Eleventh Workshop/Meeting of the SAM Implementation Group (SAM/IG/11) - Regional Project RLA/06/901
Lima, Peru, 13 to 17 May 2013

Agenda Item 8: Other business

Updating of the Air Navigation System Performance-Based Implementation Plan for the SAM Region (SAM PBIP)

(Presented by the Secretariat)

SUMMARY

This working paper presents the participants with the *Air Navigation System Performance-Based Implementation Plan for the SAM Region (SAM PBIP)* updated in respect of the ICAO Aviation Systems Block Upgrade (ASBU) methodology.

REFERENCES:

- Air Navigation System Performance-Based Implementation Plan for the SAM Region (SAM PBIP); y
- Report of the Twelfth Air Navigation Conference (AN-Conf/12) (Montreal, Canada, 15-30 November 2012).

ICAO strategic objectives:	*A – Safety* *C – Environmental protection and sustainable development of air transport*

1. **Background**

1.1 El *Air Navigation System Performance-Based Implementation Plan for the SAM Region (SAM PBIP)* was analyzed upon and approved by the Twelfth Meeting of Civil Aviation Authorities of the SAM Region (RAAC/12) held in Lima, Peru, from 3 to 6 October 2012.

1.2 The Twelfth Air Navigation Conference (AN-Conf/12) approved the new ICAO Aviation Systems Block Upgrade (ASBU) methodology, to form part of the new Global Air Navigation Plan, 4th Edition (GANP) (Doc 9750) and, through Recommendation 6/1 - *Regional performance framework – planning methodologies and tools*, approves that States and the Planning and Implementation Regional Groups (PIRG) finalize the alignment of regional air navigation plans with the GANP, focusing on implementing ASBU Block 0 modules.

2. **Analysis**

2.1 In this regard, the Secretariat revised the SAM PBIP with the aim of aligning it with ASBU. The 18 modules of Block 0 were examined and it was deemed convenient that 14 of the modules would, in principle, apply for the SAM Region.

2.2 Upon examining the contents of the ASBU Block 0 modules taken under consideration, observation was made that practically all elements therein contained had been taken under consideration in the SAM PBIP, proceeding to relate the regional performance objectives with the ASBU modules under consideration.

2.3 Some of the SAM PBIP areas have not been considered in the ASBU modules, such as SAR implementation tasks. In this respect, it was deemed appropriate that even though they had not been taken under consideration, they should remain in the SAM PBIP.

2.4 The SAM PBIP aligned with ASBU is presented in the **Appendix** to this working paper for the review of the Meeting, and later circulation to all States of the Region for final review and approval. The SAM PBIP will be presented at the *Workshop on ASBU Implementation: Alignment of Regional and National Air Navigation Performance Based Plans* to be held in Lima from 6 to 10 May 2013. The results of this Workshop will be informed upon at this Eleventh Workshop/Meeting of the SAM Implementation Group (SAM/IG/11).

3. **Action suggested**

3.1 The Meeting is invited to:

a) Take note of the information presented;
b) Analyze the topics taken under consideration in Section 2, particularly paragraph 2.4; and
c) Analyze any other matters related with this subject that the Meeting might deem necessary.

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

SOUTH AMERICAN REGIONAL OFFICE

DRAFT

AIR NAVIGATION SYSTEM PERFORMANCE-BASED IMPLEMENTATION PLAN FOR THE SAM REGION

Version 1.3

May 2013

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ATTACHMENTS TO THE DOCUMENT

FOREWORD

The Air Navigation System Performance-Based Air Navigation System Implementation Plan for the SAM Region is published by the ICAO South American Regional Office on behalf of States accredited and International Organizations involved. It considers implementations at short and mid-term, as indicated in the guidelines contained in the Global Air Navigation Plan and the plan initiatives required for evolution to a Global ATM System, as shown in the Global ATM Operational Concept.

The Regional Office, on behalf of States and Organizations involved, will publish the required revised versions of the plan to reflect current implementation activities.

Copies of the plan can be obtained by contacting:

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The present edition (Version 1.1) includes all revisions and modifications until May 2011. Subsequent amendments and corrigenda will be indicated in the Record of Amendment and Corrigenda Table, according to the procedure established in page 5.

It should also be mentioned that a list of reference documents used in the preparation of this document is presented in **Attachment H**.

The issue of amendments and corrigenda is announced regularly through correspondence with States and International Organizations, and in the ICAO website, which holders of this publication should consult. The blank boxes facilitate the recording of amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1	May 2013		

CORRIGENDA			
No.	Date applicable	Date entered	Entered by

1. Chapter 1: Foreword

1.1 Objective

1.1.1 This *Air Navigation System Performance-Based Implementation Plan for the SAM Region* has been drafted taking into account the ICAO Global Air Navigation Plan (GANP) (Doc 9750), and is framed within the Aviation System Block Upgrades (ASBU) methodology, with the aim of achieving a more efficient and interoperable airspace to meet future capacity demand, without compromising air navigation safety.

1.1.2 This Plan seeks to establish an implementation strategy so that benefits can be obtained for the air navigation community, based on the ATM-related infrastructure and available and foreseen aircraft capabilities. The document contains the Regional vision for the air navigation system (AGA/AOP, AIM, ATM, CNS, MET, SAR, Human Resources and Safety), giving high priority to environmental protection, training and safety.

1.2 Scope

1.2.1 This migration plan covers the SAM Region up to its boundaries, and includes the short- and medium-term implementations of the systems in support of the air navigation services between 2012 and 2018, period including the development of ASBU Block 0 activities. The long-term initiatives required for the evolution to a global ATM system, as shown in the Global ATM Operational Concept, will be added to this Plan as they are developed and approved.

1.3 Background

1.3.1 The Global ATM Operational Concept was approved by the Eleventh Air Navigation Conference (Montreal, September-October 2003) and published as Doc. 9854-AN/458.

1.3.2 In order to align global planning to the ATM Operational Concept, the Eleventh Air Navigation Conference (AN-Conf/11), recommended States and Regional Planning and Implementation Groups (PIRG), through Recommendation 1/1, to consider the Concept as a common global framework to guide in the planning for the implementation of the systems in support of the air navigation services.

1.3.3 GREPECAS/15 approved Conclusion 15/1 for the development by the Group of a regional performance-based plan, in keeping with the Global Air Navigation Plan and the Global ATM Operational Concept.

1.3.4 The *Air Navigation System Performance-Based Implementation Plan for the SAM Region* was completed in May 2011, and approved by the Twelfth Meeting of Civil Aviation Authorities of the SAM Region (RAAC/12) (Lima, Peru, October 2011).

1.3.5 The 37 Session of the International Civil Aviation Organization (ICAO) General Assembly (2010) directed the Organization to double its efforts to meet the global needs for airspace interoperability while maintaining its focus on safety. The block upgrades initiative was formalized at the Twelfth Air Navigation Conference (AN-Conf/12) (Montreal, November 2012) andwill form part of the new GANP, 4th Edition (Doc 9750).

1.3.6 The block upgrades describe a way to apply the concepts defined in the GANP with the goal of implementing regional performance improvements. They include the development of technology roadmaps, to ensure that standards are mature and to facilitate synchronized implementation between air and ground systems and between regions. The ultimate goal is to achieve global interoperability. Safety demands this level of interoperability and harmonization but it must be achieved at a reasonable cost with commensurate benefits.

1.3.7 Through Recommendation 6/1 - *Regional performance framework – planning methodologies and tools*, AN-Conf/12 urged States and PIRGs to harmonize the regional and national navigation plans with the ASBU methodology in response to this.

1.3.8 The *Air Navigation System Performance-Based Implementation Plan for the SAM Region* has been aligned with the ASBU methodology.

1.4 **Stakeholder roles and responsibilities**

1.4.1 Stakeholders including service providers, regulators, airspace users and manufacturers are facing increased levels of interaction as new, modernized ATM operations are implemented. The highly integrated nature of capabilities covered by the block upgrades requires a significant level of coordination and cooperation among all stakeholders. Working together is essential for achieving global harmonization and interoperability.

1.4.2 States, operators and industry will benefit from the availability of Standards and Recommended Practices (SARPs) with realistic lead times. This will enable regional regulations to be identified, allowing for the development of adequate action plans and, if needed, investment in new facilities and/or infrastructure.

1.4.3 For the industry, this constitutes a basis for planning future development and delivering products on the market at the proper target time. For service providers or operators, block upgrades should serve as a planning tool for resource management, capital investment, training as well as potential reorganization.

2. Chapter 2: Air Traffic in the SAM Region

2.1 Traffic Forecast in the SAM Region

2.1.1 Aircraft movement forecasts are important for anticipating when and where may airspace or airport congestion occur, and thus, are essential for planning capacity increases. These forecasts play an important role in the implementation of CNS/ATM systems.

2.1.2 For purposes of this Plan, use has been made of the 2007-2027 forecasts prepared at the seventh meeting of the CAR/SAM Forecasting Group (Doc. 9917) that are relevant for the SAM Region within the framework of main traffic flows (see section 3.2 of this Plan). Accordingly, it is interesting to analyse the percentage of growth expected for that period, as shown in the tables contained in **Attachment A** to this document.

2.1.3 In summary, passenger traffic in the South American Region during the 2007-2027 period is expected to increase at an annual rate of 8.8%, reaching 73 million passengers in 2027. The aircraft movement forecast for the same period shows an annual increase of 7.9%, reaching 497.000 movements for 2027. See Attachment A – Tables 1A – 1B.

2.1.4 Always within the 2007-2027 period, it is expected that passengers between South American and Central America and the Caribbean will increase 8.9%, reaching 27 million passengers in 2027. Aircraft movement for that period may reach a figure of 8.2%, with 282.000 movements in 2027. See Attachment A – Tables 2A – 2B.

2.1.5 Between South America and North America for the period 2007 – 2027, an increase of 5.7% is expected per year, reaching a figure of about 173 million passengers for 2027. Aircraft movements may reach 5%, or 1.625.700 movements in 2027. See Attachment A – Tables 3A – 3B.

2.1.6 Finally, with respect to the South Atlantic, the Europe-South America corridor specifically, a growth of 5.4% a year is expected, reaching an approximate figure of 21.5 million passengers for 2027 and a growth in aircraft movements of 5.5%, reaching more than 90.000 movements in 2027. See Attachment A – Tables 4A – 4B.

3. Chapter 3: Planning considerations

3.1 Introduction

3.1.1 As traffic volume increases throughout the world, the demands on air navigation service providers in a given airspace increase, and air traffic management becomes more complex. Increased traffic density brings about an increase in the number of flights that cannot fly their optimum path.

3.1.2 It is foreseen that the implementation of the components of the ATM operational concept will provide sufficient capacity to meet the growing demand, generating additional benefits in terms of more efficient flights and higher levels of safety. Nevertheless, the potential of new technologies to significantly reduce the cost of services will require the establishment of clear operational requirements.

3.1.3 Taking into account the benefits of the ATM operational concept, it is necessary to make many timely decisions for its implementation. An unprecedented cooperation will be required at both global and regional level.

3.1.4 ICAO introduced the Aviation System Block Upgrades (ASBU) methodology as a systemic manner to achieve a harmonized implementation of the air navigation services.

3.2 Planning Methodology

3.2.1 After identifying ATM Systems with homogeneous areas and the main traffic flows, GREPECAS conducted a study of the current and foreseen fleet of aircraft and their capabilities, the forecast traffic figures and ATM System infrastructure, including human resource availability and requirements, amongst other elements. The methodology used for the analysis phase is shown in Figure 1, hereunder.

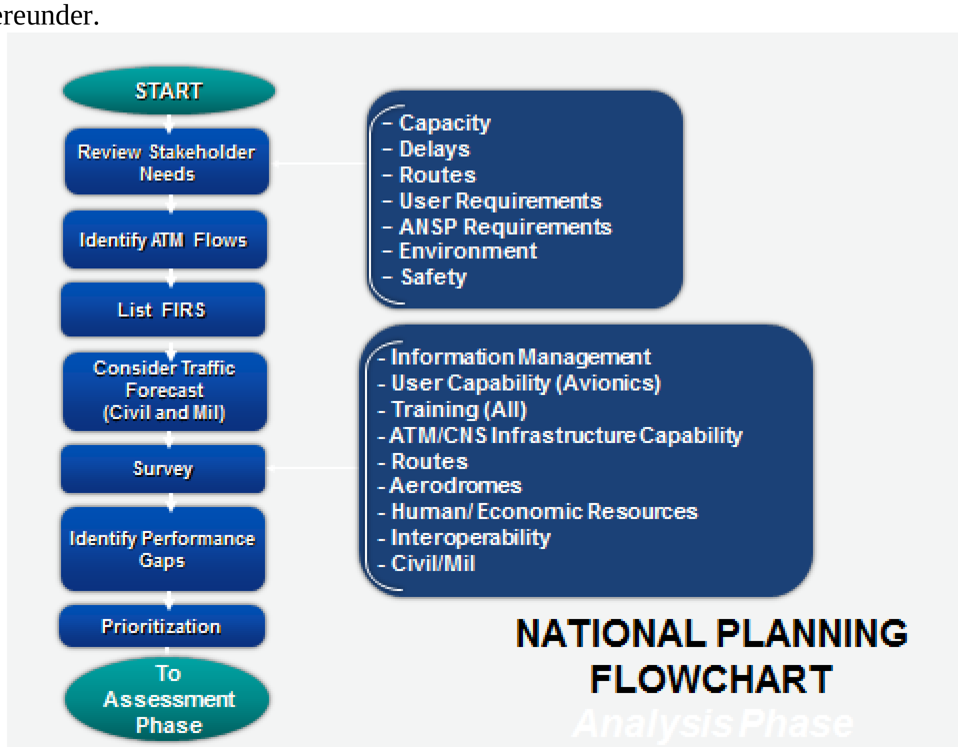


Figure 1 – Planning process (analysis)

3.2.2 An assessment made to the data obtained in the analysis phase enabled the identification of opportunities for the improvement of the operational performance. The ASBU modules and respective elements were analysed upon and selected with the aim of meeting the operational increases considered as necessary. The evaluation process used in indicated in Figure 2, hereunder:

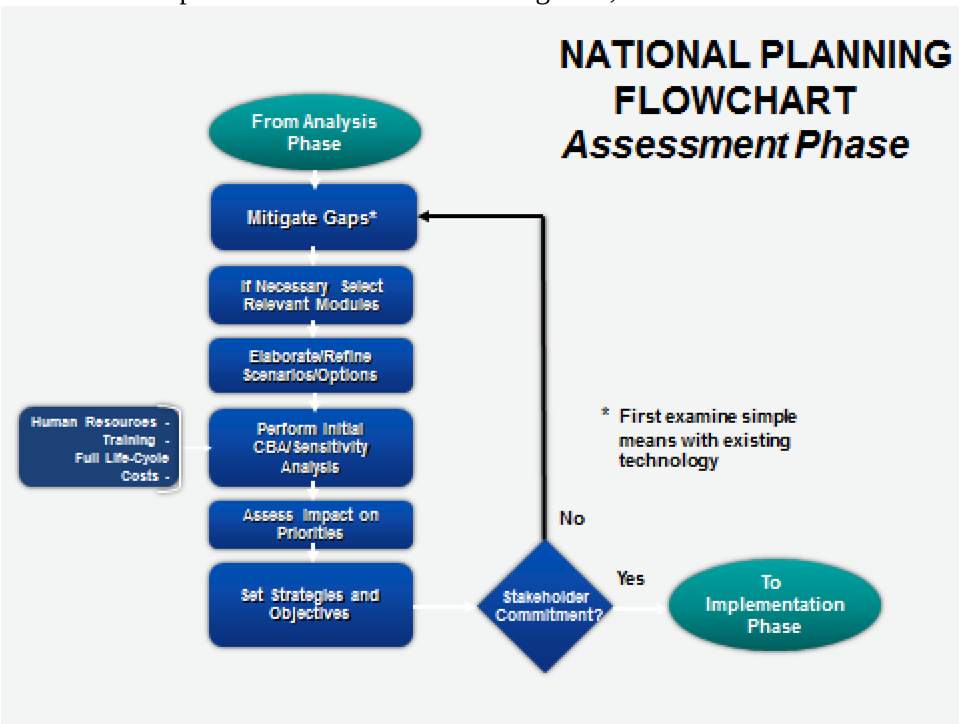


Figure 2 – Planning process (assessment)

3.2.3 The work for the SAM Region is organised based on project management techniques and clearly defined performance objectives to support the Global Plan strategic objectives aligned with the ICAO strategic plan.

3.2.4 All of the activities listed in the performance objectives will be designed based on strategies, concepts, action plan models and roadmaps that may be shared in order to align the inter-regional work with the main objective of maximising interoperability and transparency.

3.2.5 Planning of all the activities should ensure an efficient use of resources, avoiding duplicated or unnecessary activities or tasks, so as to make sure that such activities/tasks can be easily adjusted to the SAM Region. Planning must also encourage the optimisation of human resources, financial savings, and the use of electronic media, such as the Internet, videoconferences, teleconferences, e-mail, telephone and others.

3.2.6 The new processes and work methods must make sure that performance objectives can reflect based on timetables and regional progress reports to Regional Civil Aviation Authorities, GREPECAS, the ICAO Council and the ICAO Air Navigation Commission.

3.2.7 Based on this Implementation Plan, the States should develop their own national plan, containing the work programme, timetable, responsible parties and status of implementation, in order to monitor and report on the progress made in such activities. Additionally, it should also consider detailed information about the activities required for implementation, the means to provide feedback on the progress made through an annual reporting process, which will help administrations to prioritise the required actions and support, and identify annual assistance requirements of each ICAO Region.

3.2.8 The development of work programmes is based on the experience gained and lessons learned during the previous cycle of the CNS/ATM implementation process. Consequently, this Implementation Plan is aimed at maintaining a uniform regional harmonisation and improving implementation efficiency, taking advantage of infrastructure capacity and existing regional applications.

3.3 Planning tools: Implementation strategy within ASBU framework

3.3.1 An ASBU designates a set of improvements that can be implemented globally from a defined point in time to enhance the performance of the ATM system. There are four components of a block upgrade.

3.3.2 Module – is a deployable package (performance) or capability. A module will offer an understandable performance benefit, related to a change in operations, supported by procedures, technology, regulations/standards as necessary, and a business case. A module will be also characterized by the operating environment within which it may be applied. The date allocated to a module in a block is that of the initial operating capability (IOC).

3.3.3 Of some importance is the need for each of the modules to be both flexible and scalable to the point where their application could be managed through any set of regional plans and still realize the intended benefits. The preferential basis for the development of the modules relied on the applications being adjustable to fit many regional needs as an alternative to being made mandated as a one-size-fits-all application. Even so, it is clear that many of the modules developed in the block upgrades will not be necessary to manage the complexity of air traffic management in many parts of the world.

3.3.4 Thread – describes the evolution of a given capability through the successive block upgrades, from basic to more advanced capability and associated performance, while representing key aspects of the global ATM concept

3.3.5 Block – is made up of modules that when combined enable significant improvements and provide access to benefits.

3.3.6 The notion of blocks introduces a form of date segmentation in five year intervals. However, detailed considerations will call for more accurate implementation dates, often not at the exact assigned block date. The purpose is not to indicate when a module implementation must be completed unless dependencies among modules logically suggest such a completion date.

3.3.7 Performance improvement area (PIA) – sets of modules in each block are grouped to provide operational and performance objectives in relation to the environment to which they apply, thus forming an executive view of the intended evolution. The PIAs facilitate comparison of ongoing programmes.

3.3.8 The four PIAs are as follows:

a) airport operations;
b) globally interoperable systems and data – through globally interoperable system-wide information management;
c) optimum capacity and flexible flights – through global collaborative ATM; and
d) efficient flight paths – through trajectory-based operations.

3.3.9 Figure 3 illustrates the relationships between the modules, threads, blocks, and PIAs. Figure 4 explains the concept of the thread.

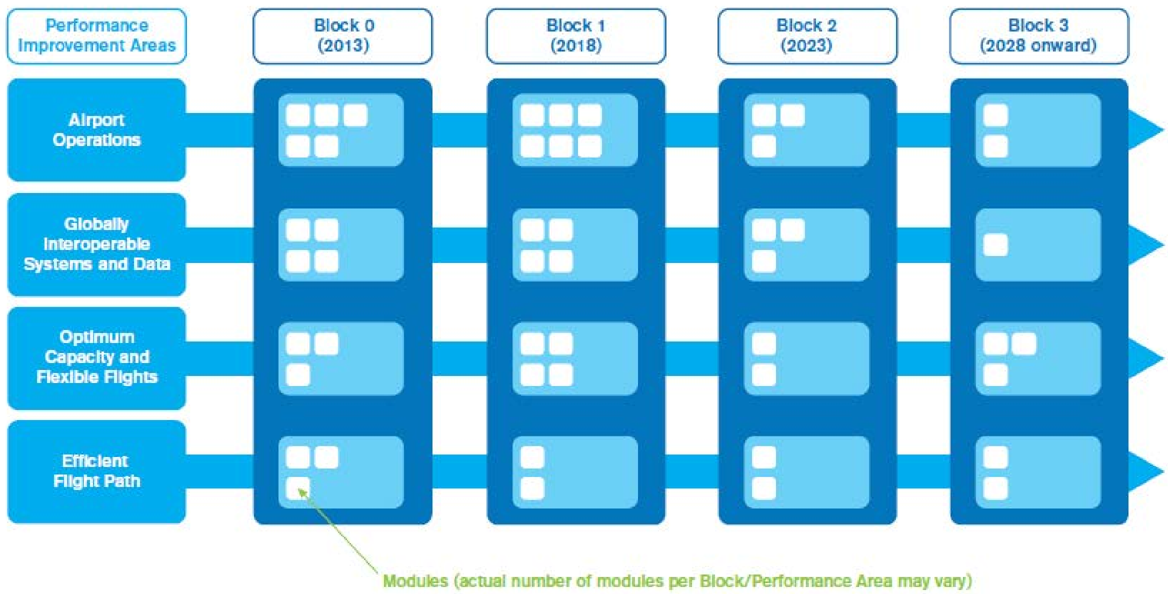


Figure 3. Summary of blocks mapped to performance improvement areas

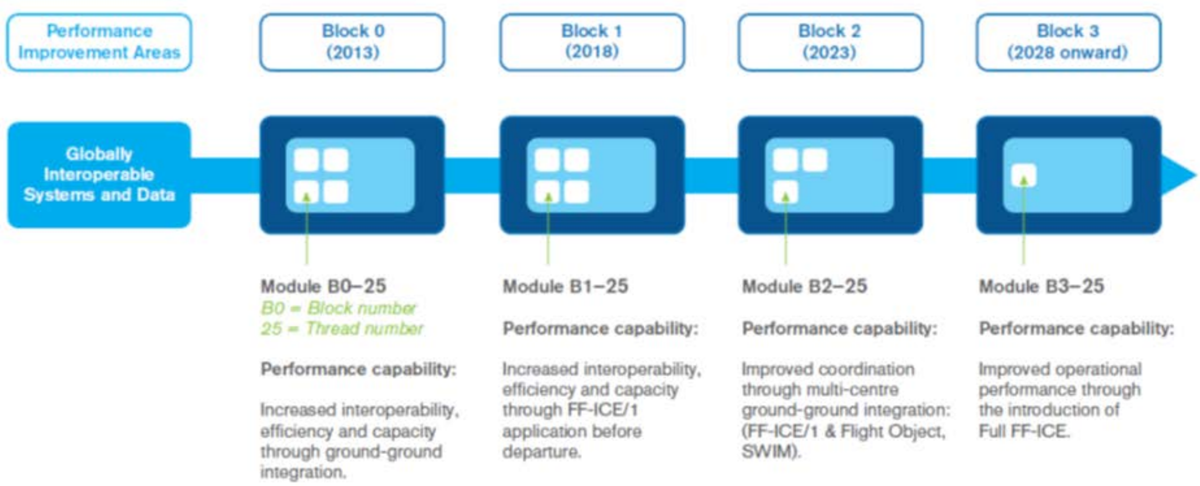


Figure 4. Module thread associated to a specific performance improvement area

3.3.10 In Figure 4, the modules under each block carry the same module number indicating that they are a part of the same thread.

3.3.11 Note that each block includes a target date reference for its availability. Each of the modules that form the Blocks must meet a readiness review that includes the availability of standards (to include performance standards, approvals, advisory/guidance documents, etc.), avionics, infrastructure, ground automation and other enabling capabilities. In order to provide a community perspective, each module should have been fielded in two regions and include operational approvals and procedures. This allows States wishing to adopt the Blocks to draw on the experiences gained by those already employing those capabilities.

3.3.12 Figure 5 illustrates the timing of each block relative to each other. Note that early lessons learned are included in preparation for the IOC date. For the Conference it is recognized that Blocks 0 and 1 represent the most mature of the modules. Blocks 2 and 3 provide the necessary vision to ensure that earlier implementations are on the path to the future.

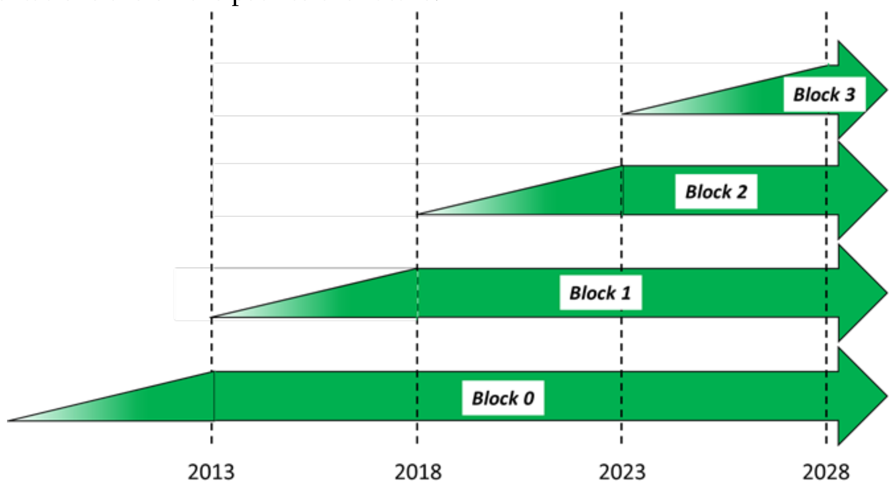


Figure 5. Timing relationships between blocks

3.3.13 An illustration of the improvements brought by Block 0 for the different phases of flight is presented in Figure 6. It highlights that the proposed improvements apply to all flight phases, as well as the network as a whole including information management and infrastructure.

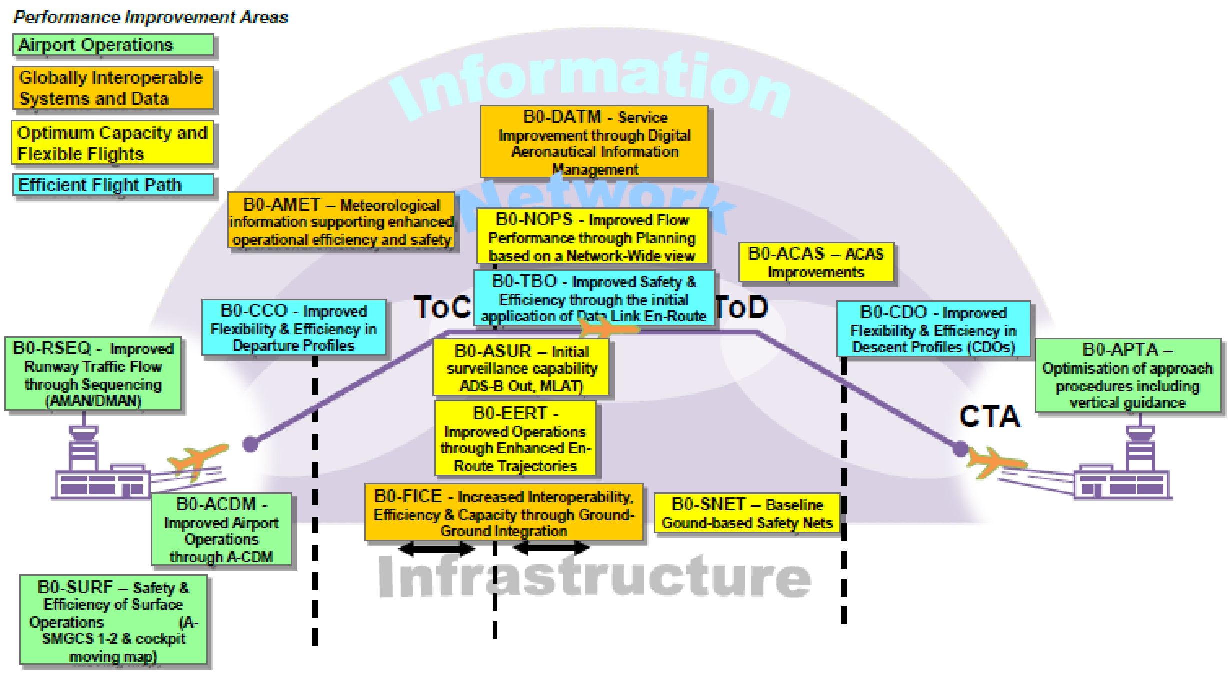


Figure 6. Block 0 in perspective

3.4 **ASBU modules under consideration in the SAM Region**

3.4.1 The Fourth Edition of the *Global Air Navigation Plan* introduces ICAO's ASBU methodology and supporting technology roadmaps based on a rolling fifteen-year planning horizon. Although the GANP has a global perspective, it is not intended that all ASBU modules are to be applied around the globe. Some of the ASBU modules contained in the GANP are specialized packages that should be applied where specific operational requirements or corresponding benefits exist.

3.4.2 Although some modules are suitable for entirely stand-alone deployment, an overall integrated deployment of a number of modules could generate additional benefits. The benefits from an integrated implementation of a number of modules may be greater than the benefits from a series of isolated implementations. Similarly, the benefits from the coordinated deployment of one module simultaneously across a wide area (e.g. a number of proximate airports or a number of contiguous airspaces/flight information regions) may exceed the benefits of the implementations conducted on an ad hoc or isolated basis.

3.4.3 An example of a need for global applicability would be performance-based navigation (PBN). Assembly Resolution A37-11 urges all States to implement approach procedures with vertical guidance in accordance with the PBN concept. Therefore, the ASBU modules on PBN approaches should be seen as required for implementation at all airports. In the same way, some modules are well suited for regional or sub-regional deployment and should take this into account when considering which modules to implement regionally and in what circumstances and agreed timeframes.

3.4.4 Based on the above paragraphs, it is important to clarify how each ASBU module fits into the framework of the SAM regional air navigation system. To assist in this regard, a module categorization and prioritization system has been developed below with the objective of ranking each module in terms of implementation priority. On the basis of operational requirements and taking into consideration benefits associated, SAM Region has chosen 15 out of 18 Block 0 Module for implementation as they respond to air navigation capacity and efficiency requirements for the Region for the period from 2012 to 2018.

3.4.5 The categories of 15 Block 0 Modules are as follows:

- **Essential (E)**: These are the ASBU modules that provide substantial contribution towards global interoperability, safety or regularity. The (3) modules for SAM Region are FICE, DATM and ACAS
- **Desirable (D):** These are the ASBU modules that, because of their strong business and/or safety case, are recommended for implementation almost everywhere. The (9) modules for SAM Region are APTA, ACDM, NOPS, ASUR, SNET, AMET, TBO, CDO, and CCO
- **Specific (S):** These are the ASBU modules that are recommended for implementation to address a particular operational environment or mitigate identified risks. The modules for SAM Region are NIL
- **Optional (O):** These are the ASBU modules that address particular operational requirements and provide additional benefits that may not be common everywhere. The (3) modules for SAM Region are SURF, RSEQ and FRTO

3.4.6 The modules considered and associated to each of the Performance Improvement Areas (PIA) are the following:

Performance Improvement Areas (PIA)	Performance Improvement Area Name	Module	Module Name
PIA 1	Airport Operations	B0-15 RSEQ	Improve Traffic flow through Runway Sequencing (AMAN/DMAN)
		B0-65 APTA	Optimization of Approach Procedures including vertical guidance
		B0-75 SURF	Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)
		B0-80 ACDM	Improved Airport Operations through Airport-CDM
PIA 2	Globally Interoperable Systems and Data - Through Globally Interoperable System Wide Information Management	B0-25 FICE	Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration
		B0-30 DATM	Service Improvement through Digital Aeronautical Information Management
		B0-105 AMET	Meteorological information supporting enhanced operational efficiency and safety
PIA 3	Optimum Capacity and Flexible Flights – Through Global Collaborative ATM	B0-10 FRTO	Improved Operations through Enhanced En-Route Trajectories
		B0-35 NOPS	Improved Flow Performance through Planning based on a Network-Wide view
		B0-84 ASUR	Initial capability for ground surveillance
		B0-101 ACAS	ACAS Improvements

Performance Improvement Areas (PIA)	Performance Improvement Area Name	Module	Module Name
		B0-102 SNET	Increased Effectiveness of Ground-Based Safety Nets
PIA 4	Efficient Flight Path – Through Trajectory-based Operations	B0-05 CDO	Improved Flexibility and Efficiency in Descent Profiles (CDO)
		B0-40 TBO	Improved Safety and Efficiency through the initial application of Data Link En-Route
		B0-20 CCO	Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)

3.5 **Transition from PFFs to ANRFs**

3.5.1 With the introduction of the ASBU methodology to the Global Air Navigation Plan, 4th edition, it is expected that the Performance Framework Form (PFF) will be restructured and aligned with the ASBU modules, and renamed as Air Navigation Report Form (ANRF).

3.5.2 Nevertheless, these two forms will continue to be included in this Plan, as well as their inter-relationship, in order to serve as reference during the transition phase to ANRF, until the next edition of the SAM Region Plan, when only ANRFs will exist.

4. Chapter 4: Air Traffic Management (ATM)

4.1 Introduction

4.1.1 According to the Global ATM Operational Concept, the general objective of ATM is to achieve a global, inter-operational air traffic management system for all users during all flight phases, that meets the agreed levels of safety, provides optimum operations, is environmental sustainable, and meets national security requirements.

4.1.2 The future system must evolve from the current system so as to, inasmuch as possible, meets the needs of the users, according to clearly established operational requirements. The reality is that migration and integration are the most difficult institutional issues facing ATM system designers.

4.1.3 Airspace boundaries and divisions should not restrict the development of the airspace structure. Planning should be coordinated between adjacent areas in order to achieve a seamless airspace, in which the user does not perceive any division. The airspace should be free of operational discontinuities and inconsistencies, and should be organised in such as way as to accommodate the requirements of the different types of users. The migration between areas should be seamless to users at all times.

4.1.4 Human intervention within the human factors and training aspects is taken under consideration in all aviation improvement modules.

4.1.1 La consideración de la actuación humana en el marco de los factores humanos y el entrenamiento está considerada en todos los módulos de mejoras de la aviación en forma transversal.

4.1.5 Some of the benefits that are expected from the implementation of these components are improved safety, reduced operating fuel costs for users, reduced delays and gas emissions, and increased system capacity.

4.1.6 The evolution of air traffic management in the SAM Region has been carefully planned to avoid the degradation of the performance of the existing system. The safety level attained to date must be preserved during the transition, as a minimum, gradually improving air navigation efficiency. Consideration has also been given to avoiding an unnecessary overloading of aircraft with multiple CNS equipment, both existing and new, during the extended transition period.

4.2 General principles

4.2.1 Unrestricted access to air navigation services listed in this document must be guaranteed to all SAM States.

4.2.2 The need for SAM States to fully comply with national plans, as well as with the standards governing the use of the new systems, is acknowledged.

4.2.3 SAM States must accept the global nature of the ATM Operational Concept and the objective of providing integration mechanisms for its timely implementation.

4.2.4 CNS infrastructure must be carefully planned based on the requirements identified for the appropriate level of air traffic management in the SAM Region.

4.2.5 The new CNS elements shall be gradually introduced, taking into account the benefits to be derived by the ATM community.

4.3 Analysis of the current situation (2012)

Gaps of the current ATM system in the SAM Region

4.3.1 The ATM system currently available in the SAM Region presents some gaps, including the following:

a) Insufficient implementation of Performance-Based Navigation (PBN) and, in general, absence of airspace management (ASM);
b) The lack of a systematic use of cost-benefit analyses for the implementation of new airspace structures causes difficulties in the definition of air navigation infrastructure implementation priorities, and prevents measuring the benefits obtained by the ATM community;
c) The lack of implementation of the policy and procedures for the flexible use of airspace hinders airspace design and management, preventing the implementation of an optimum airspace structure and the use of optimum flight paths;
d) The lack of air traffic flow management (ATFM) in most airspaces of the SAM Region causes congestion in some airspaces and airports, and prevents optimum use of ATC and airport capacity, thus affecting users;
e) The lack of coordination in the provision of the existing CNS/ATM services sometimes generates a duplication of resources and services;
f) The inadequate quality of communication media and language difficulties create problems in the provision of air traffic services. Operations still rely on increasingly congested voice radio-communications for air-ground exchanges;
g) The lack of an ATS surveillance service in some portions of the airspace of the Region prevents a harmonised reduction of aircraft spacing, due to the application of different separation criteria in FIR boundaries (with and without ATS surveillance), thus restricting the use of optimum flight profiles;
h) The lack of harmonisation of automated ATM systems in the SAM Region, as well as the scarce sharing of ATS surveillance data, generates discontinuity in ATS services; and
i) Limited facilities for real-time exchange of information between ATM, aerodromes and aircraft operators, leading to a poor response to changes made in the operational requirements of users.

4.3.2 While in the later years, improvements have substantially occurred in some sectors, the limitations of the current ATM system result in inefficient aircraft operations. These limitations include:

a) The requirement to fly circling patterns in departure and arrival procedures;
b) Existence of airspaces of a permanent nature reserved for military purposes mainly;

c) Inadequate airspace planning prevents direct flights between the origin-destination airports and/or city pairs, and also operations at incorrect flight levels and/or speeds that make it difficult for aircraft to maintain optimum flight profiles;
d) Excessive ground and en-route delays related to the system;
e) Insufficient flexibility to properly address disturbances in airline operations caused by meteorological conditions, unexpected failures in CNS systems and airport services interruption;
f) Lack of harmonization in aeronautical publications, mainly instrumental procedures.

4.4 **Strategy for the implementation of performance objectives**

4.4.1 ATM evolution in the SAM Region has been planned taking into account the ASBU that could be applied in the short and medium term. ATM performance objectives, in addition to the requirements for the implementation of ATM improvements, determine the implementation dates of planned improvements, as well as the performance objectives.

4.4.2 The planning period considered is 2013 to 2018.

4.4.3 ATM evolution is based on:

a) En-route operations;
b) TMA operations; and
c) Air operations in general.

4.4.4 ATM Planning is based on following performance objectives, as shown in **Attachment C**, and as listed below:

a) En-route airspace optimisation (SAM ATM/01 PFF);
b) TMA airspace structure optimisation (SAM ATM/02 PFF);
c) Implementation of RNP approaches (SAM ATM/03 PFF);
d) Flexible use of the airspace (SAM ATM/04 PFF);
e) ATFM implementation (SAM ATM/05 PFF);
f) Improvement of ATM situational awareness (SAM ATM/06 PFF).

4.4.5 It should be noted that the different specialties (CNS, AIS; MET; AGA/AOP; SAR) developed in this Implementation Plan support ATM development and, in turn, constitute *per-se* an integrated, indivisible system. In particular, this Implementation Plan contains some cross-cutting issues that the States must especially address, namely:

a) Development of human resources and competence management (see Chapter 10); and
b) Safety management – SMS (see Chapter 11).

4.5 En-route operations

4.5.1 The evolution of ATM for en-route operations took into account the ASBU Block 0 modules applicable to the SAM Region and was planned in order to permit optimum airspace management and organisation.

PBN implementation for en-route operations

4.5.2 PBN implementation will foster the use of advanced aircraft navigation capabilities, which, combined with the air navigation system infrastructure, will permit airspace optimisation, including the ATS route network. Thus, it will promote an ATS routing environment that meets the needs of airspace users, reducing the workload of controllers and pilots and aircraft concentration in certain parts of the airspace that may generate congestion on the system.

4.5.3 The implementation of PBN for en-route operations will require the establishment of exclusionary airspaces, considering that these would provide the conditions for making the necessary changes to the airspace structure. So as not to exclude a significant number of users, the vertical limits of the airspace where PBN will be implemented shall be examined in depth, and so will the fleet operating in the Region.

Short term

4.5.4 Taking into account the low density of air traffic in oceanic airspaces, no changes are expected in the existing airspace structure. In those airspaces where RNP-10 is applied (EUR/SAM Corridor, the Lima-Santiago route and the South Atlantic Random Route System), no short-term changes are expected. Nevertheless, designation RNP-10 (RNAV10) must be completed in oceanic routes of the Pacific Ocean.

4.5.5 In the continental airspace, RNAV-5 has been implemented in the SAM Region.

Medium term

4.5.6 It is expected that RNP-4 will be implemented in the EUR/SAM Corridor, in the Santiago-Lima segment and in selected routes of the Pacific, using ADS/CPDLC, in order to permit the use of a 30-NM lateral and longitudinal separation. This implementation will depend on the evolution of the aircraft fleet operating in these airspaces. Also, the need for the use of the Aeronautical Mobile Satellite Service (AMSS) must be assessed, for situations in which immediate intervention of the air traffic controller is necessary, to ensure 30 NM horizontal separation.

4.5.7 During this phase, it is expected that RNP-2 will be implemented in selected continental airspaces, using mandatory GNSS, taking into account that the ground infrastructure will not support RNAV applications. It will be necessary to establish a back-up system for GNSS and to develop contingency procedures in case of GNSS failure. The implementation of RNP-2 will facilitate the implementation of PBN in airspaces with no ATS surveillance service. With the mandatory use of GNSS, more information about the GNSS signal will be required.

Situational awareness and en-route data relationship applications

4.5.8 The use of ADS-C and CPDLC in oceanic airspaces will foster the necessary conditions for using 30-NM horizontal separation minima in the EUR/SAM Corridor and in the Santiago-Lima route segment. The need for Aeronautical Mobile Satellite Service (AMSS) will be assessed to ensure such separation. Furthermore, in other oceanic airspaces with less traffic density, ADS-C and CPDLC will provide reliable surveillance and communication media, reducing the workload of controllers and pilots.

4.5.9 In the continental airspace, the use of enhanced surveillance techniques (ADS-B and/or multilateration) will help reduce horizontal separation minima, enhance safety, increase capacity, and improve the cost-effectiveness of flights. The use of CPDLC instead of voice communications could bring significant benefits in terms of safety and pilot and controller workload; however its use must be assessed taking into account that it might not be feasible due to the characteristics of ATC interventions.

4.5.10 These benefits may be achieved by providing surveillance in areas that lack primary or secondary radar when so warranted by cost-benefit analyses. In airspaces where radar is used, improved surveillance may help enhance the quality and reliability of surveillance information both on the ground and in the air. The States shall conduct a consistent cost-benefit analysis to determine if, when the time comes, PSR and/or SSR systems should be replaced by ADS-B systems or multilateration.

4.5.11 The gradual implementation of ATS inter-facility data communication (AIDC) will enhance airspace safety and reduce coordination errors between ATS units.

4.5.12 The implementation of ATS surveillance systems and data Relationship applications should take into account the corresponding automation aspects, mainly with respect to the need for harmonisation between the systems applied, with a view to ensuring system interoperability.

4.5.13 Furthermore, the implementation of ATS surveillance systems and data relationship applications should consider ATM automation tools (minimum safe altitude warning; conflict prediction; conflict alert; conflict resolution advisory; path conformance control; functional integration of ground and airborne systems, etc.).

4.5.14 Amongst others, the following applications that may assist with an improvement of the situational awareness, are identified:

a) TFMS - SYNCHROMAX or similar;
b) Surveillance tools to identify the boundaries of the airspace sector;
c) Use of A-SMGC at specific aerodromes, as required;
d) Availability of SIGMET in graphical format;
e) Dissemination of AIS; and
f) Implementation of D-VOLMET.

4.6 **TMA operations**

4.6.1 The evolution of air traffic management in terminal areas shall be harmonised with the evolution of ATM for en-route operations, providing for a harmonious and integrated ATM system.

4.6.2 The evolution of ATM for TMA operations took into account the ASBU Block 0 modules applicable to the SAM Region, and was planned so as to permit an optimum airspace management and organisation.

4.6.3 The TMA structure optimisation is supplementary related to the optimisation of the routes, through the use of approach procedures, SIDs, STARs, based on PBN, the application of TMA design and management techniques, and the functional integration of ground and airborne systems.

4.6.4 As regards situational awareness and implementation of data link applications, the close relationship between the implementation of enhanced surveillance techniques (ADS-B and/or MLAT) and the use of data link applications is taken into account.

