State. The scope of these objectives will have to be precisely established, in order to enable their expression in events and quantities, including a desired tendency for the performance indicator (e.g.: reducing the ATM cost per km).

3.3.4 The performance objectives have to be expressed in qualitative terms, which will occur in the definition of the goals to be met. A typical example for a performance objective is “timely arrival improvement,” which can be one of the objectives for the “Efficiency” KPA.

3.3.5 The performance objectives must have the following characteristics:

a) Specificity – they must be expressed by objects and events that actually represent air traffic and the operational environment;

b) Measurability – it must be possible to associate them to one or more clearly established performance indicator, enabling the establishment of a data gathering process and the comparison of the results;

c) Attainability – the time parameters and the resources available for implantation must be taken into account;

d) Relevance – they must be defined wherever performance problems and/or opportunities for improving the ATM Community expectation service are anticipated;

e) Opportunity – they must be met in due time.

3.3.6 Performance management must be performed by means of specific performance objectives, to be measured by means of performance indicators. These indicators have to be defined aiming at quantifying how well the performance objectives are met. When describing the performance indicators, the metrics to be used have to be defined, as well as how to get them. One performance indicator example is "average delay opening the aircraft doors for each arrival" which can be established for verifying how well the performance objective "timely arrival improvement" is being met.

3.3.7 In order to calculate this performance objective, one must gather data on estimated and actual door opening times for arriving aircraft. Using this data, one can determine the total delay (support metrics), which divided by the number of arrivals (support metrics) will enable this indicator to be calculated.

3.3.8 Demand forecasts have to be used as input for some performance goals. The capacity goal for an operational environment (ACC, APP, airspace volume, etc), for instance, will depend on the demand forecast. Such a forecast must generate the information required for getting a better understanding of the traffic characteristics.

3.3.9 This qualitative forecast is an important tool for ATM system planning. The demand forecasts that contain just the number of flights and the aircraft sizes, based on the number of seats, are not enough for, e.g., analyzing the impact of performance improvements due to onboard equipment installation. Analysis of future required performance can require information about aircraft "mix," percentage of the fleet with specific equipment onboard, among others.

3.3.10 The demand forecasts may have different time and scope horizons. These characteristics must be oriented by the requirements set by the performance goals. ACC capacity planning for the next year can, for instance, demand a more accurate, and more detailed, demand forecast than that required for developing a 20-year strategic planning. Depending on the time horizon and on the geographic region, the forecast methods may differ. A forecast for the next year for a single control unit usually applies purely statistical methods, whereas a forecast for a long term planning for an entire country will use a specific economic analysis and several scenarios.

3.3.11 The actual performance of the system must be checked at regular intervals, by means of operational data measurements and performance indicator calculations, aiming at:

a) Establishing the initial performance of the system (baseline);
b) Controlling progress on meeting the performance objectives, by means of a performance indicator – performance goals comparison.

3.3.12 The forecast of the ATM system future performance will be paramount in orienting the planning process for the improvements. The research and development initiatives must be organized aiming to enabling risk analysis for the following situations:

a) Keeping the current ATM system, with no modifications whatsoever. In this case, the ATM system would be subject to the alterations the service provider cannot control, such as: air traffic growth, fleet composition changes, etc.;
b) Implementing changes that do not yield the expected improvements in system performance. In this case, the performance goals are not met.

3.4 NATIONAL ATM EVOLUTION

3.4.1 AIRSPACE ORGANIZATION AND MANAGEMENT (AOM)

3.4.1.1 In a short and medium term, the Airspace Organization and Management will continue to be based in a fixed route structure, with the improvements brought by PBN implementation. In view of the necessity to guarantee the airspace structure efficiency, the airspace planners must apply correct techniques in the route network reorganization, as airspace modeling and ATC simulation, with the following objectives:

a) To validate the proposed airspace structure;
b) To evaluate the PBN implementation impact, including the SID and STAR RNAV and/or RNP procedures, RNP approximation procedure, and approximation and arrival procedures based in FMS.
c) To guarantee a favorable cost/benefit relation.
d) To optimize the airspace division, to make it transparent for the users and reasonable in terms of work load to the controllers.

3.4.1.2 In a long term, it must be evolved, gradually, to a random and/or flexible route system, in which the user will define the trajectory to be used. In a first phase the use of these random and/or flexible routes will be done between the end of the SID at the origin airport and the beginning of the STAR at the destination airport. In a second phase it will be possible to choose a random and/or flexible SID and STAR, depending on the terrain conditions around each aerodrome. In this case it will be necessary to use an adequate ATM automatization, from the air navigation service provider and from the airspace users, including the interaction between the ground and on-board systems.

3.4.1.3 The real time Airspace Management is an attribution of the Air Navigation Management Center (CGNA) and must guarantee adequate use of the airspace by all system users.

3.4.1.4 The best, balanced and equitable airspace use by the civilian and military users will be facilitated by the strategic coordination and dynamic interaction between them and the CGNA, allowing the establishment of the optimum flight trajectory, reducing the operational cost. In this way pre-defined Special Use Airspace will be kept to a minimum, even if activation is only temporary. The airspace reservations must be proportional to the intended use. The CGNA will coordinate the airspace use in a dynamic way, based in the needs presented by its diverse users.

3.4.2 DEMAND CAPACITY BALANCING (DCB)

3.4.2.1 In normal operational conditions, the ATM system must have sufficient capacity to meet the normal or seasonal air traffic demand, in its optimum flight profile, in order to guarantee the scheduled take-off and landing times. The air navigation infrastructure related to the ATM (CNS, MET, AIS, ATC Automation) and the associated human resources will be allocated, aiming at the optimum system operation.

3.4.2.2 Tools and processes to predict air traffic demand will be implemented in order to supply the information needed by the air navigation infrastructure and human resources planning.

3.4.2.3 In case of unexpected events that can cause degradation in the system capacity (for example: adverse meteorological conditions, inoperativeness in the air navigation system or in the airports and unexpected demand) the necessary actions of Capacity and Flow Management will be applied by the CGNA. These actions will allow a balance between capacity and demand, in order to prevent a system overload and providing the necessary conditions for the use of the maximum available capacity. The CGNA will be able to develop the necessary capacity and demand management actions, in tactical and strategic level, using the following process/tools:

a) Analysis of the flight intentions (Ex. HOTRANS) in a period of up to 6 months, aiming at:
   - Optimize the existing capacity, in order to meet each flight intention in its optimum profile, mainly time and route;
   - To develop a joint proposal of necessary changes in time and route;

- To provide the necessary indicators to the DECEA, ANAC and INFRAERO planning sectors, concerning the necessity of ATC and/or airport capacity.

b) Use of Slots ATC (Ground Delay Program) – To be used in case strategic planning is not implemented, allowing the definition of the take-off schedule, in order to prevent the saturation in the control sector and in the airport.

c) Use of alternative routes– It will give the necessary conditions to avoid restrictions in the aircraft take-off schedules, by proposing alternative routes, in case of unexpected events that could affect the ATC and/or airport capacities. The alternative routes must be listed in a specific catalogue, and must be submitted to a process of viability analysis, including the accelerated time simulation.

d) Flight Plans Initial Treatment – It will be the process to make the requested adjustments of en-routes and flight schedules, when necessary, through an efficient communication between aircrafts operator, ATS agencies and CGNA.

3.4.2.4 The Capacity and Flow Management improvement will provide the necessary conditions for a secure/safe, ordered and clear air traffic flow. The procedures associate to the Capacity and Flow Management will make the following items possible:

a) Secure/safe air operation, by keeping the ATM system demand inside its traffic capacity, maintaining an efficient aircraft flow.

b) To minimize the operational cost to the airspace users caused by capacity restrictions in the air traffic, and airport control systems.

c) Improvement in the system capacity, indicating to the ATC and airport infrastructure improvement.

3.4.2.5 To guarantee the correct use of the Capacity and Flow Management, the maximum capacity in the control sector and in the airports will be established through the optimizations of these capacities, such as:

a) Reduction in the runway occupation time, through fast exits implementation and applicable procedures to ATC and to the pilots.

b) Implementation of air traffic procedures that explore the maximum of the available airport infrastructure, such as: parallel approaches under VMC, implementation of dynamic sequencing tools for terminal area operations.

3.4.2.6 The Capacity and demand balance implementation will be based in a Collaborative Decision Making process (CDM), looking for synergy among CGNA, aircraft operators, ATS agencies and airport operators, aiming at capacity optimization, and to fulfill the air traffic demand. If it is not possible, the CDM must be applied for the equitable distribution of the necessary restrictions.

3.4.3 ATM AUTOMATIZATION

3.4.3.1 The implementation of the ATS surveillance system and the datalink application should consider the ATC automatization aspects, such as modifications in the existed ATC system, as well as the integration requirements, mainly with the States of the SAM region, in order to ensure adequate and dynamic interoperability between them.

3.4.3.2 The new ATS surveillance system application strategy and the datalink application should consider the associated ATM automatization tools such as: conflict prediction, conflict resolution warning, trajectory conformity control, functional integration between the ground system and the aircraft system, etc.

3.4.3.3 In the long term, the ATM automatization must consider the gradual system evolution, in order to satisfy the Global ATM Operational Concept components not satisfied in short and medium terms, such as Traffic Synchronization, ATM Service Delivery Management, Conflict Management and Airspace User Operations. These components will demand automatization levels directly related to the decision-making process, in all levels, with extremely complex security/safety requirements.

3.4.4 AERODROME OPERATIONS

3.4.4.1 The Capacity and Flow Management will depend on project efficiency and on airport management, mainly in the movement area, as the eventual increase in the air traffic demand will have to be absorbed by the airports.

3.4.4.2 The airport infrastructure planning must consider the use of simulation tools, aiming at guaranteeing the efficiency of the operations in the take-off and landing runway, as well as in the surface movement. The use of joint simulations for airport and airspace always has to be applied, as it is the most efficient way to obtain an adequate aircraft flow, based on integrated project and management.

3.4.5 PERFORMANCE-BASED AIR TRAFFIC MANAGEMENT

3.4.5.1 Performance-Based Air Traffic Management will be implemented gradually, in short term, establishing Key Performance Areas and objectives, indicators and performance goals to be used on new service and/or equipment implementations or replacements in the Brazilian airspace.

3.4.5.2 In order to implement the Performance-Based Air Traffic Management, the tools required for collecting and processing indicator data that will allow the evaluation of the performance goals and objectives must be specified and implemented.

3.4.5.3 The Implementation Program for this conception must establish performance goals and objectives for each project, in order to allow for their scoping, justification and efficacy control.

3.4.6 OTHER ELEMENTS OF THE ATM OPERATIONAL CONCEPT

The other elements of the ATM operational concept are based on expectations, due to the lack of implementation experience. To make its application possible, new procedures, process and capacities will be necessary, which are unavailable currently. In this way these components will be included in this Concept of Operations as soon as they are developed.