4.6.5 There are many factors that should be taken into account when planning the requirements for a TMA air navigation service infrastructure. In addition to traffic volume, consideration should be given to other factors, such as: number and location of aerodromes, traffic characteristics, terrain, meteorological conditions, etc. Therefore, the States should analyse each particular TMA and determine, in coordination with the users, the requirements for the implementation of the corresponding air navigation services.

TMA structure optimisation

4.6.6 TMA airspace structure optimisation will be achieved through the following measures:

a) PBN implementation, which includes the implementation of SIDs and STARs with RNP and/or RNAV, and RNP approach procedures;
b) Implementation of continuous descent operations (CDO) and continuous climb operations (CCO);
c) The functional integration of ground and airborne systems; and
d) The use of improved design and management techniques.

Implementation of PBN for TMA operations

4.6.7 TMA operations have specific characteristics, taking into account the separation minima applicable between aircraft, and between aircraft and obstacles. This also involves the diversity of aircraft, including low-performance aircraft that carry out arrival and departure procedures on the same path as, or close to the paths of, high-performance aircraft.

4.6.8 In this sense, the States shall develop their own national TMA PBN implementation plans, based on the CAR/SAM PBN Roadmap and in the Action Plan Model developed by SAMIG meetings. They shall seek harmonisation of aircraft separation criteria and the applicable RNAV and/or RNP criteria, in order to avoid the need for multiple approvals for intra- and inter-regional operations.

4.6.9 The efficiency of TMA operations in a PBN environment depends on aerodrome design and management and runway operations, taking into account that any air traffic flow increase in TMA operations shall be absorbed by airport infrastructure.

Short term

4.6.10 It is expected that States will apply RNAV-1 in selected TMAs, in environments with ATS surveillance service and adequate ground-based navigation infrastructure, permitting DME/DME and DME/DME/INS operations. During this phase, operations with equipped and non-equipped aircraft will be permitted, and RNAV-1 operations shall start when an adequate percentage of approved operations is reached.

4.6.11 In environments with no ATS surveillance service and/or where there is no adequate navigation infrastructure on the ground, it is expected that the States will apply Basic RNP-1 in selected TMAs, applying mandatory GNSS, provided there is an adequate percentage of approved aircraft. Nevertheless, operations with approved and non-approved aircraft will be permitted in these TMAs once the corresponding operational benefits are verified. The implementation of overlay procedures and exclusive RNP procedures will depend on air traffic complexity and density.

4.6.12 It is expected that approach procedures with vertical guidance (APV) Baro-VNAV RNP APCH in all instrument flight runways, as per Resolution 37/11 of the 37th Assembly maintaining conventional approach procedures for non-equipped aircraft.

4.6.13 It is expected that RNP with Mandatory Clearance approach procedures (RNP AR APCH) will be applied at airports in which obvious operational benefits can be obtained, based on the existence of significant obstacles. It has also been identified that RNP AR APCH application in the Region may improve interference problems among airports, due to the proximity existing among them.

4.6.14 It is expected that States apply PBN for TMA operations, in order to flight implement procedures that provide more efficient trajectory during approach of an aircraft to the destination aerodrome. These procedures shall enable an un-interrupted flight trajectory from the beginning of the descent until the aircraft is stabilised for the landing. Recognizing environmental benefits and operations efficiency, with the aim to ensure safety, States should include continuous descent operations (CDO) implementation in their plans, according to the ICAO CDO Manual (Doc 9331).

4.6.15 As traffic demand increases, the challenges in terminal areas centre on volume, hazardous meteorological conditions (such as severe turbulence and low visibility), adjacent airports and special activity airspace in close proximity whose procedures utilize the same airspace, and policies that limit capacity, throughput, and efficiency.

4.6.16 Continuous Climb Operations (CCO) integrates with other airspace and procedures (PBN, continuous descent operations (CDO), and airspace management) to increase efficiency, safety, access and predictability; and minimize fuel use, emissions, and noise. States should include continuous climb operations (CCO) implementation in their plans, according to the ICAO CCO Manual (Doc 9993).

Medium term

4.6.17 During this phase, it is expected that the States will extend the implementation of RNAV or RNP-1 applications to selected TMAs, depending on ground infrastructure and aircraft navigation capacity. At more complex TMAs, RNAV or RNP-1 equipment will be mandatory (exclusionary airspace). At less complex TMAs, equipped and non-equipped aircraft will still be admitted.

4.6.18 During this phase, it is expected that the implementation of APV RNP APCH with Baro-VNAV and LNAV only in conformity with Resolution 37/11 of the 37th Assembly and RNP AR APCH procedures will be extended to selected airports. It is also expected that the GLS procedure will start to be used to improve the transition between the TMA and approach phases, basically using GNSS for the two phases.

4.6.19 In the mid-term, the application of other further advanced navigation specifications, such as:

a) Advanced RNP;
b) RNP 0.3 for helicopter operations;
c) Application of RF legs in Advanced RNP, Basic RNP1, RNP 0.3 and RNP APCH, according with specific operational requirements; and
d) RNP AR DEP.

Functional integration of ground and airborne systems

4.6.20 The optimisation of TMA efficiency will depend on a maximum use of automation. Likewise, aircraft will be increasingly equipped with time of arrival calculation. Thus, functional integration of ground and on-board systems will enable identification of times of arrival at specific fixes. These schedules should help in the landing sequencing process, allowing aircraft to remain close to their preferred 4D path, contributing to the application of one of the components of the ATM Operational Concept, which is Air Traffic Synchronisation.

Use of improved design and management techniques

4.6.21 Airspace planners should apply design techniques for TMA restructuring, with a view to:

a) Validating the proposed airspace structure;
b) Assessing the impact of PBN implementation, including RNAV, GLS procedures and/or RNP SID and STAR procedures, and FMS-based arrival procedures, using ATC simulations as needed;
c) Ensuring a favourable cost-benefit ratio; and
d) Optimising sectoring so as to make it seamless for users and balanced in terms of workload.

Situational awareness and data relationship applications for TMA

4.6.22 In addition to the considerations contained in the section on en-route operations, which also apply to TMA operations, the States should consider the following aspects for the implementation of ATS surveillance services and data Relationship applications in the TMA.

4.6.23 The implementation of surveillance systems (ADS-B and/or multilateration) at the TMAs will provide the conditions required for the integration of en-route and TMA operations.

4.6.24 The use of ATS surveillance systems (SSR, ADS-B and/or multilateration) will permit the use of RNAV-based navigation specifications, taking into account that surveillance will permit flight monitoring for the detection of any path deviation. Thus, it will be possible to include in TMA operations those users that would not be approved for RNP operations.

4.6.25 The implementation of improved surveillance systems will facilitate the operation of aircraft not approved for RNAV/RNP, taking into account that the controller will be able to vector them to the final approach.

4.6.26 The implementation of CPDLC in the TMA is not expected, taking into account the characteristics of ATC intervention in these airspaces. However, other data Relationship applications will reduce the workload of controllers and pilots, such as: D-ATIS and digital flight plan clearance (DCL).

4.6.27 It should be noted that TMA users might not be equipped with data Relationship systems, since there is a significant number of low performance aircraft that fly in this airspace and might not be capable of being properly equipped. In that case, procedures must be developed to allow non-equipped aircraft to fly, unless air traffic density warrants the use of exclusionary airspaces.

Air operations in general

4.6.28 This part of the Plan includes aspects contributing towards efficiency and capability applicable to general air operations.

Flexible Use of Airspace (FUA)

4.6.29 The optimum, balanced and equitable use of airspace by civil and military users, facilitated by strategic coordination and dynamic interaction, will permit the establishment of optimum flight paths, while reducing the operating cost of airspace users.

4.6.30 SAM States should establish policies for temporary or permanent use of restricted airspaces, in order to avoid the adoption of airspace restrictions inasmuch as possible, and also consider and integrate in its air navigation system unmanned aircraft systems (UAS), a new component of the aeronautical system.

4.6.31 The implementation of the flexible use of airspace should start with an assessment of hazardous, restricted and prohibited airspaces that affect or could affect traffic flow.

4.6.32 The establishment of letters of agreement between ATS and military units or other users for the dynamic and flexible use of airspace should avoid restrictions to the use of airspace, thus accommodating the needs of all airspace users.

4.6.33 In those cases in which airspace reserved is inevitable, the letters of agreement should stipulate that the activation of reserved airspace should not exceed the time required. To that end, it will be necessary to develop paths for dynamic re-routing of aircraft to avoid such airspaces.

4.6.34 The cited paths should be published in the AIP to let users know of the need to take into account such possible deviations in flight planning.

4.6.35 FUA implementation requires convincing the reserved airspaces users, mainly military authorities of the States involved, assuring them that their needs will be met whether or not airspace restrictions are applied. Consequently, seminars/meetings with such authorities will be required to demonstrate the importance of an optimised use of airspace.

Air Traffic Flow Management (ATFM)

4.6.36 SAM States must seek for an adequate balance between demand and capacity, ensuring that in normal operational conditions, the ATM system is able to attend the existing demand of air traffic. Also, it is important to highlight that ATFM measures must not be used to solve eventual intrinsic deficiencies of the ATM system.

4.6.37 The implementation of timely measures for demand/capacity balancing, in case of events that reduce system capacity, for example adverse weather conditions and/or temporary problems in airport infrastructure or ATC, will avoid an overload of the ATM system and will create the conditions for maximising airport and ATC capacity. This should increase significantly airspace capacity and operational efficiency.

4.6.38 Considering that air traffic congestion and saturation problems in the Region, States that have not implemented yet, must initiate the application of air traffic flow management measures that should be initiated with the calculation and maximisation of ATC and airport capacity, particularly runway capacity.

4.6.39 ATFM implementation in the SAM Region should take into account the objective and principles established in Appendix AL to Item 3 of the GREPECAS/13 meeting, noting that ATFM measures must foster a maximum use of existing capacity without compromising safety.

4.6.40 The ATFM Operational Concept establishes a simple strategy that should be developed in stages, maximising available capacity and allowing the parties involved to gain sufficient experience.

4.6.41 The experience gained in other Regions and by some SAM States permits the application of basic ATFM procedures at airports.

4.6.42 Thus, ATFM in the SAM Region will be implemented by stages, based on the established operational requirements, in keeping with the SAM ATFM Operational Concept.

4.6.43 So as to reconcile national plans with the SAM ATFM Regional Plan, civil aviation administrations must take required measures and carry out a close follow-up of the regional development of ATFM, and draft an ATFM implementation programme, where implementation needs are determined, the impact it will have in the national ATC system, in airspace, air traffic services and in airport services, and pertinent coordination is established, to make feasible a harmonious and timely integral regional implementation.

4.6.44 In order to maximise its efficiency in a long-term, the feasibility of implementing a centralised ATFM that should be responsible for delivering the service in as much airspace as possible, provided it is homogeneous, should be assessed.

4.7 **Alignment with ASBU**

4.7.1 Of the ASBU Block 0 modules taken under consideration of the SAM Region, the ATM area contributes to PIA 1 modules B0-15, B0-65, B0-75, , PIA 3 modules B0-10, B0-35, B0-84 and B0-102 and PIA 4 modules B0-05, B0-20 and B0-40.

4.7.2 Following are the ATM PFF indicated in paragraph 4.4.4 reflected on the following ASBU Block 0 modules indicated in paragraph 4.7.1:

a) PFF SAM ATM/01 - *Optimization of the en-route airspace structure*, with module B0-10;
b) PFFSAM ATM/02 - *TMA airspace structure optimization*, with modules B0-05 and B0-20;
c) PFF SAM ATM/03 - *Implementation of RNP approaches*, with module B0-65;
d) PFF SAM ATM/04 - *Flexible use of airspace*, with module B0-10;
e) PFF SAM ATM/05 - *ATFM implementation*, with modules B0-15, and B0-35; y
f) PFF SAM ATM/06 - *Improve ATM situational awareness*, with modules B0-75, B0-84 and B0-102.

5. Chapter 5: Communications, Navigation and Surveillance (CNS)

5.1 Introduction

5.1.1 When implementing CNS systems, SAM States must consider the ATM operational requirements contained in this Plan.

5.1.2 In view of the requirements derived from the implementation of the ATM Operational Concept, SAM States shall consider planning improvements to, and the strengthening of, aeronautical communication, navigation and surveillance services, taking into account ASBU Block 0 modules of the Global Air Navigation Plan.

Communications

5.1.3 Communication systems contemplated in this plan respond to short- and medium-term expectations of the operational requirements in the Region. Accordingly, this plan has taken into account the following communication systems:

a) Aeronautical message handling system (AMHS);
b) ATS inter-facility data communication (AIDC and OLDI);
c) Controller/pilot data Relationship communications (CPDLC);
d) Data link automatic terminal information service (D-ATIS);
e) Voice meteorological information for aircraft in flight (VOLMET) and data link (D-VOLMET);
f) Voice clearance delivery (CLRD) and data clearance (DCL); and
g) SAM Aeronautical Telecommunications network (ATN).

Navigation

5.1.4 The function of navigation systems is to support en-route, terminal, approach and landing operations and surface movements.

5.1.5 The navigation systems contemplated in this plan respond to short- and medium-term operational requirements of the Region. In this respect, this plan for navigation systems has taken into account the ground navigation infrastructure and the GNSS requirements concerning the operations foreseen in the CAR/SAM PBN Roadmap.

Surveillance

5.1.6 The function of surveillance systems is to provide aircraft position information to air traffic service units (ATS).

5.1.7 The surveillance systems contemplated in this plan respond to short- and medium-term operational requirements in the Region. Accordingly, this plan considers the following:

a) ADS-B;
b) ADS-C;
c) MLAT;
d) SSR; and
e) The integration of the aforementioned.

5.2 Analysis of the current situation (2012)

5.2.1 The current SAM communication, navigation and surveillance services situation in support of air navigation is described below, as per information provided in FASID CNS tables.

Communications - Aeronautical fixed service

5.2.2 AFTN service: The circuits foreseen have been fully implemented. However, and given their average life cycle, maintenance of the existing centres is a significant problem.

5.2.3 ATS speech service: The circuits foreseen have been fully implemented. Circuits are analogue and operate without any major problem.

5.2.4 AMHS service: This service has been implemented in almost all SAM States.

5.2.5 Memoranda of Understanding (MoU) have been drafted for the interconnection of AMHS systems between States.

Flight plan transfer

5.2.6 *OLDI*: It is available in several SAM States, although only one State uses it within the framework of its own administration.

5.2.7 *AIDC*: It is being implemented in many States.

Information delivery network

5.2.8 Currently, a satellite digital network (REDDIG) is available in the region to support the required aeronautical fixed services. In order to support the new services foreseen for the short and medium term, the new network to represent the regional ATN (REDDIG II), is in process of implementation.

Aeronautical mobile service

5.2.9 *VHF*: Services have been implemented as indicated in FASID Table CNS 2A, ensuring coverage in most of the selected areas, with problems at lower levels in selected airspaces. In the case of terminal areas and aerodromes, many facilities do not follow the recommendation of having different frequencies for APP and TWR services. The clearance delivery (CLRD) service has not been implemented at the level required.

5.2.10 *HF*: Although required in FASID Tables CNS 2 A and 2B, the HF service is not being operationally used in many States of the Region. It is mainly provided at some States that have oceanic areas in their FIRs.

5.2.11 ATIS: Implemented according to Table CNS 2A, but in an insufficient number. Use is made of conventional audio recorders and analogue VHF transmitters.

5.2.12 *CPDLC*:

a) Continental airspace: Not yet implemented; and
b) Oceanic airspace: Service implemented at some oceanic FIRs, for FANS equipped aircraft.

5.2.13 *CLRD*: Implemented in very few airports for terminal area/aerodrome.

5.2.14 D-ATIS: Implemented in very few airports.

5.2.15 VOLMET: Implemented in only one State of the Region.

Navigation

5.2.16 Radio aids: All conventional radio navigation aid systems (NDB, VOR, DME and ILS) have been implemented and fully installed pursuant to Table CNS 3 (radio navigation aids). Regarding NDBs, a deactivation process is underway, starting with those stations where the NDB is installed next to a VOR/DME.

5.2.17 ABAS is being implemented in selected airspaces of the Region for en-route, terminal area and NPA operations.

Surveillance

5.2.18 Radar systems: Conventional surveillance systems (PSR and SSR) have been implemented and installed almost entirely in the SAM Region according to Table CNS 4 A (surveillance system). The surveillance systems specified in this table cover most of the terminal areas of the States in the Region. However, not all the routes in the Region are covered.

5.2.19 Radar data exchange: It only exists in very few States of the Region.

5.2.20 ADS-B and MLAT: No services have been enabled to date.

5.2.21 ADS-C: Service provided by some oceanic FIRs, with FANS-equipped aircraft.

5.3 Strategy for the implementation of performance objectives

5.3.1 CNS implementation shall be based on a harmonised strategy for the SAM Region, with action plans and consistent timetables, taking into account operational requirements and the corresponding cost-benefit analyses, comparing the current structure with the improvements to be achieved when the new systems are implemented. Consideration should also be given to analysing the existence of two or more technologies to meet the same operational requirement.

5.3.2 Planning has been based on four global aspects, as shown in **Attachment C**, and as listed below:

a) aeronautical fixed service in the SAM Region (PFF SAM CNS/01);
b) aeronautical mobile service in the SAM Region (PFF SAM CNS/02);
c) navigation systems in the SAM Region (PFF SAM CNS/03); and
d) air surveillance service in the SAM Region (PFF SAM CNS/04).

5.3.3 A cross-cutting issue is the management of ANS personnel competencies of the air navigation system (PFF SAM HR/01). In this sense, States must pay special attention to meet ICAO requirements (see Chapter 10).

Communications

Aeronautical fixed service

5.3.4 AMHS: During this period, it is expected that AMHS systems will be implemented in those States that still have an AFTN system in place. Likewise, during that period, it is expected that each one of the AMHS systems installed will be interconnected to its respective AMHS systems, as specified in FASID Table CNS 1Bb.

5.3.5 Communication services for the ATFM: States must make the necessary efforts to implement communication services that effectively support ATFM.

5.3.6 AIDC: The States must make efforts to install automated systems in all their ACCs, with AIDC capability, and use them for the automatic transfer of flight plans between adjacent ACCs.

5.3.7 Improvement of the regional ATN network: In order to implement all the new services in a harmonised manner, the current Aeronautical Telecommunication Network (REDDIG) requires improvements regarding its technological platform, communication protocols, and an increase in capacity for the delivery of information. To this end, it is expected that, during the cited period, a new ATN network will be available to support all the existing services as well as those foreseen. During this period, a study on the optimum network configuration for the region will be conducted and, once approved, it will start being implemented.

Aeronautical mobile service

5.3.8 VHF: States must ensure coverage of continental VHF communications for lower flight levels when so required by the operations. Likewise, separate VHF channels must be implemented for TWR and APP services in the terminal area.

5.3.9 HF: The HF service must be maintained in keeping with the requirements listed in Table CNS 2B, “HF network designators for CAR/SAM aeronautical stations”.

5.3.10 CPDLC: States that have oceanic areas in their FIRs must make efforts for the provision of CPDLC services in the corresponding ACCs. Likewise, for the continental area, a technical/operational study should be carried out within the planning period, to permit its later implementation.

5.3.11 DATIS: The States must start providing DATIS services to replace similar conventional services or where they do not exist.

5.3.12 VOLMET/D-VOLMET: In attention to the MET requirement, States should start providing VOLMET services through speech communications systems and data links.

5.3.13 Protection of the radio frequency spectrum: The States must make the necessary efforts to ensure the protection and proper use of the radio frequency spectrum assigned to aviation for radiocommunication services.

Navigation

Navigation systems

5.3.14 NDB: States must continue with the NDB phase-out plan, as defined by GREPECAS/14 (April 2007). It is estimated that, during the period defined in the plan, most NDB will be deactivated.

5.3.15 VOR/DME: During the period defined in the plan, it is felt that, as part of the transition to the GNSS, VOR/DME systems must be maintained in selected TMAs, gradually starting the deactivation of en-route VOR systems.

5.3.16 DME/DME: Taking into account en route PBN and TMA implementation, as well as the use of DME/DME navigation as a back-up to the GNSS system, States should maintain the current DME systems coverage and, if necessary, States should carry out studies permitting the coverage extension of selected airspaces.

5.3.17 ILS: It is foreseen that, within the planning period, ILS systems will remain operative.

5.3.18 GLS: Approaches based on CATI GLS will begin at airports that have an operational demand that warrants them.

5.3.19 Flight trial support systems: The States must consider modernising their in-flight and ground trial elements so as to be prepared for a PBN environment.

5.3.20 Protection of the radio frequency spectrum: The States must make the necessary efforts to ensure protection and proper use of the radio frequency spectrum assigned to aviation for radionavigation services.

Surveillance

Improvements to the air surveillance service

5.3.21 ADS-B and MLAT: The main means of surveillance will continue to be collaborative surveillance in the form of SSR radars, extensively used in TMA and en-route services, and Mode S in high-density TMAs. The use of ADS-B (ES Mode S receivers) and MLAT will start providing en-route and terminal area surveillance as required; strengthening surveillance in areas covered by SSR Modes A/C and S. ADS-B (ES Mode S) will be gradually implemented on the ground to cover en-route and terminal areas.

5.3.22 A-SMGCS: It is foreseen that surface movement guidance and control systems A-SMGCS will be implemented at airports where previous studies have identified this requirement.

5.3.23 ADS-C: All States responsible of an oceanic FIR shall make operational use of ADS-C surveillance.

5.3.24 Protection of the radio frequency spectrum: The States must make the necessary efforts to ensure protection and proper use of the radio frequency spectrum assigned to aviation for air surveillance services.

5.4 Alignment with ASBU

5.4.1 Of the ASBU Block 0 modules taken under consideration of the SAM Region, the CNS area contributes to PIA 1 modules B0-65, B0-75 and B0-105, PIA 2 module B0-25, PIA 3 modules B0-35, B0-84 AND B0-102 and PIA 4 module B0-40.

5.4.2 Following are the CNS PFF indicated in paragraph 5.3.2 contributing with ASBU Block 0 modules indicated in paragraph 5.4.1:

a) PFF SAM CNS/01 – *Aeronautical fixed service*, with modules B0-25 and B0-35;
b) PFF SAM CNS/02 – *Aeronautical mobile service*, with module B0- 40;
c) PFF SAM CNS/03 – *Navigation*, with module B0-65; and
d) PFF SAM CNS/04 – *Surveillance*, with modules B0-15, B0-75, B0-84 and B0-102.

6. Chapter 6: Meteorology

6.1 Introduction

6.1.1 The next edition of the Global Air Navigation Plan (Doc 9750, GANP), will be presented to the ICAO Assembly in 2013 for approval. The draft GANP, and the aviation system block upgrade (ASBU) strategy it establishes, proposes that future air navigation technology and procedure improvements are organized and based on a consultative strategic approach that coordinates specific global performance capabilities and the flexible upgrade timelines associated with each component.

6.1.2 Meteorological information is an integral component of the tomorrow's system-wide information management (SWIM) environment, alongside aeronautical information, flight and flow information and other information sources. As meteorological information transitions from today's predominantly gridded, binary, alphanumeric and graphical formats to tomorrow's interoperable, non-proprietary code forms (such as XML/GML) within the SWIM environment using new exchange models like the weather exchange model (WXXM), tremendous potential exists to enhance the safety and the efficiency of the global air traffic management (ATM) system through enhanced availability and use of meteorological information. With this in mind, a planning threads promoting usage of integrated meteorological information to enhance operational decision making.

6.2 Meteorological information supporting enhanced operational efficiency and safety

6.2.1 In the near-term (Block 0), improved utilization by ATM of products from world area forecast centres, volcanic ash advisory centres and tropical cyclone advisory centres could support dynamic and flexible management of airspace, dynamically optimized flight trajectory planning, improved situational awareness and collaborative decision making. A focus on local arrangements is intended to enhance utilization of aerodrome warnings as well as wind shear warnings and alerts.

6.2.2 Meteorological challenges in routine operations often arise as a result of adverse and rapidly changing meteorological conditions. The proposed dynamic integration of ATM and meteorological (MET) information is expected to provide timely meteorological information to enable real-time identification, increased predictability and deployment of operationally effective ATM solutions to accommodate changing conditions, as well as facilitate tactical avoidance of hazardous meteorological conditions. Increasing use of airborne capabilities to detect and report meteorological parameters, and enhanced cockpit displays of meteorological information to enhance situational awareness, are additional elements of the strategy.

6.2.3 The Block 1 deployment includes initial ATM-MET integration, and actual and forecast meteorological information is compared with pre-characterized meteorological constraints on airspace or aerodrome threshold events using an ATM impact conversion process to identify near term capacity constraints. ATM decision makers are increasingly assisted by decision support tools using integrated meteorological information, consisting of automated systems and processes that create ranked mitigation strategies for consideration and execution.

6.2.4 At the Block 3 stage, far greater reliance is placed on airborne capabilities to provide meteorological awareness and drive tactical decision making including avoidance of hazardous meteorological conditions. Enhanced meteorological information is dynamically available to support the evolution of 4D trajectory operations. The 4D representations of meteorological information that have replaced traditional gridded, binary, alphanumeric and graphic formats provide wide benefits including increased access to meteorologically constrained airspace. ATM decision-making processes make extensive use of decision support tools that dynamically integrate meteorological information and propose mitigation strategies for consideration. Enhanced interpretation and mitigation of hazardous meteorological conditions results in extended pre-flight and flow planning capabilities.

6.2.5 The Technology requirements include the progressive establishment of an integrated 4D database capability of global meteorological information (observations and forecasts), as well as the deployment of automated systems to enable:

a) translation of raw meteorological data into predefined ATM constraints on airspace and aerodromes;

b) use of translated data to assess the impact on ATM operations, for traffic flows and individual flights; and

c) decision support tools, for both air navigation service providers (ANSPs) and users, which use ATM impact information to generate proposed mitigation strategies.

6.2.6 In the longer term, the availability of SWIM will enable further integration of meteorological information into both airborne and ground based tactical decision support tools.

6.2.7 The realization of globally interoperable, exchangeable meteorological information, including enhanced ground-to-air, air-to-ground and aircraft-to-aircraft meteorological reporting and exchange capabilities will be a significant undertaking.

6.2.8 The transition to integrated meteorological information will require agreement to, and development of, global standards for meteorological information exchange with an emphasis on the exchange of 4D (latitudinal, longitudinal, vertical and temporal) digitized meteorological information. Agreements are also necessary on what will constitute required meteorological information and graphical presentation in the digital information exchange era, to supersede the traditional gridded, binary, alphanumeric and graphic formats. Standardized meteorological information translation parameters and ATM impact conversion parameters will also require global agreement and development. Ensuring the accurate, reliable and wide availability of meteorological information remains a continuing challenge.

6.2.9 Meteorological information is recognized as a component of, ASBU modules concerning airport capacity, SWIM, flight and flow – information for a collaborative environment (FF-ICE), aeronautical information management (AIM), network operations, airborne separation, remotely-piloted aircraft (RPA), trajectory-based operations (TBO), continuous climb operations/continuous descent operations (CCO/CDO) and the global navigation satellite system (GNSS). Deployments from the meteorological information planning thread will need to take account of these wide interdependencies, therefore, States and users are urged to give due consideration to the potential added benefits which could result from the integration of a number of modules across a number of threads.

6.2.10 In this regard, the ASBU describe the way to apply the concepts defined in the Global Air Traffic Management Operational Concept (Doc 9854) in order to achieve local and regional performance improvements. The final target is to achieve global interoperability. Safety and efficiency require this level of interoperability and harmonization, which should be achieved at a reasonable cost and provide proportional benefits.

6.3 **Analysis of the current situation**

6.3.1 SAM States provide an aeronautical meteorological service that has been gradually improving in recent years. However, to ensure the availability accurate, reliable and comprehensive weather information, not all States have the necessary equipment, properly installed and / or maintained. In this respect it is essential that States have automated systems for data verification in accordance with the requirements set out in Annex 3 (thresholds). While quality management systems are in a good implementation process, the process of the quality of meteorological data should be the structure of Block 0.

6.3.2 Likewise, the lack of compliance with ICAO and WMO standards and recommendations referred to personnel involved in MET units is a deficiency that should be corrected by the States of the Region.

6.3.3 To obtain a mature QMS / MET in the region any effort by ICAO will be useless if there is not the commitment and performance of the senior management of the civil aviation administrations and providers of aeronautical meteorological services.

6.3.4 As a cross curricular subject to all these axes, there is the personnel competencies management (PFF SAM/HR 01) in accordance with the World Meteorological Organization (WMO) requirements.

6.4 **Alignment with ASBU**

6.4.1 Of the ASBU Block 0 modules taken under consideration of the SAM Region, the MET area contributes to PIA 1 modules B0-75 and B0-80, and PIA 3 module B0-105.

6.4.2 Following are the MET PFF indicated in paragraph 6.3.2 contributing with ASBU Block 0 modules indicated in paragraph 5.4.1:

a) SAM MET/01 PFF - *Implementation of the MET information quality management system*, with module B0-105;
b) SAM MET/02 PFF - *Improvements in MET facilities*, with modules B0-75 and B0-105;
c) SAM MET/03 PFF - *Improvements in the implementation of the international airways volcano watch (IAVW), in the surveillance of the accidental release of radioactive material, and in the issuance of SIGMET(s)*, with modules B0-80 and B0-105; and
d) SAM/MET 04 PFF - *Improvements in OPMET data exchange; and implementation and follow-up of the evolution of the WAFS*, with modules 0-80 and B0-105.

7. Chapter 7: Search and Rescue (SAR) Services

7.1 Introduction

7.1.1 The mission of SAR services is to find people in danger, help them and transport them to a safe place to receive proper care. The key for organising and having successful SAR services lies in top management, whose mission is to perform managerial tasks that will result in improved SAR operations, that is, the availability of an organised, trained and available SAR system capable of effectively helping people in danger.

7.1.2 The availability of SAR resources is often a critical initial capacity for responding and providing assistance to safe lives during the first stages of a disaster caused by natural causes or by the aviation activity *per se*. Accordingly, SAR services are sometimes part of an emergency management system.

7.1.3 SAR activities are an excellent means to encourage cooperation among States and organisations at the local, national and international level, since they involve missions that rarely create conflicting situations. Cooperation in this field may also lead to cooperation in other spheres. Such activities protect goods that may have a high value, which contributes to justify the existence of SAR services.

7.1.4 Close coordination between civil and military organisations is essential. National SAR coordination committees are a means for the establishment of such cooperation. The legislation should provide for the use of military and other public resources in support of search and rescue.

7.2 Analysis of the current situation (2012)

SAR requirements

7.2.1 The basic requirements for the establishment of an effective SAR system are:

a) The establishment of a regional framework concerning the need for availability of the SAR services that have jurisdiction over the different Search and Rescue Regions of the SAM Region;
b) Measures for using the available resources and procuring others as necessary;
c) The designation of the geographical areas of responsibility of the associated RCCs and RSCs;
d) Staffing, training and other personnel resources to manage and maintain the system in operation;
e) The appropriate and available means of communication; and
f) Agreements, plans, and related documents aimed at meeting the objectives and defining work relationships.

7.2.2 The periodic assessment of SAR requirements at regional level is very important for planning SAR resources and personnel in a coordinated manner, taking into account the respective SAR regions of the SAM States.

7.2.3 These updated and regionally harmonised requirements include, *inter alia*, the timely establishment of agreements between the different SAR services of SAM States for the provision of a regional search and rescue service, in keeping with the characteristics and needs of the aircraft fleet operating in the Region**.**

7.3 Implementation strategy of performance objectives

Risk management in practice

7.3.1 The use of risk management techniques gives some order to the uncertainty surrounding SAR organisations. It is an extremely useful tool for determining future work priorities and improving the capacity to meet the objective of the organisation, which is to find people in distress and take them to a safe location.

7.3.2 Risk analysis is a useful tool for those responsible for SAR organisations, since it can help in the assignment of resources that have priority for the organisation, and its results may be used to raise awareness amongst independent parties about the importance of search and rescue. SAR organisations should conduct a risk analysis and use the information thus obtained to increase their possibilities of saving lives. Planning has been based mainly on cooperation and Coordination of SAR services at a Regional level (SAM/SAR 01 PFF).

Quality management

7.3.3 Initiatives aimed at improving the quality of SAR services will substantially improve the results and reduce costs, mainly by eliminating the causes of unnecessary expenditures. These are important objectives for any administration, regardless of the volume of resources available.

7.3.4 The top management of a SAR system that assigns importance to quality tends to conduct more activities, make fewer mistakes, enjoy good reputation, and attract the resources necessary for the growth and better performance of the system.

7.3.5 In contrast, SAR organisations that do not pay attention to quality are subject to mistakes that may result in a reduced number of lives saved, the adoption of wrong or late operational decisions that create confusion, accidents and equipment failures, a deficient or inadequate use of resources, and unnecessary expenditure of economic resources.

7.3.6 Given the increasing air traffic activity and the use of large aircraft with a large passenger capacity, and its relationship with the responsibility of SAM States to protect human lives, it is important for SAR top management to develop a quality assurance programme for search and rescue (SAR) services, to be used as a quality management tool to ensure compliance with the objective of the national SAR plan of each SAM State.

7.3.7 This will also contribute to the provision of effective SAR services within the respective areas of SAR responsibility of each of these States, so as to foresee and particularly meet the many needs that would result from an accident with a large aircraft.

Competence of the search and rescue personnel

Training

7.3.8 Training is essential for operations and safety. The purpose of the SAR system is to save those who are in danger, and also to use training to reduce risks for the personnel and their means, which are very valuable. The training of personnel to conduct sound risk assessments will help ensure that the professionals who have received such training and the valuable means continue to be available for future operations.

Qualification

7.3.9 The purpose of the qualification is to validate the capacity of individuals to carry out certain tasks. They must demonstrate that they have a minimum level of knowledge and skills. This validation may be conducted in a specific position, through maintenance activities by a given team, or as a member of a group within a unit.

7.3.10 Qualification methods demonstrate the capacity of an individual to carry out concrete tasks. A qualification programme will cover the essential knowledge required to perform the functions in a given position and will test individuals in the use of the systems that they will have to manage or maintain.

Certification

7.3.11 The term certification is used in ICAO and other organisations within the context of authorising the personnel or the means to carry out certain functions. The term is also used to officially leave on record that an individual is duly trained and qualified to perform the tasks entrusted.

7.3.12 Thus, the objective of the certification is to authorise an individual to serve in a given capacity. Certificates should be issued to applicants that meet the conditions required for the service, as well as age, physical fitness, training, qualification, exam and maturity requirements. The certification must be issued in writing before the individual assumes his/her responsibilities in the surveillance service.

7.3.13 Training can only provide knowledge and skills at a basic level. Qualification and certification procedures help to demonstrate that sufficient experience, maturity and good judgment have been achieved. During the qualification process, the individual, upon showing his/her skill, should demonstrate that he/she is physically and mentally fit to be part of a group. Thus, the certification is the official acknowledgment by the organisation that it trusts the individual in the use of such skill.

7.3.14 The specific certification requirements vary according to the type of work location (ship, aircraft or RCC). The applicant to the title or certification may be assigned to a SAR specialist, who will observe how he/she carries out each of the tasks, and who will attest to his/her competence. A detailed knowledge of the geographical area of operation shall also be demonstrated. Certain tasks may require a periodic certification renewal.

7.3.15 Those responsible for managing the SAR service in general perform administrative functions; consequently, it is advisable that they participate in training courses on the following topics:

a) Planning;
b) Organisation;
c) Personnel;
d) Budget; and
e) Performance assessment

7.3.16 The use of means and personnel in search and rescue operations under severe weather or in rough terrain will require a special ability that is not generally learned through normal courses. Consequently, consideration should be given to the conduction of specialised courses for personnel training.

7.3.17 The SAM SAR/01 PFF reflects the short and medium term implementation strategy.

7.4 **Alignment with ASBU**

7.4.1 SAR planning aspects are not taken under consideration in ASBU.

8. Chapter 8: Aeronautical Information Services

8.1 Introduction

8.1.1 SAM States must consider the operational requirements of this Plan when implementing aeronautical information services.

8.1.2 In view of the requirements derived from the implementation of the ATM Operational Concept, SAM States shall consider planning for improvements to, and the strengthening of, Aeronautical Information Services, taking into account the initiatives of the Global Air Navigation Plan, as well as new provisions and requirements for short and medium-term implementation, and the related components of the aforementioned concept.

8.2 Analysis of the current situation (2012)

8.2.1 The AIS system currently available in the SAM Region presents deficiencies in some States, *inter alia:*

a) Lack of information with assurance of quality, integrity, and timely distribution of AIS products;
b) Activities are not data-oriented, and electronic information is not provided with quality assurance, in real time and with the capability of combining statistical and dynamic information in the same presentation;
c) Standard models are not used for the creation of integrated aeronautical, terrain and obstacle information data bases;
d) The English language is not used in AIS publications;
e) Topographic and land relief information is missing from instrument approach charts;
f) The geoid undulation is mission from aerodrome and heliport charts;
g) Quality control systems have not been implemented;
h) Automated systems have not been implemented;
i) The pre-flight information bulletin (PIB) is not provided;
j) Area minimum altitudes (AMA) are not included in route navigation charts;
k) English is not used in plain-language NOTAMs;
l) Post-flight information services are not facilitated;
m) Lack of training for AIS personnel;
n) Lack of aerodrome obstacle charts;
o) Lack of 1:500,000 aeronautical charts and 1:1,000,000 global chart;
p) Non-compliance with the AIRAC system; and
q) Lack of coordination between AIS/MET units for consistency between the NOTAM/ASHTAM and the volcanic ash SIGMET and for updating MET information in the AIP.

8.3 Strategy for the implementation of performance objectives

8.3.1 Planning has been based on two main axes, which are shown in Attachment C, and listed below:

a) Improving the quality, integrity and availability of aeronautical information (SAM AIM/01 PFF); and
b) Transition to the provision of electronic aeronautical information (SAM AIM/02 PFF).

Improving the quality, integrity and availability of aeronautical information

8.3.2 Full compliance with SARPs on quality assurance, integrity and timely availability of aeronautical information is a prerequisite for the transition to AIM.

8.3.3 In this sense, an action plan must be drafted and carried out to resolve current deficiencies as a prerequisite for the migration to AIM.

Aeronautical information regulation and control (AIRAC)

8.3.4 According to the AIS-AIM Transition Roadmap, the States must comply with the aeronautical information regulation and control (AIRAC) process. The quality of Aeronautical Information Services depends on the efficacy of the mechanisms for distribution, synchronisation and timing of said information.

Quality management system (QMS)

8.3.5 Quality management systems covering all the functions of aeronautical information services will be implemented and maintained.

8.3.6 The use of data sets on airborne equipment (FMS), automated systems for ATC, ground proximity warning systems (GPWS) and other systems related to an improved situational awareness make it absolutely necessary to implement processes to ensure the quality and integrity of the aforementioned data. These processes should be organised in a quality management system (QMS) applicable to all activities performed by the AIS.

8.3.7 The quality management system should be consistent with the ISO 9000 series and be certified by an accredited certification body. This certification is sufficient measure of compliance.

Monitoring of integrity in the data supply chain

8.3.8 Quality management systems should evolve until they are applied to all the data supply chain, starting at their origin.

8.3.9 In order to guarantee raw data integrity, service level agreements (SLA) must be established with the originators.

8.3.10 These SLAs will serve as a regulatory framework for the provision of data by the originators, and will contain details, *inter alia*, on: services to be provided, related indicators, acceptable and unacceptable levels of service, commitments and responsibilities of the parties, action to be taken in face of given events or circumstances, agreed data transmission formats, etc.

8.3.11 The SLAs are also a tool for measuring service performance, through the use of key performance indicators (KPIs).

Use of WGS-84

8.3.12 GNSS implementation requires the use of a common geodetic reference system. The SARPs determine that this common reference system must be WGS-84.

8.3.13 Consequently, the objective should be to express all coordinates in the WGS-84 reference system in an effective and verifiable manner. This requirement will also apply to future data products.

Transition to the provision of electronic aeronautical information

8.3.14 The transition to aeronautical information management (AIM) implies--as already stated--a data-oriented product. This transition to a digital format must be based on standard models and products that permit the exchange at a global level.

8.3.15 Based on this standardisation, the implementation of products and models will be done in a coordinated manner, at a global level, and in keeping with SARP updates resulting from new specifications.

Integrated aeronautical information database

8.3.16 For the design of the aeronautical information database, it is necessary to establish a conceptual model that defines the semantics of aeronautical information in terms of common data structures and takes into consideration the new requirements derived from the ATM Operational Concept.

8.3.17 The implementation of a conceptual model fosters interoperability and should serve as a reference in the design of the specified database.

8.3.18 Use will be made of an integrated aeronautical information database that integrates the digital aeronautical data of a State or Region and will serve to generate AIM products or services.

8.3.19 Use of database engines with spatial characteristics (geo-database) is highly advisable, since it enables data processing in geographical information systems (GIS).

8.3.20 Although it is not necessary for the design of these databases to be identical in all States or Regions, their modelling according to a common conceptual model would facilitate the subsequent exchange of data.

8.3.21 Database management may be carried out by a State or through regional initiatives.

Aeronautical information exchange model (AIXM)

8.3.22 An exchange model is essential for interoperability, since it establishes aeronautical data syntax for names and characteristics.

8.3.23 It will be established based on open standards (XML, GML), facilitating their incorporation into pre-existing or future systems.

8.3.24 It shall contemplate the exchange of dynamic information (NOTAM), enabling the extension of the traditional NOTAM format to give way to the digital NOTAM digital.

Terrain and obstacle database (e-TOD)

8.3.25 Ground proximity warning systems (GPWS), like the GIS-based procedure design and optimisation tools, require the electronic availability of high-quality terrain and obstacle data products.

8.3.26 To respond to this need, terrain and obstacle databases will be established according to common definitions that will be incorporated into the SARPs.

Electronic aeronautical information publication (e-AIP)

8.3.27 The eAIP must be considered as the evolution from the traditional paper-based AIP to the digital medium. The electronic version will have two formats: one will be suited for printing and the other will be accessible only through web browsers.

8.3.28 The eAIP must maintain a standard format, just like its predecessor, facilitating the exchange and preventing the proliferation of different presentations.

Electronic mapping and aerodrome mapping

8.3.29 Taking into account the technology available on board and in order to improve situational awareness, new digital mapping products suited to these devices will be established.

8.3.30 The use of the exchange model will allow these products to incorporate dynamic information in real time.

AIS-MET interoperability

8.3.31 Once an exchange model has been established and approved for AIM and a similar one for MET, it will be necessary to implement processes that promote AIS-MET interoperability and thus permit information integration.

8.4 Alignment with ASBU

8.4.1 Of the ASBU Block 0 modules taken under consideration of the SAM Region, the AIM area contributes to PIA 2 module B0-30 and module B0-105.

8.4.2 Following are the AIM PFF indicated in paragraph 8.3.1 that are reflected with the following ASBU Block 0 modules indicated in paragraph 8.4.1:

a) SAM AIM/01 PFF - *Improving the quality, integrity and availability of aeronautical information*, with module B0-30; and
b) SAM AIM/02 PFF - *Transition to the provision of electronic aeronautical information*, with modules B0-30 and B0-105.

9. Chapter 9: Aerodromes and Ground Aids / Aerodrome Operational Planning (AGA/AOP)

9.1 Introduction

9.1.1 SAM States must take into account the operational requirements of this Plan, including Ground Aids.

9.1.2 In view of the new requirements derived from the implementation of the ATM Operational Concept, SAM States shall consider the planning of improvements and strengthening of aerodrome services, pointing out that the ATM community includes as members the aerodromes, aerodromes exploiters and other parties contributing to the supply and operation of the physical infrastructure necessary for take-offs, landings and aircrafts flight stop services, taking into account the Global Air Navigation Plan initiatives as well as new provisions and requirements that require implementation in the short and medium term, and the related components of the cited concept (Attachment B).

9.2 Analysis of the current situation (2012)

9.2.1 Though aerodromes certification is a standard included in Annex 14 since 2003, only 5% of international airports were certified in the SAM region. Normally States do not update the information contained in the Air Navigation Plan, nor inform ICAO Regional Office about the correction of deficiencies registered in the GANDD database. Therefore, States in the Region commonly show difficulties to achieve their obligations regarding aerodromes surveillance, generating preoccupation regarding safety levels in such States, added to continuous increment of air transport demand, particularly when infrastructure is used up to capacity limits.

9.2.2 Recent introduction and implementation of new air navigation technologies contrasts with the lack of compliance of aerodrome standards, including difficulties in the adoption of new safety management tools now widely used in other human activities.

9.2.3 Most of the infrastructure of existing aerodromes were established when the design requirements were less stringent than today. Therefore, the certification of aerodromes built to less demanding requirements than current design requirements has become a barrier for the certification of aerodromes. However, safety assessment is a tool, through risk analysis and aeronautical studies, which allows aerodrome certification for those aerodromes that do not comply strictly with the standards and recommendations established by ICAO. For these cases, certification will become a reality, including always the operating conditions under which certification was granted. It is also important to determine the requirements for the safety assessment, mostly applicable when challenging natural conditions of the aerodrome leads to the development of a risk assessment/aeronautical studies. Thus, it is important to have appropriate regulatory mechanisms, solid in nature and well documented for resolving discrepancies or deficiencies that might exist in the accepted standard. However, it is important to understand that no waivers or exceptions are intended to overcome difficult compliance requirements.

9.2.4 In the AGA area, gaps that contribute to these scenery and that can affect efficiency of new air navigation technologies, such as absence or inadequacy of national regulation and orientation guidelines, lack of trained personnel to perform safety surveillance functions of exploited airports, difficulty for ensuring the supply, timely update and expedite dissemination of critical safety information, as well as information regarding terrain and emplacements that could constitute an obstruction or hazard to air navigation.

9.3 **Strategy for the implementation of performance objectives**

9.3.1 SAM States should make all possible efforts to warranty that aerodromes required physical characteristics and operational procedures followed by aerodrome exploiters correspond to ICAO standards and recommended methods (SARPS) and harmonise with Latin American regulations developed by the Regional Safety Oversight System (SRVSOP).

9.3.2 In the SAM Region, States must ensure that air navigation services support systems at aerodromes and their operators comply with national regulations, which shoul be harmonized with AGA LAR set, adopting the appropriate legal framework to formalize the responsibilities of the operator, whether the operation is public or private, and the Civil Aviation Authority.

9.3.3 The aerodrome should negotiate the increase of TMA operations in a safety environment, which requires identifying and optimising the critical elements at the inside and outside of the aerodrome that can influence this condition.

9.3.4 The optimization of TMA air space structure with the PBN implementation makes necessary measures that ensure an effective control with respect to emplacements in aerodromes proximity areas, taking into account the minima separation applicable between aircrafts and obstacles.

9.3.5 As first reference to these critical elements, the identification of aerodromes located near to operational saturation, followed by actions required to improve this capacity in terms of differentiation of these limits through the application of the best practices in the existing infrastructure, and, if necessary, in modified infrastructure, are interpreted as a necessary requirement.

9.3.6 Other external conditions to aerodrome operation that should be coordinated with responsible Regional Committees are the limitation of operations due to noise level, to the use of ground and to bird hazard, as well as the cancelation of operations due to adverse climatic conditions, that affect or limit the required optimization.

9.3.7 Planning has been based on main axes, which are shown in Attachment D, as listed below:

a) Quality assurance and availability of aeronautical data (PFF SAM AGA/01);
b) Aerodrome certification (PFF SAM AGA/02);
c) Safe aerodrome operations that to not meet ICAO SARPs (PFF SAM AGA/03);

d) Improvement of physical and operational characteristics of the aerodrome (PFF SAM AGA/04); and
e) Runway safety (PFF SAM AGA/05).

9.3.8 As a result of the assessment of aerodrome capacity factors directly affected by the increase in the flow of operations within the framework of safety management, strategies for achieving AGA/AOP objectives are identified, as summarised in five Performance Framework Formats (PFFs): Aerodrome information quality requirements, aerodrome certification, safe operations at aerodromes that do not meet ICAO SARPs (certificates with limitations), aerodrome capacity optimisation, and runway incursions and excursions.

Quality assurance and availability of aeronautical data

9.3.9 To achieve more efficient operations at aerodromes and reduce the risk of air accidents, it is necessary to ensure the quality and availability of aeronautical data by standardizing procedures and protocols of aeronautical data update, implementation and maintenance verification of the quality management systems covering all functions of aeronautical information services.

9.3.10 The tasks required to attain this performance objective includes the development of a regional action plan that identifies the need to update the information contained in Document 8733, CAR/SAM Navigation Plan, Vol. II FASID, Table AOP1. The updating of information will contribute to a reduction of air navigation deficiencies in the States, taking into account that many of them result from non-compliance with the information contained in Table AOP1 originally provided by the States. Likewise, it will be necessary to establish a juridical frame, as for example letters of agreement with AIM, not only to ensure the quality of aerodrome information, but also to update aerodrome obstacle data in the WGS-84 system through e-TOD.

9.3.11 Other task of special importance for the implementation of PBN is the adoption of systems by the States to ensure the control of emplacements near the aerodromes and the permanent monitoring to prevent irregular constructions and installations that affect negatively air navigation.

Aerodrome certification

9.3.12 Certification process of aerodromes is an indispensable requirement to improve safety in aerodromes and to establish in States an effective oversight by exploiters.

9.3.13 In cases where the State cannot overcome in the short term the difficulties for the certification of airports, it is necessary to establish multinational teams of experts of the region under the coordination of the SRVSOP that will carry out evaluations using the regulations and guides of the Regional System. The activities of the team, the obligations of the exploiter and the granting of the certificate would be issues to be convened.

9.3.14 It is important to guarantee the quality of the installations and services of the Aerodrome through a process of continuous training of the personnel involved in airport operations.

9.3.15 The adequate provision of AGA installations and services would depend of the management and competence of technical-operative personnel. Likewise, availability should be proportional to the amount of different services being supplies, based in a model that would ensure the quality of the airport system.

Safe Operations at Aerodromes non-compliant with ICAO SARPs

9.3.16 Conditions of certain part of the aerodromes infrastructure in the SAM region lead to believe that some aerodromes are susceptible of a certification with deviations regarding ICAO SARPS, however this do not exclude these aerodromes nor others of the Region to count with guidelines for the treatment of deficiencies and the implementation of operations in the aerodromes within a safety environment, which will stimulate risk management, auto audits from aerodromes and States (Document 9859) as well as ICAO audits.

9.3.17 The above requires of a regional plan to identify these aerodromes in the SAM Region, to develop guidelines by ICAO f or the implementation of aerodromes certification with deviation of ICAO SARPS, including in this guidelines the orientation towards cost efficient aeronautical studies development/SMS, to encourage States to the certification of their aerodromes. The implementation of certification of these aerodromes is also a safety objective in the SAM Region.

Improvement of physical and operational characteristics of the aerodrome

9.3.18 In term of Air Traffic Flow Management ATFM, conceptual changes of the aerodrome physical and operational characteristics should be introduced, taking into account ATFM in the strategy phase, airport exploiters should be conscious about airport capacity and its impact in the ATFM.

9.3.19 Some issues that should be considered in the structure are:

a) the design should contemplate the reduction of runway occupancy time;
b) safe manoeuvring under every meteorological conditions without capacity decrease;
c) precise guide of surface movements to and from a runway under every condition; and
d) position should be known (under an adequate level of precision) and the intention of all vehicles and aircrafts that carry out operations in the movement area, and these data should be available to the ATM community members.

9.3.20 The aerodrome exploiter should provide the necessary infrastructure, included, among others, visual aids, taxiways, runways and exits, as well as a precise guide of surface movements to improve safety and elevate to maximum the capacity of the aerodrome under every meteorological condition.

9.3.21 In order to establish a balance between demand and capacity, aerodrome exploiters should evaluate aerodrome capacities in order that air space users be able to determine when, where and how to perform operations, at the same time that conflict needs with respect to air space and aerodrome capacity are mitigated.

9.3.22 The capacity obtained through the aforementioned strategies relates to the installed infrastructure and its utilisation, understood as capacity with respect to the required demand. Accordingly, aerodrome capacity must be assessed based on saturation or near saturation under current and expected traffic conditions. Therefore, it is very important for the Region to identify airports that are close to this saturation condition in order to propose the development of manuals that contemplate, as a first objective, capacity improvements in runways, turning apron, taxiways and apron, based on the existing infrastructure and, as a second objective, the implementation of new infrastructure.

9.3.23 Accordingly, it is necessary to assess the aerodromes of the Region that are close to the point of saturation, develop a guide containing, as first measure, runway capacity optimisation procedures that use operational tools such as runway segregation, reference fields segmented runways, optimisation of surface movement and, as second measure, plan the new infrastructure that, in both cases, should be in harmony with the environment. It is necessary to include letters of operational agreement in this new operational condition, as well as the monitoring of the optimisation of runways and their supplementary systems.

Runway safety

9.3.24 The safety of aircraft operations with respect to conditions that cause runway excursions, may largely depend on pavement surface conditions, their behaviour under different weather conditions, and their use. Consequently, the identification and management of such conditions to keep them within acceptable levels favour this operational requirement. These characteristics are: friction on paved surfaces covered by snow or ice or water, surface drainage capacity, and rubber contamination.

9.3.25 The foregoing requires the development of a regional action plan for the identification of these runway surface safety requirements and the assurance of an acceptable SMS risk.

9.3.26 Likewise, aerodrome operators must report these operating conditions to users, authorities and providers, as a requirement for ensuring proper dissemination.

9.3.27 The States must monitor the progress of the programme, and this information shall be provided to ICAO in order to contribute to safety measurements.

9.4 Alignment with ASBU

9.4.1 From ASBU Block 0 modules taken under consideration of the SAM Region, the AGA area contributes to PIA 1 modules B0-15, B0-80 and B0-75 and PIA 2 module B0-30.

9.4.2 Following are the AGA PFF indicated in paragraph 9.3.2 contributing with ASBU Block 0 modules indicated in paragraph 9.4.1:

a) PIA 1 / B0-15 – Improve Traffic Flow Through Runway Sequencing (AMAN/DMAN) related to Improvement of physical and operational characteristics of the aerodrome-PFF SAM/AGA 04
b) PIA 1 / B0-75 –Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2**)** related to Improvement of physical and operational characteristics of the aerodrome-PFF SAM/AGA 04
c) PIA 1 / B0-80 **-** A-CDM related to Aerodrome Certification **-**PFF SAM/AGA 02 and Safe Operations at Aerodromes non-compliant with ICAO SARPs - PFF SAM/AGA 03.
d) PIA 2 / B0-30 - Service Improvement through Digital Aeronautical Information Management related to Quality assurance and availability of aeronautical data. (PFF SAM/AGA01).

9.4.3 The PIA Module 1 / B0-80 A-CDM, aims to improve the operational efficiency of service providers at airports by reducing delays, increased prediction of events that may happen during the flight and optimizing the utilization of resources. The expected results, improved airport capacity, which can be reached if there are improvements in the exchange of information in real time between airport operators, aircraft operators, ground service providers and air traffic control. This concept involves the implementation of a set of operating procedures and automated processes. The Aerodrome area has identified this module as an opportunity to implement the AGA requirements in the SAM region.

9.4.4 Modules PIA 1 / B0-15, PIA 1 / PIA B0-75 and 2 / B0-30 have been identified by AGA as modules that allow collaboration with other areas of airspace, ATS, AIM and CNS.

10. Chapter 10: Development of Human Resources and Competence Management

10.1 Introduction

10.1.1 In view of the new requirements derived from the implementation of the ATM Operational Concept, SAM States shall consider planning the Development of Human Resources and Competence Management, taking into account the ASBU Block 0 modules.

10.1.2 The Air Navigation system allows for the collaborative integration of human resources, information, technology, facilities and services with the support of communications, navigation and surveillance. The provision of ATM services in the SAM Region will depend on the performance of individuals and the development of new competencies, making possible their interrelationship with the operational and technical environment. Each system is developed, maintained and operated by human beings that continue to be the most flexible and critical element to manage threats and errors in ATM operations. A seamless navigation scope will be required in the future. An international team prepared to perform its functions in that new operational scenario. To achieve this, the members of this team must receive a uniform and high quality level of training.

10.1.3 The role of the individual and his contribution to the Air Navigation System will mutate according to the changes presented in the Operational Concepts and the structure of the system. The proper provision of air navigation services will depend on the management of the competencies of technical and operational personnel, as well as on their availability in sufficient numbers to cover the different services. It will also demand a redefinition of the profile of the personnel required for the system.

10.1.4 In the past, the evolution of aeronautical technologies has been gradual and, to a large extent, Civil Aviation Training Centres (CATCs) and instructors have been able to face the challenges of change, even though they did not always have refined training methodologies and instruments available. However, the new ATM systems are based on many new concepts, and their implementation represents an even bigger challenge.

10.1.5 The introduction of these new concepts within the ATM system will make planning a critical element and its efficient development will have a big impact on all aeronautical personnel, including the managerial levels. That is why competence management is one of the key issues for a successful transition.

10.1.6 As a result of the introduction of the components of the ATM Operational Concept, new aeronautical disciplines will emerge. From the point of view of human resource planning, it will be necessary to redistribute and train personnel. The need for a seamless integration of human resources to the management of safety in the design and implementation of new ATM systems and in operational training has been clearly identified.

10.1.7 The planning of personnel competence management for the implementation of the components of the ATM Operational Concept shall take into account the specific requirements of all the implementation activity of the different areas that make up this Document. The development and implementation of the expertise of human resources, the guidelines, standards, methods and the tools for human error management, the friendly use of the new technology and operational training will be the basis for ATM success in the region.

10.1.8 The planning of training in the SAM Region shall be done in standardised manner and coordinated with CATCs where the required courses would be given.

10.1.9 ICAO has adopted a new training policy that includes a process to support training organisations and courses. This new training policy covers all safety and security aspects and supplements the work of the special team on the new generation of aviation professionals (NGAP). The civil aviation training policy of ICAO permits the implementation of an integral framework that ensures that all training provided by ICAO or third parties is subject to assessment to make sure it complies with the stringent standards concerning the design and development of training courses (EB2010/40).

10.2 Analysis of the current situation (2011)

10.2.1 The CAR/SAM ANP, within its planning parameters takes into account human resources and their training. The high level of automation and interdependence of the current system gives rise to several problems related to human resources and human factors and the interaction with their environment and other persons. The experience gained in this are indicates that the human element should be considered as the critical part of any plan for the implementation of new technologies. Achievement of the ATM operational concept will be dependent on the competence of the human resources.

10.2.2 The challenges and the development of human resources will multiply during the transition period to the ATM Operational Concept. Since the existing and emerging air navigation technologies will work in parallel for some time, civil aviation personnel will have to develop new skills while maintaining those necessary for the operation and maintenance of the existing systems, using a collaborative approach for civil aviation training.

10.2.3 The analysis of the current situation reveals existing weaknesses and emerging threats.

10.2.4 Weaknesses include, *inter alia*:

a) Lack of sufficient personnel;
b) Lack of and duly trained personnel;
c) Legal and budgetary limitations of the States;
d) High cost of training (initial, specialised, recurrent, remedial);
e) Personnel that do not comply with English language proficiency requirements;
f) Personnel with inadequate knowledge to manage operate and maintain the systems;
g) Inadequate and insufficient amount of simulators for training;
h) Instructors with insufficient knowledge and qualifications to meet current needs;
i) Insufficient civil aviation training centres (CATCs) with programmes and documentation, not meeting current needs;
j) Duplication of courses at regional institutes,
k) Insufficient evaluation at training centres in order to meet the established requirements in EB/2010/40;
l) Migration of professionals due to economical incentives;
m) Lack of criteria such as profiles, experience and/or specialty in the assignment of subjects teaching;
n) Lack of advantage takin regarding knowledge acquired as regards training and experience;
o) Lack of motivation regarding personal initiatives; and
p) Unsuitable mental model.

10.2.5 Emerging threats include *inter alia*,

a) Outdated training methods (external providers);
b) New technologies;
c) Increased and complex traffic volume;
d) Change of mindset to embrace a collaborative approach; and
e) Lack of communication among the various disciplines and the whole of the aeronautical community.

10.2.6 Currently, the South American Region has a regional mechanism made up by the Directors of Civil Aviation Training Centres, which meets on an annual basis. These events are aimed at analysing human resource planning and training, cooperation amongst training centres, the creation of introductory courses to the new systems, the need to professionalise training centres in order to face the new demands of the new systems, promote the TRAINAIR programme through the incorporation of new centres into the programme, and the development of courses under this methodology. This mechanism should reflect the new requirements, and establish a programme in keeping with current requirements.

10.2.7 To obtain a holistic view on the mater, the CATCs should integrate the training in the areas of aeronautical meteorology, safety and environment.

10.3 **Strategies for the implementation of performance objectives**

10.3.1 All the areas involved in ATM have participated in the planning of the development of human resources and training requirements, including operations and airworthiness personnel of the aeronautical authority of each State. The starting point was the absence of a full integration and the need to become aware of the role of each individual within the ATM Operational Concept, taking into account the guidelines of Document 9750 – Global Air Navigation Plan, the Global ATM Operational Concept (Doc. 9854) and other related ICAO documents.

10.3.2 In a first phase, the starting point should be known through the conduct of an analysis of the situation, to later develop a roadmap that includes concrete activities to face the challenges of the new concepts, with duly trained and updated personnel.

10.3.3 The Air Navigation system should be designed to reduce potential errors optimizing their detection and mitigation. To this end we need the application of a fair culture that includes a voluntary incident reporting system enabling organisational learning.

10.3.4 ICAO programmes concerning the formation of the new generation of aviation professionals (NGAP) must be taken into account, using the results of this panel for planning the courses.

10.3.5 To facilitate international cooperation for r the development of training programmes and materials the region may use the following strategies:

a) Early identification of training needs and priorities for Air Navigation Systems personnel: Given the diverse and specific training that will be needed for the new systems, as well as the need for standardization, it is essential to establish a collaborative plan of supplies required. However, an effective plan will only be formulated once the training needs and priorities have been clearly identified; and

b) Coordination and planning of training for Air Navigation Systems personnel at regional level: Effective planning and coordination in the preparation of the appropriate materials, avoiding duplication and7or absence of some formation and specialization courses. The SAM Region has structures that could be used to fulfil this task.

10.3.6 The civil aviation training centres should prepare their instructors, under a specific profile, on the ATM Operational Concept and the supporting systems for its implementation, such as ASBU.

10.3.7 When planning specialized training, provisions should be made for inclusion of basic training in other areas, so that there will be acknowledgement of the work carried out in other units, and awareness of the impact of the task in the consideration of the global ATM. Personnel will be aware of the work done in other units and of the impact their tasks have on the overall ATM. As a strategy, the planning of personnel competence management shall consider three stages:

a) Basic training: This stage shall include the new operational ATM concepts, the new communications, navigation and surveillance systems, the new aeronautical information vision, the meteorology system, safety and environment;
b) Training for those who plan and implement: Training is required at the top management level in order to provide decision makers the necessary basic information. This type of training is required for the ATM systems implementation planners; and
c) Task-specific training: Training is required for ongoing management, operation and maintenance of systems. This category accounts for most of the training needs and is the most difficult to develop and implement.

10.3.8 Planning has been based on a main axis, which is shown in **Attachment D**, and listed below:

a) Planning training to develop air navigation systems personnel skills (SAM HR/01 PFF).

10.3.9 CATCs shall actively accompany the planning and development of update and training courses on the ATM Operational Concept to comply with the roadmap outlined as per the ASBU methodology recommended by ICAO and the States,.

10.4 **Alignment with ASBU**

10.5 The development of human resources and competency management is an essential element for the implementation of all the ASBU modules taken under consideration (see Chapter 3). Therefore, SAM HR/01 PFF is related with the 18 modules selected for the SAM Region.

11. Chapter 11: Safety Management

11.1 Introduction

The Global Aviation Safety Plan

11.1.1 The 2014-2016 Global Aviation Safety Plan (GASP) (Doc. 10004) establishes specific safety objectives and initiatives, guaranteeing the efficient and effective coordination of safety-related complementary activities among all interested parties.

11.1.2 The purpose of GASP is to continuously reduce the global accident rate through a structured and progressive approach which comprises short, medium and long term objectives. As the Global Air Navigation Plan (GANP), the objectives of GASP are compatible through specific safety initiatives classified in accordance with the various safety performance areas. These performance areas are common to each of the global objectives.

11.1.3 The objectives of the ICAO GASP and their corresponding target dates are applied to the global aviation community. Nevertheless, each of these objectives includes specific initiatives and milestones that can be continuously implemented by States on the basis of their various operational profiles and priorities. In this manner, the initiatives in GANP will lead towards making progress as per each State's safety surveillance capabilities, the States Safety Programmes (SSP) and the safety processes necessary to support the future air navigation systems.

11.1.4 The first version of the ICAO GASP was prepared in 1997 and was regularly updated until 2005. The second edition was drafted in October 2007, which was subsequently acknowledged in Resolution A36-7. The cited Resolution A 36-7 urges contracting States and the industry to adopt the principles and objectives contained in the Global Aviation Safety Plan and the Global Aviation Safety Roadmap, and to apply their methodologies in partnership with all stakeholders with a view to reducing the number and rate of aircraft accidents.

Objectives of GASP

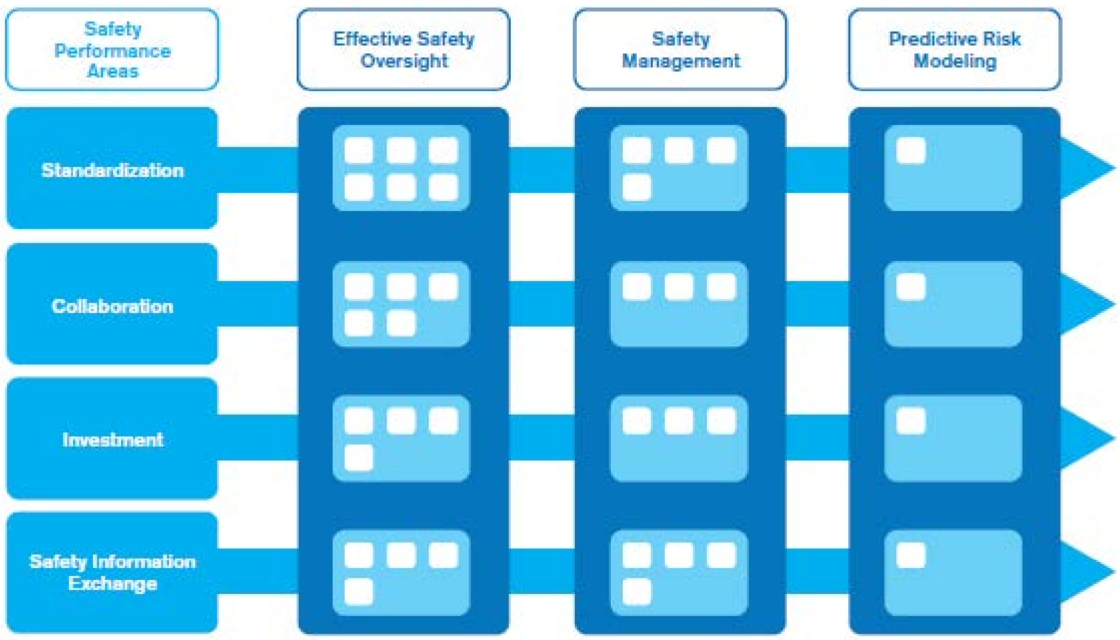
11.1.5 The short term objectives of GASP are oriented towards the implementation of the ICAO Standards and Recommended Practices (SARPs) related with State authorization, certification, and approval as they are pre-requisites enabling air traffic growth in a safe and sustainable manner. States lacking these capabilities will ensure they count with the resources, as well as with the legal, regulatory and organizational structures necessaries to comply with their fundamental obligations regarding safety surveillance. States having a mature safety surveillance system should centre in the continuous application of safety management in the short term. The target implementation of this objective is 2017.

11.1.6 The GASP medium term objective urges all States to achieve full implementation of SSP and Safety Management Systems (SMS) worldwide, to facilitate a dynamic management of the safety risks. Through the application of SSP, States will complement fundamental safety surveillance functions with the management of risks and analytical processes that can proactively identify and mitigate safety problems. The implementation target date is 2022.

11.1.7 The long term objective is the application of predictive systems to convert in the integral part of the future aviation systems. The objective is to support an operational environment defined by the increase of automation and the integration of ground and air advanced capabilities, as shown in the ASBU. The target date of this implementation is 2027.

Framework of GASP

11.1.8 The GASP can be mapped by using a safety strategic diagram, as the one shown in the figure below. This diagram shows how the safety initiatives and the GASP objectives joint to compose the safety improvement strategy.



11.1.9 The columns show the evolution of the Plan objectives. Every row represents the performance area that creates a common subject thread in support of GASP objectives.

Regional Aviation Safety Groups

11.1.10 The Regions are currently resolving safety issues through different mechanisms established by the States themselves and the industry. The Pan-American States created the Regional Aviation Safety Group— Pan-America (RASG-PA) in 2008 in response to Resolution A 36-7. This Group was established as a focal point to ensure harmonisation and coordination of safety efforts aimed at reducing aviation risks in the North American, Central American and Caribbean (NACC) and South American (SAM) Regions, and the promotion, by all the stakeholders, of the implementation of the resulting safety initiatives.

11.1.11 Current requirements on State safety management have been consolidated into Annex 19 – *Safety management*, adopted by the ICAO Council on 25 February 2013 and to become valid on 15 October 2013.

11.1.12 The State administration must establish mechanisms to ensure the effective supervision of the critical elements of the safety oversight function. Furthermore, it must create mechanisms to ensure that hazard identification and safety risk management by service providers is consistent with the established regulatory controls (requirements, specific operating regulations and implementation policies). These mechanisms include inspections, audits and surveys to ensure that safety risk regulatory controls are properly integrated in the SMS of service providers, that they are implemented as designed, and that they have the expected effect on safety risks.

State Safety Programme (SSP)

11.1.13 The introduction in the SARPs of requirements related to the State safety programme (SSP) resulted from the growing recognition that safety management principles impact most of the civil aviation management activities, including regulation, policy-making and safety oversight.

Safety Management System (SMS)

11.1.14 The States will require, as part of the State safety programme, that the air navigation service provider(s): ATS, AIS, CNS, MET, SAR y AGA implement a safety management system acceptable to the State and that, at least:

11.1.4.1. Identifies safety hazards;

11.1.4.2. Ensures the implementation of the necessary corrective measures to maintain the agreed level of safety efficacy;

11.1.4.3. Provides for ongoing monitoring and periodic assessment of safety efficacy; and 11.1.4.4. Seeks to improve the general status of the safety management system on a continuous basis.

11.1.15 The SMS will clearly define the lines of responsibility for safety within the organisation of the air navigation service provider, including the direct safety responsibility of high managerial staff.

11.1.16 When AIS, CNS, MET and/or SAR services are fully or partially provided by an entity other than an ATS provider, the requirements established in 11.1.5 and 11.1.6 will apply to those aspects of these services that a have direct operational impact.

11.1.17 In order to maintain acceptable safety levels, AIS and MET services must implement Quality Management Systems.

11.1.18 According to ICAO Annex 11, any significant change in the ATS system related to safety, including the implementation of reduced separation minima or a new procedure, will only become effective after a safety assessment has shown that they will meet an acceptable level of safety and that users have been consulted. When applicable, the responsible authority will make sure that the appropriate measures are taken for post-implementation monitoring to verify that the established level of safety is being met. When the acceptable level of safety cannot be expressed in quantitative terms due to the nature of the change, the safety assessment may rely on operational judgment.

11.2 **Current situation (2011)**

11.2.1 Since 2007, courses on safety management systems (SMS) have been dictated at a regional level and in all South American States. Also, since 2009, regional courses were dictated and in some States of the Region on State Safety Programmes (SSP) and in different forums SAM States have been encouraged to implement their SSP demanding implementation of the corresponding SMS to service providers.

11.2.2 In spite of the above, the results of the safety surveillance audits in the Region have demonstrated that few States have effectively implemented the ICAO SARPs in the ANS and AGA areas, being the Lack of Effective Implementation (LEI) in the Region of 48% in ANS and 36% in AGA, percentages that required be reduced to ensure the safety of operation in the region and satisfy the needs of GANP.

11.2.3 The region has a strategy of mutual support for the effective implementation of SARPs through a project of standardization of regulations, procedures and supporting documentation to the AAC to ensure safe implementation of the provisions contained in the GANP. This project is the development and implementation of the Latin American Aviation Regulations (LAR), which is supported by a regional project.

11.3 **Strategy for the Implementation of Performance Objectives**

11.3.1 Planning has been based on a main axis, as shown in **Attachment C**, called ‘Safety” (SAM SM/01 PFF), as follows:

11.3.1.1 Safety Management (SAM SM/01 PFF).

12. Chapter 12: Performance Improvement Areas (PIA), modules and Air Navigation Report Forms (ANRF)

12.1 Introduction

12.1.1 This Chapter describes the Performance Improvement Areas (PIA) with the respective modules taken under consideration in ASBU Block 0 for the SAM Region. In addition, it presents a standard format for each of the modules considered, for the monitoring in their implementation. The format receives the name of Air Navigation Report Form (ANRF).

12.2 Performance Improvement Area (PIA)

12.2.1 Sets of modules in each block are grouped to provide operational and performance objectives in the environment to which they apply, thus forming executive high-level view of the intended evolution. The PIAs facilitate comparison of ongoing programmes.

12.2.2 The four performance improvement areas are as follows:

a) Airport operations
b) Globally Interoperable Systems and Data - Through Globally Interoperable System Wide Information Management
c) Optimum Capacity and Flexible Flights – Through Global Collaborative ATM
d) Efficient Flight Path – Through Trajectory-based Operations

Performance Improvement Area 1: Airport operations

12.2.3 In relation to airport operations, taking advantage of technical developments in air navigation and aircraft systems may assist in improving airport capacity and efficiency. In order to contribute to an overall strategy enhancing airport capacity, four related significant modules, were selected for inclusion in the ASBU framework:

a) B0-15 - *Improve Traffic Flow through Runway Sequencing (AMAN/DMAN)*;
b) B0-65 - *Optimization of Approach Procedures including Vertical Guidance*;
c) B0-75 - *Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)*; and
d) B0-80 - *Improved Airport Operations through Airport-CDM*.

12.2.4 The initial steps on these modules implement a combination of approach procedures making optimal usage of GNSS-based performance-based navigation (PBN) approaches and traffic flow improvements through the management of arrival and departure runway sequencing. New technology is already available to enhance the surveillance of aircraft surface movement, and may also provide information on suitably equipped vehicles. Improved processes are offered to support CDM involving all stakeholders on the airport.

12.2.5 Many of the operational improvements relating to airport capacity are local by essence and may only result in benefits at individual airports. Accordingly, improvements in airport capacity should be made on the basis of local decisions that take into account current and future aircraft operations and the level and type of equipage on board the aircraft. However, in cases where interdependencies in terms of traffic flows, airspace management and so forth exist between airport pairs, the full benefit of arrival/departure/surface management may only be achieved on a harmonized regional basis. The description of the modules chosen for this performance improvement area is presented as **Attachment D**.

Performance Improvement Area 2: Globally Interoperable Systems and Data - Through Globally Interoperable System Wide Information Management

12.2.6 The Global ATM Operational Concept envisages an integrated, harmonized and globally interoperable system for all users in all phases of flight. The aim is to increase user flexibility and maximize operating efficiencies while increasing system capacity and improving safety levels in the future ATM system.

12.2.7 In relation to globally interoperable systems and data two related significant modules, were selected for inclusion in the ASBU framework:

a) B0-25 - *Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration*;
b) B0-30 - *Service Improvement through Digital Aeronautical Information Management;* and
c) B0-105 - *Meteorological information supporting enhanced operational efficiency and safety*.

12.2.8 At the first stage, these selected modules include the usage of automated ATS interfacility data communications (AIDC) messages as the basis of ground-ground coordination between neighboring ATS units contributing directly to safety improvements such as reductions in coordination errors and supports performance improvements such as reduced separation and enhanced efficiency.

12.2.9 Additionally the introduction of digital processing and management of information, through aeronautical information service (AIS)/aeronautical information management (AIM) implementation, use of aeronautical information exchange model (AIXM), migration to electronic aeronautical information publication (AIP) and better quality and availability of data contributes to the global interoperable systems and data. The description of the modules chosen for this performance improvement area is presented as Attachment D.

Performance Improvement Area 3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM

12.2.10 This performance improvement area is referred to the Optimum Capacity and Flexible Flights and in this sense 5 Modules were selected to be implemented in the SAM Region.

12.2.11 The modules are:

a) B-010 - *Improved Operations through Enhanced En-Route Trajectories*;
b) B-035 - *Improved Flow Performance through Planning based on a Network-Wide view*;
c) B-084 - *Initial capability for ground surveillance*;

d) B0-101 - *ACAS Improvements*; and
e) B-102 - *Increased Effectiveness of Ground-Based Safety Nets*.

12.2.12 These set of modules intend to optimize the use of airspace which would otherwise be segregated (i.e. special use airspace) along with flexible routing adjusted for specific traffic patterns managing Air Traffic Flow Management (ATFM) to minimize delay and maximize the use of the entire airspace.

12.2.13 It also considers the initial capability for lower cost ground surveillance supported by new technologies such as ADS-B OUT and wide area multilateration (MLAT) systems. This capability will be expressed in various ATM services, e.g. traffic information, search and rescue and separation provision.

12.2.14 In addition ground safety nets as short-term conflict alert, area proximity warnings and minimum safe altitude warnings are proposed as well as the MET information to support flexible airspace management, improved situational awareness and collaborative decision making, and dynamically- optimized flight trajectory planning.

Performance Improvement Area 4: Efficient Flight Path – Through Trajectory-based Operations

12.2.15 This performance improvement area is referred to the Efficient Flight Path and in this sense 3 Modules were selected to be implemented in the SAM Region.

12.2.16 The Modules are:

a) B0-05 - *Improved Flexibility and Efficiency in Descent Profiles (CDO)*;
b) B0-20 - *Improved Flexibility and Efficiency in Departure Profiles (CCO)*, and;
c) B0-40 - *Improved Safety and Efficiency through the initial application of Data Link En-Route*.

12.2.17 The cost impact for the selected modules is expected to be minimal and are anticipated to be borne predominantly by the air navigation service providers (ANSPs) on the basis that facilitating operator capabilities, such as performance-based navigation (PBN) and controller-pilot data link communications (CPDLC), are attributable to those programs rather than to CCO and CDO. Based on preliminary indications, the benefits of implementing these modules could be substantial for overall global system performance and, when implemented, the benefits are expected to far outweigh the costs.

12.3 Air Navigation Report Forms (ANRF)

12.3.1 This form provides a standardized approach to implementation monitoring and performance measurement of Aviation System Block Upgrades (ASBU) Modules. The Planning and Implementation Regional Groups (PIRGs) and States could use this report format for their planning, implementation and monitoring framework for ASBU Modules. Also, other reporting formats that provide more details may be used but should contain as a minimum the elements described below. The Reporting and monitoring results will be analysed by ICAO and aviation partners and then utilized in developing the Annual Global Air Navigation Report. The Global Air Navigation Report conclusions will serve as the basis for future policy adjustments aiding safety practicality, affordability and global harmonization, amongst other concerns. **Attachment E** presents the ANRF for each of the ASBU Block 0 modules taken under consideration in the SAM Region.

ATTACHMENT A

AIR TRAFFIC FORECASTS IN THE SAM REGION

TRAFFIC FLOW 1

- Buenos Aires – Santiago de Chile
- Buenos Aires – Sao Paulo/Rio de Janeiro
- Santiago de Chile – Sao Paulo/Rio de Janeiro
-

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Santiago(Intl) - Buenos Aires(Pistarini)	12185	39079	6.0
2	Sao Paulo(Intl) - Buenos Aires(Pistarini)	11843	37982	6.0
3	Rio De Janeiro(Intl) - Buenos Aires(Pistarini)	5484	33681	9.5
4	Santiago(Intl) - Rio de Janeiro	4979	25453	8.5
5	Santiago(Intl) - Sao Paulo	846	4741	9.0
	TOTAL	35337	140936	7.2

- Sao Paulo/Rio de Janeiro – Europe

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Sao Paulo-Paris	2921	8523	5.5
2	Sao Paulo-London	1665	5867	6.5
3	Rio De Janeiro-Paris	1559	6033	7.0
4	Sao Paulo-Madrid	1543	3721	4.5
5	Sao Paulo-Frankfurt	1521	3668	4.5
6	Sao Paulo-Milan	1284	4969	7.0
7	Rio De Janeiro-Madrid	1112	2213	3.5
8	Sao Paulo-Lisbon	992	2894	5.5
9	Rio De Janeiro-Lisbon	943	3323	6.5
10	Sao Paulo-Johannesburg	878	3094	6.5
11	Santiago-Rio De Janeiro	846	4741	9.0
12	Sao Paulo-Amsterdam	730	1761	4.5
13	Sao Paulo-Munich	726	2118	5.5
14	Zurich-Sao Paulo	676	1221	3.0
15	Rio De Janeiro-Porto	304	593	3.4
16	Sao Paulo-Porto	302	589	3.4
17	Rio De Janeiro-Frankfurt	190	371	3.4
18	Rio De Janeiro-Milan	16	31	3.4
19	Sao Paulo-Rome	2	4	3.4
	Total	18210	55734	5.8

TRAFFIC FLOW 2

- Sao Paulo/Rio de Janeiro – Miami
- Sao Paulo/Rio de Janeiro – New York

Rank	City Pair	Total Aircraft Movement 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Rio de Janeiro-Miami	1082	1954	3.0
2	Sao Paulo- new York (Newark)	362	979	5.1
3	Sao Paulo-Miami	3482	6289	3.0
3	Sao Paulo-New York(JFK)	3233	5839	3.0
5	Sao Paulo-new York(Newark)	362	979	5.1
	Total	8521	16040	3.2

TRAFFIC FLOW 3

- Sao Paulo/Rio de Janeiro — Lima
- Sao Paulo/Rio de Janeiro — Los Angeles

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Sao Paulo-Lima	2596	15944	9.5
2	Sao Paulo-Los Angeles	182	492	5.1
	Total	2778	16436	9.3

TRAFFIC FLOW 4

- Santiago — Lima — Miami
- Buenos Aires — New York
- Buenos Aires — Miami

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Buenos Aires - New York	835	2258	5.1
2	Buenos Aires - Miami	2652	7172	5.1
3	Santiago - Lima	4208	21511	8.5
4	Lima - Miami	2220	6004	5.1
5	Santiago - Miami	1781	4816	5.1
	Total	11696	41761	6.6

TRAFFIC FLOW 5

- North of South America – Europe

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth (Per cent) 2007-2027
1	Madrid - Bogota	1830	7774	7.5
2	Madrid - Caracas	1639	6342	7.0
3	Madrid - Lima	1323	3934	5.6
4	Madrid - Guayaquil	1099	3268	5.6
5	Paramaribo - Amsterdam	754	2242	5.6
6	Paris - Bogota	730	1318	3.0
7	Paris - Caracas	724	2322	6.0
8	Paris (Orly) - Cayenne	719	2782	7.0
9	Frankfurt - Caracas	676	2872	7.5
10	Milan - Caracas	520	1230	4.4
11	Quito - Madrid	519	1228	4.4
12	Lima - Amsterdam	493	1166	4.4
13	Lisbon - Caracas	434	1027	4.4
14	Santa Cruz - Madrid	433	1024	4.4
15	Funchal - Caracas	242	573	4.4
16	Madrid - Cali	227	537	4.4
17	Rome - Caracas	210	497	4.4
18	Porlamar - Frankfurt	209	494	4.4
19	Bogota - Barcelona	157	371	4.4
20	Tenerife - Caracas	110	260	4.4
21	Porto - Caracas	104	246	4.4
22	Porlamar - London	94	222	4.4
23	Bogota - Alicante	52	123	4.4
24	Porlamar - Manchester	48	114	4.4
25	Porlamar - Amsterdam	47	111	4.4
	Total above routes	13393	42079	5.9
	All other routes	58	137	4.4
	TOTAL	13451	42216	5.9

TRAFFIC FLOW 6

Santiago — Lima — Los Angeles

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Santiago - Lima	4208	21511	8.5
2	Los Angeles - Lima	1155	3123	5.1
3	Santiago - Los Angeles	304	822	5.1
	Total	5667	25457	7.8

TRAFFIC FLOW 7

- South America — South Africa

Rank	City Pair	Total Aircraft Movements 2007[2/]	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Sao Paulo - Johannesburg	878	3094	6.5
2	Buenos Aires - Cape Town	208	406	3.4
	Total	1086	3500	6.0

- Santiago de Chile — Easter Island — Papeete (PAC)

Rank	City Pair	Total Aircraft Movements 2007	Total Aircraft Movements 2027	Average Annual Growth(Per cent) 2007-2027
1	Santiago - Easter Island	499	1456	5.5
2	Easter Island - Papeete	209	504	4.5
	Total	708	1960	5.2

Tabla 1a: Sudamérica – Movimiento de Pasajeros

	Year	Passengers (Million)	Load Factor	Average Seats
Historical	1997	4.3	64.7	170
	2003	7.11	60.9	160
	2004	8.03	64.6	160
	2005	9.78	73.5	168
	2006	10.81	70.9	167
	2007	13.55	74.1	164
Forecast	2012	22.74	74.1	168
	2017	35.5	77	172
	2027	73.65	80	180
Average Annual Growth (Per cent)	1997-2007	12.2	1.4	-0.4
	2007-2012	10.9	0	0.5
	2012-2017	9.3	0.8	0.5
	2007-2027	8.8	0.4	0.5

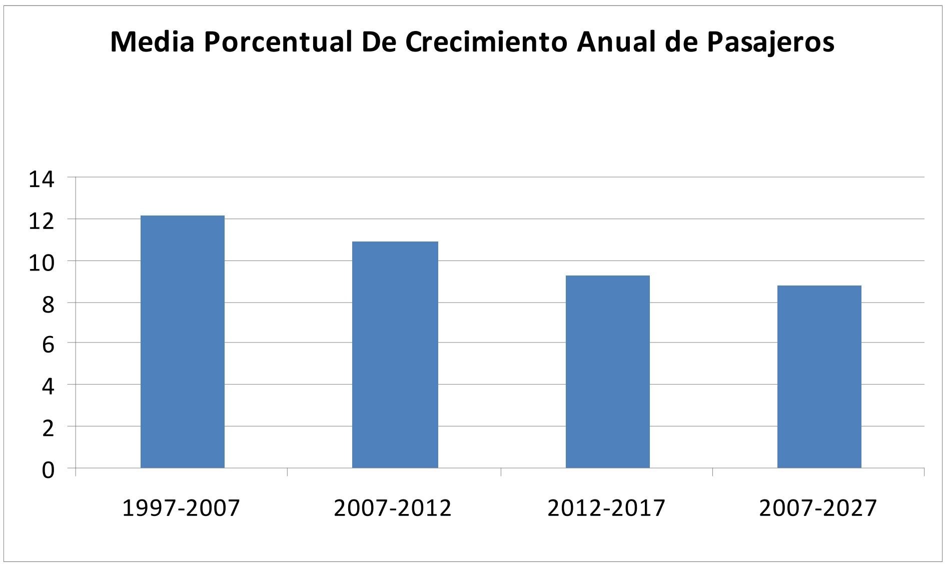
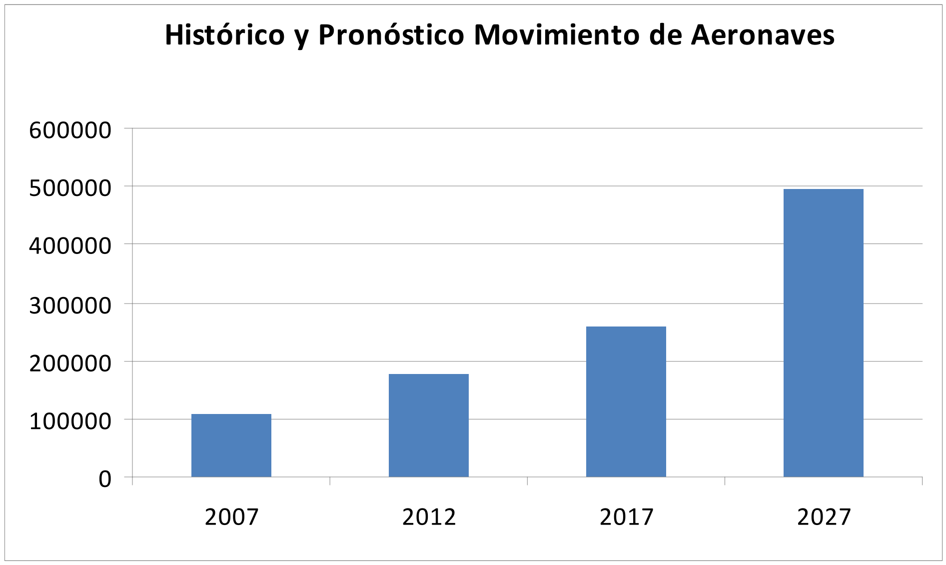


Tabla 1b: Sudamérica – Movimiento de Aeronaves

	Year	**Aircraft Movements**
Historic	2007	108523
Forecast	2012	177515
	2017	260507
	2027	497008
Average Annual Growth (Per cent)	2007-2012	10.3
	2012-2017	8
	2007-2027	7.9