3.5 MAIN PROJECTS

3.5.1 Phase I – Present to 2010

a) Definition of the Objectives and the Goals for performance tools that will orient new service and/or tool implementations or replacements;

b) Publication of an Annual Document that contains the evaluation of the Objectives, the Goals and the Performance Indicators for the previous year, and sets the goals to be met the next year;

c) Definition and implementation of data collection tools and processes that support analyzing the performance indicators bound to objectives and performance goals;

d) Implementation of modeling and ATC simulation tools, to validate the new airspace structure;

e) Implementation of tools and process for air traffic demand forecast;

f) Implementation of tools for ATC and Airport capacity calculation;

g) Implementation of approach and departure sequence tools;

h) Implementation of air traffic procedures to explore the existing airport infrastructure;

i) Definition of the air navigation infrastructure and human resources necessary to the air traffic demand predict up to 2020;

j) Capacity consolidation for the strategic implementation of the ATFM actions, considering:

- Operation of the Management System of HOTRANS;
- Integration between the Airspace Presentation System and the Data Treatment

System;
- Integration between the Control Tower Management System (SGTC) and CGNA's Data Visualization and Treatment System (STVD);
- Flow Management Cells (FMC) automatization and integration into CGNA's Data Visualization and Treatment System (STVD).

l) Implementation of tools of ATC Slots calculation (Ground Delay Program);

m) Alternative route catalogue development;

n) Flight Plan Initial Treatment implementation.

3.5.2 Phase II – 2011 up to 2015

a) Implementation of tools and capacities for real-time airspace management, considering:
- System operation monitoring, via outage identification and control;
- Implementation of the military air operations coordination cell, aiming at easing the cohabitation of military and general air circulations;
- Integration of meteorological information into CGNA's Data Visualization and Treatment System (STVD), including the definition of how to collect the meteorological information that matters;
- Evaluating the impact of meteorological phenomena on air circulation;
- Automation of the information analysis processes.

b) Implementation of new ATM automatization tools: conflict prediction, conflict resolution and warning, trajectory conformity control, functional integration between the ground system and the aircraft system, etc.

3.5.3 Phase III – 2016 up to 2020

a) Evaluate the implementation of the other elements of the ATM operational concept;

b) Extend service offers to regional partners.

4. COMMUNICATIONS

4.1 GENERAL ASPECTS

4.1.1 The aeronautical communication has as main function the verbal, message and data communication interchange, between users or automated system, and to support Navigation (GNSS) and Surveillance (ADS) functions.

4.1.2 Basically, there are two aeronautical communication categories:

a) Operational communications – fixed and mobile; and

b) Technical and administrative.

4.1.3 The operational communications are composed by fixed network (ground-to-ground link) and mobile network (air-to-ground link). The fixed network is composed by the telephony network and the ground-ground telecommunications infrastructure (LAN, MAN, and WAN), which will compose the ATN – Aeronautical Telecommunications Network, where currently exist long distance networks (WAN) based in satellite system (TELESAT), covering all National territory, using the FDMA SCPC PAMA/DAMA access method, and will be evolved to a TDMA or CDMA digital technology and also to an IP digital network using MPLS technology, connecting the SISCEAB main operational centers.

4.1.4 The air-to-ground operational communication mobile network is composed by:

a) Telecommunication infrastructure in VHF; and

b) Telecommunication infrastructure in HF.

4.1.5 The telecommunication infrastructure in VHF is composed by a long-range VHF radio system with AM modulation, forming robust voice communication networks, necessary to en-route flight operation (ACC), to terminal areas (APP), and to aerodromes (TWR). These systems, with analogical technologies, have a series of interferences, will be gradually replaced by a communication digital system in VHF, as Data Link Digital (VDL 2), in the period of 2010-2015, and by new technologies being studied by the aeronautical community (system B VHF MC CDMA) in the period of 2015-2020, composing the new communication system between pilots and controllers – CPDLC.

4.1.6 The communication infrastructure in HF forms a national system, structured throughout the years, capable of supplying service in several locations within the Brazilian airspace. Currently, the system is not used to the airplane/ground communication due to other services availability, except in the oceanic airspace and the Amazon airspace.

4.1.7 The Aeronautical Fixed Telecommunication International Network infrastructure – AFTN is responsible for the meteorological operational messages flow, AIS, flight plan, and others. About AFTN is important to consider:

a) The Diffusion Command and Control station still work properly but the equipments and operational system reached the end of their life cycle. It is significant, considering the daily message traffic, including operational, management and service communications.

The projection presents an increase in the quantity and traffic volume, and it is necessary to supply AFTN service information in other places.

b) The current message system (CCAM) that uses the AFTN network as ATM "backbone", will be improved to a new operational message distribution system (ATS message Distribution System - AMHS), based in IP, and will have the ATN network as its telecommunication infrastructure.

4.1.8 The current communication system used by ATS agencies supports the long-distance communication for the Brazilian airspace operation. Its architecture is composed by several data and voice sub-systems, distributed in all SISCEAB, and their infrastructure are formed by satellite communication link, with FDMA access technology, microwave digital links with high traffic capacity (2Mbps – E1) and PABX digital telephone central.

4.1.9 There has recently been developed, as primary network, a digital network based in IP protocol, using MPLS technology, composed by multi-protocol equipment (digital interface) as routers, which supports synchronous and asynchronous data, ATN, IP and FR networks, supplying services of images, data, and analogical and digital voice.

4.1.10 The microwave link E1 (MAN) and the MPLS network (WAN) form a Integrated Network of Digital Communication, which supplies communication services of quality, to the main DECEA operational agencies, such as radar, diagnosis system and alarm.

4.1.11 A Telecommunications infrastructure is being implemented, called SISCEAB Communications Digital Network– RDCS. In this infrastructure all telecommunication subsystem, installed or/and in modernization and implementation phase, will be included, such as:

a) Transition of the E1 Digital Link to a communication system based in WiMAX (norm IEEE – 802.16 d) technology, aiming at the SISCEAB metropolitan network(MANs) modernization;
b) Implementation of an integrated management system of SISCEAB communication network;
c) MPLS network enlargement and modernization;
d) Implementation of the Aeronautical Telecommunication Network - National ATM;
e) Technical and administrative communication network– INTRAER/DECEA;
f) Interconnection with the region SAM satellite network – REDDIG;
g) TELESAT system modernization.

4.1.12 A VSAT satellite communication network type constitutes the TELESAT system. Its main control node is located in Rio de Janeiro. The network is a star configuration, with FDMA (Frequency Division Multiple Access), (PAMA - Permanent Assignment Multiple Access) and (DAMA - Demand Assignment Multiple Access) types technology of access to the transmission environment, and 60% of its capacity is in “open channel” and 40% are available “on demand”. The open channels are used to support the ATS service. The TELESAT covers all national territory, and it is in cost/benefit analyze phase for all TELESAT system, in order to define its utilization as one of the RDCS network segment.

4.2 SYSTEM CAPACITY

4.2.1 For the Communication infrastructure, the objective is the increase in the aeronautical communications system coverage, accessibility, capacity, integrity, security/safety and performance. In most cases, the communication will be done through data interchange, while the voice communication will be used in non routine operations or emergency. The emphasis will be in the connectivity and global operation.

4.2.2 In order to optimize the airspace operation, the transition from a voice communication primary system to a system based on data interchange must be done. The communication infrastructure must evolve to support the data transference in real time, during all flights phases.

4.2.3 SCENARIO DESCRIPTION

4.2.3.1 In the Oceanic airspace:

a) The CPDLC application, with the ADS-C and RNP-4, in the oceanic airspace, will be the basic tool that will give the necessary condition for the 30 NM minimum horizontal separation application, mainly in the EUR/SAM corridor. Even in other oceanic airspace with lower air transit density, the CPDLC will provide a reliable communication, and will reduce the pilots and controllers work load, increasing the operational security/safety. In these areas, the CPDLC will be supported by on-board system as Boeing FANS 1 and Airbus FANS A, using the INMARSAT satellite segment (L Band).

b) In the future, the use of the HFDL and on-board system based in ATN/IP must be analyzed. Also, the voice system based in high frequency system (HF) will continue to be used. In a first phase, this system will be used in aircraft that do not support communication based in datalink. In a second phase, the HF system will be used in non routine operations or emergency. However, as the HF system has an inferior audio quality and is subject to frequency congestion, some or all of these communications could be transferred to the AMSS - aeronautical mobile satellite service system, current or future, in L Band, if the cost/benefit analysis presents their acceptability.

4.2.3.2 IN THE CONTINENTAL AIRSPACE:

a) The ADS-B services will be supported by extended pulse communication infrastructure of SSR Mode S or of VDL 2. For implementation in isolated homogeneous areas, as Bacia de Campos "offshore" operations, the "Universal Access Transceiver' (UAT) may be applied, if the cost/benefit analysis is favorable. Also, the utilization of the AMSS (L Band) as a system VHF secondary network and for low altitude coverage is being studied.

b) The CPDLC application in the continent, to replace the voice communication, will result in an increase in the operational security/safety, and in a decrease in the controllers and pilots work load. However, the CPDLC application in airspace with high density air traffic will be done with the simultaneous use of verbal communications in VHF, mainly in the TMA, due to the velocity requirements in the ATC interventions. When the CPDLC is used in a continental airspace with high density air traffic, the datalink technology to be used must guarantee pilots and ATC message latency and the send/receive acknowledgement. The datalink communication service will be done in accordance with the ARINC 623 standard and will be introduced using initially the ACARS protocol, and could change to IP in the future. In areas of low/medium density air traffic, for messages where timing is not important, the CPDLC service introduction will be done through ATN/VDL Mode 2 service.

c) The voice communication will continue to be supported through the 25 kHz DSB-AM system. In areas with VHF band congestion, or by demand of the economical or operational requirements, this service also could be supported by 8.33 kHz DSB-AM system.

d) The implementation of Datalink Communication among ATC Agencies will improve the operational security/safety and will reduce the coordination errors between the ATC Agencies. The communication between ATC Agencies must predict the Message Handling Services capacity, through the AMHS, with automatic exchange of operational information through a traffic transference system, making possible the coordination of messages between adjacent sectors controllers.

4.3 EVOLUTIVE TRAJECTORY

4.3.1 A critical element in the evolutive trajectory, mainly in high density areas, is the specter availability. The studies to minimize this problem, mainly in Europe and in the USA, choose the 8.33 kHz system, with VDL technology and B-VHF MC CDMA technology.

4.3.2 All systems and sub-systems (AMSS, VDL, SSR Mode S and HF datalink, and others) are Aeronautical Telecommunications Network (ATN) segments, and will be integrated through ATN/IP router. As a consequence of the technological advance, a new communication system could be developed in the next years. The adequacy of the current and future communication system, considering the scenario to support the ATM emergent requirement and RCP levels, must be estimated in quantitative terms as function of the operational environment.

4.4 MAIN PROJECTS

4.4.1 PHASE I – TODAY UP TO 2010

a) Air Traffic Services (ATS) Message Handling Services implementation - AMHS;

b) VDL Mode 2 full implementation;

c) Development, implementation and integration of a telecommunication infrastructure (RDCS) to support all SISCEAB, with an open architecture, in order to absorb all current and future services necessary to the CNS/ATM transition program;

d) Technical/operational requirements studies and documentation, to the CAR/SAM regions, allowing the ATM automation between all ATC agencies.

4.4.2 PHASE II - 2011 UP TO 2015

a) Planning of VHF AM gradual deactivation, due to the VDL system implementation, considering the required backup infrastructure;

b) New technologies development to the CPDLC System;

c) ATM Automatization implementation to the CAR/SAM region;

d) National ATN Implementation (SISCEAB);

e) Communication Digital Infrastructure implementation, based in IP, totally integrated, for the SISCEAB and region SAM;

f) Viability analysis for satellite bidirectional data link application (L Band) to support ADS-B and data transfer requirements.