Histórico y Pronóstico Movimiento de Aeronaves
600000
500000
400000
300000
200000
100000
0
2007
2012
2017
2027

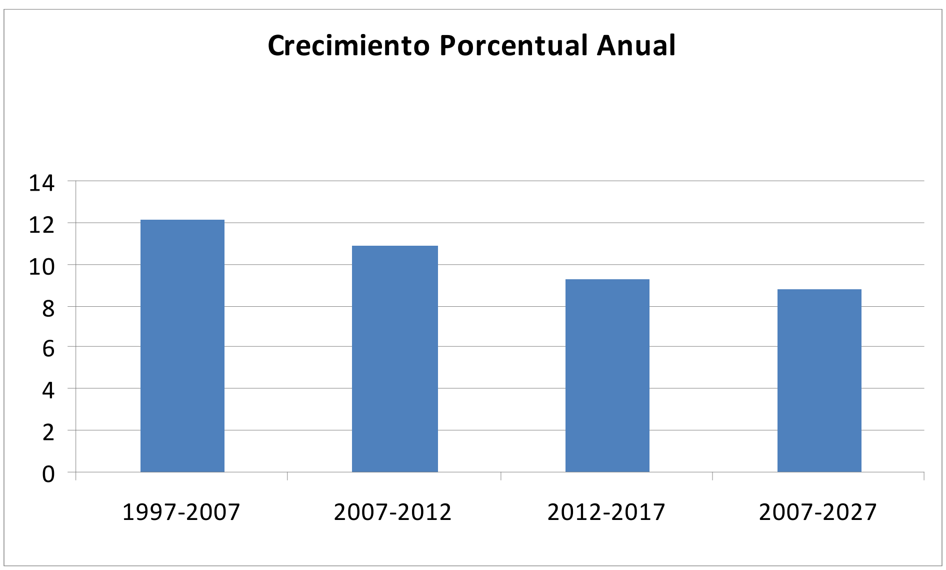
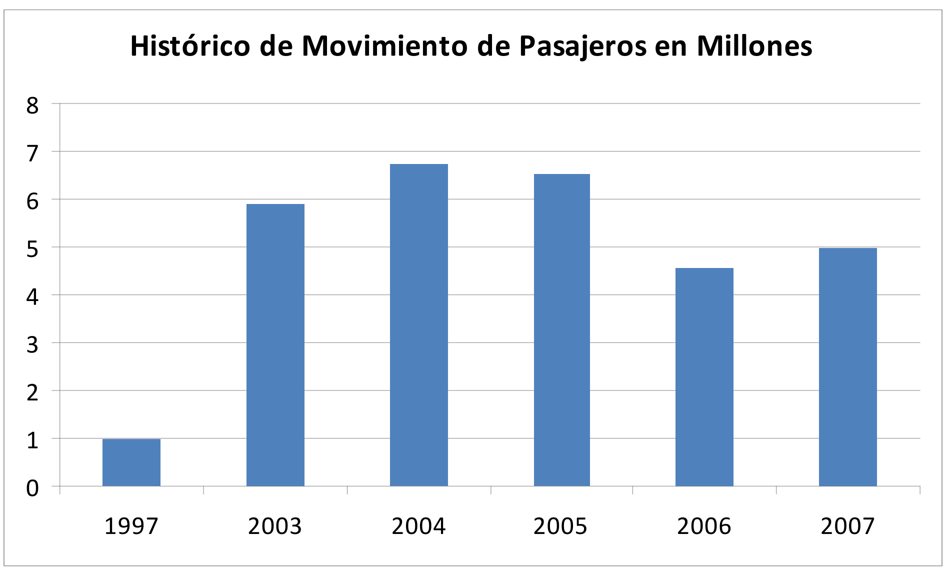

Crecimiento Porcentual Anual
14
12
10
8
6
4
2
0
1997-2007
2007-2012
2012-2017
2007-2027

Tabla 2a: Sudamérica – Centro América – Movimiento de Pasajeros

	Year	Passengers (Million)	Load Factor	Average Seats
Historical	1997	1.02	54	165
	2003	5.93	4.1	162
	2004	6.77	4.81	161
	2005	6.56	4.59	157
	2006	4.59	70	157
	2007	4.98	72.4	156
Forecast	2012	7.93	72.4	157
	2017	11.91	74.8	158
	2027	27.32	80	160
Average Annual Growth (Per cent)	1997-2007	17.2	3	-0.5
	2007-2012	9.7	0	0.1
	2012-2017	8.5	0.7	0.1
	2007-2027	8.9	0.5	0.1



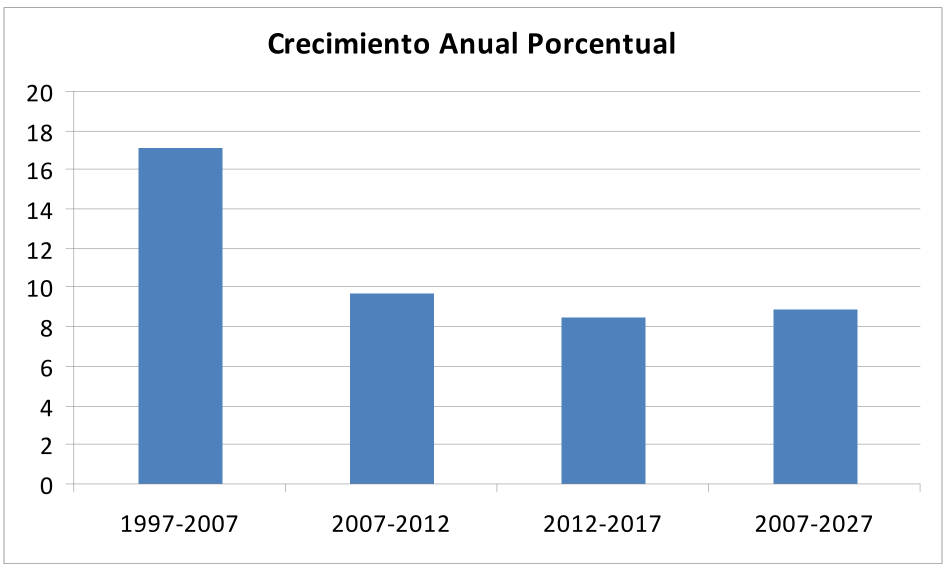
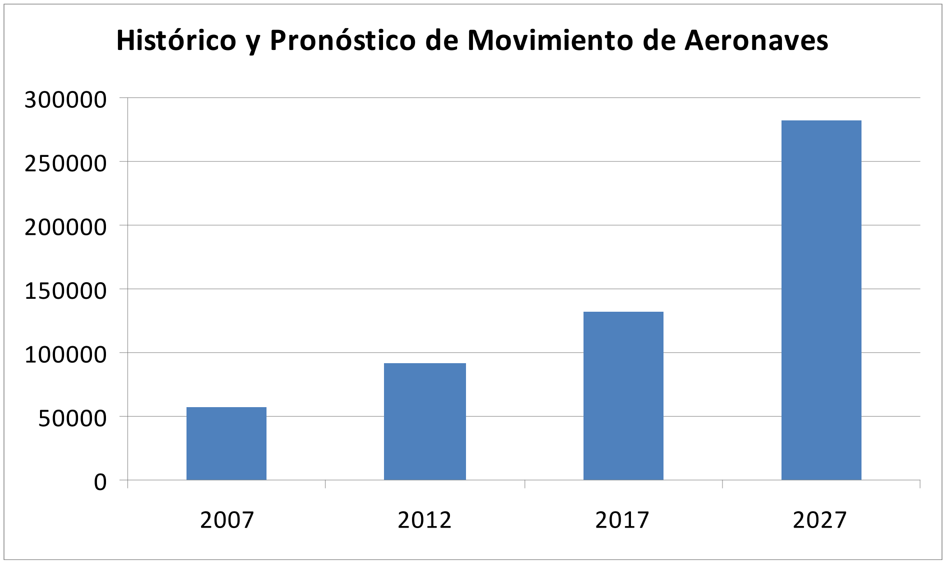


Tabla 2b: Sudamérica – Centro América -Movimiento de Aeronaves

	Year	**Aircraft Movements**
Historic	2007	58378
Forecast	2012	92446
	2017	133450
	2027	282354
Average Annual Growth (per cent)	2007-2012	9.6
	2012-2017	7.6
	2007-2027	8.2


Histórico y Pronóstico de Movimiento de Aeronaves
300000
250000
200000
150000
100000
50000
0
2007
2012
2017
2027

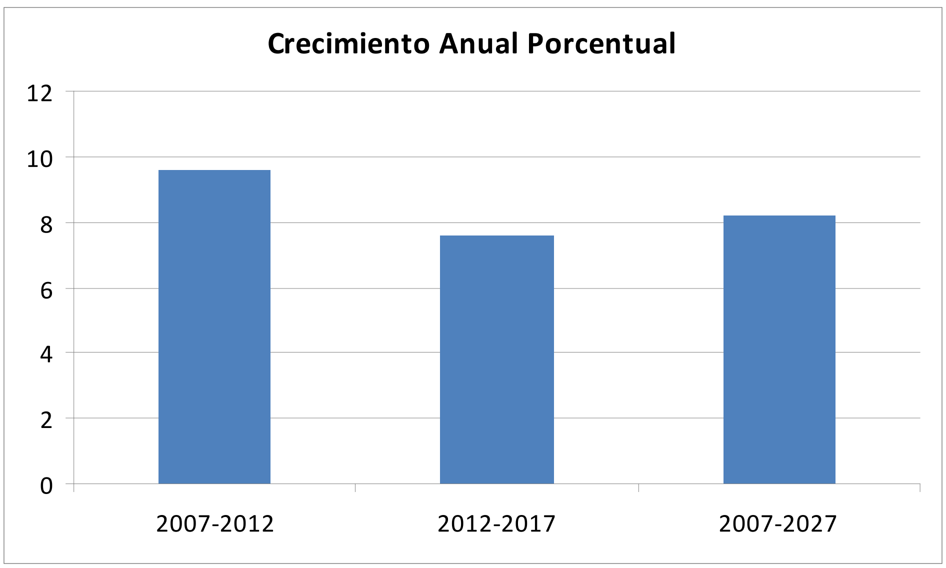
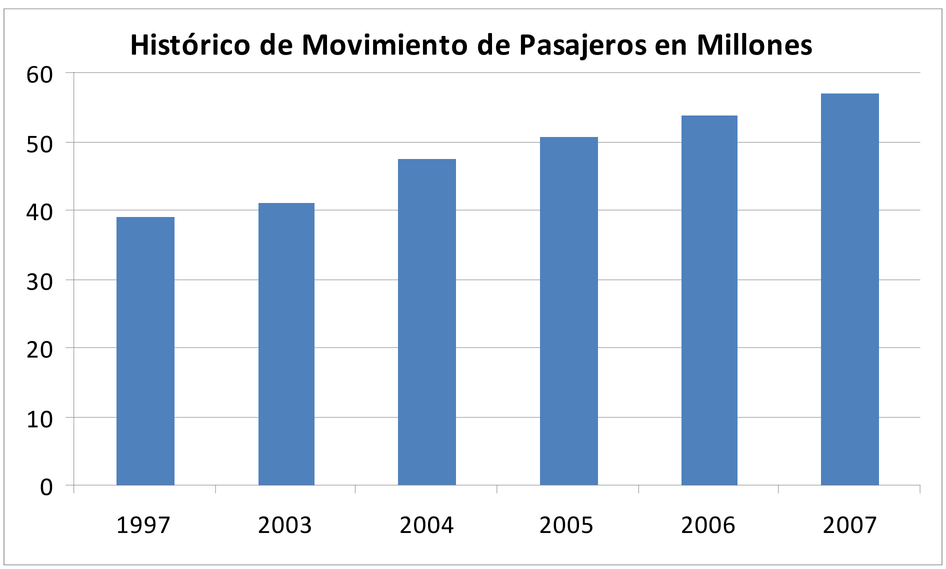
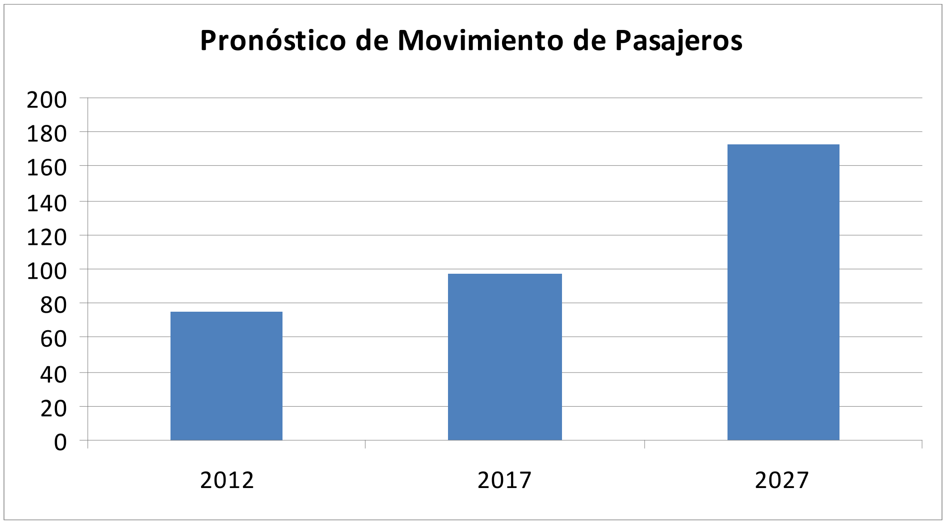

Crecimiento Anual Porcentual
12
10
8
6
4
2
0
2007-2012
2012-2017
2007-2027

Tabla 3a: Sudamérica – Norteamérica Movimiento de Pasajeros

	Year	Passengers (Million)	Load Factor	Average Seats
Historical	1997	39.2	62	189
	2003	41.23	68	168
	2004	47.42	70	166
	2005	50.83	73	166
	2006	53.88	74.4	166
	2007	56.96	76.6	166
Forecast	2012	75.66	76.6	165
	2017	97.58	79.3	167
	2027	172.97	85	170
Average Annual Growth (Per cent)	1997-2007	3.8	2.1	-1.3
	2007-2012	5.8	0	-0.1
	2012-2017	5.2	0.7	0.2
	2007-2027	5.7	0.5	0.1




Pronóstico de Movimiento de Pasajeros
200
180
160
140
120
100
80
60
40
20
0
2012
2017
2027

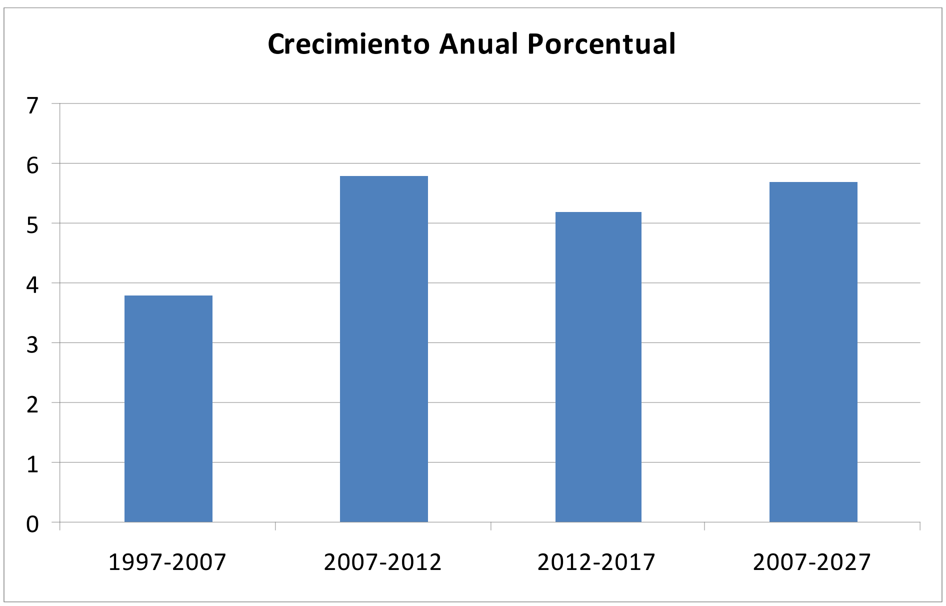
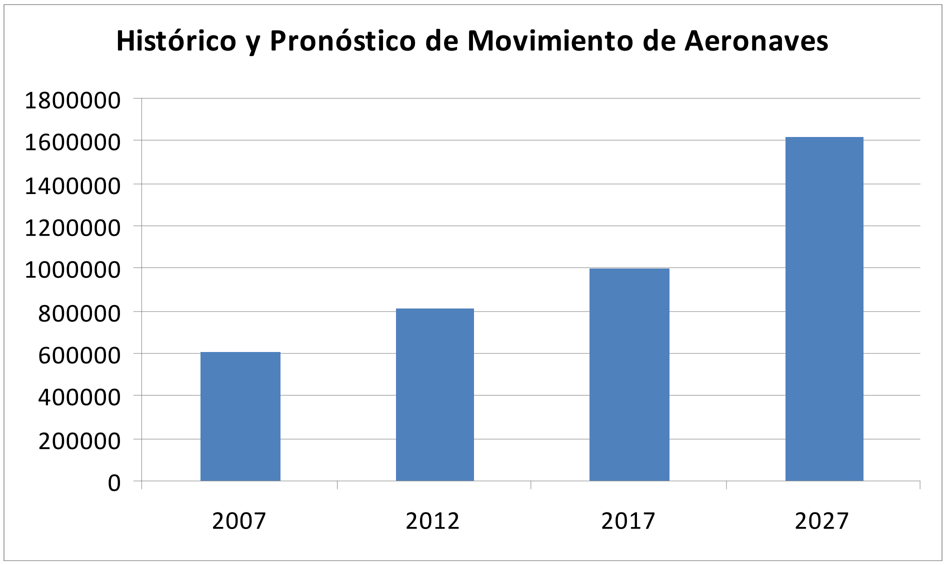

Crecimiento Anual Porcentual
7
6
5
4
3
2
1
0
1997-2007
2007-2012
2012-2017
2007-2027

Tabla 3b: Sudamérica – Norteamérica Movimiento de Aeronaves



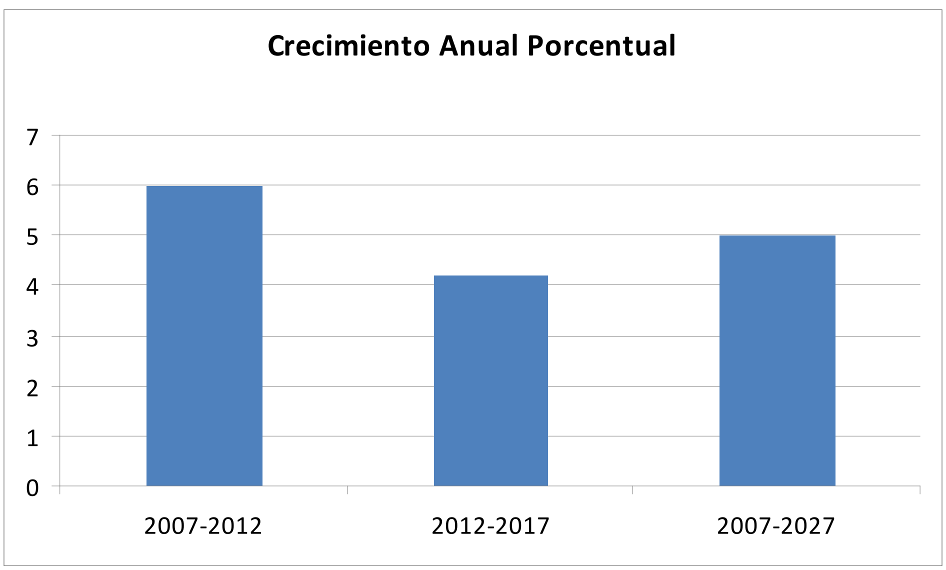
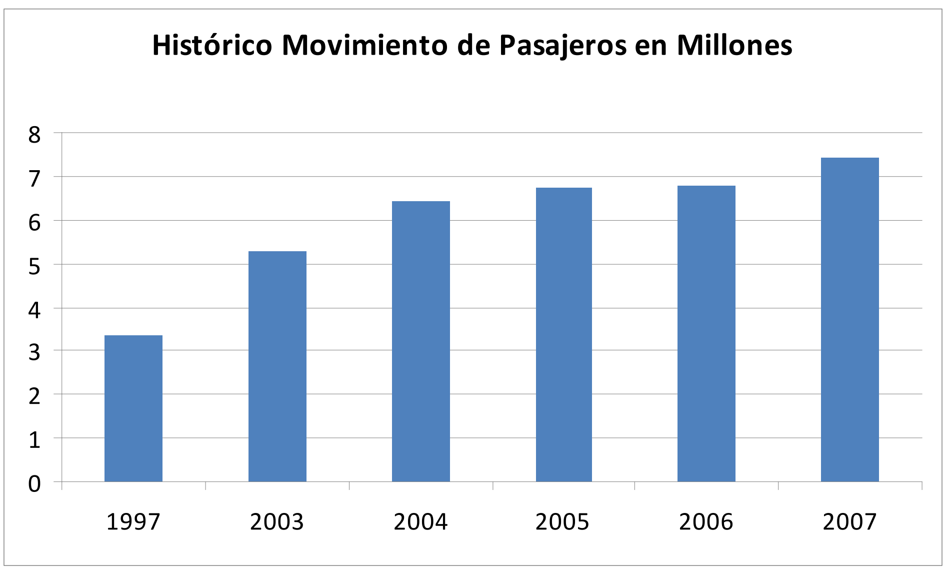
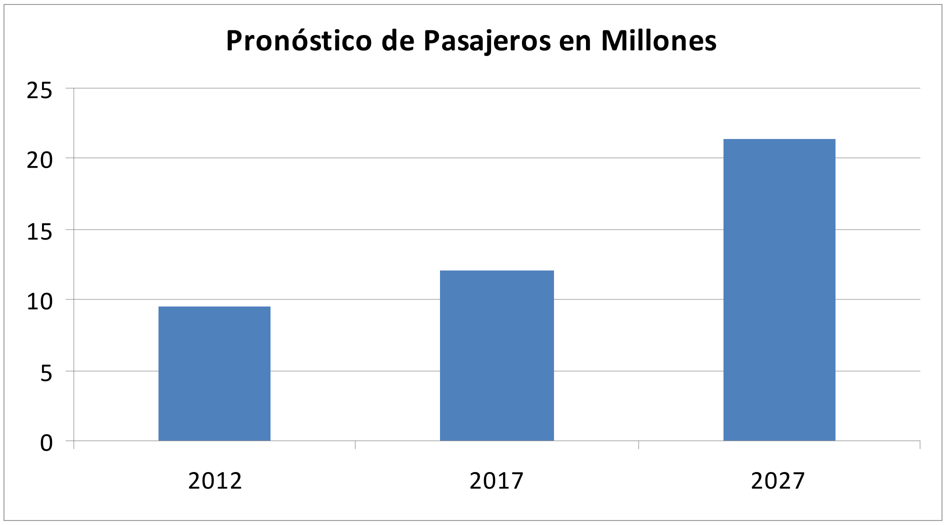


Tabla 4a: Atlántico Sur Corredor Europeo Sudamérica – Pasajeros

	Year	Passengers (Million)	Load Factor	Average Seats
Historical	1997	3.4	74.4	287
	2003	5.3	77	309
	2004	6.43	76	339
	2005	6.77	79.6	325
	2006	6.79	84.3	286
	2007	7.46	83.7	281
Forecast	2012	9.6	83.7	281
	2017	12.12	85	281
	2027	21.48	85	280
Average Annual Growth (Per cent)	1997-2007	8.2	1.2	0.3
	2007-2012	5.2	0	-0.6
	2012-2017	4.8	0.3	0
	2007-2027	5.4	0.1	-0.2





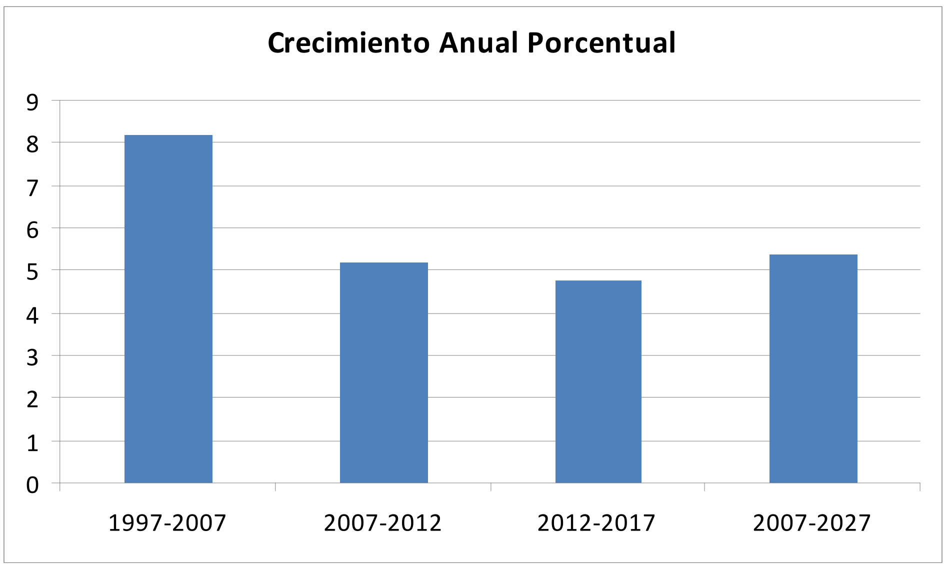
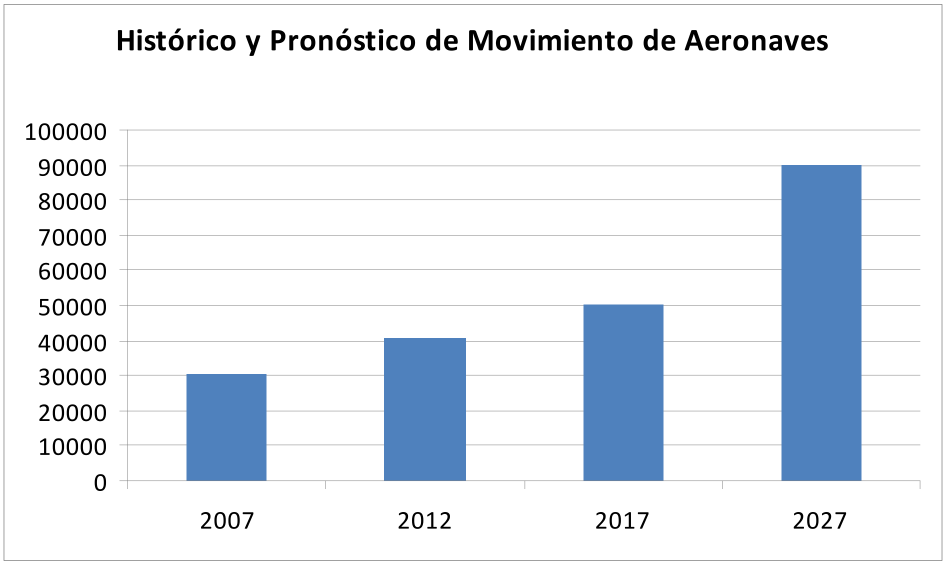
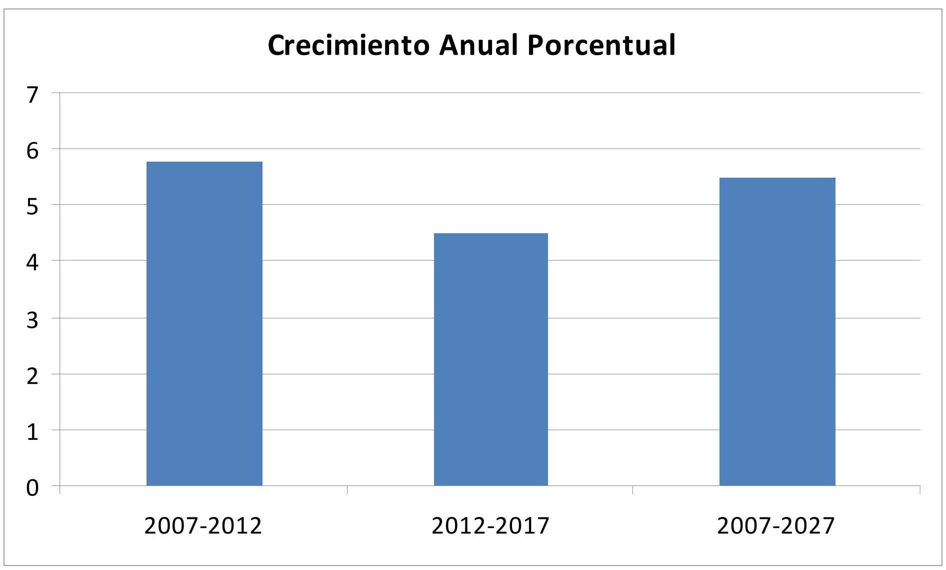


Tabla 4b: Atlántico Sur Corredor Europeo Sudamérica -Aeronaves

	Year	**Aircraft Movements**
Historic	2007	30749
Forecast	2012	40805
	2017	50732
	2027	90252
Average Annual Growth (Per cent)	2007-2012	5.8
	2012-2017	4.5
	2007-2027	5.5


Histórico y Pronóstico de Movimiento de Aeronaves
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2007
2012
2017
2027


Crecimiento Anual Porcentual
7
6
5
4
3
2
1
0
2007-2012
2012-2017
2007-2027

ATTACHMENT B

GLOBAL PLAN INITIATIVES AND THEIR RELATIONSHIP WITH THE MAIN GROUPS

GPI		En-route	Terminal Area	Aerodrome	Ancillary Infrastructure	Associated component of the Operational Concept
GPI-1	Flexible use of airspace	X	X			AOM, AUO
GPI-2	Reduced vertical separation minima	X				AOM, CM
GPI-3	Harmonisation 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-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 and 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 and alerting systems	X	X	X	X	DCB, TS, CM, AUO

GPI		En-route	Terminal Area	Aerodrome	Ancillary Infrastructure	Associated component of the Operational Concept
GPI-17	Implementation of data Relationship applications	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

ATTACHMENT C

PERFORMANCE FRAMEWORK FORM (PFF)

1. This outcome and management form is applicable to both regional and national planning, and includes references to the Global Plan. Other formats may be appropriate, but they must contain, at least, the elements described below.

1.1 **Performance objective:** Regional/national performance objectives should be defined, using the performance-based approach that best reflects the activities required to support ATM systems at regional/national level. Along their life cycle, performance objectives may change, depending on the evolution of the ATM system; therefore, during the implementation process, they should be coordinated with all the stakeholders in the ATM community and be at their disposal. The establishment of joint decision-making processes ensures that all stakeholders are involved and agree on the requirements, tasks and timetables.

1.2 **Regional performance objectives:** Regional performance objectives are the improvements required by the air navigation system to support global performance objectives, and are related to the operational environments and the priorities applicable at regional level.

1.3 **National performance objectives:** National performance objectives are the improvements required by the air navigation system in support of regional performance objectives, and are related to the operational environments and priorities applicable at State level.

1.4 **Benefits:** Regional/national performance objectives should meet the expectations of the ATM community, as described in the operational concept; they should generate benefits for the parties involved; and should be attained through operational activities and techniques aligned with each performance objective.

1.5 **Metrics:** Metrics permit to measure the objectives achieved. The monitoring and measurement of the performance of ATM systems may require metrics in areas such as access, capacity, cost-effectiveness, efficiency, environment, flexibility, prediction capacity, and safety.

1.6 **Strategy:** ATM evolution requires a clearly-defined gradual strategy that includes the tasks and activities that best represent the national and regional planning processes, in keeping with the global planning framework. The goal is to achieve a harmonised implementation process that evolves towards a global and seamless ATM system. Accordingly, it is necessary to develop short- and medium-term work programmes focused on system improvements that reflect a clear work commitment of the parties involved.

1.7 **Components of the ATM operational concept:** Each strategy or set of tasks should be associated to components of the ATM operational concept. The designators of the ATM components are as follows:

- AOM – Airspace organisation and management
- DCB – Demand/capacity balancing
- AO – Aerodrome operations

- TS – Traffic synchronisation
- CM – Conflict management
- AUO – Airspace user operations
- ATM SDM – ATM service delivery management

1.8 **Tasks:** The regional/national work programmes, based on these PFF templates, should define the tasks required to attain said performance objective while maintaining a direct relationship with the components of the ATM system. The following principles should be taken into account when developing a work programme:

- Work should be organised using project management techniques and performance-based objectives, in line with ICAO strategic objectives.
- All tasks related to the compliance with the performance objectives should be carried out based on strategies, concepts, action plans and roadmaps that may be shared amongst the parties, with the main objective of attaining transparency through interoperability and harmonisation.
- Task planning should include the optimisation of human resources, as well as the promotion of the dynamic use of electronic communication amongst the parties (for example, Internet, video-conferences, tele-conferences, e-mail, telephone and fax). Likewise, resources should be used efficiently, avoiding duplication of work or unnecessary tasks.
- The process and work methods should ensure the possibility of measuring the performance objectives, comparing them with timetables, and easy reporting of the progress made at national and regional level to the PIRGs and ICAO Headquarters, respectively.

1.9 **Period:** Indicates the start and end of that task in particular.

1.10 **Responsibility:** Indicates the organisation/entity/individual responsible for the fulfilment or management of the associated tasks.

1.11 **Status:** The status basically monitors progress in the fulfilment of said task as it proceeds to the date of completion. For the classification of the status of implementation, the words VALID, COMPLETED, REPLACED and CONTINUOUS will be used.

1.12 **Link with the global plan initiatives (GPIs)*:*** The 23 GPIs, as described in the Global Plan, provide a global strategic framework for the planning of air navigation systems, and are designed to contribute to the achievement of regional/national performance objectives. Each performance objective should be related with the corresponding GPIs. The goal is to make sure that the evolutionary work process at State and regional level is integrated within the global planning framework.

2. The PFFs prepared for the performance objectives concerning ATM, CNS, MET, SAR, AIS, AGA/AOP, personnel competence management and SMS are presented below. In addition, a matrix with the inter-relationship amongst the PFFs in included.

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM ATM/01</u>
OPTIMISATION OF THE EN-ROUTE AIRSPACE STRUCTURE</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Reduces the complexity of the airspace structure, by reinforcing safety</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Reduces fuel consumption and, consequently, CO^2 emissions into the atmosphere, due to reduction of miles flown and to continuous descent and ascent operations
• Increases airspace capacity.
• Takes advantage of aircraft RNAV capacity</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Reduction of air traffic incidents each 100,00 operations per year
• Increase ATC sector capacity
• Reduction of CO^2 emissions each 100,00 operations per year</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><th>ATM OC COMPONENTS</th><th>TASKS</th><th>PERIOD</th><th>RESPONSIBILITY</th><th>STATUS</th></tr>
<tr><td></td><td>a) Carry out implementation and assessment of Version 02 of the SAM ATS route network, and the implementation of RNAV 5 exclusionary space.</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td></td><td>b) Optimise oceanic routes and complete implementation of RNAV10 (RNP10) routes.</td><td>(*) - 2012</td><td>States</td><td>Valid</td></tr>
<tr><td></td><td>c) Review and update the SAM PBN Roadmap and the ATS route network optimisation programme.</td><td>2012 - 2013</td><td>Regional Project
States</td><td>Valid</td></tr>
<tr><td></td><td>d) Assess the status of implementation of the en-route PBN action plan.</td><td>2012</td><td>States</td><td>Valid</td></tr>
<tr><td></td><td>e) Implement a regional tool for RAI availability forecast in order to support en-route, TMA and non-precision approach operations.</td><td>2012 - 2015</td><td>States</td><td>Valid</td></tr>
<tr><td></td><td>f) Prepare Version 03 of the ATS route network, including RNP4 application for oceanic routes and RNP2 in continental airspace.</td><td>2015</td><td>Regional Project
States</td><td>Valid</td></tr>
<tr><td></td><td>g) Implement random routes in defined continental airspaces.</td><td>2018+</td><td>States</td><td>Valid</td></tr>
<tr><td></td><td>h) Monitor implementation progress.</td><td>(*) - 2018 +</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/5: performance-based navigation, GPI/7: management of dynamic and flexible ATS routes, GPI/8: collaborative airspace design and management.</td></tr>
</table>

(*) Indicates that the task has started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: SAM ATM/02 **TMA AIRSPACE STRUCTURE OPTIMISATION**	
Benefits	
Safety	• Implementation of continuous descent (CDO) operations • Increased safety during landing and reduced CFIT incidence • Reduction of airspace complexity, by reinforcing safety
Environmental protection and sustainable development of air transport	• Reduces fuel consumption and, consequently, CO^2 emissions into the atmosphere, due to reduction of miles flown and continuous descent and ascent operations; • Reduces aeronautical noise, through continuous descent operations (CDO); • Increases airspace capacity, since it permits the establishment of separate arrival/departure flows, and even the segregation of IFR from VFR flights; • Takes advantage of aircraft RNAV capacity; • Airport arrival/departure under any meteorological condition.
Metrics	
• Percentage of international aerodromes with SIDs/STARs, RNAV and/or RNP implemented, when required. • Percentage of aerodromes that have implemented continuous descent and ascent operations. • Reduction of air traffic incidents each 100,00 operations per year • Reduction of tons of CO^2 emissions each 100,00 operations per year • Reduction of aeronautical noise.	
2012 - 2018 ***Strategy***	

ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM **AUO** **CM**	a) Assess the progress made in the terminal area PBN action plan.	2012	States	Valid
	b) Implement standard RNAV 1 arrival/departure routes in selected TMAs with ATS surveillance.	(*) - 2013	States	Valid
	c) Implement RNAV 1 and/or RNP 1 standard arrival/departure routes in all the TMAs of international airports.	2012 – 2016	States	Valid
	d) Implement CDO operations in all the TMAs of international airports.	2013 - 2018	States	Valid
	e) Implement RNAV1/RNP1 exclusionary airspace in high-density TMAs.	2015 – 2018 +	States	Valid
	f) Monitor progress during implementation.	(*) - 2018	GREPECAS	Valid
Relation-ship with GPIs	GPI/1: Flexible use of airspace, GPI/5: performance-based navigation, GPI/7: management of dynamic and flexible ATS routes, GPI/8: collaborative airspace design and management, GPI/10: terminal area design and management, GPI/11: RNP and RNAV SIDs and STARs, and GPI/12: functional integration of ground and airborne systems.			

(*) Indicates that the task has been started before the period contemplated in this planning.

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM ATM/03</u>
IMPLEMENTATION OF RNP APPROACHES</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Increases safety during landing, reducing the incidence of CFIT
• Permits the establishment of safe approach procedures at airports with limitations due to rough terrain.</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Reduces miles flown and/or permits optimum descent flights, decreasing fuel consumption, and thus CO^2 emissions into the atmosphere;
• Takes advantage of aircraft capacity for flying optimum paths;
• Improved airport operational minima.</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Percentage of RNP APCH procedures that have been implemented, including APV Baro VNAV and LNAV implemented only at runway ends with instrument operations, according to the 37^{th} Assembly Resolution 37/11.</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><th>ATM OC COMPONENTS</th><th>TASKS</th><th>PERIOD</th><th>RESPONSIBILITY</th><th>STATUS</th></tr>
<tr><td rowspan="4">AOM
AUO
AO
CM</td><td>a) Assess progress of PBN action plan on approach procedures.</td><td>2012</td><td>SAMIG</td><td>Valid</td></tr>
<tr><td>b) Implement RNP APCH procedures (or RNP AR APCH when operationally advantageous), including APV BARO VNAV, and LNAV only, in conformity with ICAO Assembly Resolution A37/11.</td><td>(*) – 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>c) Start-up of the implementation of GLS procedures (GBAS) CAT I landing at selected airports.</td><td>2015 – 2018 +</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Monitor the progress made during implementation.</td><td>(*) - 2018+</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/1: Flexible use of airspace, GPI/5: performance-based navigation, GPI/8: collaborative airspace design and management, GPI/12: functional integration of ground and airborne systems and GPI/14; runway operations.</td></tr>
</table>

(*) Indicates that the task has been started before the period contemplated in this planning.

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM ATM/04</u>
FLEXIBLE USE OF AIRSPACE</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Improvement of coordination and civil/military cooperation strengthens airspace safety.</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Permits a more efficient ATS route structure, by reducing miles flown, fuel consumption and, consequently, CO^2 emissions into the atmosphere.
• Increases airspace capacity.
• Greater availability of reserved airspace aviation at times when there is no activity from those airspace users</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Percentage of committees or similar civil/military coordination bodies implemented
• Number of civil/military coordination and cooperation agreements implemented
• Permanent reduction of reserved airspaces</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="7">AOM
AUO
CM</td><td>a) Develop guidance material on civil/military coordination and cooperation, for the definition of policies, procedures and national standards;</td><td>(*) - 2012</td><td>Regional Project
States</td><td>Valid</td></tr>
<tr><td>b) Carry out an assessment of the amount and extension of reserved airspaces</td><td>(*) - 2012</td><td>States</td><td>Valid</td></tr>
<tr><td>c) Establish committees or similar civil/military coordination bodies;</td><td>(*) - 2012</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Make arrangements to have a permanent relationship and close cooperation between ATS civil units and the appropriate military units, as well as other reserved airspace users;</td><td>(*) - 2012</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Establish procedures for coordination of temporary reservation of airspace (TRA) through issuance of NOTAMs or specific real time reserved airspace activation procedures, when so required for ANSPs.</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>f) Develop a regional strategy and work programme for the implementation of the flexible use of airspace, through a phased approach, starting with a more dynamic sharing of reserved airspace, taking UAS into consideration.</td><td>2012 - 2018</td><td>Regional Project
States</td><td>Valid</td></tr>
<tr><td>g) Monitor progress during implementation.</td><td>(*) - 2013</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/1: Flexible use of airspace; GPI/18: Aeronautical information.</td></tr>
</table>

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REGIONAL PERFORMANCE OBJECTIVE: SAM ATM/05 **ATFM IMPLEMENTATION**				
Benefits				
Safety	• Avoids ATC and airport system overload, by reinforcing safety			
Environmental protection and sustainable development of air transport	• Less delays caused by meteorological and traffic conditions, leading to a reduced consumption of fuel and emission of pollutants • Improved prediction • Improved management of the demand that exceeds service in ATC sectors and aerodromes			
Metrics				
• Percentage of flights delayed due to measures implemented by ATC				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
DCB **AO** **AOM** **CM**	a) Assess the progress made in the ATFM implementation work programme	2012	States	Valid
	b) Assess meteorological information requirements for ATFM implementation purposes.	2012	States	Valid
	c) Develop a regional method for establishing demand/capacity forecasts	(*) - 2013	States	Valid
	d) Develop and implement regional procedures for an efficient and optimum use of aerodrome and runway capacity	(*) - 2014	States	Valid
	e) Develop and implement methods for improving efficiency, as required, through airspace management.	(*) - 2015	States	Valid
	f) Develop and implement operational coordination procedures between States ATFM units;	2012 – 2018+	States	Valid
	g) Monitor progress during implementation.	(*) – 2018+	GREPECAS	Valid
Relation-ship with GPIs	GPI/1: Flexible use of airspace; GPI/6: air traffic flow management; GPI/7: dynamic and flexible management of ATS routes; GPI/9: situational awareness; GPI/13 aerodrome design and management; GPI/14: runway operations; and GPI/16: decision support and alerting systems.			