4.4.3 PHASE III – 2016 UP TO 2020

a) Start of the gradual VHF AM deactivation, due to VDL systems implementation, considering the required backup infrastructure;

b) SISCEAB Communication Digital Network – RDCS, implemented and integrated completely, through REDDIG and MEVA II network, as base to ATM Integration and Automation in the Region;

c) Intensification of the studies for a new CPDLC communication system, based on B-VHF MC CDMA, and possibly based on IP.

5. NAVIGATION

5.1 GENERAL ASPECTS

5.1.1 PERFORMANCE-BASED NAVIGATION

5.1.1.1 Performance-Based Navigation specifies the RNAV system performance requirements to aircrafts that operate in ATS route, in an instrument approach procedure or in the airspace.

5.1.1.2 The performance requirements are defined in terms of accuracy, integrity, continuity, availability and necessary functionalities for the operation proposed by an airspace concept. The performance requirements are identified in the navigation specifications, which identify the equipments and sensors that could be used to satisfy such requirements.

5.1.1.3 There is RNP specification and RNAV specification. The RNP specification has the monitoring and alert performance on-board of the aircraft, and it is assigned as RNP “X”, where X is the accuracy value associated with the navigation performance. The RNAV specification does not have monitoring and alert performance on-board of the aircraft, and in the same way, it is assigned as RNAV “X”.

5.1.1.4 The navigation based in performance depends on:

a) The RNAV system installation on-board the aircraft, which is being approved to meet the functional and navigation performance requirements, specified to RNAV and/or RNP operations in a specific airspace;

b) The fulfillment, by the flight crew, of the operational requirements established by the RNAV operation regulating entity;

c) One explicit concept of airspace, which includes RNAV and/or RNP operations; and

d) The availability of one infrastructure that promotes adequate air navigation.

5.1.2 GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

5.1.2.1 The main way to meet the performance requirements recommended by PBN is the satellite navigation. In order to understand the Satellite Navigation components, is important to review the relation between the GNSS, the Satellite Based Augmentation System (SBAS), the Ground Based Augmentation System (GBAS) and Aircraft Based Augmentation System (ABAS). The base for navigation, positioning, and global synchronism is supplied by 3 GNSS satellite constellations:

a) The Global Positioning System (GPS –United States);
b) The Galileo (Europe, to be operational in 2012); and
c) The GLONASS (Russia).

5.1.2.2 The satellites use medium Earth orbit, with inclination of 50 to 65 degrees in reference to the equatorial plane. The quantity of satellites in each orbit is calculated based in the altitude, in order to cover all Earth surface. The constellations supply the user with navigation capacity, with global covering, including capacity for non-precision approach. There are four augmentation systems to minimize limitations of accuracy, integrity, availability and service continuity: SBAS, GBAS, GRAS and ABAS. With them, the GNSS is able meet the civil aviation requirements.

5.1.2.3 Satellite Based Augmentation System (SBAS)

a) The SBAS can be used for increasing the system availability and integrity, for route navigation, Terminal Management Area (TMA), non-precision approach and approach with vertical guidance (APV) based in baroaltimeter (Barometric Vertical Navigation - Baro-VNAV). The SBAS is an essential requirement for the APV I and II procedures that will probably give operational minima (ceiling and visibility) lower than the Baro-VNAV.
b) A SBAS system covers a large area as navigation support. Although one satellite has hemispheric cover, additional satellites are needed in order to guarantee redundancy. The SBAS can give integrity to the GPS, Galileo and GLONASS constellations, and can increase the system accuracy, integrity, availability and continuity. The systems can also be used to give position and time information to be used by the ADS-B/C – (Automatic Dependent Surveillance).
c) Some SBAS projects under development in the different regions of the world are:
   - WAAS – Wide Area Augmentation System – USA.
   - EGNOS – European Geostationary Navigation Overlay Service - under development by the European industry (Alcatel and Thales), orientated by the

European Space Agency, the European Commission and EUROCONTROL.

- MSAS – MTSAT Satellite-based Augmentation System - Japan
- GAGAN – GPS Aided Geo Augmented Navigation System - India

d) The SBAS is formed by equipments and software, and is used to improve the Standard Positioning Service (SPS) of the US Global Positioning System (GPS). The system may also support additional systems, such as Galileo and GLONASS. The SBAS improves the GPS performance for continuous coverage in all flight phases. SBAS improves the GNSS performance in the following aspects:

- Improves the availability and reliability, as it uses the GEO satellite in addition to the GPS constellation as synchronism source, and is always on sight in its coverage area;
- Improves the accuracy, using GPS Differential correction techniques;
- Improves the security/safety, using integrity monitor.

e) The SBAS gives a Signal-in-Space (SIS) to the certified aircraft avionics, in any phases of flight. The GNSS satellite data are received and processed in the SBAS Reference Station (SRSs), which are strategically placed in order to provide adequate coverage to the required service volume. These data are sent to the SBAS Master Stations (SMSs) that process data that comes from multiple SRSs, in order to determine the integrity, the differential correction and the residual errors for each monitored satellite according to the ionospheric grid point (5º latitude and 5º longitude) where the user is.

f) Multiple SMSs can be used to eliminate specific failures in a SBAS network. The information that came from the SMSs is sent to each Ground Uplink Subsystem (GUS), and transmitted together with the GEO navigation message to the GEO satellites. The GEO satellites transmit these data to the Users by GNSS frequency, using GNSS modulation. Each SBAS ground station/subsystem is connected through a Ground Communications Network (TCN).

g) Figure 4, below, presents the FAA`s Wide Area Augmentation System – WAAS. This is currently the only operational SBAS in the world.

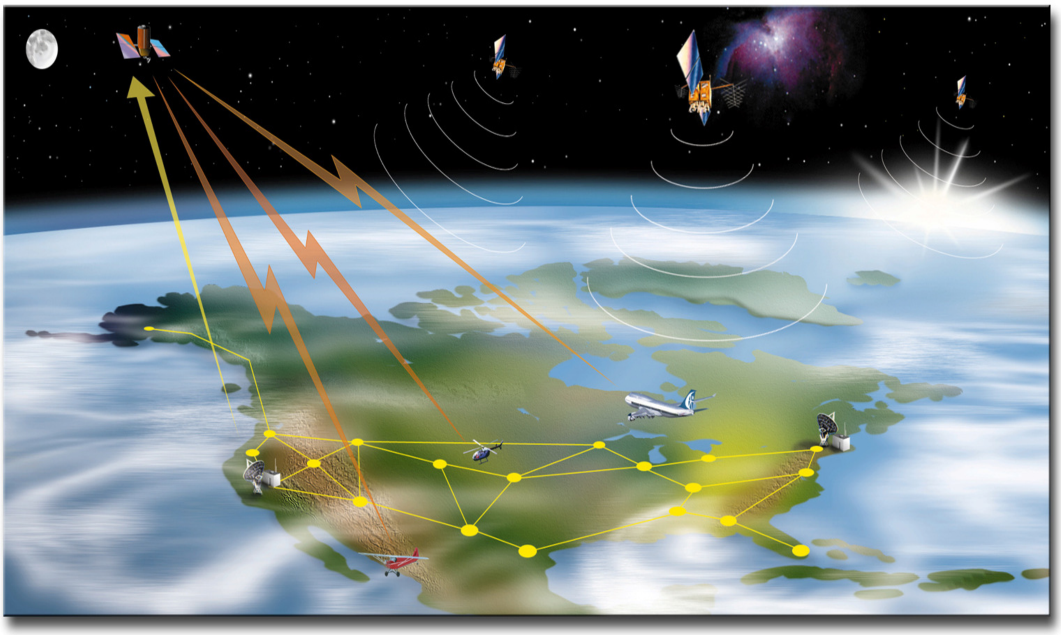

Figure 4 FAA's WAAS Configuration

h) Although the SBAS technology is available to be used now, it will not be used in Brazil in short and medium term based in the following reasons:

- The ionospheric interference will adversely affect the reliability of the GNSS signal, in practically all areas of Brazilian airspace, resulting in an unfavorable cost/benefit relation.
- About 85% of the Brazilian air operations happen with commercial aircraft in airports with an adequate air navigation infrastructure.
- The implementation of a second civil frequency in the GPS, and the start of GALILEO operations, may improve the GNSS integrity and availability enough to make the SBAS implementation unnecessary.

5.1.2.4 Ground Based Augmentation System (GBAS)

a) The GBAS is used for all categories of precision approach, landing, guided take-off, missed approach and surface operations, within the GBAS coverage (approximately 20 nautical miles for approaching service). The GBAS will provide the necessary conditions to RNP value inferior to 0.3 in TMA operation, allowing the reduction in the minimum separation between aircrafts, and between aircrafts and obstacles. Also, the GBAS can provide:

- Operational redundancy: the GBAS availability, for CAT I precision approach, is larger than SBAS';

- CAT I service in mountainous terrain;
- CAT II/III for multiple runways with only one GBAS installation;
- Positioning information with high precision, which allows navigation in low visibility surface.

b) Initially, the GBAS system will be certified to Category I operations, so it will be implemented at airports of higher air traffic level, where the ILS substitution will bring more benefits for the system operation and maintenance. GBAS has excellent cost-benefit in airports with more than one runway and in places with adjacent airports in a 20NM radius, since it can replace several ILS. The GBAS is projected to give precision approach and landing capacity CAT I/II/III. The GBAS will give local coverage of approximately 20 NM, if IFR approaches are considered, and it could support multiple operations in this size of airspace. The GBAS consists of 3 primary subsystems, as present in Figure 5:

- The satellite subsystem, which provides reach signal and orbital parameter, for the GPS use.
- The GBAS ground subsystem, which provides VHF Data Broadcast, including Differential Corrections and integrity parameters. Also, the ground station gives the information status to the Air traffic Control (ATC) and for the maintenance technicians.
- The airborne subsystem receives and decodes the correction, integrity and the VDB ascendant link data. It uses the correction data with the satellite range signal to estimate, with high integrity and accuracy, the position, velocity and time.

c) Coverage: Each GBAS approach has a coverage volume, which is inspected in flight and authorized for use. For aircraft adequately equipped, this volume goes approximately from 20 NM of the runway approach extremity to 4 NM beyond the runway approach extremity. Each ground GBAS has a coverage volume of VHF Data Broadcast, which is extended from the surface visual line up to 10,000 feet above ground level (AGL), with a radial distance of 23 NM from the VDB antenna. Within the coverage volume, the GBAS gives terminal, approach and landing capacities for multiple runway extremities. The reach of the protected VDB reception– 60 NM – is defined as the airspace volume where the VDB signal has spectrum protection, integrity and can be received, decoded and used by an on-board user. In many cases, for an on-board user, it is probable that the VDB reception extends until the reach of the visual radio (100 to 200 NM).

d) Operation in adjacent airports: the GBAS capacity may provide service in adjacent airports, within the station service volume and will depend on several factors, such as: signal power, terrain conditions, distance between airports, and others. It is desirable that all airports inside a GBAS service volume could be provided with the same service level, in order to prevent the implementation of two stations.

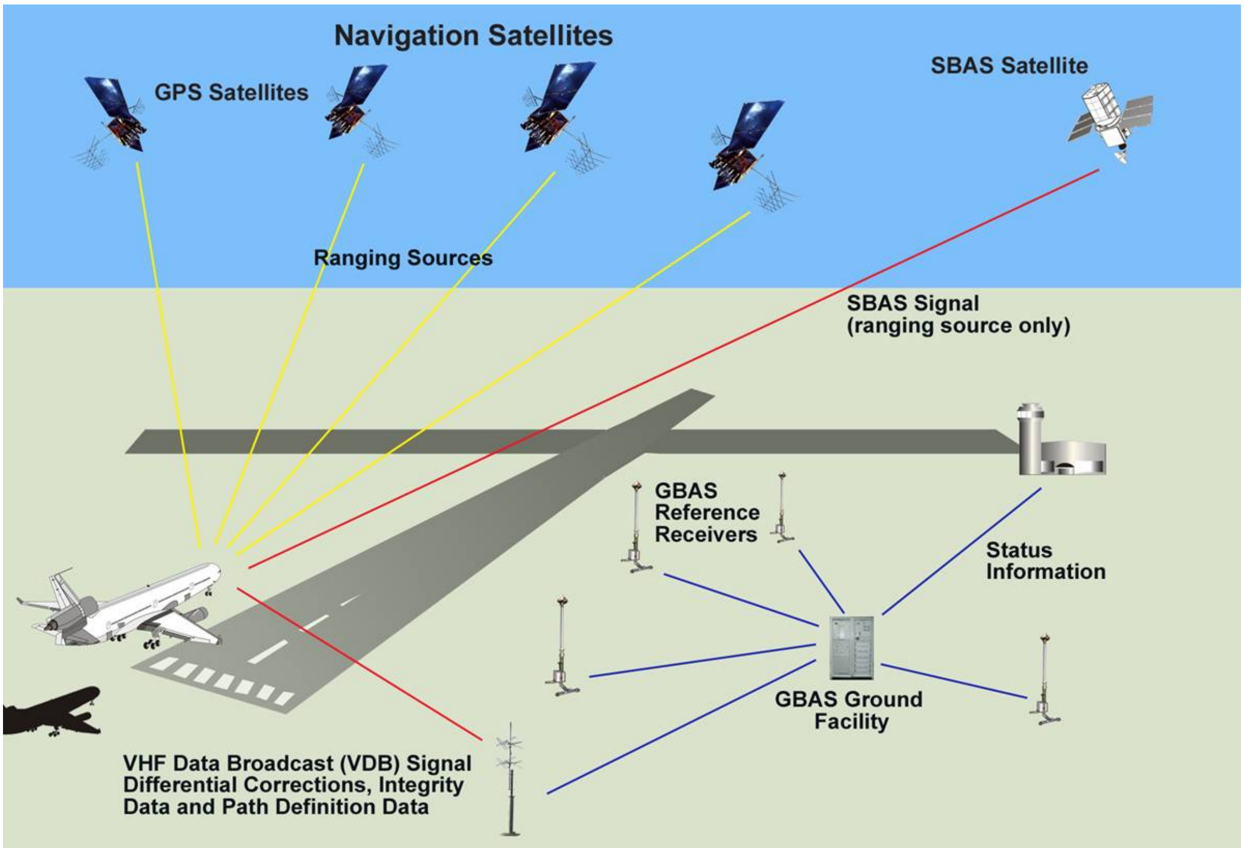

Figure 5 Ground-Based Augmentation System (GBAS)

5.1.2.5 Ground-based Regional Augmentation System (GRAS)

a) GRAS is being developed by Australia. This system will use a grid of reference stations and correction messages with national range, using VHF. This system works like a GBAS, but its reference stations are far apart, in order to cover a large area (all of Australia). Due to this, precision is lower and it can provide, at best, APV approaches.

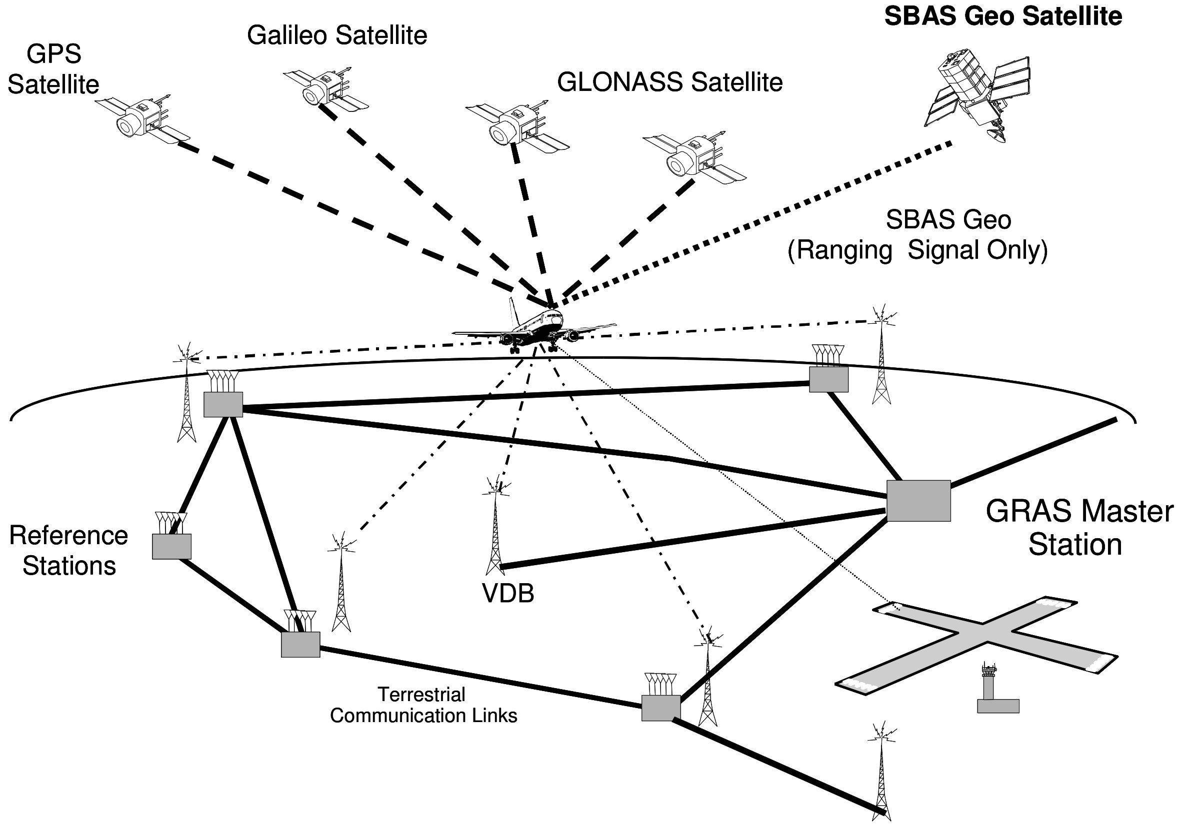

Figure 6 Ground-based Regional Augmentation System (GRAS)

5.1.2.6 Aircraft Based Augmentation Systems (ABAS)

a) It is the system that allows the increment in the GNSS integrity function, based in information from the Satellite system and/or other available sources in the aircraft navigation system.

b) The ABAS consist basically of an algorithm in the receiver (RAIM), which considers that 4 satellites are required to obtain position and synchronism and with the presence of 5 or more satellites in line, it periodically verifies the position, calculating it with different sets of 4 satellites and verifies if the calculated positions are inside an adequate tolerance in order to keep the required navigation performance.

c) Additionally, it can have other algorithm that compare the position calculated by GNSS with other systems, such as IRS, DME, Altimeter, indicating a system integrity fault if discrepancies are found between the systems.

d) The existence of RAIM algorithm is demanded for the GNSS use in air navigation procedures. This algorithm is very effective; provided no more than one satellite fails and the information about satellite availability are conveniently informed to the system. It has an impact in the navigation service availability and continuity, considering the necessity of 5 or more satellites for its functioning.

e) The Aircraft Based Augmentation Systems – ABAS (RAIM) is widely used in Brazil to authorize the execution of GNSS procedures, to ensure its performance since en-route operations, STAR and non-precision approaches, as a secondary navigation means. The use of this kind of "augmentation" as a basic means of navigation depends on the implementation of instruments of GNSS performance control (GPMS) and institutional arrangements.

5.1.2.7 IONOSPHERE

a) The GNSS signals are subject to several sources of interference in their path to the receiver. One of the most important ones, and difficult to correct, is the ionosphere.

b) The ionospehere is a layer in the upper atmosphere between 50 km and 1200 km above the Earth's surface. It is ionized by the ultraviolet rays and other solar radiation. It affects the radio signal propagation in several ways, depending on the frequency.

c) The main cause of the great variation in the GNSS signals are the iono delays, related to the 11-year solar cycle and to seasonal changes. The delays increase with the solar activity, and are bigger at noon (local time) than at night; they tend to be bigger during equinox. There are big fluctuations near the magnetic Equator and low latitude regions. These fluctuations are random and affect the GNSS information. The ionosphere over the tropical area is irregular and difficult to model. The decision to use any GNSS must consider:

- Need to mitigate the ionosphere effects;
- Adequacy of existing software (ex: SBAS and GBAS);
- User intent to install the required equipments on board;
- Possibility to use other means to support the operational requirements;
- Accurate cost-benefit analysis.

5.1.2.8 Ground Based Components

a) VOR – VHF Omnidirectional Radio Range – This system provides the basic orientation to the en-route navigation, terminal and non-precision approach. The information supplied by the VOR for the aircrafts is the aircraft magnetic azimuth relative to the VOR ground station.

b) DME – Distance Measuring Equipment – Radiotelemetric Equipment – The DME operation is executed by sending and receiving pulse pairs – two pulses of fixed duration and separation, using a decoder. The transponder must reply all interrogation, and the time difference between interrogation and reply is measured by the interrogator's timing circuitry and translated into a distance measurement.

c) ILS – Instrument Landing System – It is a precision approach ground based system, which provides precise guidance to an aircraft approaching. It gives to the pilot indications of distance for optimum point of landing. It provides lateral and vertical guidance, as well as other navigational parameters required by an approach or landing. Nowadays the ILS is one of the main precision landing systems approved by the ICAO, and although it is adequate, it has limitations related to location, frequency allocation, cost, and performance.

d) NDB – Non-Directional Radio Beacon – Aeronautical Radio Beacon is a radio broadcast station non-directional, working in low and medium frequency to transmit ground wave signal to aircraft receiver. The non-directional radio beacon for air navigation are used to complement the VOR-DME during the transition of en-route phase to the airport approach, or as an assistant to the non-precision approach in many airports.

5.2 SYSTEM CAPACITY

5.2.1 The Brazilian airspace navigation system capacity must provide conditions to an adequate navigation, considering the meteorological conditions in each region, as well as the air traffic density, including operations en-route, in TMA, approach and landing. The integrity, accuracy, and performance must be improved, using the Performance Based Navigation (PBN), mainly through the Global Navigation Satellite System (GNSS).