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<table>
<tr><th colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM ATM/06</u>
IMPROVE ATM SITUATIONAL AWARENESS</th></tr>
<tr><th colspan="5">Benefits</th></tr>
<tr><td>Safety</td><td colspan="4">• The availability of terrain and obstacle electronic date in the pilot post permits a reduces number of CFIT accidents
• Improved situational awareness provides data that facilitate operational decision-making, enhancing safety.</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Improved air traffic demand provides a reduction in aircraft separation, enabling a best air traffic flow management and ATC capacity.
• Contributes to collaboration between the flight crew and the ATM system
• Contributes to collaborative decision-making (CDM) through the sharing of aeronautical data
• Reduced workload for pilots and controllers</td></tr>
<tr><th colspan="5">Metrics</th></tr>
<tr><td colspan="5">• Reduction of CFIT accidents
• Reduction of operational errors including LHDs</td></tr>
<tr><th colspan="5">2012 - 2018
Strategy</th></tr>
<tr><th>ATM OC COMPONENTS</th><th>TASKS</th><th>PERIOD</th><th>RESPONSIBILITY</th><th>STATUS</th></tr>
<tr><td rowspan="6">ATM-SDM
AO
CM</td><td>a) Develop an action plan for improving situational awareness of pilots and controllers.</td><td>(*) - 2012</td><td>Regional Project</td><td>Valid</td></tr>
<tr><td>b) Implement flight plan data processing systems (new FPL format) and data communication tools between ACCs.</td><td>(*) – 2014</td><td>States</td><td>Valid</td></tr>
<tr><td>c) Implement ATS surveillance technologies and their applications as required.</td><td>2012 – 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Implement air-ground communication systems through Data link (ADS-C/CPDLC in oceanic airspaces ADS-B, D-ATIS, DCL, D-VOLMET, etc.</td><td>(*) – 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Implement advanced automation support tools to contribute to aeronautical information sharing.</td><td>2015 – 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>f) Monitor the implementation</td><td>(*) – 2018+</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/1: Flexible use of airspace; GPI/6: air traffic flow management; and GPI/7: dynamic and flexible ATS route management; GPI/9: situational awareness; GPI/13: aerodrome design and management; GPI/14: runway operations; y GPI/16: decision support and alerting systems; GPI/17: implementation of Data link applications; GPI/18: aeronautical information; GPI/19: meteorological systems, GPI/22: communication infrastructure.</td></tr>
</table>

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REGIONAL PERFORMANCE OBJECTIVE: SAM ATM/07 **FLIGHT PLAN IMPLEMENTATION**				
Benefits				
Safety	• Incorporation of additional information in FPL reinforces safety.			
Environmental protection and sustainable development of air transport	• Expanded airspace capacity; • Enhanced operational efficiency.			
Metrics				
• Percentage of States that have implemented the new FPL.				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
SDM **ATM**	a) Guides on the transition to the new format of the filed flight plan.	(*)	ICAO	Valid
	b) Develop a regional strategy for the transition to the new format of the filed flight plan.	(*)	ICAO	Valid
	c) Identification of stakeholders and possible impact of the implementation of the new format of the filed flight plan (FPL/RPL/CPL).	(*)	States	Valid
	d) Assessment of current/future flight plan processing capabilities with respect to the new flight plan format.	(*)	States	Valid
	e) Behaviour trials between systems capable of processing the NEW flight plan.	(*)	States	Valid
	f) Development of contingency procedures and determination of technical/operational considerations for the transition.	(*)	States	Valid
	g) Identification of the main parties involved in FP data flow and the definition of the transition steps based on: - Systems capable of processing both formats: current and NEW. - Systems to be modernised / implemented before 2012 and that will be capable of processing the new format of the filed flight plan.	(*)	States	Valid
	h) Publication of transition actions, trials and other publications for users and interested parties	(*)	GREPECAS	Valid
	i) Assess transition actions and make adjustments.	(*)	States	Valid
	j) Implement the transition plan.	(*)	States	Valid
	k) Monitor transition activities.	(*)	ICAO	Valid
Relation-ship with GPIs	GPI/4: alignment of upper airspace classifications; GPI/1: flexible use of airspace; GPI/6 air traffic flow management; GPI/7: dynamic and flexible ATS route management; GPI/9: situational awareness; GPI/13: aerodrome management and design; GPI/14: runway operations; GPI/16: decision support and alerting systems; GPI/17: implementation of Data link applications; GPI/18: aeronautical information; GPI/19: meteorological systems; GPI/21: navigation systems; GPI/22: communication infrastructure			

NOTE: This PFF is based on the format presented to the CNS/ATM/SG/1 in March 2010. This Subgroup is responsible for the development of tasks.
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<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM CNS/01</u>
IMPROVEMENTS TO THE AERONAUTICAL FIXED SERVICE IN THE SAM REGION</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Reduction of operational coordination errors between adjacent ACCs;
• Increased ATM situational awareness; and
• Reduced pilot and controller workload.</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Increased capacity and availability of aeronautical fixed service in support of ATS, MET, AIS and SAR applications; and
• Support to ATFM / CDM.</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of AMHS interconnection as per FASID Table 1Bb;
• Number of AIDC interconnections as per FASID Table 1Bb; and
• Percentage of phases completed for the implementation of the new regional network.</td></tr>
<tr><td colspan="5">2012 – 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="7">AOM
ATM-SDM
DCB
CM
AUO</td><td>a) Complete the implementation of AMHS systems in those States that do not have such systems yet</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>b) AMHS interconnection between adjacent States</td><td>(*) - 2014</td><td>States</td><td>Valid</td></tr>
<tr><td>c) Implement communication services for the centralised ATFM</td><td>2015 - 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Implement AIDC in the automated centres of the SAM Region</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Operational implementation of AIDC between adjacent ACCs</td><td>(*) - 2014</td><td>States</td><td>Valid</td></tr>
<tr><td>f) Implementation of new digital network (REDDIG II)</td><td>2012 -2015</td><td>States</td><td>Valid</td></tr>
<tr><td>g) Monitor implementation progress</td><td>2012-2017</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/6: ATFM, GPI/9: situational awareness, GPI/ 16: decision support and alerting systems, GPI/18: aeronautical information, GPI/17: data link applications, GPI/19: meteorological systems, GPI/22: communication infrastructure.</td></tr>
</table>

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REGIONAL PERFORMANCE OBJECTIVE: SAM CNS/02 IMPROVEMENTS TO THE AERONAUTICAL MOBILE SERVICES IN THE SAM REGION	
Benefits	
Safety	• Reduction of operational coordination errors between adjacent ACCs, making ATS coordination more efficient; and • Reduction of pilot and controller workload.
Environmental protection and sustainable development of air transport	• Assured coverage and quality of communications in ATS service; • Increased availability of communications for the ATS service; • Support to AIM/MET service; and • Assured radio frequency spectrum assigned to aviation for the communication service.
Metrics	
• Percentage of compliance with FASID Table 2-A; • Number of CPDLC systems implemented; • Number of DCL systems implemented; • Number of D-ATIS systems implemented, and • Number of VOLMET systems implemented.	

2012 - 2018
Strategy

ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM ATM-SDM DCB CM	a) Complete the implementation of the services required in Table CNS 2-A “Aeronautical Mobile Service - AMSS”	(*) - 2014	States	Valid
	b) Continental en-route: Complete coverage of VHF communications in the lower airspace, when operations so require	2012- 2015	States	Valid
	c) Implement oceanic area CPDLC, maintaining HF service as back-up	(*) - 2018	States	Valid
	d) Implement CPDLC in selected continental area	2012- 2018	States	Valid
	e) Terminal area: Implementation of different VHF channels for control tower and APP services at all airports where a single channel is used for APP and control tower services	(*) - 2015	States	Valid
	f) Implementation of DCL services at selected aerodromes	2016-2018	States	Valid
	g) Implementation of D-ATIS services at selected aerodromes.	2012-2017	States	Valid
	h) Implementation of VOLMET services (voice and data)	(*) - 2018	States	Valid
	i) Guarantee protection of the radio frequency spectrum used for current and foreseen communication services	(*) - 2018	States ICAO	Valid
	j) Monitor implementation progress	2012-2018	GREPECAS	Valid
Relation-ship with GPIs	GPI/6: ATFM, GPI/9: Situational awareness, GPI/17: Data link applications, GPI/19: Meteorological systems, GPI/22: Communication infrastructure, GPI 23: Aeronautical radio spectrum.			

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<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM CNS/03</u>
IMPROVEMENTS TO NAVIGATION SYSTEMS IN THE SAM REGION</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Support to aircraft spacing;
• Reduced pilot and controller workload; and
• Increased landing safety, avoiding CFIT</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Increased airspace capacity and structure;
• Increased integrity of the GNSS system;
• Support to PBN implementation; and
• Reduced costs.</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of deactivated NDBs in accordance with FASID Table 3-3; and
• Number of GBAS implemented at airports with sufficient operational demand.</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="6">AOM
ATM-SDM
TS
AUO</td><td>a) Continue with NDB phase-out</td><td>*- 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>b) Implement new DME systems in support of en route operations where the PBN plan so considers it</td><td>2012-2018</td><td>States
ICAO</td><td>Valid</td></tr>
<tr><td>c) Implement GBAS at airports with sufficient operational demand</td><td>2015-2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Modernisation of flight trial platforms for GNSS applications</td><td>2012-2017</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Guarantee the protection of the radio frequency spectrum used for current and future radio navigation services</td><td>(*)-2018</td><td>States
ICAO</td><td>Valid</td></tr>
<tr><td>f) Monitor implementation progress</td><td>2012-2018</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/5: RNAV and RNP; GPI/6: ATFM; GPI/7: dynamic and flexible ATS route management; GPI/10: terminal area design and management; GPI/11: RNP and RNAV SIDs and STARs; GPI/12: functional integration of ground and airborne systems; GPI/13: aerodrome design and management; GPI/14: runway operations; GPI/21: navigation systems; GPI 23: aeronautical radio spectrum.</td></tr>
</table>

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<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM CNS/04</u>
IMPROVEMENTS TO THE ATS SURVEILLANCE SERVICE IN THE SAM REGION</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Increased ATM situational awareness;
• Improved ATS coordination, reducing coordination errors between adjacent ACCs; and
• Reduction of pilot and controller workload.</td></tr>
<tr><td>Environmental protection and sustainable development of air transport</td><td colspan="4">• Facilitates ATS planning;
• Increased airspace capacity;
• Supports the implementation of PBN and random routes; and
• Optimisation of information sharing resources.</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of ADS-C systems implemented in oceanic FIRs;
• Number of adjacent ACCs with exchange of ATS surveillance data,
• Percentage of ensure airspace for upper levels with ADS-B coverage, and
• Number of A-SMGS systems implemented.</td></tr>
<tr><td colspan="5">2012 – 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="6">AOM
AO
TS
CM
ATM-SDM</td><td>a) implement ADS-B and/or MLAT systems in en-route areas</td><td>2012-2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>b) Implement surface movement guidance and control systems (A-SMGCS) at airports where previous study indicates its requirement</td><td>2013- 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>c) Implement the ADS-C service in all States with responsibility over an oceanic FIR</td><td>(*) - 2018</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Implement the exchange of ATS surveillance data between adjacent ACCs</td><td>(*) - 2018+</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Guarantee the protection of the radio frequency spectrum used for current and future radio navigation services</td><td>(*) - 2018</td><td>States
ICAO</td><td>Valid</td></tr>
<tr><td>f) Monitor implementation progress</td><td>2012-2018</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/5: RNAV and RNP; GPI/6: ATFM; GPI/9: situational awareness; GPI/10: terminal area design and management; GPI/11: RNP and RNAV SIDs and STARs with; GPI/12: functional integration of ground and on-board systems; GPI/13: aerodrome design and management; GPI/14: runway operations; GPI/17: data link applications, GPI/22: communication infrastructure, GPI 23: aeronautical radio spectrum.</td></tr>
</table>

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REGIONAL PERFORMANCE OBJECTIVE: SAM MET/01 **IMPLEMENTATION OF THE MET INFORMATION QUALITY MANAGEMENT SYSTEM**				
Benefits				
Safety	• Ensure the quality of meteorological data and products provided to all the users of the ATM community • Improve the trust of the user with respect to meteorological data used for flight planning and re-planning.			
Metrics				
• Number of international aerodromes with implemented QMS/MET. • Number of international aerodromes with certified QMS/MET.				
2012 – 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
	a) Ensure the implementation of the MET information quality management system QMS/MET)	(*) 2012-2015	Regional Project States	Valid
	b) Develop the LAR-MET	2013-2015	Regional Project States	Valid
	c) Certify and maintain the certification of the QMS/MET quality management system by an approved organisation in all AOP aerodromes.	(*) 2015	States	Valid
	d) Monitor the process of QMS/MET implementation	2012-2018	GREPECAS	Valid
Relationship with GPIs	GPI/18: Aeronautical information and GPI/19: Meteorological systems.			

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REGIONAL PERFORMANCE OBJECTIVE: <u>SAM MET/02</u> IMPROVEMENTS IN MET FACILITIES				
Benefits				
Safety	• Provide more reliable MET information to all the ATM community. • Assistance in decision-making for ATM. • Assurance of availability of MET information for the user • Contribute to situational awareness of aeronautical users for all weather operations (AWO).			
Metrics				
• Number of international aerodromes with operative AWOS. • Number of MWOs with the required equipment and systems. • Number of AOP aerodromes with updated summaries and climatological tables.				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
AOM **DCB** **AO** **AUO** **ATM-SDM** **CM**	a) Establish a regional plan for the automation of meteorological data at all AOP aerodromes. b) Establish a regional plan to strengthen Meteorological Watch Offices (MWOs) with the infrastructure required for the effective watch in the FIRs.	2012-2018	Regional Project States	Valid
	c) Establish programmes for periodic inspection and calibration of meteorological instruments of EMA(s)	2012-2014	States	Valid
	d) Develop and implement a programme for the update of the summaries and climatological tables of AOP aerodromes.	2012-2014	States	Valid
	e) Monitor the implementation of the different programmes	2012-2014	GREPECAS States	Valid
Relationship with GPIs	GPI/9: Situational awareness, GPI/14: Runway operations, GPI/18: Aeronautical information and GPI/19: Meteorological systems.			

REGIONAL PERFORMANCE OBJECTIVE: SAM MET/03
IMPROVEMENTS IN THE IMPLEMENTATION OF INTERNATIONAL AIRWAYS VOLCANO WATCH (IAVW), SURVILLANCE OF THE ACCIDENTAL RELEASE OF RADIOACTIVE MATERIAL AND THE ISSUANCE OF SIGMETs

Benefits

Safety	• Increased flight safety with the provision of information on volcanic ash and severe phenomena
Environmental protection and sustainable	• Support pre-flight planning, optimising air routes with respect to volcanic ash and the accidental release of radioactive material. • Support the planning of new air routes in a safe and sustainable manner.

Metrics

- Number of States with IAVW and their implemented evolutions.
- Number of States with contingency plan for volcanic ash and accidental release of radioactive material, approved.

2012 – 2018
Strategy

ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM **AO** **AUO** **ATMSDM** **DCB** **CM**	a) Develop a plan to ensure the implementation of improvements in the international airways volcano watch	(*) 2012	Regional Project	Valid
	b) Develop a Guide for IAVW implementation in the Region, based on ICAO Document 9766.	2012-2013	Regional Project States	Valid
	c) Update the letters of agreement between CAAs/MET/State vulcanologic bodies, describing the responsibilities of each institution (including VONA format)	(*) 2012	States	Valid
	d) Where applicable, develop written agreements with national meteorological services (NMS) in case of accidental release of radioactive material.	(*) 2012	States	Valid
	e) Update the letters of operational agreement between ATS/MET units,	(*) 2012	States	Valid
	f) Develop a regional contingency planfor cases of volcanic activity	2012-2013	Regional Project	Valid
	g) Develop a regional contingency plan for cases of accidental release of radioactive material.	2012-2013	Regional Project	Valid
	h) Update the procedures in MWOs and VAACs according to Amendments 76 and 77 of Annex 3	2013-2018	States	Valid
Relation-ship with GPIs	GPI/9: Situational awareness, GPI/14: Runway operations, GPI/16: Decision support and alerting systems, GPI/18: Aeronautical information and GPI/19: Meteorological systems.			

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REGIONAL PERFORMANCE OBJECTIVE: SAM MET/04 IMPROVEMENTS IN OPMET INFORMATION EXCHANGE AND FOLLOW-UP OF WAFS EVOLUTION	
Benefits	
Safety	• Timely provision of duly coded OPMET information to the ATM community • Increased regional use of meteorological forecasts (upper wind, turbulence, icing, convective clouds and others).
Environmental protection and development of air transport	• Increased efficiency of operations and reduced carbon emissions
Metrics	
• Increased availability of OPMET information (in percentage) at regional and international level. • Number of States that have implemented WAFS and its evolutions.	
2012 - 2018 ***Strategy***	

ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM **DCB** **AO** **AUO** **ATMSDM** **CM**	a) Establish a regional procedure to ensure timely availability of duly coded OPMET information	(*) 2018	States / Brasilia OPMET database	Valid
	b) Develop contingency procedures for the dissemination of OPMET information through the Internet in case of communication system failure.	2012 - 2013	States	Valid
	c) Implement the new turbulence, icing, and convective cloud forecasts	(*) 2013	States	Valid
	d) Develop and implement a transition plan for OPMET information coding in XML format	2013-2018	Regional Project States	Valid
	e) Establish plans for the migration from ISCS to WIFS.	(*) 2014	States	Valid
	f) Develop, together with COM units, a migration plan that permits WAFS products to be compatible with the future NextGEN/SESAR environment.	2013-2018+	Regional Project	Valid
	g) Develop and implement regional procedures in support of ATM.	(*) 2018+	ICAO States	Valid
Relation-ship with GPIs	GPI/9: Situational awareness, GPI/14: Runway operations, GPI/18: Aeronautical information and GPI/19: Meteorological systems.			

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REGIONAL PERFORMANCE OBJECTIVE: SAM SAR/01 COOPERATION AND COORDINATION OF SAR SERVICES AT REGIONAL LEVEL				
Benefits				
Safety	• Favours the application of practical risk management principles			
Environmental protection and development of air transport	• Ensure cooperation and coordination amongst the interested parties			
Metrics				
• Number of letters of agreement established for SAR • Number of SAR exercises conducted				
2012 - 2018 Strategy				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
N/A	a) Assess SAR requirements at regional level	2011	ICAO-States	Valid
	b) Adopt SAR requirements at regional level	2012 - 2014	States	Valid
	c) Comply with risk and quality management practical principles	(*) - 2017	States	Valid
	d) Develop, update, establish and ratify SAR agreements between States	(*) - 2017	States	Valid
	e) Harmonise SAR training plans	(*) - 2013	CATC	Valid
	f) Conduct annual SAR exercises at regional level	(*) - 2015	States	Valid
	g) Monitor implementation progress	2012 - 2018	GREPECAS	Valid
Relation-ship with GPIs	Not applicable			

(*) Indicates that the task has been started before the date contemplated in this planning.

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM AIM/01</u>
IMPROVEMENT OF QUALITY, INTEGRITY AND AVAILABILITY OF AERONAUTICAL INFORMATION</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td colspan="2">Safety</td><td colspan="3">• Assures data integrity and resolution
• Favours information traceability</td></tr>
<tr><td colspan="2">Environmental protection and development of air transport</td><td colspan="3">• Assures timely awareness of significant changes in information</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of States that meet the AIRAC calendar
• Number of States that have implemented QMS
• Number of corrected deficiencies
• Number of States establish SLA agreements
• Number of States that completed WGS84 implementation</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="8">AOM
AO
DCB
AUO</td><td>a) Action plan to resolve AIS deficiencies.</td><td>(*) 2012</td><td>States</td><td>Valid</td></tr>
<tr><td>b) Assess the status of implementation and update of the AIM Action Plan</td><td>2012</td><td>Regional Project</td><td>Valid</td></tr>
<tr><td>c) Effective compliance with the AIRAC system</td><td>(*) - 2012</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Establish a quality management system (QMS)</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>e) Complete the use of WGS-84, taking into account the new data products</td><td>(*) - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>f) Develop guidelines on service level agreements (SLAs) between data originators and AIM</td><td>* - 2012</td><td>Regional Project</td><td>Valid</td></tr>
<tr><td>g) Establish agreements with data originators (SLAs)</td><td>2012 - 2013</td><td>States</td><td>Valid</td></tr>
<tr><td>h) Monitor the implementation of the AIM Action Plan</td><td>2012 - 2018</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relation-ship with GPIs</td><td colspan="4">GPI/9: Situational awareness, GPI/16: Decision support and alerting systems, GPI/18: Aeronautical information, GPI/20: WGS-84, GPI/21: Navigation systems.</td></tr>
</table>

(*) Indicates that the task has been started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: SAM AIM/02 TRANSITION TO THE PROVISION OF ELECTRONIC AERONAUTICAL INFORMATION	
Benefits	
Safety	• Support to ground proximity warning systems (GPWS) and procedure design and optimisation tools.
Environmental protection and development of air transport	• Integration of dynamic and static information into a single display to facilitate situational awareness. • Access to information during all flight phases.
Metrics	
• Number of States that have implemented the transition plan	
2012 - 2018 ***Strategy***	

ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM **AO** **CM** **DCB** **TS** **AUO** **ATM-SDM**	a) Prepare a transition plan for the provision of electronic aeronautical information	2012	Regional Project	Valid
	b) Implement the transition plan for the provision of electronic aeronautical information	2013 - 2018+	States	Valid
	c) Develop and establish a programme to facilitate AIS - MET interoperability	2016 - 2018	Regional Project	Valid
	d) Prepare an Action Plan for implementation of a GIS	(*) 2012	Regional Project	Valid
	e) Monitor the implementation of the transition plan for the provision of electronic aeronautical information	2012 - 2018+	GREPECAS	Valid
Relationship with GPIs	GPI/9: Situational awareness, GPI/16: Decision support and alerting systems, GPI/18: Aeronautical information, GPI/19: Meteorological systems, GPI/20: WGS-84.			

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM AGA/01</u>
QUALITY AND AVAILABILITY OF AERONAUTICAL DATA</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Less aircraft accidents at the aerodrome;
• Improved aircraft safety at the aerodrome;</td></tr>
<tr><td>Environmental protection and development of air transport</td><td colspan="4">• Efficient aerodrome operations based on aeronautical data quality assurance.</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of deficiencies related to non-compliance of the information contained in FASID Table AOP 1. Doc. 8733, Vol. II
• Number of aerodromes with processes defined and implemented with AIM</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="3">AO
CM
AUO</td><td>a) Develop a regional action plan to update the information contained in Document 8733 CAR/SAM Navigation Plan, Vol. II FASID, Table AOP1</td><td>(*) - 2018</td><td>Regional Project/ GREPECAS</td><td>Valid</td></tr>
<tr><td>b) Establish and implement a process to assure the provision of aeronautical data to AIM by the airport operator with the corresponding quality requirements.</td><td>(*) - 2018</td><td>Regional Project/States</td><td>Valid</td></tr>
<tr><td>c) Update aerodrome obstacle data in the WGS-84.</td><td>(*) – 2018+</td><td>Regional Project/ GREPECAS</td><td>Valid</td></tr>
<tr><td>Relationship with GPIs</td><td colspan="4">GPI/9: situational awareness, GPI/10: terminal area design and management, GPI/13: aerodrome design and management; GPI/14: runway operations, GPI/18: aeronautical information, GPI/20: WGS-84.</td></tr>
</table>

(*) Indicates that the task has been started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: SAM AGA/02 AERODROME CERTIFICATION				
Benefits				
Safety	• Less aircraft accidents at the aerodrome;			
Environmental protection and development of air transport	• Efficient aerodrome operations based on compliance with the SARPs;			
Metrics				
• Number of certified aerodromes • Number of trained inspectors • Number of aerodromes with a certification validated under LAR AGA.				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
AO **CM** **AUO** **DCB**	a) Harmonise national regulations of States with LAR-AGA	2012 – 2015	States	Valid
	b) Train regional aerodrome inspectors with the MIAGA	(*) – 2015	Regional Project	Valid
	c) Train regional aerodrome inspectors in auditing techniques	2014 - 2015	Regional Project	Valid
	d) Conduct multinational audit (certification) trials in the aerodromes of the Region	2014 – 2015	Regional Project/States	Valid
	e) Certification of aerodromes on the basis of LAR-AGA	(*) - 2018	States	Valid
	f) Validate aerodrome certificates granted before harmonization with LAR AGA	2015 – 2018+	States	Valid
	g) Surveillance of the certification process	2012 – 2018+	GREPECAS	Valid
Relationship with GPIs	GPI/9: situational awareness, GPI/10: terminal area design and management, GPI/13: aerodrome design and management. GPI/14: Runway operations.			

(*) Indicates that the task has been started before the date contemplated in this planning.

<table>
<tr><td colspan="5">REGIONAL PERFORMANCE OBJECTIVE: <u>SAM AGA/03</u>
SAFE OPERATIONS AT AERODROMES THAT DO NOT MEET ICAO SARPS</td></tr>
<tr><td colspan="5">Benefits</td></tr>
<tr><td>Safety</td><td colspan="4">• Dispose of tools for the evaluation of deviations
• Reduce aircraft incidents in aerodrome</td></tr>
<tr><td>Environmental protection and development of air transport</td><td colspan="4">• Efficient aerodrome operations</td></tr>
<tr><td colspan="5">Metrics</td></tr>
<tr><td colspan="5">• Number of certified aerodromes</td></tr>
<tr><td colspan="5">2012 - 2018
Strategy</td></tr>
<tr><td>ATM OC COMPONENTS</td><td>TASKS</td><td>PERIOD</td><td>RESPONSIBILITY</td><td>STATUS</td></tr>
<tr><td rowspan="4">AO
CM
AUO</td><td>a) Identify the regional airports with physical and operational characteristics that do not comply with ICAO SARPs.</td><td>(*) – 2014</td><td>Regional Project</td><td>Valid</td></tr>
<tr><td>b) Develop a procedure for certification with deviation, including orientations for the evaluation of the non-conformities.</td><td>(*) - 2014</td><td>Regional Project</td><td>Valid</td></tr>
<tr><td>c) Implement the procedure for certification with deviations.</td><td>2013 - 2018</td><td>States</td><td>Valid</td></tr>
<tr><td>d) Surveillance of certification process.</td><td>2012 - 2018</td><td>GREPECAS</td><td>Valid</td></tr>
<tr><td>Relationship with GPIs</td><td colspan="4">GPI/9: situational awareness, GPI/13: aerodrome design and management. GPI/14: runway operations.</td></tr>
</table>

(*) Indicates that the task has been started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: SAM AGA/04 IMPROVEMENT OF AERODROME PHYSICAL AND OPERATIONAL CHARACTERISTICS				
Benefits				
Safety	• Increases safe aircraft operations.			
Environmental protection and development of air transport	• Guides and operational criteria that increase capacity with efficiency; • Traffic fluidity in the movement areas.			
Metrics				
• Number of aerodromes in which capacity has been optimised. • Number of aerodromes with increased capacity due to infrastructure improvement				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
	a) Develop procedures for the calculation of aerodromes capacity	(*) - 2014	Regional Project	Valid
	b) Train instructors to replicate procedures for calculation of capacity	(*) - 2014	Regional Project	Valid
AO CM AUO	c) Implement procedures for calculation of capacity and assess the aerodromes whose installed capacity is near saturation.	(*) - 2014	States	Valid
	d) Develop procedures to optimise aerodrome runway and apron capacity	(*) - 2013	Regional Project	Valid
	e) Apply procedures for optimising aerodrome runway and apron capacity	2013 - 2018	States	Valid
	f) Develop environmental management procedures in coordination with the Regional Committees	(*) - 2018	Proyecto Regional	Valid
	g) Establish, in coordination with CNS, requirements to be applied to aerodromes operations for the implementation of surface movement guide and control systems	(*) - 2018	Regional Project	Valid
	h) Surveilance of runway and apron capacity optimisation	(*) - 2018	GREPECAS	Valid
Relationship with GPIs	GPI/9: situational awareness; GPI/13: aerodrome design and management; GPI/14: Runway operations.			

(*) Indicates that the task has been started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: SAM HR/01 **Planning of training for development of personnel competence in air navigation system**				
Benefits				
Safety	• Reinforces safety			
Environmental protection and sustainable development of air transport	• Information available with a level of quality that is appropriate to the requirements. • Personnel duly trained as instructors in the ATM operational concept. • Personnel duly trained to manage, operate and maintain the air navigation system.. • Increases situational awareness of the personnel. • Provides for quality air navigation services.			
Metrics				
• Number of States that meet the training requirements in the ATM Operational Concept. • Number of CATCs certified by ICAO or by States				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
AOM, AO AUO DCB ATM-SDM CM TS	a) Develop the training programme for air navigation service personnel to respond to the new challenges, taking into account ICAO documentation.	2012-2013	Regional Project	Valid
	b) Follow up the activities of the New Generation of Aviation Professionals (NGAP) Special Team and implement the results in the region.	201-12 - 2016	States	Valid
	c) Establish a group of trainers in the ATM Operational Concepts to train instructors in the SAM Region	2012-2013	Regional Project	Valid
	d) Prepare guides for training, planning and the ATM Operational Concept.	2013-2014	Regional Project	Valid
	e) Prepare a programme for instructors on training, planning and the ATM Operational Concept.	2013-2014	Regional Project	Valid
	f) Strengthen Civil Aviation Training Centres (CATCs) of the Region through certification, evaluation and follow up	2012 – 2014	Regional Project States	Valid
	g) Conduct courses on training, planning and the ATM Operational Concept	2013-2016	States	Valid
	h) Monitor the training and updating of air navigation personnel	2016-2018+	GREPECAS States	Valid
Relation-ship with GPIs	*The updating and training of aeronautical personnel is a cross-cutting issue for all ATM system areas.*			

REGIONAL PERFORMANCE OBJECTIVE: <u>SAM SM/01</u> SAFETY				
Benefits				
Safety	• Strengthens safety			
Metrics				
• N° of EI for ANS and AGA • Number of States that have implemented SSPs • Number of international airports that have implemented SMS • Number of ATS services that have implemented SMS.				
2012 - 2018 ***Strategy***				
ATM OC COMPONENTS	**TASKS**	**PERIOD**	**RESPONSIBILITY**	**STATUS**
AOM **AUO**	a) Development of associated standards and procedures to comply with safety surveillance requirements at the air navigation and aerodrome services	2013-2015	Regional Project	Valid
	b) Assist in the strengthening of the civil aviation administrations, to comply with the air navigation and aerodrome services surveillance tasks	2014-2018	Regional Project	Valid
	c) Follow up of the RASG-PA work programme, as a reference for the activities of the region.	(*) – 2018+	States	Valid
	d) Prepare guidelines for the implementation of SMS in ATS services and international aerodromes.	(*) - 2012	Regional Project	Valid
	e) Assist in the implementation of State safety programmes (SSPs).	2012	Regional Office	Valid
	f) Develop regional safety databases	2012 - 2013	Regional Project	Valid
	g) Formulate guidelines for the protection of safety data	2012 - 2014	Regional Project	Valid
	h) Effective implementation of SMS in ATS and international airports.	(*) - 2014	States	Valid
	i) Develop and implement a training plan concerning the development and application of a safety case	(*) - 2012	States	Valid
	j) Assess and assist States in the effective implementation of actions, in order to improve safety.	(*) - 2018	GREPECAS	Valid
	k) Continuous monitoring and periodical assessment of safety efficacy and SMS and SSP implementation	2012 - 2018	GREPECAS	Valid
Relation-ship with GPIs	The systemic safety approach is holistic, applied to the whole ANS system.			

(*) Indicates that the task has been started before the date contemplated in this planning.

RELATIONSHIP OF THE ACTIVITIES BETWEEN PFF(s)

AREA	ATM	AGA/AOP		AIM		CNS		MET	
ATM		ATM/2-AGA/AOP/1	c – c d – c	ATM/2-AIM/1	b – d, e c – d, e d – d, e e – d, e	ATM/1-CNS/2	b – a, c e – c, d f – a, b, c, d	ATM/1-MET/3	a – e, g
		ATM/3-AGA/AOP/1	a – a, b b – c c - c	ATM/2-AIM/2	b – a, b, d, e c – a, b, d, e d – a, b, d, e e – a, b, d, e	ATM/1-CNS/3	a – b f - b	ATM/1-MET/4	a – g
		ATM/3-AGA/AOP/4	b – a, b, c, d, e, f					ATM/2-MET/3	b – e, f, g c – e, f, g d - e, f, g e - e, f, g
		ATM/3-AGA/AOP/5	b – a, b					ATM/3-MET/3	b – e, f, g c – e, f, g
		ATM/5-AGA/AOP/4	c – a, b, c, d, e, f d - a, b, c, d, e, f	ATM/3-AIM/1	b – d, e c – d, e	ATM/1-CNS/4	b – c e – c f – a, c, d g – a, c, d	ATM/5-MET/1	b – a, c
						ATM/2-CNS/3	b – b	ATM/5-MET/2	b – a, b, c, d

AREA	ATM	AGA/AOP		AIM		CNS		MET	
							c - b		
						ATM/3 CNS/3	c - c	ATM/5-MET/3	b – a, c, d, e, g, h
						ATM/5-CNS/1	f -c	ATM/5-MET/4	b – a, b, c, g
						ATM/6-CNS/1	b – a, b, c, d, e d – c, d, f, g, h	ATM/7-MET/1	c – a d - a
				ATM/3-AIM/2	e – b	ATM/6-CNS/4	c – a, b, c, d d – a, c	ATM/7-MET/4	c – d d - d
				ATM/4-AIM/1	e – c, d, e				
				ATM/6-AIM/2	b – a, b, d, e c – a, b, d, e				
AGA/AOP				AGA/AOP/1-AIM/1	b – d g - e	AGA/AOP/4-CNS/4	g - b	AGA/AOP/5-MET/2	a - a
				AGA/AOP/1-AIM/2	b – d, e				
CNS				CNS/1-AIM/2	a – a, b f – a, b			CNS/2-MET/4	h – a, c. g

AREA	ATM		AGA/AOP		AIM		CNS		MET	
MET					MET/1-AIM/1	a - g				
					MET/3-AIM/2	f – c g – c				
					MET/1-AIM/2	a-g				
SAR	SAR/1-ATM/4	f - d								
RRHH	All the tasks of PFF/1		All the tasks of PFF/1		All the tasks of PFF/1		All the tasks of PFF/1		All the tasks o fPFF/1	
SM	All the tasks of PFF/1		All the tasks of PFF/1		All the tasks of PFF/1		All the tasks of PFF/1		All the tasks of PFF/1	

PFF RELATIONSHIP WITH ASBU BLOCK 0 MODULES SELECTED FOR THE SAM REGION
RELACIÓN DE LOS PFFCON LOS MÓDULOS DEL ASBU DEL BLOQUE 0 SELECCIONADO PARA LA REGIÓN SAM

ASBU / PFF	PIA1				PIA2			PIA3					PIA4		
	B015	**B0 65**	**B075**	**B0 80**	**B025**	**B030**	**B010**	**B035**	**B084**	**BO101**	**B0102**	**B0105**	**B005**	**B020**	**B040**
PFF SAM ATM/01							~~X~~								
PFFSAMATM/02													X	X	
PFFSAM ATM/03		~~X~~													
PFF SAM ATM/04							~~X~~								
PFF SAM ATM/05	~~X~~							~~X~~							
PFF SAM ATM/06			~~X~~						~~X~~		~~X~~				
PFF SAMATM/07 (I)*															
PFF SAM CNS/01					X			X				X			
PFFSAM CNS/02															X
PFF SAM CNS/03		~~X~~													
PFF SAM CNS/04			~~X~~						~~X~~		~~X~~				
PFFSAM MET/01												~~X~~			
PFF SAM MET/02			~~X~~									~~X~~			
PFF SAM MET/03				~~X~~								~~X~~			
PFF SAM MET/04				~~X~~								~~X~~			
PFFSAM SAR/01															
PFF SAM AIM/01						X									
PFF SAM AIM/02						X						~~X~~			
PFF SAM AGA/01						X									
PFF SAM AGA/02				~~X~~											
PFF SAM AGA/03				~~X~~											
PFF SAM AGA/04	~~X~~		~~X~~												
PFFSAM SAR701															
PFF SAM HHRR/01	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~
PFF SAM SM/01															

- I =Implantado

ATTACHMENT D

DESCRIPTION OF MODULES CONSIDERED FOR THE SAM REGION

PERFORMANCE IMPROVEMENT AREA 1: AIRPORT OPERATIONS

B0-15: Improve Traffic Flow through Runway Sequencing (AMAN/DMAN)

Introduction

This module introduces system capabilities to provide assistance for sequencing and metering to manage arrivals and departures (including time-based metering) to and from a multi-runway aerodrome or locations with multiple dependent runways at closely proximate aerodromes, to efficiently utilize the inherent runway capacity.

Baseline

Currently, sequencing is the manual process by which the air traffic controller uses local procedures and his expertise to sequence departures or arrivals in real time. This is generally leading to sub-optimal solutions both for the realized sequence and the flight efficiency, in particular in terms of taxi times and ground holding for departures, and in terms of holding for arrivals.

Change brought by the module

For departures, the sequence will allow improved start/push-back clearances, reducing the taxi time and ground holding, delivering more efficient departure sequences, reducing surface congestion and effectively and efficiently making use of terminal and aerodrome resources.

Departure management tools maximize the use of airspace capacity and assure full utilization of resources. They have the additional benefit of fuel efficient alternatives to reduce airborne and ground holding in an era in which fuel continues to be a major cost driver and emissions are a high priority. The use of these tools to assure facility of more efficient arrival and departure paths is a main driver in some modules of Block 0.

Necessary procedures (air and ground)

It is necessary to develop the systems and operational procedures for AMAN/DMAN. In particular, procedures for the extension of metering into en-route airspace will be necessary. RNAV/RNP for arrival will also be crucial as well.

Element 1: AMAN and time-based metering

Arrival management (AMAN) sequences the aircraft, based on the airspace state, wake turbulence, aircraft capability, and user preference. The established sequence provides the time that aircraft may have to lose before a reference approach fix, thereby allowing aircraft to fly more efficiently to the that fix and to reduce the use of holding stacks, in particular at low altitude. The smoothed sequence allows increased aerodrome throughput.

Time-based metering is the practice of separation by time rather than distance. Typically, the relevant ATC authorities will assign a time in which a flight must arrive at the aerodrome. This is known as the control time of arrival (CTA). CTAs are determined based on aerodrome capacity, terminal airspace capacity, aircraft capability, wind and other meteorological factors. Time-based metering is the primary mechanism in which arrival sequencing is achieved.

Element 2: Departure management

Departure management (DMAN), like its arrival counterpart, serves to optimize departure operation to ensure the most efficient utilization of aerodrome and terminal resources. Slots assignment and adjustments will be supported by departure management automations like departure management (DMAN) or departure flow management (DFM). Dynamic slot allocation will foster smoother integration into overhead streams and help the airspace users to better meet metering points and comply with other ATM decisions. Departure management sequences the aircraft, based on the airspace state, wake turbulence, aircraft capability, and user preference, to fit into the overhead en-route streams without disrupting the traffic flow. This will serve to increase aerodrome throughput and compliance with allotted departure time.

Intended performance operational improvement

In terms of Capacity improvements, time-based metering will optimize usage of terminal airspace and runway capacity. The utilization of terminal and runway resources will be optimized.

Efficiency is positively impacted as reflected by increased runway throughput and arrival rates. Efficiency is achieved through:

1) harmonized arriving traffic flow from en-route to terminal and aerodrome. Harmonization is achieved via the sequencing of arrival flights based on available terminal and runway resources; and
2) streamlined departure traffic flow and smooth transition into en-route airspace. Decreased lead time for departure request and time between call for release and departure time. Automated dissemination of departure information and clearances.

In terms of predictability it decreases uncertainties in aerodrome/terminal demand prediction and in terms of flexibility it enables dynamic scheduling.

Just as a reference to take into account, a detailed business case has been built for the time-based flow management programme in the United States. The business case has proven the benefit/cost ratio to be positive. Implementation of time-based metering can reduce airborne delay. This capability was estimated to provide over 320 000 minutes in delay reduction and $28.37 million in benefits to airspace users and passengers over the evaluation period.

Necessary system capability

Avionics

No avionics capability is required in support of the time-based metering for departure. For approach, time-based metering is mainly achieved through ATC speed clearance to adjust the aircraft sequence in the AMAN. This operation can be facilitated by requiring the aircraft to meet a CTA at a metering fix, relying on the aircraft required time of arrival function from current flight management system (FMS).

Ground systems

The key technological aspects include automation support for the synchronization of arrival sequencing, departure sequencing, and surface information; improve predictability of arrival flow, further hone sector capacity estimates, and management by trajectory. Less congested locations might not require extensive automation support to implement.

Both TBFM and arrival/departure management (AMAN/DMAN) application and existing technologies can be leveraged, but require site adaptation and maintenance.

Human factors considerations

ATM personnel responsibilities will not be affected directly. However, human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Automation support is needed for air traffic management in airspace with high demands. Thus, training is needed for ATM personnel.

Training in the operational standards and procedures are required for this module. Likewise, the qualifications requirements which form an integral part to the implementation of this module.

Reference documents and guidance materials

- European ATM Master Plan, Edition 1.0, March 2009, update in progress
- SESAR Definition Phase Deliverables
- TBFM Business Case Analysis Report
- NextGen Midterm Concept of Operations v.2.0
- RTCA Trajectory Operations Concept of Use

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-15: Improve Traffic Flow Through Runway Sequencing (AMAN/DMAN)</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. AMAN
2. DMAN</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- Automation support</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator:
Percentage of international aerodromes with AMAN/DMAN</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Time-based metering will optimize usage of terminal airspace and runway capacity.</td><td><u>KPA-Efficiency</u>
Efficiency is positively impacted as reflected by increased runway throughput and arrival rates.</td><td><u>KPA-Environment</u>
Not Applicable</td><td><u>KPA-Safety</u>
Not Applicable</td></tr>
</table>

<u>B0-65: Optimization of Approach Procedures including Vertical Guidance</u>

Introduction

This module complements other airspace and procedures elements (continuous descent operations (CDO), PBN and airspace management) to increase efficiency, safety, access and predictability.

The use of performance-based navigation (PBN) and ground-based augmentation system (GBAS) landing system (GLS1) procedures will enhance the reliability and predictability of approaches to runways, thus increasing safety, accessibility and efficiency. This is possible through the application of Basic global navigation satellite system (GNSS), Baro vertical navigation (VNAV), satellite-based augmentation system (SBAS) and GLS. The flexibility inherent in PBN approach design can be exploited to increase runway capacity.

Baseline

Conventional navigation aids (e.g. Instrument landing system (ILS), VHF omnidirectional radio range (VOR), non-directional radio beacon (NDB)) have limitations in their ability to support the lowest minima to every runway. In the case of ILS, limitations include cost, the availability of suitable sites for ground infrastructure and an inability to support multiple descent paths to multiple runway ends. VOR and NDB procedures do not support vertical guidance and have relatively high minima that depend on siting considerations.

Change brought by the module

With the exception of ground-based augmentation system (GBAS) for GLS, performance-based navigation (PBN) procedures require no ground-based navaids and allow designers complete flexibility in determining the final approach lateral and vertical paths. PBN approach procedures can be seamlessly integrated with PBN arrival procedures, along with continuous descent operations (CDO), thus reducing aircrew and controller workload and the probability that aircraft will not follow the expected trajectory.

With the exception of ground-based augmentation system (GBAS) for GLS, performance-based navigation (PBN) procedures require no ground-based navaids and allow designers complete flexibility in determining the final approach lateral and vertical paths. PBN approach procedures can be seamlessly integrated with PBN arrival procedures, along with continuous descent operations (CDO), thus reducing aircrew and controller workload and the probability that aircraft will not follow the expected trajectory.

States can implement GNSS-based PBN approach procedures that provide minima for aircraft equipped with basic GNSS avionics with or without Baro VNAV capability, and for aircraft equipped with SBAS avionics. GLS, which is not included in the PBN Manual, requires aerodrome infrastructure but a single station can support approaches to all runways and GLS offers the same design flexibility as PBN procedures. This flexibility provides benefits when conventional aids are out of service due to system failures or for maintenance. Regardless of the avionics fit, each aircraft will follow the same lateral path. Such approaches can be designed for runways with or without conventional approaches, thus providing benefits to PBN-capable aircraft, encouraging equipage and supporting the planning for decommissioning of some conventional aids.

The key to realizing maximum benefits from these procedures is aircraft equipage. Aircraft operators make independent decisions about equipage based on the value of incremental benefits and potential savings in fuel and other costs related to flight disruptions.

Metrics *to determine success of the module are proposed in the Manual on Global Performance of the Air Navigation System (Doc 9883).*

Intended performance operational improvement

In contrast with ILS, the GNSS-based approaches (PBN and GLS) do not require the definition and management of sensitive and critical areas resulting in potentially increased runway capacity.

Cost savings related to the benefits of lower approach minima: fewer diversions, overflights, cancellations and delays. Cost savings related to higher airport capacity in certain circumstances (e.g. closely spaced parallels) by taking advantage of the flexibility to offset approaches and define displaced thresholds.

This implementation contributes to safety with stabilized approach paths and to environment benefits through reduced fuel burn increasing airport accessibility as well.

In terms of cost benefit analysis Aircraft operators and air navigation service providers (ANSPs) can quantify the benefits of lower minima by using historical aerodrome weather observations and modelling airport accessibility with existing and new minima. Each aircraft operator can then assess benefits against the cost of any required avionics upgrade. Until there are GBAS (CAT I/III) Standards, GLS cannot be considered as a candidate to globally replace ILS. The GLS business case needs to consider the cost of retaining ILS or MLS to allow continued operations during an interference event.