5.2.2 THE PBN MAIN BENEFITS ARE:

a) Increase in the airspace security/safety, through the continuous and stabilized descending procedures implementation, with vertical guidance, significantly reducing events of Controlled flight into terrain (CFIT);

b) Reduction in the aircrafts flight time, through the implementation of optimum flight trajectory, independent of the ground air navigation, reducing the fuel consumption and, consequently, reducing the emissions to the environment;

c) Utilization of the RNAV and/or RNP capacity already installed in a lot of aircraft fleet that flight within Brazilian airspace;

d) Trajectory optimization, in any meteorological condition, making possible to prevent critical conditions of terrain and environment, such as aircraft noise, through the use of RNAV and/or RNP trajectories;

e) Implementation of more precise trajectory, approach, take-off, and landing, reducing the dispersion and giving more predicable traffic flow;

f) Delay reduction in airspace and airports with high density air traffic, with the increase in the ATC capacity, due to the implementation of parallel routes, new points in the TMA and approach procedures with lower operational minimum;

g) Potential reduction in the parallel routes separation in order to accommodate more air traffic in the same flow;

h) Work load reduction for the air traffic controller and pilot. The use of RNAV and/or RNP trajectory will reduce the necessity of radar vectors, and consequently, the time used in the pilot/controller communications.

5.2.3 SCENARIO DESCRIPTION

5.2.3.1 Oceanic Airspace

The oceanic airspace has low-density air traffic; therefore no expressive modifications in its structure are expected in the short term (up to 2010). In medium term, the RNP 4 should be applied in the EUR/SAM corridor, and with the use of ADS/CPDLC, it will give the necessary conditions for the 30 NM lateral and longitudinal separation. The RNP 4 application will depend on the aircraft fleet evolvement that uses this airspace, due to the necessity of datalink communication implementation, in order to make the separation reduction feasible.

5.2.3.2 Continental Airspace – En-route operations

a) The air traffic demand in the Brazilian airspace is relatively low, if compared with the American and European airspaces, so the RNAV-5 in the superior airspace will be enough to meet in the short-term, the needs of airspace restructuring, in order to meet the user and air navigation service provider needs. It is important to say that the RNAV-5 is the most simple navigation specification available for immediate application that will appear in the Performance Based Navigation Manual (Doc. 9613), and it will allow the inclusion of a larger number of users in a exclusive use airspace, since it allows the use of all types of air navigation.

b) In medium term, the RNP-2 could be used, with the expansion of the GNSS application, if the airspace users are adequately equipped. The use of RNP-2 will ease the deactivation of the ground air navigation support, since the navigation specification will depend on the GNSS utilization. However, the establishment of a backup system for the GNSS will be necessary, as so the development of contingency procedures in case of failure of this system. The RNP-2 is narrowly related to the ADS-B implementation, since this surveillance technique needs the GNSS information for the positioning information precision. The RNP-2 application will make necessary an improvement in the information system concerning the GNSS operation, which could be obtained from the GNSS Monitoring System (GPMS).

c) It is important to emphasize the importance of the RNAV and/or RNP criteria harmonization in the CAR/SAM regions, in order to prevent the necessity of multiple approvals for the intra and inter regional operations.

5.2.3.3 Continental Airspace – Terminal Control Area (TMA)

a) The TMA operations have its own characteristics, due to the separation minimum applicable between aircrafts and between aircrafts and obstacles. Moreover, the operation of aircrafts with distinct performance, including flights in the inferior airspace and use the same take-off and landing runways represents an additional complexity to the air navigation services.

b) The TMA operation efficiency depends on the airports management and efficient design, aiming at the maximum utilization of the airport capacity, as so its adequate evolution, because the increase in the air traffic demand must be absorbed by the airport infrastructure.

c) In short term, the RNAV-1 will be applied to the TMA with ATS surveillance service. The navigation infrastructure must be adequate in order to allow the use of DME/DME and DME/DME/INS operations, aiming at supporting the user without GNSS, and to provide backup infrastructure to the GNSS. At this phase operations of aircrafts equipped and non-equipped RNAV-1 will be admitted, provided an adequate number of aircrafts are equipped, and ATC simulations ensure its feasibility, considering an eventual increase in the workload of the air traffic controllers. In medium term, the RNAV 1 approval will be compulsory to the TMA operation with larger complexity and air traffic demand (exclusive airspace).

d) In TMA without radar surveillance service and/or without adequate air navigation infrastructure, the RNP-1 could be used, with exclusive use of GNSS, provided there is an adequate number of aircrafts approved and ATC simulations ensure its feasibility.

e) In what concerns to approach, RNP APCH non-precision approach procedures must be implanted in all airports with IFR regulation. In short term, conventional approach procedures must be kept for non-equipped aircrafts.

f) One of the main causes of controlled flight into terrain (CFIT) events is the approach procedure where several descending and leveling phases are applied. The stabilized approach operations are essential to prevent this kind of accident.

g) Procedures of approach with vertical guidance (APV), based in Baro-VNAV will be applied, for a more efficient trajectory until the runway head, allowing an uninterrupted flight trajectory since the descent until the aircraft touchdown. The 3-D navigation will be essential and approach procedures APV Baro-VNAV must be implanted, in short term, in all airports with IFR, with priority for airports without ILS procedures.

h) The RNP APCH AR approach procedures will be implemented where big operational benefits are attainable, at airports with significant obstacle environment.

i) In medium term the ILS navigation services could be replaced by GBAS system, which provide the demanded accuracy, availability, integrity and continuity by all precision approach categories. GBAS equipments could be installed in some airports, where operational benefits can be reached.

j) The GBAS system and the precision approach procedures, in ground and on-board, will improve the en-route and TMA (SID and STAR) operation, including curve approach trajectory. Also, the GBAS will improve the reliability of the information supplied to the ADS-B. The transition between arriving and approach will be improved by the GLS procedures. In some airports, the ILS system will be kept as a GNSS/GBAS backup.

5.3 MAIN PROJECTS

5.3.1 PHASE I – TODAY UP TO 2010

a) Implementation of GBAS CAT I stations in airports with enough operational demand;

b) RNAV-5 implementation to en-route operation;

c) SID/STAR RNAV-1 implementation in Brasília, Recife and São Paulo;

d) RNP APCH and APVBaro/VNAV approach procedures implementation in IFR airports;

e) RNP AR approach procedures implementation, where operational benefits could be gain;

f) Automatic tool implementation for air navigation procedures elaboration, aiming at new procedures demand, such as RNAV e RNP;

g) GNSS backup infrastructure implementation;

h) DME infrastructure change to comply with ICAO requirements for RNAV

(DME/DME) in selected terminals.

5.3.2 PHASE II – 2011 UP TO 2015

a) GBAS CAT II implementation in selected airports;
b) Air navigation ground support deactivation process start-up, keeping only the backup infrastructure;
c) RNP 2 implementation to en-route operations;
d) SID/STAR RNAV-1 implementation in the others Brazilian TMA;
e) GLS approach procedures implementation in the main Brazilian airport.

5.3.3 PHASE III – 2016 UP TO 2020

a) Continue the air navigation ground support deactivation process, keeping the backup infrastructure, if necessary;
b) Operation with own satellite or existed satellite leasing viability analysis, considering provide GNSS service to other state (ex. GPMS), which could allow operation independent of WAAS and/or EGNOS;
c) GBAS Cat III implementation in selected airports;
d) CAT I approaches implementation in the other Brazilian airports;
e) Make the Brazilian navigation architecture available to South American Region, in order to develop a regional capacity.

6. SURVEILLANCE

6.1 GENERAL ASPECTS

6.1.1 ATS SURVEILLANCE SERVICE

6.1.1.1 The ATS Surveillance Service will be provided using ADS-B services, primary radar, secondary radar, Multilateration, or any other similar ground based system that allows the aircraft identification. The ATS Surveillance Service can be subdivided in:

a) Independent Surveillance:
   - Primary Surveillance Radar (PSR);
   - Secondary Surveillance Radar (SSR);
   - Multilateration.

b) Dependent Surveillance:
   - ADS-B.

6.1.1.2 Primary Surveillance Radar

The Primary Surveillance Radar is an independent surveillance system that provides information on direction and distance of any object in movement, within its coverage area. The primary radar is an important tool for national security, also to the surveillance of Approach Control in high aircraft flow.

6.1.1.3 Secondary Surveillance Radar

a) The secondary radar provides data to the air traffic control, using the on board transponder interrogation, at the frequency of 1030 MHz from ground to air, and 1090 MHz from air to ground. Currently there are three kinds of secondary radar:
   - SSR – basic secondary radar;
   - MSSR - monopulse secondary surveillance radar; and
   - SSR Mode S – secondary radar with selective interrogations.

b) The SSR and MSSR provide information of aircrafts identification (Mode A), and of altitude (Mode C) to the ATC. The Mode-S radar uses mono-pulse antenna with selective interrogation. The SSR Mode S is the latest ground based surveillance system. In addition to Mode A/C surveillance capacity, the Mode S supports datalink transactions and is defined as a sub-net subordinate to ATN. The Mode-S also uses extended information fields, periodically generated, in order to support automatic dependent surveillance (ADS-B), and to improve the airborne collision avoidance system performance. The periodically generated extended information fields are formed by a group of messages that provides information of position, velocity, and aircraft identification.

6.1.1.4 Multilateration

a) Multilateration is a kind of independent cooperative surveillance that uses the signals transmitted by an airplane to calculate its own position. As the Multilateration system can use the airplane existing transmissions, the WAM system can be used without modification in the on board equipments. To process the ground signals, appropriate receiver station and one central processing station are required.

b) A Multilateration system consists of several antennas that receive a signal from one aircraft, and one central processing station that calculates the aircraft position based on the time difference of arrival (TDOA) of the signal to these antennas.

c) Multilateration techniques have been successfully used in the airport surveillance. Usage of these techniques is increasing, through its application in bigger areas such as terminal management area (TMA). These systems are called Wide Area Multilateration (WAM).

6.1.1.5 ADS-B

a) The ADS-B should provide surveillance service with superior capacity, if compared with the ATS surveillance system based in radar, due to the improvement in the information update rate, which could be up to 2 times per second.

b) Due to its low cost, if compared with the radar equipments, the ADS-B could improve the ATS surveillance capacity in the national airspace, mainly in remote areas, where radar equipments do not have a good cost/benefit relation.

c) The aeronautical community is investigating the ADS-B use for the air-air surveillance (ADS-B In), to provide traffic information to the pilots in the cabin, in order to identify the aircrafts equipped with ADS-B position, increasing their situational awareness. In the future, with this information, the pilot will be able to provide his own separation, in specific situations.

6.1.2 ADS-C

6.1.2.1 The Automatic Dependent Surveillance based in Contract (ADS-C) will allow the intercontinental flights in the oceanic airspace. When installed in the aircraft and in the ground, these capacities and procedures will improve the aeronautical security/safety and efficiency, and will reduce the aircrafts minimum separation.

6.1.2.2 The ADS-C transmits aircraft position, identity and other information to ground systems.

6.1.2.3 All ADS-C communications are point-to-point and are always exchanged between two terminal systems, for example: aircraft and ground function.

6.1.2.4 The ADS-C has a bi-directional communication flow between the aircraft and the ground functions. The communication link can use geostationary satellite resources.

6.1.2.5 One “contract” is used by the ground system to control the position information rates and the transmission conditions. This “contract” begins in the ground function and must be an agreement between the ground equipment and the aircraft. It allows the data transmission requirements to be specified by the ground function (data and rate to be sent to ground). One aircraft can have several different contracts with different ground function at the same time.

6.1.2.6 By using a point-to-point datalink, each ADS-C message reception is reliable, unless there is a datalink communication total loss, in which case the sender will be notified. The system reliability is ensured by the data distribution to whom it may concern or by the communication failure information.

6.1.3 REQUIRED SURVEILLANCE PERFORMANCE (RSP)

6.1.3.1 The ICAO is developing a plan aiming at defining the Surveillance, Navigation, Communication and Air Traffic Management performance requirements, in order to ensure that the system is configured to provide the optimum functional level. The most efficient systems are hybrids, with different technologies (ex: ADS/Multilateration).

6.1.3.2 The ICAO surveillance system requirements are:

a) The surveillance systems must provide aircraft position information up to date to ensure the adequate separation;
b) For low density continental airspace, used for en-route operations, including remote areas, a 12 seconds update rate is adequate;
c) In high density en-route/terminal environment, a 4 seconds update rate is more appropriate;
d) The surveillance system accuracy must support the minimum separation to the defined airspace;
e) The surveillance system must allow the ATM to provides to the user one en-route flight trajectory choice and to accommodate emergency procedures; and
f) The surveillance system must support search and rescue operations.

6.1.3.3 The ADS implementation needs:

a) Position data provided by the on-board navigation equipment;
b) Message timing information in the period of 1 second;
c) Air-ground datalink; and
d) Ground infrastructure providing information to the ATC.

6.1.3.4 The RSP will consider aspects such as capacity, availability, accuracy and update rate. An eventual RSP establishment will allow the future planners to evaluate the development of different operational scenarios and the surveillance system configuration efficacy.

6.2 <u>SYSTEM CAPACITY</u>

6.2.1 The surveillance system used within Brazilian airspace must be improved and extended to oceanic and remote areas, supporting the necessary coverage in high air traffic density area, looking for the most favorable cost/benefit relation to the airspace users and to the air navigation service provider. The surveillance must gradually evolve to allow an improvement in the crew situational awareness specifically where the CPDLC will be applied. The improvement in the surveillance will focus the Automatic Dependent Surveillance (ADS) implementation, through ground-air and air-air datalink, combined with an accurate and reliable aircraft navigation system.

6.2.2 SCENARIO DESCRIPTION

6.2.2.1 Oceanic airspace

a) In the Oceanic airspace, the ADS-C will be the adequate tool for the improved surveillance system implementation, which will replace the position report via HF. The ADS-C use, combined with the CPDLC and RNP-4, will provide the necessary conditions to the 30 NM minimum horizontal separation implementation, mainly in the EUR/SAM Corridor, allowing more users to use their preferred flight levels.

b) The ADS-C will be supported by the on-board FANS 1 (Boeing) and FANS A (Airbus), using satellite. In the future the use of HFDL and on-board ATN based systems must be evaluated.

6.2.2.2 Continental Airspace

a) In the continental airspace, based in the Civil Aviation requirements, the ADS-B will allow the reduction in the radar system currently used, with a lower cost, contributing to the air navigation service provider and to the airspace user system efficiency.

b) The effective ADS-B surveillance coverage will be enough to provide ATS surveillance within Brazilian Airspace, using the FL 100 as reference, for en-route operations, and in controlled airspace, and the TMA minimum altitude for operations in this airspace. The coverage will be better than the current coverage with radar, as the ground ADS/B station cost will allow the coverage "overlap" mainly in regions with higher air traffic demand and making the system resilient.

c) About the situational awareness on-board the aircraft, the "ADS-B IN" will allow the flight crew to obtain information about close aircrafts, increasing the operational security/safety. In long term the "ADS-B IN" information will be part of the Airborne Separation Assistance System (ASAS), which will be the tool that will provide the flight crew with the necessary elements for doing its own separation.

d) The secondary radar systems must be kept as a system backup, and to provide surveillance service to non-equipped users in a transition phase.

e) In specific cases, where the cost/benefit relation is favorable, the Multilateration could be provided. However, in this case, it is important to remember that this system does not give the necessary situational awareness to the flight crew due to not receiving information from other aircraft.

6.3 <u>MAIN PROJECTS</u>

6.3.1 PHASE I – TODAY UP TO 2010

a) Start the Mode-S, ADS-B and/or Multilateration at Bacia de Campos off-shore operation and other similar airspace;

b) ADS-C service immediate implementation;

c) Implement a test platform for the ADS-B implementation in the continental airspace;

d) Install surface movement surveillance capacity in selected airports, using Multilateration and/or ADS-B.

6.3.2 PHASE II – 2011 UP TO 2015

a) Install ADS-B coverage within the Brazilian airspace, with the following references:
   - En-route operations: FL 100;
   - TMA operations: TMA inferior limit;
   - Coverage in the higher air traffic density area (FIR Brasília and Curitiba; FIR Recife littoral zone).

b) Plan discontinuing the Primary Radar use in the civil aviation wherever no operational requirements mandate it;

c) Plan the secondary radar coverage “overlap” deactivation process, for en-route operations (assuming all users are adequately equipped with ADS-B).

6.3.3 PHASE III – 2016 UP TO 2020

a) Start to discontinue the Primary Radar use in the civil aviation wherever no operational requirements mandate it;

b) Start the secondary radar coverage “overlap” deactivation process, for en-route operations (assuming all users are adequately equipped with ADS-B);

c) To analyze embarked surveillance system, in order to support some of the Global ATM Operational Concept components (AO, DCB, TS and CM);

d) To make the service available to regional partners.

7. AERONAUTICAL SERVICES (AIS AND MET)

7.1 AERONAUTICAL INFORMATION MANAGEMENT (AIM)

7.1.1 GENERAL ASPECTS

7.1.1.1 The basic scope of the Aeronautical Information Management is defined by the ICAO Annex 15: "aeronautical information service must receive and/or originate, compare or combine, edit, format, publish/store and distribute aeronautical data/information relative to all national territory, and areas external to this perimeter where the State is in charge of the air traffic service". This clearly presents the relevant activities required to meet the AIM needs on the SISCEAB.

7.1.1.2 Considering the AIM mandatory elements, the service scope can be split in three functional areas:

a) Information Acquisition;
b) Information Management;
c) Information Distribution.

7.1.1.3 The Aeronautical Information contains all required information to describe the air navigation infrastructure and its status or the required condition to support flight operations. We can consider that the air navigation infrastructure, as describe here, is composed of airports, navigation aids, communications, surveillance, air traffic management, provided flight information services, navigation procedures, air space, and risks to air navigation. This is different from flight information, which deals with dynamic information that specifically impacts the flight, as climate conditions, traffic, and flight plan information.

7.1.1.4 The need for aeronautical information is established based on the ICAO requirements defined in Annex 15, and they consider the user expectation, and the characteristics of the operational systems used by the ATM provider.

7.1.1.5 The AIM role is to acquire, manage and store aeronautical information, to distribute it to the operational units, when required, and to be prepared to further distribute it to operators and users. This role sets the AIM as the focal point for acquisition and distribution of information related to the Air Navigation System usage by air traffic users, Company employees and others directly interested. AIM functions include data and information acquisition, aeronautical information management, information and data binning in documents and reference products, and maintenance of quality management processes.

7.1.1.6 AIM implementation must reach the following objectives:

a) Accelerate the information flow between source and users, through real time gathering of aeronautical information, and with the use of datalink between aircraft and AIM database;
b) Develop a reference source of aeronautical information products for operational use (Aeronautical Information Publishing subordinated to the ICAO);
c) Identify opportunities to reduce the time required to implement changes to the aeronautical information;
d) Establish an auditing process to ensure the information integrity from the source to its distribution;
e) Keep a certified quality management system for aeronautical data/information, according to the principles and policies of the Security/Safety Management System (SMS);
f) Meet customer expectations for aeronautical information supply; and
g) Meet the State internal requirements referent to the aeronautical information and data products.

7.1.2 GNSS PERFORMANCE MONITORING SYSTEM (GPMS):

7.1.2.1 With the development of CNS/ATM technologies based in satellite, the Civil Aviation Authorities around the world face the challenge of having the next generation of ATC and ATM system more dependent of GNSS system, such as GPS and Galileo, which are out of its operational control. The GNSS benefits were recognized by ICAO, but the solution to face the dependency challenge, without the operational control, is not concluded yet. Moreover, the singular characteristics of the ionosphere in the Southern Latitudes require the ability to monitor GNSS signals and to transmit the service level status through the Brazilian airspace. The navigation system based in satellite has generated a challenge to the service availability prediction. The impact of an inoperative satellite is not intuitive, due to constellation dynamics. The capacity of performance monitoring in real time and of prediction are necessary as an essential tool to ensure the secure/safe operation of all navigation systems based in satellite.

7.1.2.2 Nowadays there is no capacity to generate NOTAM with information in the graph format in real time, to support the space based navigation or augmentation system associated. A Performance Monitoring System should be responsible for ensuring that satellite based systems, such GPS, Galileo, WAAS, EGNOS, MSAS, LAAS, and future services GNSS, SBAS and GBAS, can supply a continuous, secure/safe and reliable signal.

7.1.2.3 The NOTAMS are, typically, specific for place and service. The specific NOTAMS for satellite based navigation offer important challenges to the AIS system, since a failure can affect a large geographic area and can include multiple airports, with different service levels. The GNSS Performance Monitoring Network will carry out the following functions:

a) To collect GNSS SIS data;

b) To execute the correction in the GNSS SIS navigation data and the integrity processing;

c) To send the data collected in (a) and generated in (b) to the Real Time Processing Subsystem of SVM and to the Main Database Subsystem.

7.1.2.4 Elements of basic data include GPS measurement data from each monitoring station, plus GPS differential correction, and integrity data generated by the Master station.