Necessary procedures (air and ground)

The following documents provide background and implementation guidance for ANSPs, aircraft operators, airport operators and aviation regulators:

The Performance-based Navigation (PBN) Manual (Doc 9613), the Global Navigation Satellite System (GNSS) Manual (Doc 9849) Annex 10 — Aeronautical Telecommunications and the Procedures for Air Navigation Services — Aircraft Operations, Volume I — Flight Procedures and Volume II — Construction of Visual and Instrument Flight Procedures (PANS-OPS, Doc 8168) provide guidance on system performance, procedure design and flight techniques necessary to enable PBN approach procedures.

The World Geodetic System — 1984 (WGS-84) Manual (Doc 9674) provides guidance on surveying and data handling requirements. The Manual on Testing of Radio Navigation Aids (Doc 8071) (Doc 8071), Volume II — Testing of Satellite-based Radio Navigation Systems provides guidance on the testing of GNSS. This testing is designed to confirm the ability of GNSS signals to support flight procedures in accordance with the standards in Annex 10.

ANSPs must also assess the suitability of a procedure for publication, as detailed in PANS-OPS, Volume II, Part I, Section 2, Chapter 4, Quality Assurance. The Quality Assurance Manual for Flight Procedure Design (Doc 9906), Volume 5 –Validation of Instrument Flight Procedures provides the required guidance for validation of instrument flight procedures including PBN procedures. Flight validation for PBN procedures is less costly than for conventional aids for two reasons: the aircraft used do not require complex signal measurement and recording systems; and there is no requirement to check signals periodically.

Necessary system capability

Avionics

PBN approach procedures can be flown with basic instrument flight rules (IFR) GNSS avionics that support on board performance monitoring and alerting; these support lateral navigation (LNAV) minima. Basic IFR GNSS receivers may be integrated with Baro VNAV functionality to support vertical guidance to LNAV/vertical navigation (VNAV) minima. In States with defined SBAS service areas, aircraft with SBAS avionics can fly approaches with vertical guidance to LPV minima, which can be as low as ILS CAT I minima when flown to a precision instrument runway, and as low as 250 ft minimum descent altitude (MDA) when flown to an instrument runway. Within an SBAS service area, SBAS avionics can provide advisory vertical guidance when flying conventional non-directional beacon (NDB) and very high frequency omnidirectional radio range (VOR) procedures, thus providing the safety benefits associated with a stabilized approach. Aircraft require avionics to fly GBAS land system (GLS) approaches.

Ground systems

SBAS-based procedures do not require any infrastructure at the airport served, but SBAS elements (e.g. reference stations, master stations, geostationary (GEO) satellites) must be in place such that this level of service is supported. The ionosphere is very active in equatorial regions, making it very technically challenging for the current generation of SBAS to provide vertically guided approaches in these regions. A GLS station installed at the aerodrome served can support vertically guided CAT I approaches to all runways at that aerodrome.

Human performance

The implementation of approach procedures with vertical guidance enables improved cockpit resource management in times of high and sometime complex workload. By allowing crew procedures to be better distributed during the conduct of the procedure, exposure to operational errors is reduced and human performance is improved. This results in clear safety benefits over procedures that lack guidance along a vertical path. Additionally, some simplification and efficiencies may be achieved in crew training as well.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures, however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues identified during implementation be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training in the operational standards and procedures are required for this module and can be found in the Reference Documents and Guidance material section

in to this module. Likewise, the qualification requirements are identified in th Regulatory/standardization needs and Approval Plan (Air and Ground e section which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

1) Regulatory/standardization: use current published criteria as given in Section 8.4 as no new or updated regulatory guidance or standards documentation is needed at this time.
2) Approval plans: no new or updated approval criteria are needed at this time. Implementation plans should reflect available aircraft, ground systems and operational approvals.

Reference documents and guidance material

- ICAO Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids*. As of 2011 a draft Standards and Recommended Practices (SARPs) amendment for GLS to support CAT II/III approaches is completed and is being validated by States and industry.
- ICAO Annex 11 — *Air Traffic Services*
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 8168, *Procedures for Air Navigation Services — Aircraft Operations*
- ICAO Doc 9674, *World Geodetic System — 1984 (WGS-84) Manual*
- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc 9849, *Global Navigation Satellite System (GNSS) Manual*
- ICAO Doc 9906, *Quality Assurance Manual for Flight Procedure Design*, Volume 5 -*Validation of Instrument Flight Procedures*
- ICAO Doc 8071, *Manual on Testing of Radio Navigation Aids*, Volume II — *Testing of Satellite-based Radio Navigation Systems*
- ICAO Doc 9931, *Continuous Descent Operations (CDO) Manual*
- FAA AC 20-138, TSO-C129/145/146

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-65: Optimization of Approach Procedures Including Vertical Guidance</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. APV with Baro VNAV
2. APV with SBAS
3. APV with GBAS</td><td colspan="2"><u>Equipage/Air</u>
- Basic IFR GNSS avionics integrated with Baro VNAV functionality
- SBAS avionics
- GBAS avionics</td><td colspan="2"><u>Equipage/Ground</u>
- SBAS (reference stations, master stations, GEO satellites)
- GBAS</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. 1. Indicator:
2. Percentage of international aerodromes having instrument runways provided with APV on the basis of
3. Baro VNAV/SBAS/GBAS</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Increased aerodrome accessibility</td><td><u>KPA-Capacity</u>
Increased runway capacity</td><td><u>KPA-Efficiency</u>
Reduced fuel burn due to lower minima, fewer diversions, cancellations, delays</td><td><u>KPA-Environment</u>
Reduced emissions due to reduced fuel burn.</td><td><u>KPA-Safety</u>
Increased safety through stabilized approach paths.</td></tr>
</table>

B0-75: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)

Introduction

This module builds upon traditional surface movement guidance and control system (SMGCS) implementation (visual surveillance, aerodrome signage, lighting and markings) by the introduction of capabilities enhancing air traffic control (ATC) situational awareness through:

a) display to the aerodrome controller of the position of all aircraft on the aerodrome movement area;
b) display to the aerodrome controller of all vehicles on the aerodrome maneuvering area; and
c) generation of runway incursion alerts (where local operational, safety and cost- benefit analyses so warrant).

This level of implementation, corresponding to levels 1 and 2 of the A-SMGCS concept and being associated to the provision of ATS, is independent of aircraft equipage beyond that associated with cooperative surveillance equipage (e.g. SSR Mode S or A/C transponders).

For automatic dependent surveillance—broadcast (ADS-B) APT the facilities and procedures will be the same with the performance levels associated to conventional SMGCS. The B0 level of implementation is dependent of aircraft/vehicle ADS-B Out equipage.

Baseline

Surface operations historically have been managed by use of visual scanning by both ANSP personnel and flight crew, both as the basis for taxi management as well as aircraft navigation and separation. These operations are significantly impeded during periods of reduced visibility (weather obscuration, night) and high demand, e.g. when a large proportion of aircraft are from the same operator and/or of the same aircraft type.

In addition, remote areas of the aerodrome surface are difficult to manage if out of direct visual surveillance. As a result, efficiency can be significantly degraded, and safety services are unevenly provided. Complementary to such historical means of aerodrome traffic management, enhanced surface situational awareness has been based upon use of an aerodrome surface movement primary radar system and display (SMR). This permits the surveillance of all aircraft and ground vehicles without any need for cooperative surveillance equipment installed on the aircraft/vehicles. This improvement allows ANSP personnel to better maintain awareness of ground operations during periods of low visibility. In addition, the presence of safety logic allows for limited detection of runway incursions.

Change brought by the module

This module implements:

a) additional capabilities to the aerodrome surveillance environment by taking advantage of cooperative surveillance that provides the means to establish the position of all aircraft and vehicles and to specifically identify targets with individual flight/vehicle identification. Ground vehicles operating on the maneuvering area will be equipped with cooperative surveillance transponders compatible with the specific A-SMGCS equipment installed so as to be visible to tower ground surveillance display systems; and
b) SMR-like capabilities by implementing ADS-B APT at those aerodromes where surveillance is not available.

Element 1 – Surveillance

In the case of A-SMGCS, this element enhances the primary radar surface surveillance with the addition of at least one cooperative surface surveillance system. These systems include multi-lateration, secondary surveillance radar Mode S, and ADS-B. As with TMA and en-route secondary surveillance radars/ADS-B, the cooperative aspect of the surveillance allows for matching of equipped surveillance targets with flight data, and also reduces clutter and degraded operation associated with primary surveillance. The addition of cooperative surveillance of aircraft and vehicles adds a significant positive benefit to the performance of safety logic, as the tracking and short-term trajectory projection capabilities are improved with the higher quality surveillance. The addition of this capability also provides for a marginal improvement in routine management of taxi operations and more efficient sequencing of aircraft departures.

In the case of ADS-B APT, as an element of an A-SMGCS system, it provides controllers with traffic situational awareness on movement areas. The provision of surveillance information to the controller will allow the deployment of SMGCS procedures, augmenting the controller‘s situational awareness and helping the controller to manage the traffic in a more efficient way. In this respect, the ADS-B APT application does not aim to reduce the occurrence of runway incursions, but may reduce the occurrence of runway collisions by assisting in the detection of the incursions.

Element 2 – Alerting

In the case of A-SMGCS, where installed and operated, alerting with flight identification information also improves the ATC response to situations that require resolution such as runway incursion incidents and improved response times to unsafe surface situations. Levels of sophistication as regards this functionality currently vary considerably between the various industrial solutions being offered. B0 implementations will serve as important initial validation for improved algorithms downstream.

In the case of ADS-B APT, system generated alerting processes and procedures have not been defined (as this is considered premature at this development stage). It is possible that future variations of the ADS-B APT application will assess the surveillance requirements necessary to support alerting functions.

Intended performance operational improvement

The A-SMGCS improves access to portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. It also sustains an improved aerodrome capacity during periods of reduced visibility and ensures equity in ATC handling of surface traffic regardless of the traffic‘s position on the aerodrome.

The ADS-B APT as an element of an A-SMGCS system, provides traffic situational awareness to the controller in the form of surveillance information and potentially improves capacity. The availability of the data is dependent on the aircraft and vehicle level of equipage.

In terms of efficiency A-SMGCS reduce taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only and ADS-B APT potentially reduces taxi times by providing improved traffic situational awareness to controllers.

Cost benefit analysis is positive taking into consideration the improved levels of safety and improved efficiencies in surface operations leading to significant savings in aircraft fuel usage. As well, aerodrome operator vehicles will benefit from improved access to all areas of the aerodrome, improving the efficiency of aerodrome operations, maintenance and servicing.

This implementation reduces ATC workload and improve ATC efficiency.

Necessary system capability

Avionics

Existing aircraft ADS-B and/or SSR transponder systems, including correct setting of aircraft identification.

Vehicles

Vehicle cooperative transponder systems, type as a function of the local A-SMGCS installation. Industry solutions readily available.

Ground systems

A-SMGCS: the surface movement radar should be complemented by a cooperative surveillance means allowing tracking aircraft and ground vehicles. A surveillance display including some alerting functionalities is required in the tower.

ADS-B APT: cooperative surveillance infrastructure deployed on the aerodrome surface; installation of a tower traffic situational awareness display.

Human performance

Human factors considerations

Workload analyses will be necessary to ensure ATC can cope with increased aerodrome capacities in reduced visual conditions using A-SMGCS. ATC response to A-SMGCS generated runway incursion alarms and warnings will require human factors assessments to ensure that ATC performance in this regard does in fact improve and not diminish. Human factors assessments will also be necessary for the assessment of the compatibility of A-SMGCS tower display installations with other tower surveillance display systems.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective (see Section 6 for examples). The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Reference Documents and Guidance material to this module. Likewise, the qualifications requirements are identified in the Regulatory/standardization r needs and Approval Plan (Air and Ground)which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Standards approved for aerodrome multilateration, ADS-B and safety logic systems exist for use in Europe, the United States and other Member States. Standards for surface movement radar (SMR) exist for use globally.

Reference documents and guidance material

- Community Specification on A-SMGCS Levels 1 and 2
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 7030, *Regional Supplementary Procedures* (EUR SUPPS)
- ICAO Doc 9924, *Aeronautical Surveillance Manual*
- ICAO Doc 9871, *Technical Provisions for Mode S Services and Extended Squitter*
- ICAO Doc 9830, *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual*
- ICAO Doc 7030/5, (EUR/NAT) *Regional Supplementary Procedures*, Section 6.5.6 and 6.5.7
- FAA Advisory Circulars
- AC120-86 Aircraft Surveillance Systems and Applications
- AC120-28D Criteria for approval of Category III Weather Minima for Take-off, Landing, and Rollout
- AC120-57A Surface Movement Guidance and Control System
- Avionics standards developed by RTCA SC-186/Eurocae WG-51 for ADS-B
- Aerodrome map standards developed by RTCA SC-217/Eurocae WG-44
- EUROCAE ED 163 Safety, Performance and Interoperability Requirements document for ADS-B Airport Surface surveillance application (ADS-B APT)
- FAA NextGen Implementation Plan
- European ATM Master Plan

Module summary

<table>
<tr><td colspan="3"><u>Title of the Module:</u>
B0-75: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)</td></tr>
<tr><td><u>Elements</u>
1. Surveillance
2. Alerting systems
3. (Not included in the Module but added here as they are closely linked to this Module) Visual aids for navigation and Wild life strike hazard reduction</td><td><u>Equipage/Air</u>
- ADS-B / SSR transponder system</td><td><u>Equipage/Ground</u>
- SMR/SSR Mode S/ ADS B/ Multilateration
- Surveillance display with alerting functionalities in the tower.
- A cooperative transponder system for vehicles
- Visual aids for navigation</td></tr>
<tr><td colspan="3">Implementation monitoring and intended performance impact</td></tr>
<tr><td><u>Implementation</u></td><td colspan="2">Qualitative performance benefits associated with five main KPAs only</td></tr>
</table>

progress 1. Indicator: *Percentage of international aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration* 2. Indicator: *Percentage of international aerodromes with a cooperative transponder systems on vehicles* 3. Indicator: *Percentage of international aerodromes complying with visual aid requirements as per Annex 14*	KPA-Access/Equity Improves KPA-Access/Equity to portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. Ensures equity in ATC handling of surface traffic regardless of the traffic's position on the international aerodrome.	KPA-Capacity Sustained level of aerodrome capacity during periods of reduced visibility	KPA-Efficiency Reduced taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only. Reduced fuel burn.	KPA-Environment Reduced emissions due to reduced fuel burn	KPA-Safety Reduced runway incursions. Improved response to unsafe situations. Improved situational awareness leading to reduced ATC workload.

B0-80: Improved Airport Operations through Airport-CDM

Introduction

This module is designed to implement collaborative applications that will allow the sharing of surface operations data among the different stakeholders on the airport. This will improve surface traffic management reducing delays on movement and maneuvering areas and enhance safety, efficiency and situational awareness

Baseline

Surface operations, especially for the turnaround phase, involve all operational stakeholders at an airport. They each have their own processes that are conducted as efficiently as possible. However, by relying on separated systems and not sharing all relevant information, they currently do not perform as efficiently as they could.

The baseline will be operations without airport collaboration tools and operations.

Change brought by the module

Implementation of airport collaborative decision making (A-CDM) will enhance surface operations and safety by making airspace users, ATC and airport operations better aware of their respective situation and actions on a given flight.

Airport-CDM is a set of improved processes supported by the interconnection of various airport stakeholders information systems. Airport-CDM can be a relatively simple and low cost programme.

Intended performance operational improvement

In terms of capacity this module enhanced use of existing infrastructure of gate and stands (unlock latent capacity) and reduced workload, and assure a better organization of the activities to manage flights.

It also increases efficiency of the ATM system for all stakeholders. In particular for aircraft operators: improved situational awareness (aircraft status both home and away); enhanced fleet predictability and punctuality; improved operational efficiency (fleet management); and reduced delay.

Environmental benefits are achieved with this implementation reducing taxi time, fuel and carbon emissions and lower aircraft engine run time

The business case has proven to be positive due to the benefits that flights and the other airport operational stakeholders can obtain. However, this may be influenced depending upon the individual situation (environment, traffic levels investment cost, etc.).

Necessary procedures (air and ground)

The existing procedures need to be adapted to the collaborative environment in order to provide full benefits. These changes will affect the way the pilot, controller, airlines operations and ATFM unit will exchange information and manage the departing queue. The pushback and engine start up are just in time taking in account assigned runway, taxiing time, runway capacity, departure slot and departure constraints.

Necessary system capability

Avionics

No airborne equipment is required.

Ground systems

Collaborative decision-making (CDM) does not require specific new functionalities. The difficulty is more to interconnect ground systems depending on the systems in place locally but experience has proven that industrial solutions/support exist. Where available, shared surveillance information may enhance operations.

Human factors considerations

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Reference Documents and Guidance material section. Likewise, the qualifications requirements are identified in the regulatory requirements in Regulatory/standardization needs and Approval Plan (Air and Ground) section which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: updates are required to the following current published criteria:

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO *CDM Manual*

Approval plans: updates are required for:

- EUROCONTROL, A-CDM Implementation Manual
- FAA NextGen Implementation Plan

Reference documents and guidance material

- ICAO CDM Manual (being finalized)
- European Union, OJEU 2010/C 168/04: Community Specification ETSI EN 303 212 v.1.1.1: European Standard (Telecommunications series) Airport Collaborative Decision Making (A-CDM)
- EUROCAE ED-141: Minimum Technical Specifications for Airport Collaborative Decision Making (Airport-CDM) Systems
- EUROCONTROL A-CDM Programme documentation, including an Airport - CDM Implementation Manual
- FAA NextGen Implementation Plan 2011

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-80: Improved Airport Operations through Airport-CDM</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. Airport –CDM
2.(Not included in the Module but added here as they are closely linked to this Module) Aerodrome certification, Aerodrome emergency planning, Airport planning and Heliport operations</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- Interconnection of ground systems of different partners for Airport-CDM
- Rescue and Fire Fighting (RFF) Equipment as per Annexe 14</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: percentage of international aerodromes with Airport-CDM

2. Indicator: Percentage of certified international aerodromes

3. Indicator: Percentage of international aerodromes with RFF equipment as per Annex 14</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Enhances equity on the use of aerodrome facilities.</td><td><u>KPA-Capacity</u>
Enhanced use of existing Implementation of gate and stands (unlock latent capacity). Reduced workload, better organization of the activities to manage flights.</td><td><u>KPA-Efficiency</u>
Improved operational efficiency (fleet management); and reduced delay. Reduced fuel burn due to reduced taxi time and lower aircraft engine run time.</td><td><u>KPA-Environment</u>
Reduced emissions due to reduced fuel burn</td><td><u>KPA-Safety</u>
Not Applicable</td></tr>
</table>

PERFORMANCE IMPROVEMENT AREA 2: GLOBALLY INTEROPERABLE SYSTEMS AND DATA

B0-25: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration

Introduction

This module was designed to improve coordination between air traffic service units (ATSUs) by using ATS interfacility data communication (AIDC) defined by the ICAO Manual of Air Traffic Services Data Link Applications (Doc 9694). The transfer of communication in a data link environment improves the efficiency of this process particularly for oceanic ATSUs.

Baseline

The baseline for this module is the traditional coordination by phone, and procedural and/or radar distance/time separations.

Flights which are being provided with air traffic services are transferred from one air traffic services (ATS) unit to the next in a manner designed to ensure safety. In order to accomplish this objective, it is a standard procedure that the passage of each flight across the boundary of the areas of responsibility of the two units is coordinated between them beforehand and that the control of the flight is transferred when it is at, or adjacent to, the said boundary.

Where it is carried out by telephone, the passing of data on individual flights as part of the coordination process is a major support task at ATS units, particularly at area control centres (ACCs). The operational use of connections between flight data processing systems (FDPSs) at ACCs replacing phone coordination (on-line data interchange (OLDI)) is already proven in Europe.

This is now fully integrated into the ATS interfacility data communications (AIDC) messages in the *Procedures for Air Navigation Services — Air Traffic Management*, (PANS-ATM, Doc 4444) which describes the types of messages and their contents to be used for operational communications between ATS unit computer systems. This type of data transfer (AIDC) will be the basis for migration of data communications to the aeronautical telecommunication network (ATN).

Information exchanges between flight data processing systems are established between air traffic services units for the purpose of notification, coordination and transfer of flights and for the purpose of civil/military coordination.

These information exchanges rely upon appropriate and harmonized communication protocols to secure their interoperability and apply to:

a) communication systems supporting the coordination procedures between air traffic services units using a peer-to-peer communication mechanism and providing services to general air traffic; and
b) communication systems supporting the coordination procedures between air traffic services units and controlling military units, using a peer-to-peer communication mechanism.

Change brought by the module

The module makes available a set of messages to describe consistent transfer conditions via electronic means across boundaries of ATS units. It consists of the implementation of the set of AIDC messages in the flight data processing systems (FDPS) of the different ATS units involved and the establishment of a Letter of Agreement (LoA) between these units to set the appropriate parameters.

Prerequisites for the module, generally available before its implementation, are an ATC system with flight data processing functionality and a surveillance data processing system connected to each other. This module is a first step towards the more sophisticated 4D trajectory exchanges between both ground/ground and air/ground according to the ICAO *Global Air Traffic Management Operational Concept* (Doc 9854).

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

In terms of capacity this implementation reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases.

This reduced separation can also be used to more frequently offer aircraft flight levels closer to the flight optimum; in certain cases, this also translates into reduced en-route holding contributing to efficiency.

Additionally in terms of safety the Air Traffic Controllers also, have a better knowledge of more accurate flight plan information reducing errors in the ATC loop coordination.

Increase of throughput at ATS unit boundary and reduced ATCO workload will outweigh the cost of FDPS software changes. The business case is dependent on the environment.

Necessary procedures (air and ground)

Required procedures exist. They need local analysis of the specific flows and should be spelled out in a Letter of Agreement between ATS units; the experience from other regions can be a useful reference.

Avionics

No specific airborne requirements.

Ground systems

Technology is available. It consists in implementing the relevant set of AIDC messages in flight data processing and could use the ground network standard AFTN-AMHS or ATN. Europe is presently implementing it in ADEXP format over IP wide area networks.

The technology also includes for oceanic ATSUs a function supporting transfer of communication via data link.

Human factors considerations

Ground interoperability reduces voice exchange between ATCOs and decreases workload. A system supporting appropriate human-machine interface (HMI) for ATCOs is required.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the HMI has been considered from both a functional and ergonomic perspective (see Section 6 for examples). The possibility of latent failures, however, continues to exist and vigilance is required during all implementation activity. In addition it is important that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

To make the most of the automation support, training in the operational standards and procedures will be required and can be found in the links to the documents in Reference Documents and Guidance material section

of this module. Likewise, the qualifications requirements are identified in the regulatory requirements in the Regulatory/standardization needs and Approval Plan (Air AND Ground) section which are integral to the implementation of this module**.**

Regulatory/standardization needs and approval plan (air AND ground)

Regulatory/standardization: use current published criteria that include:

a) ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*; and
b) EU Regulation, EC No 552/2004.

Approval plans: to be determined based on regional consideration of ATS interfacility data communications (AIDC).

Reference documents and guidance material

- ICAO Doc 4444, *Procedures for Air Navigation Services* **-** *Air Traffic Management*, Appendix 6 **-** *ATS Interfacility Data Communications (AIDC) Messages*

- ICAO Doc 9880, *Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols*, Part II — *Ground-Ground Applications — Air Traffic Services Message Handling Services (ATSMHS).*
- ICAO Doc 9694, *Manual of Air Traffic Services Data Link Applications;* Part 6;
- GOLD Global Operational Data Link Document (APANPIRG, NAT SPG), June 2010;
- Pan Regional Interface Control Document for Oceanic ATS Interfacility Data Communications (PAN ICD) Coordination Draft Version 0.3. 31 August 2010;
- Asia/Pacific Regional Interface Control Document (ICD) for ATS Interfacility Data Communications (AIDC) available at http://www.bangkok.icao.int/edocs/icd_aidc_ver3.pdf, ICAO Asia/Pacific Regional Office.
- EUROCONTROL Standard for On-Line Data Interchange (OLDI); and EUROCONTROL Standard for ATS Data Exchange Presentation (ADEXP).

Procedures

To be determined.

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-25: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. AIDC
2. (Not included in the Module but added here as they are closely linked to this Module) AMHS/IPS</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- A set of AIDC messages in FDPS
- AFTN (AMHS/IPS)</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator:
Percentage of ATS units with AIDC

2. Indicator:
States implementing AMHS/IPS</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases.</td><td><u>KPA-Efficiency</u>
The reduced separation can also be used to more frequently offer aircraft flight levels closer to the optimum; in certain cases, this also translates into reduced en-route holding.</td><td><u>KPA-Environment</u>
Not Applicable</td><td><u>KPA-Safety</u>
Better knowledge of more accurate flight plan information.

.</td></tr>
</table>

B0-30: Service Improvement through Digital Aeronautical Information Management

Introduction

The Eleventh Air Navigation Conference (2003) recommended the urgent adoption of a common aeronautical exchange model which took into account operational systems and concepts of data interchange, including specifically aeronautical information conceptual model/aeronautical information exchange model (AICM/AIXM), and addressed their mutual interoperability.

The move from aeronautical information service (AIS) to aeronautical information management (AIM), and from paper to electronic media, is already well supported by standardized formats based on widely used information technology standards (UML, XML/GML) operating on commonplace technology products and electronic storage.

The expectations are that the transition to AIM will not involve many changes in terms of the scope of information to be distributed. The major change will be the increased emphasis on data distribution, which should place the future AIM in a position to better serve airspace users and air traffic management (ATM) in terms of their information management requirements.

This module describes the planning to initial introduction of digital processing and management of information, through aeronautical information service (AIS)/aeronautical information management (AIM) implementation, use of aeronautical information exchange model (AIXM), migration to electronic aeronautical information publication (AIP) and better quality and availability of data.

In the short- to medium-term, the focus is on the continuing transition of the services provided by aeronautical information services (AIS) from a product-centred, paper-based and manually-transacted focus to a digitally-enabled, network-centred and service-oriented aeronautical information management (AIM) focus. AIM envisages a migration to a data centric environment where aeronautical data will be provided in a digital form and in a managed way.

Baseline

The baseline is the traditional provision of aeronautical information, based on paper publications and NOTAMs.

AIS information provided by SAM States has traditionally been based on paper documents and text messages (NOTAM) and maintained and distributed as such. In spite of manual verifications, this did not always prevent errors or inconsistencies. In addition, the information had to be transcribed from paper to automated ground and airborne systems, thus introducing additional risks. Finally, the timeliness and quality of required information updates could not always be guaranteed.

Change brought by the module

This module continues the transition of AIS from traditional product provision to a digitally enabled service oriented environment with information exchange utilizing standardized formats based on widely used information technology standards (UML, XML/GML). This will be supported by industrial products and stored on electronics devices. Information quality is increased, as well as that of the management of aeronautical information in general. The AIP moves from paper to electronic support.

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

This implementation reduces costs in terms of data inputs and checks, paper and post, especially when considering the overall data chain, from originators, through AIS to the end users. It also reduces the time necessary to promulgate information concerning airspace status that allow for more effective airspace utilization and allow improvements in trajectory management.

There is an essential contribution to interoperability and safety also, due to the reduction in the number of possible inconsistencies, reducing a several number of manual entries and ensures consistency among data through automatic data checking based on commonly agreed business rules.

The business case for the aeronautical information conceptual model (AIXM) has been conducted in Europe and in the United States and has shown to be positive. The initial investment necessary for the provision of digital AIS data may be reduced through regional cooperation and it remains low compared with the cost of other ATM systems. The transition from paper products to digital data is a critical pre-requisite for the implementation of any current or future ATM or air navigation concept that relies on the accuracy, integrity and timeliness of data.

Necessary procedures (air and ground)

No new procedures for air traffic control are required, but the process for AIS needs to be revisited. To obtain the full benefit, new procedures will be required for data users in order to retrieve the information digitally, for example, to allow airlines provide digital AIS data to on-board devices, in particular electronic flight bags (EFBs).

Avionics

No avionics requirements.

Ground systems

The aeronautical information is made available to AIS through digital processes and to external users via either a subscription to an electronic access or physical delivery; the electronic access can be based on Internet protocol services. The physical support does not need to be standardized. The main automation functions that need to be implemented to support provision of electronic AIS are the national aeronautical data, NOTAM (both national and international) and meteorological management including data collection, verification and distribution.

Human factors considerations

The automated assistance is well accepted and proven to reduce errors in manual transcription of data.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human- machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failure however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training is required for AIS/AIM personnel.

Regulatory/standardization needs and approval plan (air and ground)

- Regulatory/standardization: current published requirements
- Approval plans: to be determined, based upon regional applications.

Reference documents and guidance material

- ICAO Doc 8126, *Aeronautical Information Services Manual*, including AIXM and eAIP as per Third Edition
- ICAO Doc 8697, *Aeronautical Chart Manual*
- *Roadmap for the Transition from AIS to AIM*
- Manuals on AIM quality system and AIM training.

Note: Further changes to ICAO Annex 15 – *Aeronautical Information Services* are in preparation.

Procedures

In preparation.

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-30: Service Improvement through Digital Aeronautical Information Management</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. AIXM
2. eAIP
3. Digital NOTAM
4.(Not included in the Module but added here as they are closely linked to this Module)
WGS-84; eTOD; and QMS for AIM</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
AIXM; eAIP and Digital NOTAM
WGS-84; eTOD; QMS for AIM
The aeronautical information is made available to external users via either a subscription to an electronic access or physical delivery; The electronic access can be based on Internet protocol services.</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator:
States implementing AIXM; eAIP, Digital NOTAM WGS-84; eTOD; QMS for AIM</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Not Applicable</td><td><u>KPA-Efficiency</u>
Not Applicable</td><td><u>KPA-Environment</u>
Reduced amount of paper for promulgation of information</td><td><u>KPA-Safety</u>
Reduction in the number of possible inconsistencies</td></tr>
</table>

<u>B0-105: Meteorological information supporting enhanced operational efficiency and safety</u>

General

Elements 1 to 3 of this module illustrate the meteorological information made available by world area forecast centers (WAFC), volcanic ash advisory centers (VAAC) and tropical cyclone advisory centers (TCAC) that can be used by the air traffic management (ATM) community to support dynamic and flexible management of airspace, improved situational awareness and collaborative decision making, and (in the case of WAFS forecasts) dynamically-optimized flight trajectory planning.

Elements 4 and 5 of this module illustrate the meteorological information issued by aerodrome meteorological offices in the form of aerodrome warnings, wind shear warnings and alerts (including those generated by automated meteorological systems) that contribute to improving safety and maximizing runway capacity. In some instances, the systems used for the detection of wind shear (such as ground based LIDAR) have proven utility in wake turbulence detection and tracking/monitoring, and thus also support the improving safety and maximizing runway capacity from a wake turbulence encounter prevention perspective. Additionally Element 6 of this module describes SIGMET which is meteorological information provided by a Meteorological Watch Office (WMO) on severe observed or expected events of turbulence, icing thunderstorm, volcanic ash, etc. that are considered an immediate hazard to aircraft en-route.

It should be recognized that elements 1 to 6 herein represent a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety. Other such meteorological information that is not described here includes, for example, meteorological observations, reports and forecasts, aircraft observations and reports, and aeronautical climatological information.

Baseline

WAFCs within the framework of the world area forecast system (WAFS) prepare global gridded forecasts of upper wind, upper-air temperature and humidity, geopotential altitude of flight levels, flight level and temperature of tropopause, direction, speed and flight level of maximum wind, cumulonimbus clouds, icing, and clear-air and in-cloud turbulence. These global gridded forecasts are issued 4-times per day, with fixed time validity T+0 to T+36 at 3-hour time-steps. In addition, the WAFCs prepare global forecasts of significant weather (SIGWX) phenomena in binary code form. These global forecasts of SIGWX phenomena are issued 4-times per day, with validity at T+24. The United Kingdom and United States are designated as WAFC provider States. Accordingly, WAFCs London and Washington make available the aforementioned forecasts on the ICAO Aeronautical Fixed Service (AFS).

VAACs within the framework of the International Airways Volcano Watch (IAVW) respond to a notification that a volcano has erupted, or is expected to erupt or volcanic ash is reported in its area of responsibility. The VAACs monitor relevant satellite data to detect the existence and extent of volcanic ash in the atmosphere in the area concerned, and activate their volcanic ash numerical trajectory/dispersion model in order to forecast the movement of any ash cloud that has been detected or reported. In support, the VAACs also use surface-based observations and pilot reports to assist in the detection of volcanic ash. The VAACs issue advisory information (in plain language textual form and graphical form) concerning the extent and forecast movement of the volcanic ash cloud, with fixed time validity T+0 to T+18 at 6-hour time-steps. The VAACs issue these forecasts at least every six hours until such time as the volcanic ash cloud is no longer identifiable from satellite data, no further reports of volcanic ash are received from the area, and no further eruptions of the volcano are reported. The VAACs maintain a 24-hour watch. Argentina, Australia, Canada, France, Japan, New Zealand, the United Kingdom and the United States are designated (by regional air navigation agreement) as the VAAC provider States. Accordingly, VAACs Buenos Aires, Darwin, Montreal, Toulouse, Tokyo, Wellington, London, Anchorage and Washington make available the aforementioned advisories on the ICAO AFS.

TCACs monitor the development of tropical cyclones in their area of responsibility, using relevant satellite data, meteorological radar data and other meteorological information. The TCACs are meteorological centres designated by regional air navigation agreement on the advice of the World Meteorological Organization (WMO). The TCACs issue advisory information (in plain language textual form and graphical form) concerning the position of the tropical cyclone center, its direction and speed of movement, central pressure and maximum surface wind near the center, with fixed time validity T+0 to T+24 at 6-hour time-steps. The TCACs issue updated advisory information for each tropical cyclone, as necessary, but at least every six hours. Australia, Fiji, France, India, Japan and the United States are designated (by regional air navigation agreement) as TCAC provider States. Aforementioned advisories are made available on the ICAO AFS, through TCACs located in Darwin, Nadi, La Reunion, New Delhi, Tokyo, Honolulu and Miami.

Aerodrome warnings provide concise information of observed or expected meteorological conditions that could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services.

Wind shear warnings are prepared for aerodromes where wind shear is considered a factor. Wind shear warnings give concise information on the observed or expected existence of wind shear which could adversely affect aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the runway during the landing roll or take-off run. Note that where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1 600 ft) above runway level, then 500 m (1,600 ft) is not to be considered restrictive.

SIGMETs are information that describes the location of specified en-route weather phenomena which may affect the safety of aircraft operations. SIGMETs are issued by MWOs for such phenomena as thunderstorms, turbulence, icing, mountain wave, radiation, volcanic ash and tropical cyclone. The latter two categories of SIGMETs are based on information provided in the appropriate advisories from the respective VAACs and TCACs.

Change brought by the module

The global availability of meteorological information as provided with the framework of the WAFS and IAVW enhances the pre-tactical and/or tactical decision making for aircraft surveillance, air traffic flow management and flexible/dynamic aircraft routing. Similar information is also provided by TCACs and MWOs in support of ATM decisions. The locally-arranged availability of aerodrome warnings, wind shear warnings and alerts (where wind shear is considered a factor), contributes to improved safety and maximized runway capacity during adverse meteorological conditions. Wind shear detection systems can, in some instances, be utilized for wake turbulence detection and tracking/monitoring.

Change brought by the module

The global availability of meteorological information as provided with the framework of the WAFS and IAVW enhances the pre-tactical and/or tactical decision making for aircraft surveillance, air traffic flow management and flexible/dynamic aircraft routing. Similar information is also provided by TCACs and MWOs in support of ATM decisions. The locally-arranged availability of aerodrome warnings, wind shear warnings and alerts (where wind shear is considered a factor), contributes to improved safety and maximized runway capacity during adverse meteorological conditions. Wind shear detection systems can, in some instances, be utilized for wake turbulence detection and tracking/monitoring.

Element 1: WAFS

The WAFS is a worldwide system within which two designated WAFCs provide aeronautical meteorological en-route forecasts in uniform standardized formats. The grid point forecasts are prepared by the WAFCs in a regular grid with a horizontal resolution of 1.25 degrees of latitude and longitude, and issued in binary code form using the GRIB code form as prescribed by WMO. The significant weather (SIGWX) forecasts are issued by the WAFCs in accordance with the provisions in Annex 3 — Meteorological Service for International Air Navigation (Chapter 3 and Appendix 2) in binary code form using the BUFR code form prescribed by WMO and in PNG-chart form as formalized backup means. ICAO administers the WAFS with the cooperation of the WAFC provider States and concerned international organizations through the World Area Forecast System Operations Group (WAFSOPSG).

Element 2: IAVW

The IAVW ensures international arrangements for monitoring and providing advisories to MWOs and aircraft operators of volcanic ash in the atmosphere. The advisories support the issuance of SIGMET on these events by the respective MWOs. The IAVW is based on the cooperation of aviation and non-aviation operational units using information derived from observing sources and networks that are provided by States for the detection of volcanic ash in the atmosphere. The forecasts issued by the nine designated VAACs are in plain language text and PNG chart form. The advisory information on volcanic ash is prepared by VAACs in accordance with Annex 3 (Chapter 3 and Appendix 2). ICAO administers the IAVW with the cooperation of the VAAC provider States and concerned international organizations through the International Airways Volcano Watch Operations Group (IAVWOPSG). Additionally, ICAO recognizes the importance of State volcano observatories as part of the world organization of volcano observatories in their role or providing information on the pre-eruption and eruption of volcanoes.

Element 3: Tropical cyclone watch

TCAC, per regional air navigation agreement, monitor the formation, movement and degradation of tropical cyclones. The forecasts issued by the TCACs are in plain language text and graphical form. The advisory information on tropical cyclones is prepared by TCACs in accordance with Annex 3 (Chapter 3 and Appendix 2). The advisories support the issuance of SIGMET on these events by the respective MWOs.

Element 4: Aerodrome warnings

Aerodrome warnings give concise information of meteorological conditions that could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. Aerodrome warnings are issued in accordance with Annex 3 (Chapter 7 and Appendix 6) where required by operators or aerodrome services. Aerodrome warnings should relate to the occurrence or expected occurrence of one or more of the following phenomena: tropical cyclone, thunderstorm, hail, snow, freezing precipitation, hoar frost or rime, sandstorm, dust-storm, rising sand or dust, strong surface wind and gusts, squall, frost, volcanic ash, tsunami, volcanic ash deposition, toxic chemicals, and other phenomena as agreed locally. Aerodrome warnings are issued usually for validity periods of not more than 24 hours. Aerodrome warnings are disseminated within the aerodrome in accordance with local arrangements to those concerned, and should be cancelled when the conditions are no longer occurring and/or no longer expected to occur at the aerodrome.

Element 5: Wind shear warnings and alerts

Wind shear warnings are prepared for aerodromes where wind shear is considered a factor, issued in accordance with Annex 3 (Chapter 7 and Appendix 6) and disseminated within the aerodrome in accordance with local arrangements to those concerned. Wind shear conditions are normally associated with the following phenomena: thunderstorms, microbursts, funnel cloud (tornado or waterspout), and gust fronts, frontal surfaces, strong surface winds coupled with local topography; sea breeze fronts, mountain waves (including low-level rotors in the terminal area) and low-level temperature inversions.

At aerodromes where wind shear is detected by automated, ground-based, wind shear remote-sensing or detection equipment, wind shear alerts generated by these systems are issued (updated at least every minute). Wind shear alerts give concise, up-to-date information related to the observed existence of wind shear involving a headwind/tailwind change of 7.5 m/s (15 kt) or more which could adversely affect aircraft on the final approach path or initial take-off path and aircraft on the runway during the landing roll or take-off run.

In some instances, the systems used for the detection of wind shear have proven utility in wake turbulence detection and tracking/monitoring. This may prove especially beneficial for congested and/or complex aerodromes (e.g. close parallel runways) since ground-based LIDAR at an aerodrome can serve a dual purpose – i.e. wake vortices are an issue when wind shear is not.

Element 6: SIGMET

SIGMETs are information issued by each State‘s MWO for their respective FIR and/or CTA. SIGMETs are messages that describe the location of specified en-route weather phenomena which may affect the safety of aircraft operations. SIGMETs are typically issued for thunderstorms, turbulence, icing, mountain wave, volcanic ash, tropical cyclones and radiation.

Intended performance operational improvement/metric to determine success

Optimized usage of airspace capacity, thus achieving arrival and departure rates.

Reduction in costs through reduced arrival and departure delays (viz. reduced fuel burn).

Harmonized arriving air traffic (en-route to terminal area to aerodrome) and harmonized departing air traffic (aerodrome to terminal area to en-route) will translate to reduced arrival and departure holding times and thus reduced fuel burn.

Reduced fuel burn through optimized departure and arrival profiling/scheduling.

Supports pre-tactical and tactical arrival and departure sequencing and thus dynamic air traffic scheduling.

Gate-to-gate seamless operations through common access to, and use of, the available WAFS, IAVW and tropical cyclone watch forecast information.

Common understanding of operational constraints, capabilities and needs, based on expected (forecast) meteorological conditions.

Decreased variance between the predicted and actual air traffic schedule.

Increased situational awareness and improved consistent and collaborative decision-making.

Necessary procedures (air and ground)

No new procedures necessary.

Necessary system capability

Avionics

No new or additional avionics requirements and brought about by this module.

Ground systems

ANSPs, airport operators and airspace users may want to implement functionalities allowing them to display in plain text or graphical format the available meteorological information. For Block 0, airspace users may use their AOC data link connection to the aircraft to send the meteorological information where appropriate

Human factors considerations

General statements on the impact on operational functions.

This module will not necessitate significant changes in how air navigation service providers and users access and make use of the available meteorological information today.

Training and qualification requirements

No new or additional training and qualification requirements are brought about by this module.

Reference documents

- ICAO and Industry Standards (i.e. MOPS, MASPS, SPRs)
- ICAO and World Meteorological Organization (WMO) international standards for meteorological information (including, content, format, quantity, quality, timeliness and availability)

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-105: Meteorological information supporting enhanced operational efficiency and safety</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. WAFS-IAVW-TCW
2. Aerodrome warning, wind shear warning and alerts
3. SIGMET information</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- Connection to the AFS satellite and public Internet distribution systems
- Connection to the AFTN
- Local arrangements for reception of aerodrome warning ,wind shear warning and alerts</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1 Indicator:
States implementation of SADIS 2G satellite broadcast and/or Secure SADIS FTP service.

2. Indicator:
States implementation of WAFS Internet File Service (WIFS)</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Optimized usage of airspace and aerodrome capacity due to MET support</td><td><u>KPA-Efficiency</u>
Reduced arrival/departure holding time, thus reduced fuel burn due to MET support</td><td><u>KPA-Environment</u>
Reduced emissions due to reduced fuel burn due to MET support</td><td><u>KPA-Safety</u>
Reduced incidents/accidents in flight and at international aerodromes due to MET support.</td></tr>
</table>

PERFORMANCE IMPROVEMENT AREA 3: OPTIMUM CAPACITY AND FLEXIBLE FLIGHTS – THROUGH GLOBAL COLLABORATIVE ATM

B0-10: Improved Operations through Enhanced En-Route Trajectories

Introduction

This module is applicable to en-route and terminal airspace. Benefits can start locally. The larger the size of the concerned airspace the greater the benefits, in particular for flex track aspects. Benefits accrue to individual flights and flows. This will allow greater routing possibilities, reducing potential congestion on trunk routes and busy crossing points, resulting in reduced flight length and fuel burn.

In many areas, flight routings offered by air traffic services (ATS) are static and are slow to keep pace with the rapid changes of users operational demands, especially for long-haul city-pairs. In certain parts of the world, legacy regional route structures have become outdated and are becoming constraining factors due to their inflexibility.

The navigational capabilities of modern aircraft make a compelling argument to migrate away from the fixed route structure towards a more flexible alternative. Constantly changing upper winds have a direct influence on fuel burn and, proportionately, on the carbon footprint. Therein lies the benefit of daily flexible routings. Using what is already available on the aircraft and within air traffic control (ATC) ground systems, the move from fixed to flex routes can be accomplished in a progressive, orderly and efficient manner.

Baseline

The baseline for this module is varying from a State/region to the next. However, while some aspects have already been the subject of local improvements, the baseline generally corresponds to an airspace organization and management function which is at least in part characterized by: individual State action, fixed route network, permanently segregated areas, conventional navigation or limited use of area navigation (RNAV), rigid allocation of airspace between civil and military authorities. Where it is the case, the integration of civil and military ATS has been a way to eliminate some of the issues, but not all.

In many areas, flight routings offered by air traffic services (ATS) are static and are slow to keep pace with the rapid changes of users operational demands, especially for long-haul city-pairs. In certain parts of the region, regional route structures have become outdated and are becoming constraining factors due to their inflexibility that affect inclusive other States.

Change brought by the module

This module is aimed at improving the profiles of flights in the en-route phase through the deployment and full application of procedures and functionalities on which solid experience is already available, but which have not been systematically exploited and which are of a nature to make better use of the airspace.

The module is the opportunity to exploit performance-based navigation (PBN) capabilities in order to eliminate design constraints and operate more flexibly, while facilitating the overall handling of traffic flows.

The module is made of the following elements:

a) airspace planning: possibility to plan, coordinate and inform on the use of airspace. This includes collaborative decision-making (CDM) applications for en-route airspace to anticipate on the knowledge of the airspace use requests, take into account preferences and inform on constraints;
b) flexible use of airspace (FUA) to allow both the use of airspace otherwise segregated, and the reservation of suitable volumes for special usage; this includes the definition of conditional routes; and
c) f lexible routing (flex tracking): route configurations designed for specific traffic pattern. This module is a first step towards more optimized organization and management of the airspace but which would require more sophisticated assistance. Initial implementation of PBN, RNAV for example, takes advantage of existing ground technology and avionics and allows extended collaboration of air navigation service providers (ANSPs) with partners: military, airspace users, neighboring States.

Element 1: Airspace planning

Airspace planning entails activities to organize and manage airspace prior to the time of flight. Here it more specifically refers to activities to improve the strategic design by a series of measures to better know the anticipated use of the airspace and adjust the strategic design by pre-tactical or tactical actions.

Element 2: Flexible use of airspace (FUA)

Flexible use of airspace is an airspace management concept according to which airspace should not be designated as either purely civil or purely military airspace, but should be considered as one continuum in which all users‘ requirements have to be accommodated to the maximum extent possible. There are activities which require the reservation of a volume of airspace for their exclusive or specific use for determined periods, owing to the characteristics of their flight profile or their hazardous attributes and the need to ensure effective and safe separation from non-participating air traffic. Effective and harmonized application of FUA needs clear and consistent rules for civil/military coordination which should take into account all users‘requirements and the nature of their various activities. Efficient civil/military coordination procedures should rely on rules and standards to ensure efficient use of airspace by all users. It is essential to further cooperation between neighboring States and to take into account cross border operations when applying the concept of FUA.

Where various aviation activities occur in the same airspace but meet different requirements, their coordination should seek both the safe conduct of flights and the optimum use of available airspace.
Accuracy of information on airspace status and on specific air traffic situations and timely distribution of this information to civil and military controllers has a direct impact on the safety and efficiency of operations.

Timely access to up-to-date information on airspace status is essential for all parties wishing to take advantage of airspace structures made available when filing or re-filing their flight plans.

The regular assessment of airspace use is an important way of increasing confidence between civil and military service providers and users and is an essential tool for improving airspace design and airspace management.

FUA should be governed by the following principles:

a) coordination between civil and military authorities should be organized at the strategic, pre-tactical and tactical levels of airspace management through the establishment of agreements and procedures in order to increase safety and airspace capacity, and to improve the efficiency and flexibility of aircraft operations;
b) consistency between airspace management, air traffic flow management and air traffic services should be established and maintained at the three levels of airspace management in order to ensure, for the benefit of all users, efficiency in airspace planning, allocation and use;
c) the airspace reservation for exclusive or specific use of categories of users should be of a temporary nature, applied only during limited periods of time-based on actual use and released as soon as the activity having caused its establishment ceases;
d) States should develop cooperation for the efficient and consistent application of the concept of FUA across national borders and/or the boundaries of flight information regions, and should in particular address cross-border activities; this cooperation shall cover all relevant legal, operational and technical issues; and
e) ATS units and users should make the best use of the available airspace.

Element 3: Flexible routing

Flexible routing is a design of routes (or tracks) designed to match the traffic pattern and other variable factors such as meteorological conditions. The concept, used over the North-Atlantic since decades can be expanded to address seasonal or week end flows, accommodate special events, and in general better fit the meteorological conditions, by offering a set of routes which provide routings closer to the user preferences for the traffic flows under consideration.

When already in place, flex tracks systems can be improved in line with the new capabilities of ATM and aircraft, such as PBN and automatic dependent surveillance (ADS).

Convective meteorological conditions, particularly deep convection associated with towering cumulus and/or cumulonimbus clouds, causes many delays in today‘s system due to their hazardous nature (severe icing, severe turbulence, hail, thunderstorms, etc.), often-localized nature and the labor intensive voice exchanges of complex reroutes during the flight. New data communications automation will enable significantly faster and more efficient delivery of reroutes around such convective activity. This operational improvement will expedite clearance delivery resulting in reduced delays and miles flown during convective meteorological conditions.

Intended Performance Operational Improvement

Metrics to determine the success of the module are proposed in the Manual on Global Performance of the Air Navigation System (Doc 9883).

This module support a better access to airspace by a reduction of the permanently segregated volumes.

In terms of capacity the availability of a greater set of routing possibilities allows reducing potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations. This in turn allows reducing controller workload by flight.

The different elements concur to trajectories closer to the individual optimum by reducing constraints imposed by permanent design. In particular the module will reduce flight length and related fuel burn and emissions. The potential savings are a significant proportion of the ATM related inefficiencies. The module will reduce the number of flight diversions and cancellations. It will also better allow avoiding noise sensitive areas.

Some of the benefits include: reduced flight operating costs, reduced fuel consumption, more efficient use of airspace (access to airspace outside of fixed airway structure), reduced carbon footprint, and reduced controller workload.

Necessary procedures (air and ground)

Required procedures exist for the main. They may need to be complemented by local practical guidance and processes; however, the experience from other regions can be a useful reference source to be customized to the local conditions.

The development of new and/or revised ATM procedures is automatically covered by the definition and development of listed elements. However, given the interdependencies between some of the modules, care needs to be taken so that the development of the required ATM procedures provides for a consistent and seamless process across these modules.

The airspace requirements (RNAV, RNP and the value of the performance required) may require new ATS procedures and ground system functionalities. Some of the ATS procedures required for this module are linked with the processes of notification, coordination and transfer of control, supported by messages exchange (Module B0-25).

Element 1: Airspace planning

See general remarks above.

Element 2: FUA

The ICAO Civil/Military Cooperation in Air Traffic Management (Cir 330) offers guidance and examples of successful practices of civil and military cooperation. It realizes that successful cooperation requires collaboration that is based on communication, education, a shared relationship and trust.

FUA regional guidance developed for SAM Region.

Element 3: Flexible routing

A number of operational issues and requirements will need to be addressed to enable harmonized deployment of flex route operations in a given area such as:

a) some adaptation of letters of agreement;

b) revised procedures to consider the possibility of transfer of control at other than published fixes;
c) use of latitude/longitude or bearing and distance from published fixes, as sector or flight information region (FIR) boundary crossing points;
d) review of controller manuals and current operating practices to determine what changes to existing practices will need to be developed to accommodate the different flows of traffic which would be introduced in a flex route environment;
e) specific communication and navigation requirements for participating aircraft will need to be identified;

f) developing procedures that will assist ATC in applying separation minima between flights on the fixed airway structure and flex routes both in the strategic and tactical phases;
g) procedure to cover the transition between the fixed network and the flex route airspace both horizontally and vertically. In some cases, a limited time application (e.g. during night) of flex route operations could be envisaged. This will require modification of ATM procedures to reflect the night traffic patterns and to enable the transition between night flex route operations and daytime fixed airway operations; and
h) training package for ATC.

Necessary system capability

Avionics

Deployment of PBN is ongoing. The benefits provided to flights can facilitate its dissemination, but it will remain linked to how aircraft can fly.

Dynamic re-routing can require aircraft connectivity (Aircraft communication addressing and reporting system (ACARS)) to its flight operating center for flight tracking and the up-load of new routes computed by the FOC flight planning system (FPS), and possibly FANS 1/A capability for the exchange of clearance with ATC.

Ground systems

Technology is available. Even CDM can be supported by a form of internet portal. However, since aviation operations are global, standardization of the information and its presentation will be increasingly required (see thread 30 on SWIM).

Basic FUA concept can be implemented with the existing technology. Nevertheless for a more advanced use of conditional routes, a robust collaborative decision system will be required including function for the processing and display of flexible or direct routes containing latitude/longitude. In addition to published fixes a coordination function is also needed and may need specific adaptations to support transfer of control over non published points.

Enhanced FPS today are predicated on the determination of the most efficient flight profile. The calculations of these profiles can be driven by cost, fuel, time, or even a combination of the factors. All airlines deploy FPS at different levels of sophistication and automation in order to assist flight dispatchers/planners to verify, calculate and file flight plans.

Additionally, the flight dispatcher would need to ensure the applicability of over-flight permissions for the over-flown countries. Regardless of the route calculated, due diligence must always be exercised by the airline in ensuring that NOTAMs and any restrictive flight conditions will always be checked and validated before a flight plan is filed. Further, most airlines are required to ensure a flight following or monitoring program to update the crews with any changes in the flight planning assumptions that might have changed since the first calculation was made.

Human factors considerations

The roles and responsibilities of controller/pilot are not affected. However, human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

The required training is available and the change step is achievable from a human factors perspective. Training in the operational standards and procedures are required for this module. Likewise, the qualifications requirements are identified in the regulatory requirements which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: use current published requirements.

Approval plans: to be determined, based upon regional applications.

Element 1: Airspace planning

See general remarks above.

Element 2: FUA

Until today, the Article 3 of the Chicago Convention expressly excludes the consideration of State aircraft from the scope of applicability.

Exemption policies for specific State aircraft operations and services are currently used as a method to cope with the discrepancy of civil and military aviation needs. Some States already realize that for State aircraft a solution lays in an optimum compatibility to civil aviation, although military requirements have to be met.

ICAO provisions related to coordination between civil and military in support to the flexile use of airspace can be found in several annexes, PANS and manuals.

Annex 11 — Air Traffic Services allows States to delegate responsibility for the provision of ATS to another State. However, States retain sovereignty over the airspace so delegated, as confirmed by their adherence to the Chicago Convention. This factor may require additional effort or coordination in relation to civil/military cooperation and an appropriate consideration in bilateral or multilateral agreements.

Element 3: Flexible routing

LoA: Letters of agreement (LoA) might be revised to reflect the specificities of flex route operations. Local hand-off procedures, timings and frequency allocations must be clearly detailed. Allocation schemes are also useful in designing major unidirectional flows, such as the EUR-Caribbean flows.

Common enabler: PBN procedures

Within an airspace concept, PBN requirements will be affected by the communication, surveillance and ATM environments, the navaid infrastructure, and the functional and operational capabilities needed to meet the ATM application. PBN requirements also depend on what reversionary, non-RNAV means of navigation are available and what degree of redundancy is required to ensure adequate continuity of functions.

The selection of the PBN specification(s) for a specific area or type of operation has to be decided in consultation with the airspace users. Some areas need only a simple RNAV to maximize the benefits, while other areas such as nearby steep terrain or dense air traffic may require the most stringent RNP. International public standards for PBN are still evolving. International PBN is not widespread. According to the ICAO/IATA Global PBN Task Force, international air traffic management and state flight standards rules and regulations lag behind airborne capability.

There is a need for worldwide harmonization of RNP requirements, standards, procedures and practices, and common flight management system functionality for predictable and repeatable RNP procedures, such as fixed radius transitions, radius-to-fix legs, required time of arrival (RTA), parallel offset, VNAV, 4D control, ADS-B, data link, etc.

A safety risk management document may be required for every new or amended procedure. That requirement will extend the time required to implement new procedures, especially PBN-based flight procedures.

Reference documents and guidance material

- ICAO Doc 4444, Procedures for Air Navigation Services -Air Traffic Management, Chapter 5
- ICAO Doc 9426, Air Traffic Services Planning Manual
- ICAO Doc 9554, Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations
- ICAO Doc 9613, Performance-based Navigation (PBN) Manual
- ICAO Doc 9689, Manual on Airspace Planning Methodology for the Determination of Separation Minima
- ICAO CDM and ATFM (under development) Manual
- ICAO Doc 9554, Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations
- ICAO Circular 330 AN/189, Civil/Military Cooperation in Air Traffic Management

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-10: Improved Operations through Enhanced En-Route Trajectories</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. Airspace planning
2. Flexible Use of airspace
3. Flexible Routing</td><td colspan="2"><u>Equipage/Air</u>
- FANS 1/A and ACARS</td><td colspan="2"><u>Equipage/Ground</u>
- CDM through Internet portal</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: Percentage of time segregated airspaces are available for civil operations in the State

2. Indicator: Percentage of PBN routes implemented</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Better access to airspace by a reduction of the permanently segregated volumes of airspace.</td><td><u>KPA-Capacity</u>
Flexible routing reduces potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations.</td><td><u>KPA-Efficiency</u>
In particular the module will reduce flight length and related fuel burn and emissions. The module will reduce the number of flight diversions and cancellations. It will also better allow avoiding noise sensitive areas.</td><td><u>KPA-Environment</u>
Fuel burn and emissions will be reduced.</td><td><u>KPA-Safety</u>
Not Applicable</td></tr>
</table>

B0-35: Improved Flow Performance through Planning based on a Network-Wide view

General

The techniques and procedures brought by this module capture the experience and state-of-the-art of the current air traffic flow management (ATFM) systems in place in some regions, and which have developed as they were facing demand-capacity imbalances. Global ATFM seminars and bi-lateral contacts have allowed the dissemination of good practices.

Experience clearly shows the benefits related to managing flows consistently and collaboratively over an area of a sufficient geographical size to take into account sufficiently well the network effects. The concept for ATFM and demand and capacity balancing (DCB) should be further exploited wherever possible. System improvements are also about better procedures in these domains, and creating instruments to allow collaboration among the different actors.

Overall, to meet the objectives of balancing demand and capacity, keeping delays to a minimum and avoiding congestion, bottlenecks and overload, ATFM undertakes flow management in three broad phases. Each flight will usually have been subjected to these phases, prior to being handled operationally by ATC.

Strategic ATFM activity takes place during the period from several months until a few days before a flight. During this phase, comparison is made between the expected air traffic demand and the potential ATC capacity. Objectives are set for each ATC unit in order for them to provide the required capacity. These objectives are monthly reviewed in order to minimize the impact of the missing capacity on the airspace users. In parallel, an assessment of the number and routings of flights, which aircraft operators are planning, enables ATFM to prepare a routing scheme, balancing the air traffic flows in order to ensure maximum use of the airspace and minimize delays.

Pre-tactical ATFM is action taken during the few days before the day of operation. Based on the traffic forecasts, the information received from every ATC center covered by the ATFM service, statistical and historical data, the ATFM notification message (ANM) for the next day is prepared and agreed through a collaborative process. The ANM defines the tactical plan for the next (operational) day and informs aircraft operators (AOs) and ATC units about the ATFM measures that will be in force on the following day. The purpose of these measures is not to restrict but to manage the flow of traffic in a way that minimizes delay and maximizes the use of the entire airspace.

Tactical ATFM is the work carried out on the current operational day. Flights taking place on that day receive the benefit of ATFM, which includes the allocation of individual aircraft departure times, re-routings to avoid bottlenecks and alternative flight profiles to maximize efficiency.

ATFM has also progressively been used to address system disruptions and evolves into the notion of management of the performance of the Network under its jurisdiction, including management of crises provoked by human or natural phenomena.

Baseline

The need for ATFM has emerged as traffic densities increased, and it took form progressively. It is observed that this need is now spreading progressively over all continents, and that even where overall capacity is not an issue, the efficient management of flows through a given volume of airspace deserves a specific consideration at a scale beyond that of a sector or an ACC, in order to better plan resources, anticipate on issues and prevent undesired situations.

Change brought by the module

ATFM has developed progressively over the last thirty years. It is noticeable that key steps have been necessary to be able to predict traffic loads for the next day with a good accuracy, to move from measures defined as rate of entry into a given piece of airspace (and not as departure slots) to measures implemented before take-off and taking into account the flows/capacities in a wider area.

More recently the importance of proposing alternative routings rather than only a delay diagnosis has been recognized, thereby also preventing over-reservations of capacity. ATFM services offer a range of web-based or business to business services to ATC, airports and aircraft operators, actually implementing a number of CDM applications.

In order to regulate flows, ATFM may take measures of the following nature:

a) departure slots ensuring that a flight will be able to pass the sectors along its path without generating overflows;
b) rate of entry into a given piece of airspace for traffic along a certain axis;
c) requested time at a way-point or an FIR/sector boundary along the flight;
d) miles-in-trail figures to smooth flows along a certain traffic axis;
e) re-routing of traffic to avoid saturated areas;
f) sequencing of flights on the ground by applying departure time intervals (MDI);
g) level capping; and
h) delaying of specific flights on the ground by a few minutes ("take-off not before").

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the *Manual on Global performance of the Air Navigation System* (Doc 9883).

This module improved access by avoiding disruption of air traffic in periods of demand higher than capacity and ATFM processes take care of equitable distribution of delays.

It provides a better utilization of available capacity, network-wide; in particular the trust of ATC not being faced by surprise to saturation tends to let it declare/use increased capacity levels; ability to anticipate difficult situations and mitigate them in advance.

Reduced fuel burn due to better anticipation of flow issues; a positive effect to reduce the impact of inefficiencies in the ATM system or to dimension it at a size that would not always justify its costs (balance between cost of delays and cost of unused capacity). It also reduces block times and times with engines on.

The reduced fuel burn as delays are absorbed on the ground, and the predictability of schedules as the ATFM algorithms tends to limit the number of large delays impact positively in environment.

The reduced occurrences of undesired sector overloads improve safety.

The business case has proven to be positive due to the benefits that flights can obtain in terms of delay reduction.

Necessary procedures (air and ground)

An ICAO guidance material on ATFM is being developed and need to be completed and approved. US/Europe experience is enough to help initiate application in other regions.

New procedures are required to link much closer the ATFM with ATS in the case of using miles-in-trail or Arrival management or Departure management (see Module B0-15).

Necessary system capability

Avionics

No avionics requirements.

Ground systems

When serving several FIRs, ATFM systems are generally deployed as a specific unit, system and software connected to the ATC units and airspace users to which it provides its services. Regional ATFM units have been the subject of specific developments. The main functions for ATFM systems are: demand and capacity balancing, performance measurements and monitoring, network operations plan management and traffic demand management.

Human factors considerations

Controllers are protected from overloads and have a better prediction of their workload. ATFM does not interfere in real-time with their ATC tasks. However, human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective (See Section 6 for examples). The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Flow managers in the flow management unit and controllers in area control centres (ACCs) using the remote flow management information or applications needs specific training and airline dispatchers using the remote flow management information or applications need training.

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: new standards and requirements is required for standard ATFM messages.

Approval plans: to be determined.

Reference documents and guidance material

- CAR/SAM ATFM and CDM Manual.
- ICAO CDM and ATFM (under development) Manual.

Module summary

Title of the Module: B0-35: Improved Flow Performance through Planning based on a Network-Wide view					
Elements: Air Traffic Flow Management		Equipage/Air - Nil		Equipage/Ground - System software for ATFM	
Implementation monitoring and intended performance impact					
Implementation progress 1. Indicator: *Percentage of ATS units using ATFM services.*	Qualitative performance benefits associated with five main KPAs only				
	KPA-Access/Equity Improved Access and equity in the use of airspace or aerodrome by avoiding disruption of air traffic. ATFM processes take care of equitable distribution of delays.	KPA-Capacity Better utilization of available capacity, ability to anticipate difficult situations and mitigate them in advance.	KPA-Efficiency Reduced fuel burn due to better anticipation of flow issues; Reduced block times and times with engines on.	KPA-Environment Reduced fuel burn as delays are absorbed on the ground, with shut engines; or at optimum flight levels through speed or route management..	KPA-Safety Reduced occurrences of undesired sector overloads

B0-84: Initial capability for ground surveillance

General

The surveillance service delivered to users may be based on a mix of three main types of surveillance as defined in the ICAO *Aeronautical Surveillance Manual* (Doc 9924):

a) independent non-cooperative surveillance: The aircraft position is derived from measurement not using the cooperation of the remote aircraft;
b) independent cooperative surveillance: The position is derived from measurements performed by a local surveillance subsystem using aircraft transmissions. Aircraft-derived information (e.g. pressure altitude, aircraft identity) can be provided from those transmissions; and
c) dependent cooperative surveillance: The position is derived on board the aircraft and is provided to the local surveillance subsystem along with possible additional data (e.g. aircraft identity, pressure altitude). 1.1.2 The module describes the dependent/cooperative and independent/cooperative surveillance services.

Baseline

Currently, air to ground aircraft position and surveillance is accomplished through the use of primary, secondary radar surveillance, voice position report, ADS-C and CPDLC, etc. The primary surveillance radar derives aircraft position based on radar echo returns. The secondary radar is used to transmit and receive aircraft data for barometric altitude, identification code. However, current primary and secondary radars cannot be easily sited in oceanic locations, or rough terrain such as in mountainous regions, and have a heavy reliance on mechanical components with large maintenance requirements.

Change brought by the module

This module introduces the opportunity to expand ATC radar equivalent service with two new surveillance techniques that can be used, separately or jointly: ADS-B and MLAT. These techniques provide alternatives to classic radar technology at a lower implementation and maintenance cost, thereby allowing the provision of surveillance services in areas where they are currently not available for geographical or cost reasons. These techniques also allow, in certain conditions, a reduction of separation minima thereby potentially increasing the ability to accommodate larger volumes of traffic.

Element 1: ADS-B

Dependent surveillance with accurate position sources such ADS-B is recognized as one of the important enablers of several of the ATM operational concept components including traffic synchronization and conflict management (Recommendation 1/7, AN-Conf/11, 2003). The transmission of ADS-B information (ADS-B OUT) is already used for surveillance in some non-radar areas (Block 0).

Dependent surveillance is an advanced surveillance technology that allows avionics to broadcast an aircraft's identification, position, altitude, velocity, and other information. The broadcast aircraft position is more accurate than with conventional secondary surveillance radar (SSR) because it is normally based on the global navigation satellite system (GNSS) and transmitted at least once per second. The inherent accuracy of the GPS determined position and the high update rate will provide service providers and users improvements in safety, capacity, and efficiency.

Note.– ADS-B is dependent upon having a source of required positional accuracy (such as global navigation satellite system (GNSS) today).

Operationally, the lower costs of dependent surveillance ground infrastructure in comparison to conventional radars support business decisions to expand radar equivalent service volumes and the use of radar-like separation procedures into remote or non-radar areas. In addition to lower costs, the non-mechanical nature of the ADS-B ground infrastructure allows it to be sited in locations that are difficult for radar installations.

Use of dependent surveillance also improves the search and rescue support provided by the surveillance network. In non-radar areas, ADS-B's positional accuracy and update rate allows for improved flown trajectory tracking allowing for early determination of loss of contact and enhances the ability for search and rescue teams to pinpoint the related location.

Additionally, dependent surveillance information can be an enabler for sharing of surveillance data across FIR boundaries and significantly improves the performance of predictive tools using aircraft derived velocity vector and vertical rate data. This is particularly useful to support safety net tools. It also downlinks other useful ATC relevant data similar to Mode S DAPS.

ADS-B OUT Standards and Recommended Practices (SARPs) (ICAO Annex 10 — *Aeronautical Telecommunications* , Volume IV — S*urveillance and Collision Avoidance Systems* and the *Manual on Technical Provisions for Mode S Services and Extended Squitter* (Doc 9871)) and MOPS (RTCA-DO260-B/Eurocae ED102-A) are available. AN-Conf/11 recommended ADS-B on 1090MHz for international use and this is happening. Equipage rate is growing together with Mode S, airborne collision avoidance system (ACAS) and ADS-B OUT mandates. ADS-B OUT, Version 2 also provides for ACAS RA DOWNLINK information in support of monitoring activities currently only possible in secondary surveillance radar (SSR) Mode S coverage.

Element 2: Multilateration (MLAT)

MLAT technique is a new technique providing independent cooperative surveillance. Its deployment is made easier by the use of airborne mode S equipment capability with the spontaneous transmission of messages (squitters). In this case the signal transmitted by aircraft is received by a network of receivers located at different places. The use of the different times of arrival at the different receivers allows an independent determination of the position of the source of signals. In theory this technique can be passive and use the existing transmissions made by the aircraft or be active and trigger replies in the manner of Mode S SSR interrogations. Conventional Mode A/C transponders respond when they are interrogated.

MLAT systems were initially deployed on main airports to make the surveillance of aircraft on the surface. The technique is now used to provide surveillance over wide area (wide area MLAT system - WAM). MLAT requires more ground stations than ADS-B and reliable linked network and has large geometric requirements than ADS-B, but has the early implementation advantage of using current Mode A/C aircraft equipage.

Intended performance operational improvement/metric to determine success

This module contributes to Safety reducing the number of major incidents and support to search and rescue services. It also contributes to the capacity in areas of traffic density compared to procedural minima.

Improved coverage, capacity, velocity vector performance and accuracy can improve ATC performance in both radar and non radar environments. Terminal area surveillance performance improvements are achieved through high accuracy, better velocity vector and improved coverage.

Comparison between procedural minima and 5 NM separation minima would allow an increase of traffic density in a given airspace; or comparison between installing/renewing SSR Mode S stations using Mode S transponders and installing ADS-B OUT (and/or MLAT systems) could be used in cost benefit analysis.

Necessary procedures (air and ground)

The relevant *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) provisions are available.

Necessary system capability

Avionics

For ADS-B surveillance services, aircraft must be equipped with ADS-B OUT. Accuracy and integrity are reported from the avionics. Users of the data decide on the required accuracy and integrity for the application.

For MLAT, aircraft need to be equipped with Mode S radar transponders.

Ground systems

Units providing surveillance services must be equipped with a ground-based surveillance data processing system able to process and display the aircraft positions. Connection to a flight data processing system allows positive identification by correlating positions and flight data.

Units may provide ADS-B surveillance in environments where there is full or partial avionics equipage depending on the capabilities and procedures of the air traffic control (ATC) system.

ATC systems must also be designed to enable the delivery of separation services between ADS-B-to-ADS-B and ADS-B-to-radar and fused targets.

Human factors considerations

The air traffic controller has a direct representation of the traffic situation, and reduces the task of controllers or radio operators to collate position reports.

Training and qualification requirements

Controllers must receive specific training for separation provision, information service and search and rescue based on the ADS-B and WAM systems in use.

Training in the operational standards and procedures are required for this module. Likewise, the qualifications requirements are identified in the regulatory requirements.

Reference documents and guidance material

- ICAO Annex 10 — *Aeronautical Telecommunications*, Volume IV □*Aeronautical Radio*
- *Frequency Spectrum Utilization*
- ICAO Doc 9828, *Report of the Eleventh Air Navigation Conference (2003)*
- ICAO Doc 9871, *Technical Provisions for Mode S Services and Extended Squitter*
- RTCA MOPS DO260 and DO260A EUROCAE ED102 and ED102A.
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 9924, *Aeronautical Surveillance Manual*
- ICAO *Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation* (Circular 326)
- ICAO Asia Pacific: ADS-B Implementation and Operations Guidance Document.

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-84: Initial capability for ground surveillance</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. ADS-B
2. Multilateration</td><td colspan="2"><u>Equipage/Air</u>
- ADS-B OUT.
- Mode S radar transponders for Multilateration</td><td colspan="2"><u>Equipage/Ground</u>
- FDPS and SDPS
- ADS-B
- Multilateration</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: Percentage of international aerodromes with ADS-B/MLAT</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Typical separation minima are 3 NM or 5 NM enabling an increase in traffic density compared to procedural minima.
TMA surveillance performance improvements are achieved through high accuracy, better velocity vector and improved coverage.</td><td><u>KPA-Efficiency</u>
Not Applicable</td><td><u>KPA-Environment</u>
Not Applicable</td><td><u>KPA-Safety</u>
Reduction of the number of major incidents. Support to search and rescue.</td></tr>
</table>

B0-101 ACAS improvement

General

This module is dealing with the short term improvements to the performance of the existing airborne collision avoidance system (ACAS). ACAS is the last resort safety net for pilots. Although ACAS is independent from the means of separation provision, ACAS is part of the ATM system.

Baseline

ACAS is subject to global mandatory carriage for airplanes with a MTCM greater than 5.7 tons. The current version of ACAS II is 7.0.

Change brought by the module

This module implements several optional improvements to airborne collision avoidance system in order to minimize "nuisance alerts" while maintaining existing levels of safety. The traffic alert and collision avoidance system (TCAS) version 7.1 introduces significant safety and operational benefits for ACAS operations.

Safety studies indicate that ACAS II reduces risk of mid-air collisions by 75% – 95% in encounters with aircraft that are equipped with either a transponder (only) or ACAS II respectively. ACAS II Standards and Recommended Practices (SARPs) are aligned with RTCA/EUROCAE MOPS.The SARPs and the MOPS have been upgraded in 2009/2010 to resolve safety issues and to improve operational performance. The RTCA DO185B and EUROCAE ED143 include these improvements also known as TCAS, v7.1.

The TCAS, v7.1 introduces new features namely the monitoring of own aircraft's vertical rate during a resolution advisory (RA) and a change in the RA annunciation from "Adjust Vertical Speed,Adjust" to "Level Off". It was confirmed that the new version of the CAS logic would definitely bring significant safety benefits, though only if the majority of aircraft in any given airspace are properly equipped. ICAO agreed to mandate the improved ACAS (TCAS, v7.1) for new installations as of 1/1/2014 and for all installations no later than 1/1/2017.

During a TCAS encounter, prompt and correct response to RAs is the key to achieve maximum safety benefits. Operational monitoring shows that pilots do not always follow their RA accurately (or do not follow at all). Roughly 20% of RAs in Europe are not followed.

TCAS safety and operational performance highly depends on the airspace in which it operates. Operational monitoring of TCAS shows that unnecessary RAs can occur when aircraft approach their cleared flight level separated by 1 000 ft with a high vertical rate. Roughly 50% of all RAs in Europe are issued in 1000 ft level-off geometries. AN-Conf/11 recognized the issue and requested to investigate automatic means to improve ATM compatibility.

In addition, two optional features can enhance ACAS performance:

a) coupling TCAS and auto-pilot/flight director to ensure accurate responses to RAs either automatically or manually thanks to flight director (APFD function); and
b) introduce a new altitude capture law to improve TCAS compatibility with ATM (TCAP function).

Intended Performance Operational Improvement

Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

Efficiency ACAS improvement will reduce unnecessary resolution advisory (RA) and then reduce trajectory deviations.
Safety ACAS increases safety in the case of breakdown of separation.
Cost Benefit Analysis TBD

Necessary Procedures (Air and Ground)

ACAS procedures are defined in PANS-ATM, Doc 4444 and in PANS-OPS, Doc 8168.
This evolution does not change procedures.

Necessary System Capability

Avionics

- RTCA DO185B / EUROCAE DO143 MOPS are available for TCAS implementation.
- RTCA DO325 Annex C is being modified to accommodate the 2 functions (APFD and TCAP).

Human Performance

Human factors considerations

ACAS performance is influenced by human behaviour. ACAS is a last resort function implemented on aircraft with a flight crew of two pilots. The operational procedures (PANS-OPS and PANS-ATM) have been developed and refined for qualified flight crews. Airbus has been able to certify the APFD function, which includes human factors aspects, on A380.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human machine interface has been considered from both a functional and ergonomic perspective (See Section 6 for examples). The possibility of latent failures however, continues to exist and vigilance is required during all implementation activity. It is further requested that human factor issues identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which are integral to the implementation of this module. Training guidelines are described in the *Airborne Collision Avoidance System (ACAS) Manual* (Doc 9863). Recurrent training is recommended.

Regulatory/standardization needs and Approval Plan
(Air and Ground)

Regulatory/standardization: use current published requirements that include the material given in Section 8.4. Approval plans: must be in accordance with application requirements e.g. EASA NPA 2010-03 requirement of 1/3/2012 for new installations and 1/12/2015 for all installations, or ICAO mandate of 1/1/2014 for new installations and 1/1/2017 for all installations.

Reference Documents

Standards

- ICAO Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport Aeroplanes*
- *ICAO* Annex 10 — *Aeronautical Telecommunications*, Volume IV - *Surveillance Radar and Collision Avoidance Systems* (Including Amendment 85- July 2010)
- EUROCAE ED-143/RTCA DO-185B, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II)
- RTCA DO-325, Minimum Operational Performance Standards (MOPS) for Automatic Flight
- Guidance and Control Systems and Equipment. Appendix C estimated 2013
- RTCA DO185B/EUROCAE DO143 MOPS for TCAS implementation

Procedures

- ICAO Doc 4444, *Procedures for Air Navigation Services - Air Traffic Management*
- ICAO Doc 8168, *Procedures for Air Navigation Services — Aircraft Operations*, Volume I — *Flight*.

Guidance material

- ICAO Doc 9863, *Airborne Collision Avoidance System (ACAS) Manual*

Approval documents

- FAA TSO-C119c.
- EASA ETSO-C119c.
- FAA AC120-55C.
- FAA AC20-151a.
- RTCA DO-185B, MOPS for TCAS II
- RTCA DO-325, Appendix C, for APFD and TCAP
- EUROCAE ED-143, MOPS for TCAS II

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-101: ACAS Improvements</td></tr>
<tr><td colspan="2"><u>Elements:</u>
ACAS II (TCAS version 7.1)</td><td colspan="2"><u>Equipage/Air</u>
- TCAS V7.1</td><td colspan="2"><u>Equipage/Ground</u>
Nil</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: Percentage of aircraft with ACAS, logic Version 7.1</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Not Applicable</td><td><u>KPA-Efficiency</u>
ACAS improvement will reduce unnecessary resolution advisory (RA) and then reduce trajectory deviations.</td><td><u>KPA-Environment</u>
Not Applicable</td><td><u>KPA-Safety</u>
ACAS increases safety in the case of breakdown of separation.</td></tr>
</table>

B0-102: Increased Effectiveness of Ground-Based Safety Nets

General

This module aims to implement a baseline set of ground-based safety nets. Ground-based safety nets are intended to assist the air traffic controller in generating, in a timely manner, alerts of an increased risk to flight safety (collision, unauthorized airspace penetration and controlled flight into terrain), which may include resolution advice.

Change brought by the module

Ground-based safety nets are functionalities of ATM systems that have the sole purpose of monitoring the environment of operations, during airborne phases of flight, in order to provide timely alerts of an increased risk to flight safety. Ground-based safety nets make an essential contribution to safety and remain required as long as the operational concept remains human centered.

Ground-based safety nets have been in use since the 1980s. Provisions for ground-based safety nets were introduced in PANS-ATM, Doc 4444 in the early 2000s. This module corresponds to a baseline version of the safety nets as already implemented or being implemented in many areas.

This element is intended to assist the controller, in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima. STCA must alert when the separation provision layer has been compromised but must also provide sufficient warning time to allow for corrective action, i.e. thus avoiding an airborne collision avoidance system (ACAS) resolution advisory (RA) will be generated. In some environments this necessitates the use of separation minima in STCA that are significantly lower than the separation minima used in the separation provision layer. STCA is only effective when each alert causes the controller to immediately assess the situation and if necessary take appropriate action.

There is presently no system compatibility between STCA (which advises of pending conflict to ATC only) and ACAS (which provides both advisory and mandatory resolution to the pilot only). However, both systems can complement each other and procedures need to be in place, that takes into account the limitations and advantages of each system.

Element 2: Area proximity warning (APW)

This element is intended to warn the controller, about unauthorized penetration of an airspace volume by generating, in a timely manner, an alert of a potential or actual infringement of the required spacing to that airspace volume. APW can be used to protect static, fixed airspace volumes (e.g. danger areas) but increasingly also dynamic, modular airspace volumes to enable flexible use of airspace.

Element 3: Minimum safe altitude warning (MSAW)

This element is intended to warn the controller, about increased risk of controlled flight into terrain accidents by generating, in a timely manner, an alert of aircraft proximity to terrain or obstacles. MSAW is only effective when each alert causes the controller to immediately assess the situation and if necessary take appropriate action.

Intended performance operational improvement/metric to determine success

In terms of safety this module contributes to the significant reduction of the number of major incidents.

The business case for this element is entirely made around safety and the application of ALARP (as low as reasonably practicable) in risk management.

The relevant PANS-ATM provisions exist. In addition they must regularly analyze the data and circumstances pertaining to each alert in order to identify and correct any shortcomings pertaining to ground-based safety nets, airspace design and ATC procedures.

Necessary system capability

Avionics

Aircraft should support cooperative surveillance using existing technology such as Mode C/S transponder or ADS-B out.

Ground systems

ATS units providing surveillance services must be equipped with the ground-based safety nets that are appropriate and optimized for their environment. Appropriate offline tools should be available to support the analysis of every safety alerts.

Human factors considerations

The generated alerts should normally be appropriate and timely, and the controller should understand under which circumstances interactions can occur with normal control practices or airborne safety nets. The two main issues from human performance are related to nuisance alerts which should be kept to a minimum and warning time for a genuine alert which should be high enough to support the completion of the procedure.

The use of ground-based safety nets will depend on the controller‘s trust. Trust is a result of many factors such as reliability and transparency. Neither mistrust nor complacency is desirable; training and experience is needed to develop trust at the appropriate level.

Training and qualification requirements

Controllers must receive specific ground-based safety nets training and be assessed as competent for the use of the relevant ground-based safety nets and recovery techniques.

Reference documents and guidance material

- PANS-ATM (Doc 4444), section 15.7.2 and 15.7.4
- EUROCONTROL Specifications for STCA, APW, MSAW and APM, available at http://www.EUROCONTROL.int/safety-nets

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-102: Increased Effectiveness of Ground-Based Safety Nets</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. Short Term Conflict Alert (STCA)
2. Area Proximity Warning (APW)
3. Minimum Safe Altitude Warning (MSAW)</td><td colspan="2"><u>Equipage/Air</u>
- SSR Mode C/S transponder
- ADS-B OUT</td><td colspan="2"><u>Equipage/Ground</u>
- Short Term Conflict Alert,
- Area Proximity Warnings and
- Minimum Safe Altitude Warnings</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator:
Percentage of ATS units with ground based safety nets</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Not Applicable</td><td><u>KPA-Efficiency</u>
Not Applicable</td><td><u>KPA-Environment</u>
Not Applicable</td><td><u>KPA-Safety</u>
Significant reduction of the number of major incidents.</td></tr>
</table>

PERFORMANCE IMPROVEMENT AREA 4: EFFICIENT FLIGHT PATH – THROUGH TRAJECTORY-BASED OPERATIONS

B0-05: Improved Flexibility and Efficiency in Descent Profiles (CDO)

Introduction

Flexibility in airspace design should realize further reductions in emissions and aircraft noise impacts and facilitate reduced separation and flow management to increase overall capacity in terminal areas. The stability and predictability of flight paths assist pilot and air traffic controllers decision-making. This module integrates with other airspace and procedures (continuous descent operations (CDO), performance-based navigation (PBN) and airspace management) to increase efficiency, safety, access and predictability.

As traffic demand increases, the challenges in terminal areas center on volume, hazardous meteorological conditions (such as severe turbulence and low visibility), adjacent airports and special activity airspace in close proximity whose procedures utilize the same airspace, and policies that limit capacity, throughput, and efficiency.

Traffic flow and loading (across ingress and egress routes) are not always well-metered, balanced or predictable. Obstacle and airspace avoidance (in the form of separation minima and criteria), noise abatement procedures, as well as wake encounter risk mitigation, tend to result in operational inefficiencies (e.g. added time or distance flown, thus more fuel).

Inefficient routing can also cause under-use of available airfield and airspace capacity. Finally, challenges are presented to States by serving multiple customers (international and domestic with various capabilities): the intermingling of commercial, business, general aviation and many times military traffic destined to airports within a terminal area that interact and at times inhibit each other‘s operations.

Baseline

The baseline for this module may vary from one State, to the next. Noted is the fact that some aspects of the movement to PBN have already been the subject of local improvements in many areas; and these areas and users are already realizing benefits.

Change brought by the module

Flight operations in many terminal areas precipitate the majority of current airspace delays in many States. Opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb and descent profiles, and increase capacity at the most congested areas should be a high-priority initiative in the near-term.

The core capabilities that should be leveraged are RNAV; RNP where needed; CDO; where possible, increased efficiencies in terminal separation rules in airspace; effective airspace design and classification; air traffic control (ATC) flow and ATC surveillance. Opportunities to reduce emissions and aircraft noise impacts should also be leveraged where possible.

Aircraft equipage is a significant contributor and the reliance on area navigation (RNAV) and required navigation performance (RNP) capabilities requires the continued development of PBN provisions as well as increased PBN implementation worldwide. ICAO provisions and guidance material are also necessary to support trajectory modelling and trajectory information exchange, and enhanced provisions for data link applications and messages will support exchange of trajectory data.

Element 1: Continuous descent operations

Continuous descent is one of several tools available to aircraft operators and ANSPs to benefit from existing aircraft capabilities and reduce noise, fuel burn and the emission of greenhouse gases. Over the years, different route models have been developed to facilitate CDO and several attempts have been made to strike a balance between the ideal of environmentally friendly procedures and the requirements of a specific airport or airspace.

CDO can provide for a reduction in fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots, without compromising the optimal airport arrival rate (AAR).

CDO is enabled by airspace design, procedure design and facilitation by ATC, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach fix/final approach point (FAF/FAP). An optimum CDO starts from the top-of-descent (TOD) and uses descent profiles that reduce controller-pilot communications and segments of level flight.

Furthermore it provides for a reduction in noise, fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots.

Element 2: Performance-based navigation

PBN is a global set of area navigation standards, defined by ICAO, based on performance requirements for aircraft navigating on departure, arrival, approach or en-route.

These performance requirements are expressed as navigation specifications in terms of accuracy, integrity, continuity, availability and functionality required for a particular airspace or airport.

PBN will eliminate the regional differences of various required navigation performance (RNP) and area navigation (RNAV) specifications that exist today. The PBN concept encompasses two types of navigation specifications:

a) RNAV specification: navigation specification-based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1; and

b) RNP specification: navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4.

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the Manual on Global Performance of the Air Navigation System (Doc 9883).

In terms of Efficiency cost savings and environmental benefits through reduced fuel burn and optimal management of the top-of-descent in the en-route airspace have a positive impact as well as the positive contribution on environment.

There is more predictability in more consistent flight paths and stabilized approach paths reducing the need for vectors and contributing on the ATC workload.

In addition the reduction in the incidence of controlled flight into terrain (CFIT) added to separation with the surrounding traffic and the reduction of number of conflicts contribute to safety also.

In terms of potential savings as a result of CDO implementation, it is important to consider that CDO benefits are heavily dependent on each specific ATM environment. Nevertheless, if implemented within the ICAO CDO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive.

Necessary procedures (air and ground)

The ICAO Continuous Descent Operations (CDO) Manual (Doc 9931) provides guidance on the airspace design, instrument flight procedures, ATC facilitation and flight techniques necessary to enable continuous descent profiles.

It therefore provides background and implementation guidance for:

a) air navigation service providers (ANSPs);
b) aircraft operators;
c) airport operators; and
d) aviation regulators.

The ICAO Performance-based Navigation (PBN) Manual (Doc 9613) provides general guidance on PBN implementation. This manual identifies the relationship between RNAV and RNP applications and the advantages and limitations of choosing one or the other as the navigation requirement for an airspace concept.

It also aims at providing practical guidance to States, ANSPs and airspace users on how to implement RNAV and RNP applications, and how to ensure that the performance requirements are appropriate for the planned application.

Necessary system capability

Avionics

CDO is an aircraft operating technique aided by appropriate airspace and procedure design and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, with low engine thrust settings and, where possible, a low drag configuration, thereby reducing fuel burn and emissions during descent.

The optimum vertical profile takes the form of a continuously descending path, with a minimum of level flight segments only as needed to decelerate and configure the aircraft or to establish on a landing guidance system (e.g. ILS).

The optimum vertical path angle will vary depending on the type of aircraft, its actual weight, the wind, air temperature, atmospheric pressure, icing conditions and other dynamic considerations.

Ground systems

Within an airspace concept, PBN requirements will be affected by the communication, surveillance and ATM environments, the NAVAID infrastructure and the functional and operational capabilities needed to meet the ATM application.

PBN performance requirements also depend on what reversionary, non-RNAV means of navigation are available and what degree of redundancy is required to ensure adequate continuity of functions. Ground automation needs initially little changes to support CDO: potentially a flag on the display. For better integration the ground trajectory calculation function will need to be upgraded.

Human factors considerations

The decision to plan for RNAV or RNP has to be decided on a case by case basis in consultation with the airspace user. Some areas need only a simple RNAV to maximize the benefits, while other areas such as nearby steep terrain or dense air traffic may require the most stringent RNP.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, are reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Since required navigation performance authorization required (RNP AR) approaches also require significant training, ANSPs should work closely with airlines to determine where RNP AR approach should be implemented. In all cases PBN implementation needs to be an agreement between the airspace user, the ANSP and the regulatory authorities.