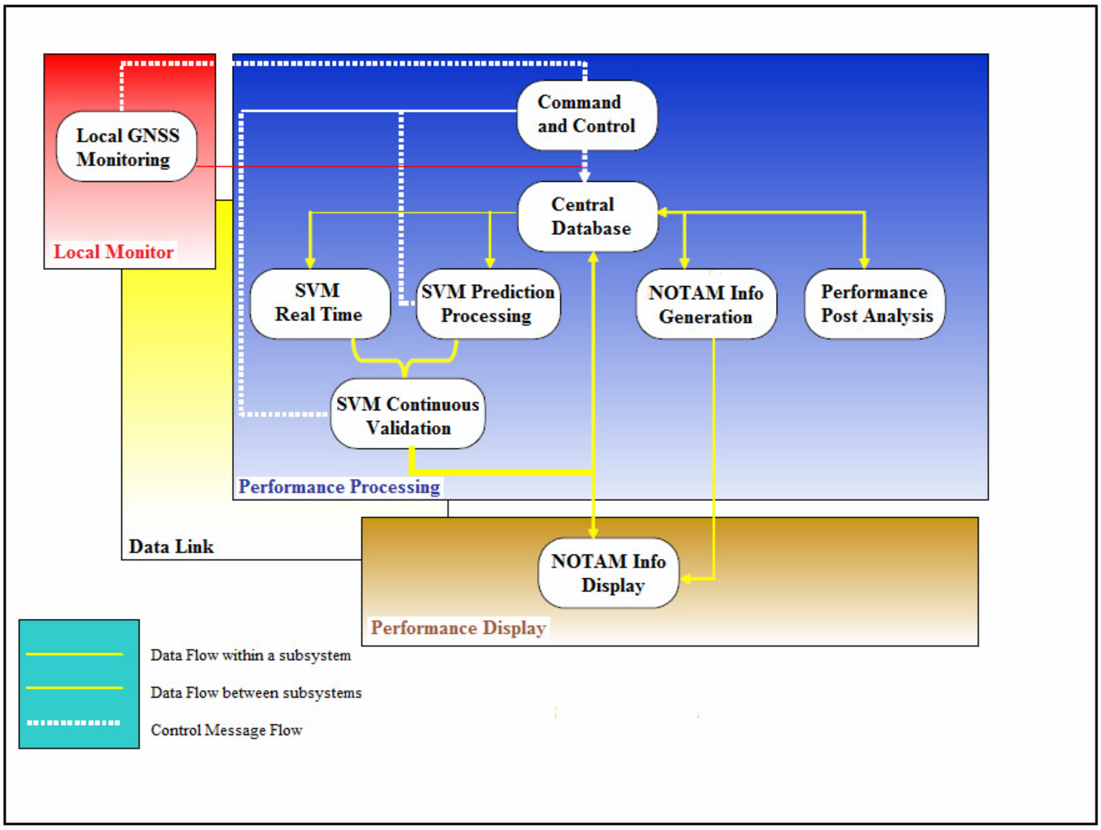

Figure 7 GPMS Architecture Diagram

7.1.2.5 Prediction processing and Real Time Service Volume Model (SVM): For a country that does not have the GNSS constellation control (GPS) and wants to develop the GPS as a basic way of navigation, a Service Volume Model (SVM), able to generate real time information, is an essential evaluation tool to develop the capacity to generate information for the daily air operations. The operational service volume model will be used, which informs prediction performance of receiver equipments as RAIM (TSO C129) and SBAS (TSO C145/146).

7.1.2.6 The possibility of use of these two receivers (TSO C129 and C145/146) aims at providing users with any of the possible equipment configurations. The basic difference between the two equipments is the logic of the RAIM algorithm used: the TSO C129 logic uses the SA and the TSO C145/146, being more modern, considers the SA deactivation in the GPS constellation, by the North American Government.

7.1.2.7 Data Analysis and Filing: The collected data will be used for real time analysis and database filing. The operator or analyst will access the stored data in case of accident investigation and report elaboration. Periodically, a backup copy will be made, and the backup will be kept separately in CD/ROMs or remote hard disks. The database will include the following functions:

a) Data Collection;

b) Database Management;

c) Historical Data Analysis.

7.1.2.8 Operational applications: As it was mentioned the NOTAMS are, typically, specific for place and service. The specific NOTAMS for satellite based navigation offer important challenges to the NOTAM system, since a failure can affect a large geographic area and can include multiple airports, with different service levels. Flight Service Station and/or air traffic staff have to monitor and predict short-term fluctuations in the service volume in the real time satellite navigation service, in order to give secure/safe support to flight operations in the national airspace system. The GPMS will integrate a real time SVM and graphic capacity in order to generate accurate and real time NOTAM information, to meet the ICAO standard text. The real time performance-monitoring network will evaluate the short-term performance (up to 2 hours) and long term (more than 2 hours) for all satellite based navigation system. The short-term evaluation will allow the operator to give real time information to the Air Traffic Control, about the continuity and availability parameters for the system and the impact of these parameters in the approach availability.

7.1.2.9 The Performance Monitoring has to ensure the GNSS operation monitoring and has to give, in real time, to its operators and users, the following data, through a simple Graphical User Interface (GUI):

a) GNSS Continuous and Current Operational Status;

b) GNSS Previous Performance, continuously registered (e.g. 30 min);

c) GNSS Future Performance, continuously predicted (e.g. 30 min);

d) Real Time Analysis;

e) Short Term Prediction;

f) Real Time Exhibition.

7.1.2.10 The GPMS will evolve gradually, with the implementation of master stations and GNSS Real Time Monitor (GRTM), in order to provide initial monitoring capacity to the Brazilian airspace. This architecture will guarantee to DECEA the signal performance in the space, when its use is authorized within Brazilian airspace. The system will monitor GPS, WAAS, EGNOS, GBAS, ABAS and other augmentation systems that will be implemented.

7.2 MAIN PROJECTS

7.2.1 Phase I - Today to 2010

a) Implement GPMS to cover all Brazilian airspace.

7.2.2 Phase II – 2011 to 2015

a) Enhance GPMS, in order to include all IFR airports and SBAS and GBAS installations.

7.2.3 Phase III – 2016 to 2020

a) Enhance GPMS with additional stations, including master stations, reference stations and monitoring terminals in air traffic control organizations in all of Brazil and in any neighbor Nations that participate in the system, in order to monitor any new satellite constellations or augmentation systems that may be implemented.

7.3 METEOROLOGICAL SERVICES

7.3.1 GENERAL ASPECTS

7.3.1.1 The meteorological service scope is to establish a structure that allows a transition from the current aeronautical meteorological system to an automated real time system that meets, in quality and opportunity, the SISCEAB needs as part of the Global ATM system.

7.3.1.2 The ICAO Global ATM system concept requires the prompt access to real time global meteorological information. This requirement can only be met when most of the meteorological systems are automated.

7.3.1.3 Only real time automated information, including ADS messages, will allow accurate on-board information of altitude winds and air stream forecasts, and the development of the meteorological situation over the planned procedures for approach and climb. It is then natural the high use of meteorological information through datalink to update on-board systems in all flight phases. This includes, among others, the implementation of D-ATIS and D-VOLMET systems.

7.3.1.4 On the other hand, more accurate meteorological information associated with the real time transmission will be required by the ATM to support its tactical and collaborative surveillance decisions, in the context of its 7 main components, contributing to the optimized use of the air space. This process is currently named “nowcast”.

7.3.1.5 The SISCEAB is the most complex and broad air navigation system of the Region, committed with most of the international flows and with an expressive national traffic, and its move to adopt the whole Global ATM Operational Concept, will require adapting its national aeronautical meteorological project to the regional and global plans. This is the only way that it will be able to keep its technical and managerial competency in this field, compatible with the roles set to the SISCEAB.

7.3.1.6 The expected results from the implementation of meteorological services compatible with the Air Traffic Management requirements are:

a) Foster as possible the creation of a global, integrated and transparent meteorological system to provide meteorological services to the international civil aviation.

b) Publish at ATC organizations and at the air companies operational control centers, real time information of the superior wind fields, in the WAFS global forecast exposition format, and wind fields derived from wind information reported automatically from aircrafts through ADS messages; severe weather forecasts and reports, specially volcanic ash, thunderstorms, clear sky turbulence and ice formation, to support tactical decisions relative to aircraft security/safety, air traffic flow management, and also to update flight plans to distribute the aircraft in flexible routes.

c) Provide automatic uplink to the airplane of meteorological conditions of the airfield, at approach and landing, through the D-ATIS, D-VOLMET, and automated systems dedicated to detect severe weather conditions.

d) Provide automatic downlink of the meteorological information, derived from airplane sensors (wind, temperature, turbulence and humidity) to the ATC computers, to provide monitoring of the wind superior fields in real time, wind profiles during descent, in order to help on the automatic sequencing of the aircraft to maximize the capacity of the operation during approaches; and in parallel, to provide ways and numeric models of global meteorological forecasts to improve the quality of all subsequent global forecasts.

e) Allow the use of meteorological sensors to generate information to feed the intelligent processing systems that will provide report messages and automated forecasts of windshields over the airfield, helping the aircraft separation optimization, and specially to maximize the capacity of the runway.

7.3.2 MAIN PROJECTS

7.3.2.1 Phase I - Today to 2010

a) Implement uplink of the automate reports generated by the meteorological ground stations (D-ATIS) in the following airports: Guarulhos, Galeão, Congonhas and Santos Dumont;

b) Implement an automated uplink to the airplane of the meteorological information from the D-VOLMET, to replace the VHF VOLMET in the Atlantic FIR;

c) Implement an automated downlink of wind and temperature data generated by the airplane on landing approach, during climb and cruise.

7.3.2.2 Phase II – 2011 to 2015

a) Implement uplink of the automate reports generated by the meteorological ground stations (D-ATIS) in the following airports: Brasília, Campinas, Recife, Salvador, Porto Alegre, Curitiba, Manaus, Confins and Pampulha;

b) Implement an automated uplink to the airplane of the meteorological information from the D-VOLMET, to replace the VHF VOLMET in the Amazon, Brasília, Curitiba and Recife FIR;

c) Implement an automatic windshield/microburst detection system and provide that the warnings generated can be automatically displayed through uplink;

d) Automatically display the products generated by the WAFC, VAAC and TCAC globally in the ATC and CGNA operational consoles, as well as in the air companies.

8. HUMAN FACTORS AND HUMAN RESOURCES

8.1 HUMAN FACTORS

8.1.1 The new CNS technologies and the air traffic operational management concept require a clear differentiation between the "human factor" and the "human resource" concepts that were treated almost as synonymous in the traditional analysis. Most aeronautical accidents have as a contributing factor the human performance. Although it is the most flexible and valuable piece of the aeronautical system, the human being is also the most vulnerable to factors that can negatively affect its behavior. For an improved security/safety and effectiveness it is mandatory to better understand the human factor and apply this knowledge pro-actively and broadly. The “Human Factor” is an expression that the ICAO decided to define clearly and objectively, as its uninformed use could be associated with any factor related to the human beings.

8.1.2 The introduction of the components of the Global ATM Operational Concept in the transition of the SISCEAB to the CNS/ATM system concept will imply in an important impact to the performance of the human component, on the ground and on-board. This way, using the human factor concept throughout the development and implementation process will provide the necessary basis for secure/safe implementations, and will be the key success element in all process.

8.1.3 Many aeronautical disciplines will change due to the new CNS/ATM technologies. There will be significant changes to the ATM and CNS people environment, particularly for the Air Traffic Controllers (ATCO). Information technologies, data communications and process automatization will be intensively used in most ATS facilities.

8.1.4 The transition process to the new concept does not mean the human resources will require immediate adaptation. Just like the ATM System, the human resources should be adapted progressively, as new procedures, functions or technological resources are implemented and become ready for service. This way, it is of the utmost importance that the Human Factors impact on the implementations are analyzed immediately, defining new required psychotechnical profiles, academic requirements, basic professional training, job training, etc.

8.1.5 IMPORTANT AREAS

8.1.5.1 Automatization and advanced technologies in the ATM system

The human factor must be considered since the operational concept phase, so that the system to be implemented can leverage the advantages from the human intervention capacity and from the technologies based on high levels of automatization. All system development must be based on the automatization principles designed around the human being.

8.1.5.2 Airplane and ATM system integration

The CNS/ATM system will allow high level of integration between the airplane and air traffic management systems. As many system components will interact in a direct way, the communication between pilot and controllers will be changed. A systemic approach will be required to handle the airplane/ATM system integration to avoid that the operation become too complex.

8.1.5.3 Human performance in the new ATM system

The human element will continue to be key in the new system and the satisfactory application of the ICAO ATM Concept will depend on him. Special attention will be given to the factors related with the organization and management of the collective and individual performance in the air traffic management. The information management in complex systems, the impact of the increased use and dependency of the communication through data, the automated tools for decision support, the individual responsibility and the capacity of intelligent intervention are items that will be formally discussed in the many implementation phases.

8.2 HUMAN RESOURCES

8.2.1 The adequate supply of Air Navigation Services is always dependent on the selection, supply and capacitation of the human resources in the operational and technical areas, as well as the availability in the required quantity to support the different services.

8.2.2 The required profile for DECEA professionals, in special the air traffic controllers, will be highly changed. The most important changes will be the communication through datalink, the increased automatization and the supply of new services, as they will be in all levels more committed with the success of the operators planning (e.g., sharing the airplane separation between controllers and pilots).

8.2.3 The need for human resources capacitation will be specially increased during the transition period. It will be required to provide training and recycle a large quantity of human resources in the new technologies, equipments and procedures, as well as a sufficient quantity of resources will need to keep the previous qualification to support the current systems. It is important to highlight the need to use adequate training tools, which for the air traffic controllers is composed basically of simulators that need to be the closest as possible to the new operational scenario that will be implemented.

8.2.4 The human resources capacitation planning to implement the components of the ATM Operational Concept must consider the specific requirements of each one of the activities, as for example, the requirements for the PBN capacitation, which contains air space planning activities, air navigation procedures creation, air space security/safety evaluation, operators and airplanes approval, and pilots and controllers training.

8.2.5 The implementation of the ATM Operational Concept components will increase the need of training at the CAR/SAM Regional level, giving opportunities for the Civil Aviation Centers to provide training courses to the States and to CAR/SAM International Organizations. In this context, the Air Space Control Institute (ICEA) will need to become a reference for those States and International Organizations.

9. OBJECTIVES BY FLIGHT PHASES

9.1 SYSTEM CAPACITY

9.1.1 The system capacity must be adequate to the airspace users since the beginning of take-off, while still on the ground, going through TMA flight and en-route phases, until its arrival in the final destination, including the airplane parking. All these procedures form the "gate-to-gate" operation, as presented in Figure 8.

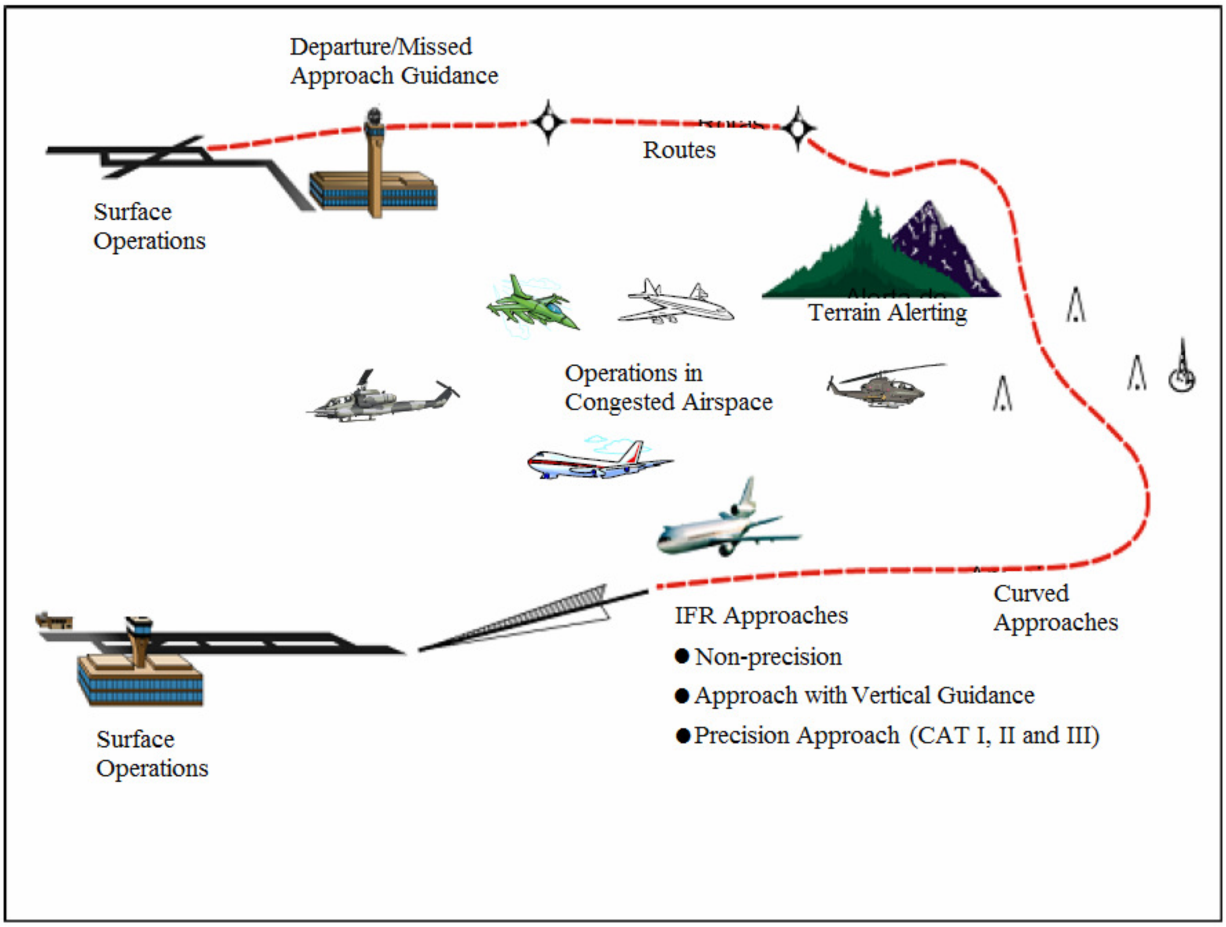

Figure 8 Operational Concept "Gate-to-Gate"

9.1.2 The ATM services will be supported by the communication, navigation, surveillance, AIM and MET infrastructure within the Brazilian airspace. The automatization and process changes will allow the use of strategic steps to avoid the traffic congestion and to meet the demand for user's preferential trajectories.

9.2 AIRPORT SURFACE OPERATIONS

The main objective in surface operations is to remove restrictions in the aircraft movement from the “gate” to the “pushback”, and to the runway, and also in the reverse direction for aircrafts in approach. The forecasted increase in airport movements will imply in an increase in the vehicle movement in the maneuver area, being more intense in peak hours with aircraft concentration. In this way, the use of ground surveillance technology for aircrafts and vehicles will be important to allow the best movement management. This resource will support meeting take-off and approach schedules, especially in areas with visibility restrictions due to meteorological conditions.

9.3 TERMINAL CONTROL AREA OPERATIONS (TMA)

9.3.1 The airspace structure in the terminal control areas will allow the increase in the exit and arrival sector, considering the environmental restrictions, in order to allow the best use of the Performance Based Navigation - PBN (RNAV and/or RNP), following the established operational requirements and using the Flight Management System (FMS).

9.3.2 SPECIFIC GOALS

a) Approach procedures, SID and STAR RNAV application in all TMA;
b) Approach procedures, SID and STAR RNP application in TMA with operational requirements;
c) Establishment of ATC procedures to optimize the RNAV and/or RNP aircrafts operation, which operate in a mixed environment (RNAV and/or RNP approved and non-approved aircrafts);
d) Establishment of departure procedures (SID) and a flexible Standard Instrument Arrival (STAR) system, with optimized climb and descent profile, in order to make a more efficient transition for en-route structure;
e) Reduce aircraft separation criteria;
f) Establishment and certification of specific approach procedures, SID and STAR, for rotary-wing aircraft (helicopters), in order to increase the traffic flow by separating its

operations;

g) Development of flexible RNAV trajectories to allow the flight within the Special Use Airspace (EAC);
h) Development of airspace structure based in RNAV and/or RNP, to include procedures/trajectories for aircrafts flying under IFR, VFR and special VFR operation;
i) Development of procedures to improve the missed approach trajectories, where the operational requirements are present.

9.4 EN-ROUTE OPERATIONS – CONTINENTAL AIRSPACE

9.4.1 The PBN implementation will allow the use of advanced aircraft navigation capacities, and with the available navigation infrastructure, the airspace structure will be improved, including the routes network. In this way, it will be possible to establish routes that meet the airspace user needs, reducing the air traffic controller and pilot workload and lowering the concentration of aircraft around navaids.

9.4.2 The use of exclusive airspace will be necessary for the PBN implementation for en-route operation, where non-approved aircrafts will not be able to enter. In this way, the necessary improvements in the airspace structure can be made. However, the vertical limit for PBN implementation for en-route operation must be analyzed, in order to not prevent operations for a significant amount of airspace users.

9.4.3 SPECIFIC GOALS

a) Establishment of airspace structure to provide optimum descent profile, allowing the aircrafts to remain in higher altitudes for longer periods during arrival phase;
b) Establishment of an automated ATC system to optimize coordination between ATC agencies and sectors of the same ATC agency, in order to reduce restrictions imposed by sectors limits and FIR;
c) Use of flexible routes, with the user's cooperation, in order to avoid demand and capacity instability;
d) Use of structured routes only in high-density traffic environment, to avoid terrain and in case of EAC activation;
e) Development of flexible routes to support direct routing based in RNAV and/or RNP (fixed-wing and helicopter);
f) Development of low altitude airspace structure, using RNAV and/or RNP, to support

helicopter “offshore” operations;

g) Development of alternatives and flexible RNAV and/or RNP routes, to allow flights through and/or around the EAC;

h) Use RNAV and/or RNP capacity to reduce the aircraft separation for en-route operations.

9.5 EN-ROUTE OPERATIONS – OCEANIC AIRSPACE

9.5.1 The GNSS and the Inertial System will be used as the main navigation way in the oceanic environment.

9.5.2 The ATC Automated System improvement, the use of Performance Based Navigation, the use of datalink based communication, and the use of Automatic Dependent Surveillance-Contract will be essential to the increase in the oceanic airspace capacity, through the reduction in the aircraft separation, in order to support the forecasted air traffic and existing demand.

9.5.3 SPECIFIC GOALS

a) Increase in system capacity through the reduction in the aircraft lateral and longitudinal minimum separation;

b) Increase in system flexibility, replacing the fixed routes structure by a random route system;

c) Development of ADS/CPDLC capacity.

10. GENERAL COMMENTS

10.1 This document concludes that the ATM System is a cooperative effort of human resources, information, technologies, and services that came from the ATM Provider, Operators, Industry, Airports, State Regulatory Agency, and airspace users. It aims Air Traffic Management in an operationally seamless airspace, configured to the operational security/safety and structured to meet the performance objectives established according to all flight planning expectations.

10.2 The ATM system, as many other systems, needs a constant integration of its elements, aligned to the same objectives and with a perfect interdependence relation with the external environment, since several factors can affect the realization of planned activities for one or more of these elements.

10.3 In this way, the ATM system organization and integration is responsibility of all the national ATM community and it must be organized in order to avoid an eventual instability to the group, either by concept deficiency, method, model or process, as it can damage all the other system elements.

11. FINAL COMMENTS

Subjects not discussed in this plan will be submitted to the DECEA General Director.

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