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: use current published requirements that include the material given below. Approval plans: must be in accordance with application requirements e.g. airspace design, air traffic operations, PBN requirements for fixed radius transitions, radius-to-fix legs, required time of arrival (RTA), parallel offset, etc.

Reference documents and guidance material

- For flight plan requirements in Amendment 1, ICAO Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444).
- ICAO Doc 9613, Performance-based Navigation (PBN) Manual
- ICAO Doc 9931, Continuous Descent Operations (CDO) Manual
- SAM Advisory Circulars.

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-05: Improved Flexibility and Efficiency in Descent Profiles (CDO)</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. CDO
2. PBN STARs</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- Nil</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: Percentage of international aerodromes with CDO implemented

2. Indicator: Percentage of international aerodromes/TMAs with PBN STARs implemented</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Not Applicable</td><td><u>KPA-Efficiency</u>
Cost savings through reduced fuel burn.
Reduction in the number of required radio transmissions.</td><td><u>KPA-Environment</u>
Reduced emissions as a result of reduced fuel burn</td><td><u>KPA-safety</u>
More consistent flight paths and stabilized approach paths.
Reduction in the incidence of controlled flight into terrain (CFIT).</td></tr>
</table>

<u>B0-20: Improved Flexibility and Efficiency in Departure Profiles (CCO)</u>

Introduction

This module integrates with other airspace and procedures (PBN, continuous descent operations (CDO), and airspace management) to increase efficiency, safety, access and predictability; and minimize fuel use, emissions, and noise.

As traffic demand increases, the challenges in terminal areas center on volume, hazardous meteorological conditions (such as severe turbulence and low visibility), adjacent airports and special activity airspace in close proximity whose procedures utilize the same airspace, and policies that limit capacity, throughput, and efficiency.

Traffic flow and loading (across arrival and departure routes) are not always well metered, balanced or predictable. Obstacle and airspace avoidance (in the form of separation minima and criteria), noise abatement procedures and noise sensitive areas, as well as wake encounter risk mitigation, tend to result in operational inefficiencies (e.g. added time or distance flown, thus more fuel).

Inefficient routing can also cause under-use of available airfield and airspace capacity. Finally, challenges are presented to States by serving multiple customers (international and domestic with various capabilities): the intermingling of commercial, business, general aviation and many times military traffic destined to airports within a terminal area that interact and at times inhibit each other's operations.

Baseline

Flight operations in many terminal areas precipitate the majority of current airspace delays in many States. Opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb and descent profiles, and increase capacity at the most congested areas should be a high-priority initiative in the near-term.

The baseline for this module may vary from one State, region or location to the next. Noted is the fact that some aspects of the movement to PBN have already been the subject of local improvements in many areas; these areas and users are already realizing benefits.

The lack of ICAO PBN operational approval guidance material and subsequently the emergence of States or regional approval material, which may differ or be even more demanding than intended, is slowing down implementation and is perceived as one of the main roadblocks for harmonization.

There is still some work to be done to harmonize PBN nomenclature, especially in charts and States/regional regulations (e.g. most of European regulations still make use of basic area navigation (B-RNAV) and precision area navigation (P-RNAV).

Efficiency of climb profiles may be compromised by level off segments, vectoring, and an additional overload of radio transmissions between pilots and air traffic controllers. Existing procedure design techniques do not cater for current FMS capability to manage the most efficient climb profiles. There is also excessive use of radio transmissions due to the need to vector aircraft in an attempt to accommodate their preferred trajectories.

Change brought by the module

The core capabilities that should be leveraged are RNAV; RNP where possible and needed; continuous climb operations (CCO), increased efficiencies in terminal separation rules; effective airspace design and classification; and air traffic flow. Opportunities to reduce flight block times, fuel/emissions and aircraft noise impacts should also be leveraged where possible.

This module is a first step towards harmonization and a more optimized organization and management of the airspace. Many States will require knowledgeable assistance to achieve implementation. Initial implementation of PBN, RNAV for example, takes advantage of existing ground technology and avionics and allows extended collaboration of air navigation service providers (ANSPs) with partners: military, airspace users, and neighbouring States. Taking small and required steps and only performing what is needed or required allows States to rapidly exploit PBN.

Other remarks

Operating at the optimum flight level is a key driver to improve flight fuel efficiency and minimizing atmospheric emissions. A large proportion of fuel burn occurs in the climb phase and for a given route length, taking into account aircraft mass and the meteorological conditions for the flight, there will be an optimum flight level, which gradually increases as the fuel on-board is used up and aircraft mass therefore reduces. Enabling the aircraft to reach and maintain its optimum flight level without interruption will therefore help to optimize flight fuel efficiency and reduce emissions.

CCO can provide for a reduction in noise, fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots.

CCO is an aircraft operating technique aided by appropriate airspace and procedure design and appropriate air traffic control (ATC) clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, thereby reducing fuel burn and emissions during the climb portion of flight.

The optimum vertical profile takes the form of a continuously climbing path, with a minimum of level flight segments only as needed to accelerate and configure the aircraft.

The optimum vertical path angle will vary depending on the type of aircraft, its actual weight, the wind, air temperature, atmospheric pressure, icing conditions and other dynamic considerations.

A CCO can be flown with or without the support of a computer-generated vertical flight path (i.e. the vertical navigation (VNAV) function of the flight management system (FMS)) and with or without a fixed lateral path. The maximum benefit for an individual flight is achieved by allowing the aircraft to climb on the most efficient climb profile along the shortest total flight distance possible.

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the Manual on Global Performance of the Air Navigation System (Doc 9883).

An optimal management and efficient aircraft operating profiles with reduction in the number of required radio transmissions and lower pilot and air traffic control workload have a positive impact in terms of efficiency.

It is important to consider that CCO benefits are heavily dependent on each specific ATM environment. Nevertheless, if implemented within the ICAO CCO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive.

Necessary procedures (air and ground)

The ICAO *Performance-based Navigation (PBN) Manual* (Doc 9613) provides general guidance on PBN implementation.

This manual identifies the relationship between RNAV and RNP applications and the advantages and limitations of choosing one or the other as the navigation requirement for an airspace concept.

It also aims at providing practical guidance to States, ANSPs and airspace users on how to implement RNAV and RNP applications, and how to ensure that the performance requirements are appropriate for the planned application.

The ICAO *Continuous Climb Operations (CCO) Manual* (Doc xxxx – under development) provides guidance on the airspace design, instrument flight procedures, ATC facilitation and flight techniques necessary to enable continuous descent profiles.

It therefore provides background and implementation guidance for:

a) air navigation service providers;
b) aircraft operators;
c) airport operators; and d) aviation regulators.

Necessary system capability

Avionics

CCO does not require a specific air or ground technology. It is an aircraft operating technique aided by appropriate airspace and procedure design, and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, in which the aircraft can attain cruise altitude flying at optimum air speed with climb engine thrust settings set throughout the climb, thereby reducing total fuel burn and emissions during the whole flight. Reaching cruise flight levels sooner where higher ground speeds are attained can also reduce total flight block times. This may allow a reduced initial fuel upload with further fuel, noise and emissions reduction benefits.

The optimum vertical profile takes the form of a continuously climbing path. Any level or non-optimal reduced climb rate segments during the climb to meet aircraft separation requirements should be avoided. Achieving this whilst also enabling CDO is critically dependent upon the airspace design and the height windows applied in the instrument flight procedure. Such designs need an understanding of the optimum profiles for aircraft operating at the airport to ensure that the height windows avoid, to greatest extent possible, the need to resolve potential conflicts between the arriving and departing traffic flows through ATC height or speed constraints.

Ground systems

Controllers would benefit from some automation support to display aircraft capabilities in order to know which aircraft can do what.

Human factors considerations

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Training in the operational standards and procedures are required for this module and can be found in the links to the documents below.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: use current published requirements that include the guidance material

Approval plans: must be in accordance with application requirements.

Understanding the policy context is important for making the case for local CCO implementation and ensuring high levels of participation. CCO may be a strategic objective at international, State, or local level, and as such, may trigger a review of airspace structure when combined with CDO.

For example, noise contour production may be based on a specific departure procedure (noise abatement departure procedure 1 (NADP1) or NADP2-type). Noise performance can be improved in some areas around the airport, but it may affect existing noise contours elsewhere. Similarly CCO can enable several specific strategic objectives to be met and should therefore be considered for inclusion within any airspace concept or redesign. Guidance on airspace concepts and strategic objectives is contained in the Performance-based Navigation (PBN) Manual (Doc 9613).

Objectives are usually collaboratively identified by airspace users, ANSPs, airport operators as well as by government policy. Where a change could have an impact on the environment, the development of an airspace concept may involve local communities, planning authorities and local government, and may require formal impact assessment under regulations.

Such involvement may also be the case in the setting of the strategic objectives for airspace. It is the function of the airspace concept and the concept of operations to respond to these requirements in a balanced, forward-looking manner, addressing the needs of all stakeholders and not of one of the stakeholders only (e.g. the environment). Doc 9613, Part B, Implementation Guidance, details the need for effective collaboration among these entities.

In the case of a CCO, the choice of a departure procedure (NADP1 or NADP2-type), requires a decision of the dispersion of the noise. In addition to a safety assessment, a transparent assessment of the impact of CCO on other air traffic operations and the environment should be developed and made available to all interested parties.

Reference documents and guidance material

- *ICAO Doc 8168, Procedures for Air Navigation Services — Aircraft Operations*
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management Guidance Material*
- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc xxxx, *Continuous Climb Operations (CCO) Manual* (only in English yet)

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-20: Improved Flexibility and Efficiency in Departure Profiles (CCO)</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. CCO
2. PBN SIDs</td><td colspan="2"><u>Equipage/Air</u>
- Nil</td><td colspan="2"><u>Equipage/Ground</u>
- Nil</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator: Percentage of international aerodromes with CCO implemented

2. Indicator: Percentage of international aerodromes with PBN SIDs implemented</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
Not Applicable</td><td><u>KPA-Efficiency</u>
Cost savings through reduced fuel burn and efficient aircraft operating profiles.
Reduction in the number of required radio transmissions.</td><td><u>KPA-Environment</u>
Authorization of operations where noise limitations would otherwise result in operations being curtailed or restricted.
Environmental benefits through reduced emissions.</td><td><u>KPA-Safety</u>
More consistent flight paths.
Reduction in the number of required radio transmissions.
Lower pilot and air traffic control workload</td></tr>
</table>

B0-40: Improved Safety and Efficiency through the initial application of Data Link En-Route

Introduction

Air-ground data exchanges have been the subject of decades of research and standardization work and are an essential ingredient of the future operational concepts since they can carry reliably richer information than what can be exchanged over radio. This module covers what is available and can be used more widely now.

One element of the module is the transmission of aircraft position information, forming the automatic dependent surveillance contract (ADS-C), principally for use over oceanic and remote areas where radar cannot be deployed for physical or economic reasons.

A second element is controller pilot data link communications (CPDLC) comprising a first set of data link applications allowing pilots and controllers to exchange ATC messages concerning communications management, ATC clearances and stuck microphones. CPDLC reduces misunderstandings and controller workload giving increased safety and efficiency whilst providing extra capacity in the ATM system.

Baseline

Prior to this module, air-ground communications used voice radio (VHF or HF depending on the airspace), known for limitations in terms of quality, bandwidth and security. There are also wide portions of the region with no radar surveillance. ATC instructions, position reports and other information have to be transmitted through HF radios where voice quality is especially bad most of the time, leading to significant workload to controllers and pilots (including HF radio operators), poor knowledge of the traffic situation outside radar coverage, large separation minima, and misunderstandings. In high density airspace controllers currently spend 50% of their time talking to pilots on the VHF voice channels where frequencies are a scarce resource; this also represents a significant workload for controllers and pilots and generates misunderstandings.

Change brought by the module

The module concerns the implementation of a first package of data link applications, covering ADS-C, CPDLC and other applications for ATC. These applications provide significant improvement in the way ATS is provided as described in the next section.

At the moment, data link implementations are based on different standards, technology and operational procedures, although there are many similarities.

Element 1: ADS-C over oceanic and remote areas

ADS-C provides an automatic dependent surveillance service over oceanic and remote areas, through the exploitation of position messages sent automatically by aircraft over data link at specified time intervals. This improved situational awareness (in combination with appropriate PBN levels) is improving safety in general and allows reducing separations between aircraft and progressively moving away from pure procedural modes of control.

Element 2: Continental CPDLC

This application allows pilots and controllers to exchange messages with a better quality of transmission. In particular, it provides a way to alert the pilot when the microphone is stuck as well as a complementary means of communication. CPDLC is used as supplemental means of communications. Voice remains primary.

Over dense continental airspace, they can significantly reduce the communication load, allowing better task organization by the controller, in particular by not having to interrupt immediately to answer radio. They provide more reliability for the transmission and understanding of frequency changes, flight levels and flight information etc, thereby increasing safety and reducing the number of misunderstandings and repetitions.

Intended performance operational improvement

Metrics to determine the success of the module are proposed in the Manual on Global Performance of the Air Navigation System (Doc 9883).

Element 1: ADS-C over oceanic and remote areas

<u>Capacity</u>

A better localization of traffic and reduced separations allow increasing the offered capacity.

Efficiency

Routes/tracks and flights can be separated by reduced minima, allowing to apply flexible routings and vertical profiles closer to the user-preferred ones.

Flexibility

ADS-C permits to make route changes easier

Safety

Increased situational awareness; ADS-C based safety nets like cleared level adherence monitoring, route adherence monitoring, danger area infringement warning; better support to search and rescue.

Cost Benefit Analysis

The business case has proven to be positive due to the benefits that flights can obtain in terms of better flight efficiency (better routes and vertical profiles; better and tactical resolution of conflicts).

Element 2: Continental CPDLC

Capacity

Reduced communication workload and better organization of controller tasks allowing to increase sector capacity

Safety

Increased situational awareness; reduced occurrences of misunderstandings; solution to stuck microphone situations

Cost Benefit Analysis

It has to consider:

a) the benefits that flights can obtain in terms of better flight efficiency (better routes and vertical profiles; better and tactical resolution of conflicts); and
b) reduced controller workload and increased capacity.

Necessary procedures (air and ground)

Procedures have been described and are available in ICAO documents: *Manual of Air Traffic Services Data Link Applications* (Doc 9694) and the Global Operational Data Link Document (GOLD). Currently GOLD and LINK2000+ operational material is being merged, leading to an update of GOLD that allows global applicability, independent from airspace and technology.

Necessary system capability

Avionics

Standards for the enabling technology are available in ICAO documents and industry standards. Today, the existing data link implementations are based on two sets of ATS data link services: FANS 1/A and ATN B1, both will exist. FANS1/A is deployed in oceanic and remote regions whilst ATN B1 is being implemented in Europe according to European Commission legislation (EC Reg. No. 29/2009) – the data link services implementing rule.

These two packages are different from the operational, safety and performance standpoint and do not share the same technology but there are many similarities and can be accommodated together, thanks to the resolution of the operational and technical issues through workaround solutions, such as accommodation of FANS 1/A aircraft implementations by ATN B1 ground systems and dual stack (FANS 1/A and ATN B1) implementations in the aircraft.

Ground systems

For ground systems, the necessary technology includes the ability to manage ADS-C contract, process and display the ADS-C position messages. CPDLC messages need to be processed and displayed to the relevant ATC unit. Enhanced surveillance through multi-sensor data fusion facilitates transition to/from radar environment.

Human factors considerations

ADS-C is a means to provide the air traffic controller with a direct representation of the traffic situation, and reduces the task of controllers or radio operators to collate position reports. In addition to providing another channel of communications, the data link applications allow in particular air traffic controllers to better organize their tactical tasks. Both pilots and controllers benefit from a reduced risk of misunderstanding of voice transmissions.

Data communications allow reducing the congestion of the voice channel with overall understanding benefits and more flexible management of air-ground exchanges. This implies an evolution in the dialogue between pilots and controllers which must be trained to use data link rather than radio. Automation support is needed for both the pilot and the controller. Overall, their respective responsibilities will not be affected.

Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

Training and qualification requirements

Automation support is needed for both the pilot and the controller which therefore will have to be trained to the new environment and to identify the aircraft/facilities which can accommodate the data link services in mixed mode environments.

Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

Regulatory/standardization needs and approval plan (air and ground)

Regulatory/standardization: use current published requirements that include the guidance material. It should also be noted that new ICAO OPLINK OPS guidance material is under development.

Approval plans: must be in accordance with application requirements.

The GOLD ad hoc working group is working on an update of GOLD-Ed 1 in the framework of harmonization of procedures independent from airspace and technology.

Reference documents and guidance material

- ICAO Doc 9694, Manual of Air Traffic Services Data Link Applications.
- Global Operation Data Link Document (GOLD) Ed 2 (under development).
- Commission Regulation (EC) No 29/2009 of 16 January 2009 laying down requirements on data link services for the single European sky.
- EUROCAE ED-100A/RTCA DO-258A, Interoperability Requirements for ATS Applications using ARINC 622 Data Communications.
- EUROCAE ED-110B/RTCA DO-280B, Interoperability Requirements Standard for Aeronautical Telecommunication Network Baseline 1 (Interop ATN B1).
- EUROCAE ED-120/RTCA DO-290, Safety and Performance Requirements Standard for Initial Air Traffic Data Link Services In Continental Airspace (SPR IC).
- EUROCAE ED-122/RTCA DO-306, Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard).
- EUROCAE ED-154A/RTCA DO-305A, Future Air Navigation System 1/A – Aeronautical Telecommunication Network Interoperability Standard (FANS 1/A – ATN B1 Interop Standard).

Module summary

<table>
<tr><td colspan="6"><u>Title of the Module:</u>
B0-40: Improved Safety and Efficiency through the initial application of Data Link En-Route</td></tr>
<tr><td colspan="2"><u>Elements:</u>
1. ADS-C over oceanic and remote areas
2. Continental CPDLC</td><td colspan="2"><u>Equipage/Air</u>
- FANS 1/A; ATN B1</td><td colspan="2"><u>Equipage/Ground</u>
- ADS-C
- VDL Mode 2/Continental CPDLC</td></tr>
<tr><td colspan="6">Implementation monitoring and intended performance impact</td></tr>
<tr><td rowspan="2"><u>Implementation progress</u>
1. Indicator:
Number of ADS-C /CPDLC procedures available over oceanic and remote Areas</td><td colspan="5">Qualitative performance benefits associated with five main KPAs only</td></tr>
<tr><td><u>KPA-Access/ Equity</u>
Not Applicable</td><td><u>KPA-Capacity</u>
A better localization of traffic and reduced separation allow increased capacity.
Reduced communication workload and better organization of controller tasks allowing increasing sector capacity.</td><td><u>KPA-Efficiency</u>
Routes/tracks and flights can be separated by reduced minima, allowing to apply flexible routings and vertical profiles closer to the user-preferred ones.</td><td><u>KPA-Environment</u>
Reduced emissions as a result of reduced fuel burn.</td><td><u>KPA-afety</u>
ADS-C based safety nets supports cleared level adherence monitoring, route adherence monitoring, danger area infringement warning and improved search and rescue.
Reduced occurrences of misunderstandings; solution to stuck microphone situations.</td></tr>
</table>

ATTACHMENT E

AIR NAVIGATION REPORT FORM
HOW TO USE - EXPLANATORY NOTES

1. **Air Navigation Report Form (ANRF):** This form provides a standardized approach to implementation monitoring and performance measurement of Aviation System Block Upgrades (ASBU) Modules. The Planning and Implementation Regional Groups (PIRGs) and States could use this report format for their planning, implementation and monitoring framework for ASBU Modules. Also, other reporting formats that provide more details may be used but should contain as a minimum the elements described below. The Reporting and monitoring results will be analysed by ICAO and aviation partners and then utilized in developing the Annual Global Air Navigation Report. The Global Air Navigation Report conclusions will serve as the basis for future policy adjustments aiding safety practicality, affordability and global harmonization, amongst other concerns.

2. **Regional/National Performance objective:** In the ASBU methodology, the performance objective will be the title of the ASBU module itself. Furthermore, indicate alongside corresponding Performance Improvement area (PIA). Consequently, for ASBU Block 0, a total of 18 ANRFs will need to be developed that reflects respective 18 Modules.

3. **Impact on Main Key Performance Areas:** Key to the achievement of a globally interoperable ATM system is a clear statement of the expectations/benefits to the ATM community. The expectations/benefits are referred to eleven Key Performance Areas (KPAs) and are interrelated and cannot be considered in isolation since all are necessary for the achievement of the objectives established for the system as a whole. It should be noted that while safety is the highest priority, the eleven KPAs shown below are in alphabetical order as they would appear in English. They are access/equity; capacity; cost effectiveness; efficiency; environment; flexibility; global interoperability; participation of ATM community; predictability; safety; and security. However, out of these eleven KPAs, for the present, only five have been selected for reporting through ANRF, which are Access & Equity, Capacity, Efficiency, Environment and Safety. The KPAs applicable to respective ASBU module are to be identified by marking Y (Yes) or N (No).

4. **Implementation Progress:** This section indicates status of progress in the implementation of different elements of the ASBU Module for both air and ground segments.

5. **Elements related to ASBU module:** Under this section list elements that are needed to implement the respective ASBU Module. Furthermore, should there be elements that are not reflected in the ASBU Module (example: In ASBU B0-80/Airport CDM, Aerodrome certification and data link applications D-VOLMET, D-ATIS, D-FIS are not included; Similarly in ASBU B0-30/AIM, note that WGS-84 and eTOD are not included) but at the same time if they are closely linked to the module, ANRF should specify those elements. As a part of guidance to PIRGs/States, the FASID (Volume II) of every Regional ANP will have the complete list of all 18 Modules of ASBU Block 0 along with corresponding elements, equipage required on the ground and in the air as well as metrics specific to both implementation and benefits.

6. **Implementation Status (Ground/Air):** Planned implementation date (moth/year) and the current status/responsibility for each element are to be reported in this section. Please provide as much details as possible and should cover both avionics and ground systems. If necessary, use additional pages.

7. **Implementation Roadblocks/Issues**: Any problems/issues that are foreseen for the implementation of elements of the Module are to be reported in this section. The purpose of the section is to identify in advance any issues that will delay the implementation and if so, corrective action is to be initiated by the concerned person/entity. The four areas, under which implementation issues, if any, for the ASBU Module to be identified, are as follows:

- Ground System Implementation:
- Avionics Implementation:
- Procedures Availability:
- Operational Approvals:

Should be there no issues to be resolved for the implementation of ASBU Module, indicate as “NIL”.

8. **Performance Monitoring and Measurement:** Performance monitoring and measurement is done through the collection of data for the supporting metrics. In other words, metrics are quantitative measure of system performance – how well the system is functioning. The metrics fulfil three functions. They form a basis for assessing and monitoring the provision of ATM services, they define what ATM services user value and they can provide common criteria for cost benefit analysis for air navigation systems development. The Metrics are of two types:

A. Implementation Indicators/supporting metrics: This indicator supported by the data collected for the metric reflects the status of implementation of elements of the Module. For example- Percentage of international aerodromes with CDO implemented. This indicator requires data for the metric “number of international aerodromes with CDO”.

B. Benefit Metrics: This Metric allows to asses benefits accrued as a result of implementation of the module. The benefits or expectations, also known as Key Performance Areas (KPAs), are interrelated and cannot be considered in isolation since all are necessary for the achievement of the objectives established for the system as a whole. It should be noted that while safety is the highest priority, the eleven KPAs shown below are in alphabetical order as they would appear in English. They are access/equity; capacity; cost effectiveness; efficiency; environment; flexibility; global interoperability; participation of ATM community; predictability; safety; and security. However, out of these eleven KPAs, for the present, only five have been selected for reporting through ANRF, which are Access & Equity, Capacity, Efficiency, Environment and Safety. It is not necessary that every module contributes to all of the five KPAs. Consequently, a limited number of metrics per type of KPA, serving to measure the module(s)’ implementation benefits, without trying to apportion these benefits between module, have been identified at the end of this table. This approach would facilitate States in collecting data for the chosen metrics.

On the basis of examples of Performance Indicators/supporting Metrics detailed in this document, PIRGs/States to reflect under this section the appropriate metrics that represents the monitoring of respective ASBU Module both in terms of implementation as well as benefits to five KPAs.

The impact on KPAs could be extended to more than five KPAs mentioned above if maturity of the system allows and the process is available within the State to collect the data.

Performance Improvement Area 1:
Airport Operations

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-15: Improve Traffic Flow Through Runway Sequencing (AMAN/DMAN) **Performance Improvement Area 1: Airport Operations**					
ASBU B0-15: Impact on Main Key Performance Areas (KPA): KPA-02 – Capacity, KPA-04 – Efficiency, KPA-09 – Predictability, KPA-06 – Flexibility.					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	N	N

ASBU B0-15: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. AMAN and time based metering	Dec. 2015
2. Departure management	Dec. 2015
3. Movement Area Capacity Optimization	Dec. 2015 – Airport operator

ASBU B0-15: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. AMAN and time based metering	Lack of automation system to support synchronization	NIL	Lack of appropriate training. Lack of STARs PBN Lack of Slots assignment.	
2. Departure management	Lack of automation system to support synchronization	NIL	Lack of slots assignment. Lack of SIDs PBN Lack of appropriate training	
3. Movement Area Capacity Optimization	NIL	NIL	Lac of procedures for RWY, TWY & platform capacity calculation. Guidelines for movement area capacity optimization	NIL

ASBU B0-15: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. AMAN and time based metering	Indicator: Percentage of international aerodromes with AMAN and time based metering Supporting metric: Number of international airport with AMAN and time based metering
2. Departure management	Indicator: Percentage of international aerodromes with DMAN Supporting metric: Number of international airport DMAN
3. Movement Area Capacity Optimization	Indicator: percentage of international aerodromes with Airport-capacity calculated Supporting metric: Number of international aerodromes with Airport capacity calculated.

ASBU B0-15: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Not applicable.
Capacity	Increase airport movement area capacity through optimization.
Efficiency	Efficiency is positively impacted as reflected by increased runway throughput and arrival rates.
Environment	Not applicable.
Safety	Not applicable.

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-65: Optimization of Approach Procedures Including Vertical Guidance Performance Improvement Area 1: Airport Operations					
ASBU B0-65: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	Y

ASBU B0-65: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. APV with Baro VNAV	December 2016 – Service Providers and users
2. APV with SBAS	Not applicable
3. APV with GBAS	December 2018 – Initial implementation at some States (services providers)

ASBU B0-65: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground system Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. APV with Baro VNAV	NIL	Insufficient number of equipped aircraft	Insufficient appropriate training	Lack of appropriate training
2. APV with SBAS	Not Applicable	Not applicable	Not applicable	Not applicable
3. APV with GBAS	Lack of cost benefit analysis Adverse ionosphere	Insufficient number of equipped aircraft	Insufficient appropriate training	Lack of appropriate training Evaluation of a real operational requirement

ASBU B0-65: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. APV with Baro VNAV	Indicator: Percentage of international aerodromes having instrument runways provided with APV with Baro VNAV procedure implemented Supporting metric: Number of international airport having approved APV with Baro VNAV procedure implemented
2. APV with SBAS	Not Applicable

ASBU B0-65: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
3. APV with GBAS	Indicator: Percentage of international aerodromes having instrument runways provided with APV GBAS procedure implemented Supporting metric: Number of international airport having APV GBAS procedure implemented.

ASBU B0-65: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Increased aerodrome accessibility
Capacity	Increased runway capacity
Efficiency	Reduced fuel burn due to lower minima, fewer diversions, cancellations, delays
Environment	Reduced emissions due to reduced fuel burn
Safety	Increased safety through stabilized approach paths.

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-75: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2) **Performance Improvement Area 1:** **Airport operation**					
ASBU B0-75: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	Y

B0-75: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	June 2018 Service provider
2. Surveillance system on board (SSR transponder, ADS B capacity)	June 2018 Service Provider
3. Surveillance system for vehicle	June 2018 Service Provider
4. Visual aids for navigation	December 2015 Service Provider
5. Wild life strike hazard reduction	December 2015 Aerodrome operator/wildlife committee
6. Display and processing information	June 2018 Service Provider

ASBU B0-75: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	NIL	NIL	Lack of procedures and training	Lack of inspector for approvals operations
2. Surveillance system on board (SSR transponder ,ADS B capacity)	NIL	Lack of surveillance system on board (ADS B capacity) On general aviation and some commercial aircraft	Lack of procedures and training	NIL
3. Surveillance system for vehicle	NIL	NIL	Lack of procedures and training	NIL

ASBU B0-75: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
4. Visual aids for navigation	Implementation of new technologies (such as LED) not compliant with Annex 14	NIL	NIL	NIL
5. Wild life strike hazard reduction	NIL	NIL	Lack of Aerodrome Wildlife Committee	NIL

ASBU B0-75: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
6. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	Indicator: Percentage of international aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement Supporting metric: Number of international aerodrome with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement
7. Surveillance system on board (SSR transponder ,ADS B capacity)	Indicator: Percentage of surveillance system on board (SSR transponder, ADS B capacity) Supporting metric: Number of aircraft with surveillance system on board (SSR transponder ,ADS B capacity)
8. Surveillance system for vehicle	Indicator Percentage of international aerodromes with a cooperative transponder systems on vehicles Supporting metric: Number of vehicle with surveillance system installed
9. Visual aids for navigation	Indicator: Percentage of international aerodromes complying with visual aid requirements as per Annex 14 Supporting metric: Number of international aerodromes complying with visual aid requirements as per Annex 14
10. Wild life strike hazard reduction	Indicator: Percentage of reduction of wildlife incursions Supporting metric: Number of runway incursions due to wild life strike

ASBU B0-75: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Improves portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. Ensures equity in ATC handling of surface traffic regardless of the traffic's position on the international aerodrome
Capacity	Sustained level of aerodrome capacity during periods of reduced visibility
Efficiency	Reduced taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only. Reduced fuel burn
Environment	Reduced emissions due to reduced fuel burn
Safety	Reduced runway incursions. Improved response to unsafe situations. Improved situational awareness leading to reduced ATC workload

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-80: Improved Airport Operations through Airport - CDM Performance Improvement Area 1: Airport Operations					
ASBU B0-80: Impact on Main Key Performance Areas (KPA): KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment.					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	Y	N

ASBU B0-80: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Airport –CDM	Dec. 2015 – Airport Operator
2. Aerodrome certification	Dec 2018 – State CAA
3. Airport Planning	Dec. 2018 – State CAA
4. Heliport Operations	Dec. 2018 – State CAA

ASBU B0-80: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Airport –CDM	Interconnection of ground systems of different partners for Airport-CDM	NIL	NIL	NIL
2. Aerodrome certification	NIL	NIL	LAR AGA	NIL
3. Airport Planning	NIL	NIL	NIL	NIL
4. Heliport Operations	NIL	NIL	NIL	NIL

ASBU B0-80: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Airport –CDM	Indicator: Percentage of international aerodromes with Airport-CDM Supporting metric: Number of international aerodromes with Airport-CDM
2. Aerodrome certification	Indicator: Percentage of certified international aerodromes Supporting metric: Number of certified international aerodromes
3. Airport Planning	Indicator: Percentage of international aerodromes with Master Plans Supporting metric: Number of international aerodromes with Master Plans
4. Heliport Operations	Indicator: Percentage of Heliports with operational approval Supporting metric: Number of Heliports with operational approval

ASBU B0-80: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Enhanced equity on the use of aerodrome facilities.
Capacity	Enhanced use of existing Implementation of gate and stands (unlock latent capacity). Reduced workload, better organization of the activities to manage flights. Enhanced aerodrome capacity according with the demand
Efficiency	Improved operational efficiency (fleet management); and reduced delay. Reduced fuel burn due to reduced taxi time and lower aircraft engine run time. Improved aerodrome expansion in accordance with Master Plan
Environment	Reduced emissions due to reduced fuel burn
Safety	Not applicable

Performance Improvement Area 2:
Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-25: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration **Performance Improvement Area 2:** **Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management**					
ASBU B0-25: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	N	Y

ASBU B0-25: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Complete AMHS implementation at States still not counting with this system	December 2014 Services provider
2. AMHS interconnection	December 2014 Services provider
3. Implement AIDC /OLDI at SAM States automated centres	June 2014 Services provider
4. Implement operational AIDC/OLDI between adjacent ACC´s	June 2018 Services provider
5. Implement the new regional network (REDDIG II)	June 2014 Services provider

ASBU B0-25: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Complete AMHS implementation at States still not counting with this system	NIL	NIL	NIL	NIL
2. AMHS interconnection	TPDI negotiations between MTAs	NIL	NIL	NIL
3. Implement AIDC /OLDI at SAM States automated centres	NIL	NIL	NIL	NIL
4. Implement operational AIDC/OLDI between adjacent ACC´s	Compatibility between AIDC or OLDI systems from various manufacturers	NIL	NIL	NIL

ASBU B0-25: Implementation Roadblocks/Issues				
Elements	Implementation Area			
	Ground System Implementation	Avionics Implementation	Procedures Availability	Operational Approvals
5. Implement the new regional network (REDDIG II)	NIL	NIL	NIL	NIL

ASBU B0-25: Performance Monitoring and Measurement (Implementation)	
Elements	Performance Indicators/Supporting Metrics
1. Complete AMHS implementation at States still not counting with this system	Indicator: Percentage of States with AMHS implemented Supporting metric: Number of AMHS installed
2. AMHS interconnection	Indicator: Percentage of States with AMHS interconnected with other AMHS Supporting metric: Number of AMHS interconnections implemented
3. Implement AIDC /OLDI at SAM States automated centres	Indicator: Percentage of ATS units with AIDC or OLDI Supporting metric: Number of AIDC or OLDI systems installed
4. Implement operational AIDC/OLDI between adjacent ACC´s	Indicator: Percentage of ACCs with AIDC or OLDI systems interconnection implemented Supporting metric: Number of AIDC interconnections implemented, as per CAR/SAM FASID Table CNS 1Bb
5. Implement the new regional network (REDDIG II)	Indicator: Percentage of phases completed for the implementation of the new digital network Supporting metric: Number of REDDIG II implementation phase

ASBU B0-25: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	Benefits
Access & Equity	NIL
Capacity	Reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases
Efficiency	The reduced separation can also be used to more frequently offer aircraft flight levels closer to the optimum; in certain cases, this also translates into reduced en-route holding
Environment	NIL
Safety	Better knowledge of more accurate flight plan information

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-30: Service Improvement through Digital Aeronautical Information Management **Performance Improvement Area 2: Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management**					
ASBU B0-30: Impact on Main Key Performance Areas					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	N	Y	Y

ASBU B0-30: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. QMS for AIM	Dec.2015
2. e.TOD implementation	Dec.2016
3. WGS-84 implementation	Implemented
4. AIXM implementation	Dec.2018
5. E-AIP implementation	Dec.2015
6. Digital NOTAM	Dec. 2018

ASBU B0-30: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. QMS for AIM 2. e-TOD implementation 3. WGS-84 implementation 4. AIXM implementation 5. e-AIP implementation 6. Digital NOTAM	Lack of electronic Database. Lack of electronic access based on Internet protocol services.	NIL	Lack of procedures to allow airlines provide digital AIS data to on-board devices, in particular electronic flight bags (EFBs). Lack of training for AIS/AIM personnel.	NIL

ASBU B0-30: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. QMS for AIM	Indicator: % of States QMS Certified Supporting Metric: number of States QMS Certification
2. e-TOD implementation	Indicator: % of States e-TOD Implemented Supporting Metric: number of States with e-TOD Implemented
3. WGS-84 implementation	Indicator: % of States WGS-84 Implemented Supporting Metric: number of States with WGS-84 Implemented
4. AIXM implementation	Indicator: % of States with AIXM implemented Supporting Metric: number of States with AIXM implemented

ASBU B0-30: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
5. e-AIP implementation	Indicator: % of States with e-AIP Implemented Supporting Metric: number of States with e-AIP Implemented
6. Digital NOTAM	Indicator: % of States with Digital NOTAM Implemented Supporting Metric: number of States with Digital NOTAM Implemented

ASBU B0-30: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	NA
Environment	Reduced amount of paper for promulgation of information
Safety	Reduction in the number of possible inconsistencies

SAM AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – Module N° B0-105: Meteorological information supporting enhanced operational efficiency and safety Performance Improvement Area 2: Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management					
ASBU B0-105: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	Y	Y

ASBU B0-05: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. WAFS	In process of improvement
2. IAVW	In process of improvement
3. Tropical cyclone watch	In process of improvement
4. Aerodrome warnings	In process of improvement
5. Wind shear warnings and alerts	MET provider services / 2015
6. SIGMET	MET provider services / 2015
7. QMS/MET	MET provider services / 2018

ASBU B0-105: Meteorological information supporting enhanced operational efficiency and safety				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. WAFS	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A
2. IAVW	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A
3. Tropical cyclone watch	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A

ASBU B0-105: Meteorological information supporting enhanced operational efficiency and safety				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
4. Aerodrome warnings	Connection to the AFTN	Nil	Local arrangements for reception of aerodrome warnings	N/A
5. Wind shear warnings and alerts	Connection to the AFTN	Nil	Local arrangements for reception of wind shear warning and alerts	N/A
6. SIGMET	Connection to the AFTN	Nil	N/A	N/A
7. QMS/MET	Nil	Commitment of top management	N/A	N/A

ASBU B0-105: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. WAFS	Indicator: States implementation of WAFS Internet File Service (WIFS) Supporting metric: Number of States implementation of WAFS Internet File Service (WIFS)
2. IAVW	Indicator: Percentage of international aerodromes/MWOs with IAVW procedures implemented Supporting metric: Number of international aerodromes/MWOs with IAVW procedures implemented
3. Tropical cyclone watch	Indicator: Percentage of international aerodromes/MWOs with tropical cyclone watch procedures implemented Supporting metric: Number of international aerodromes/MWOs with tropical cyclone watch
4. Aerodrome warnings	Indicator: Percentage of international aerodromes/AMOs with Aerodrome warnings implemented Supporting metric: Number of international aerodromes/AMOs with Aerodrome warnings implemented
5. Wind shear warnings and alerts	Indicator: Percentage of international aerodromes/AMOs with wind shear warnings procedures implemented Supporting metric: Number of international aerodromes/AMOs with wind shear warnings and alerts implemented
6. SIGMET	Indicator: Percentage of international aerodromes/MWOs with SIGMET procedures implemented Supporting metric: Number of international aerodromes/MWOs with SIGMET procedures implemented
7. QMS/MET	Indicator: Percentage of MET Provider Sates with QMS/MET implemented Supporting metric: Number of MET Provider Sates with QMS/MET certificated

ASBU B0-105: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Not applicable
Capacity	Optimized usage of airspace and aerodrome capacity due to MET support
Efficiency	Reduced arrival/departure holding time, thus reduced fuel burn due to MET support
Environment	Reduced emissions due to reduced fuel burn due to MET support
Safety	Reduced incidents/accidents in flight and at international aerodromes due to MET support.

Performance Improvement Area3:
Optimum Capacity and Flexible Flights – Through Global Collaborative ATM

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – ASBU B0-10: Improved Operations through Enhanced En-Route Trajectories **Performance Improvement Area3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM**					
ASBU B0-10: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	N

ASBU B0 10: Implementation Progress	
Elements	**Implementation Status** **Air Ground**
1. Airspace planning	Dec.2018
2. Flexible Use of airspace	Dec. 2016
3. Flexible Routing	Dec. 2018

ASBU B0-10: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground system Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Airspace planning	Lack of organize and manage airspace prior to the time of flight Lack of AIDC		Lack of procedures	
2. Flexible Use of airspace	NIL		Lack of implementation FUA Guidance	
3. Flexible Routing	ADS-C/CPDLC	Lack of FANS 1/A Lack of ACARS	Lack of LOAs and procedures	Poor percentage of fleet approvals

B0-10: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Airspace planning	Not assigned Indicator and metrics.
2. Flexible Use of airspace	Indicator: % of time segregated airspaces are available for civil operations in the State Supporting Metric: Reduction of delays in time of civil flights.
3. Flexible Routing	Indicator: % of PBN routes implemented Supporting Metric: KG of Fuel savings Supporting Metric: Tons of CO2 reduction

ASBU B0-10: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Better access to airspace by a reduction of the permanently segregated volumes of airspace.
Capacity	Flexible routing reduces potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations.
Efficiency	In particular the module will reduce flight length and related fuel burn and emissions. The module will reduce the number of flight diversions and cancellations. It will also better allow avoiding noise sensitive areas.
Environment	Fuel burn and emissions will be reduced
Safety	NA

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – ASBU B0-35: Improved Flow Performance through Planning based on a Network-Wide view **Performance Improvement Area3:** **Optimum Capacity and Flexible Flights – Through Global Collaborative ATM**					
ASBU B0-35: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	Y

ASBU B0-35: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Air Traffic Flow Management	Dec. 2015

ASBU B0-35: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Air Traffic Flow Management	Lack of system software for ATFM Lack of ATFM units implemented	NIL	Lack of ATFM and CDM procedures Lack of training	

ASBU B0-35: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Air Traffic Flow Management	Indicator: % of implemented FMUs Support Metric: Number of States with ATFM units implemented.

ASBU B0-35: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Improved Access and equity in the use of airspace or aerodrome by avoiding disruption of air traffic. ATFM processes take care of equitable distribution of delays
Capacity	Better utilization of available capacity, ability to anticipate difficult situations and mitigate them in advance
Efficiency	Reduced fuel burn due to better anticipation of flow issues; Reduced block times and times with engines on
Environment	Reduced fuel burn as delays are absorbed on the ground, with shut engines; or at optimum flight levels through speed or route management
Safety	Reduced occurrences of undesired sector overloads

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – ASBU B0-84: Initial capability for ground surveillance Performance Improvement Area3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM					
ASBU B0-84: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	N	N	Y

ASBU B0-84: Implementation Progress	
Elements	**Implementation Status (Air Ground)**
1. Implementation of ADS B	June 2018 Users and service provider
2. Implementation of Multilateration	June 2018 Users and service provider
3. Automation system (Presentation)	Dec 2017 Users and service provider

ASBU B0-84: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Implementation of ADS B	Lack of ADS B systems implementation due to recent implementation of conventional surveillance systems	Lack of ADS B implementation in general aviation, and old commercial fleet	Lack of procedures	Lack of inspectors with appropriate capability
2. Implementation of multilateration	Facilities at remote stations Establishment of communications networks	NIL	NIL	Lack of inspectors with appropriate capability
3. Automation system (Presentation)	Lack of any automation functionality	NIL	NIL	NIL

B0-84: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Implementation of ADS B	Indicator: Percentage of international aerodromes with ADS-B implemented Supporting metric: Number of ADS B implemented
2. Implementation of Multilateration	Indicator: Percentage of multilateration system implemented Supporting metric: Number of multilateration system implemented
3. Automation system (Presentation)	Indicator: Percentage of ATS units with automation system implemented Supporting metric: Number of automation system implemented in ATS units

ASBU B0-84: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	Typical separation minima are 3 NM or 5 NM enabling an increase in traffic density compared to procedural minima TMA surveillance performance improvements are achieved through high accuracy, better velocity vector and improved coverage
Efficiency	NA
Environment	NA
Safety	Reduction of the number of major incidents. Support to search and rescue

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-101: ACAS Improvements Performance Improvement Area3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM					
ASBU B0-102: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	Y	N	Y

ASBU B0-101: Implementation Progress	
Elements	**Implementation Status (Air Ground)**
1. ACAS II (TCAS Version 7.1)	

ASBU B0-101: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. ACAS II (TCAS Version 7.1)				

ASBU B0-101: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. ACAS II (TCAS Version 7.1)	

ASBU B0-101: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	ACAS improvement will reduce unnecessary resolution advisory (RA) and then reduce trajectory deviations
Environment	NA
Safety	ACAS increases safety in the case of breakdown of separation

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-102: Increased Effectiveness of Ground-Based Safety Nets **Performance Improvement Area3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM**					
ASBU B0-102: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	N	N	Y

ASBU B0-102: Implementation Progress	
Elements	**Implementation Status (Air Ground)**
1. Short Term Conflict Alert (STCA)	June 2014 /Service Provider
2. Area Proximity Warning (APW)	June 2014 / Service Provider
3. Minimum Safe Altitude Warning (MSAW)	June 2014

ASBU B0-102: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Short Term Conflict Alert (STCA)	NIL	NIL	NIL	NIL
2. Area Proximity Warning (APW)	NIL	NIL	NIL	NIL
3. Minimum Safe Altitude Warning (MSAW)	NIL	NIL	NIL	NIL

ASBU B0-102: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Short Term Conflict Alert (STCA)	Indicator Percentage of ATS units with ground based safety nets (STCA,) implemented Metric Support Number of safety NET (STCA) implemented
2. Area Proximity Warning (APW)	Indicator Percentage of ATS units with ground based safety nets (APW) implemented Metric Support Number of safety NET (APW) implemented
3. Minimum Safe Altitude Warning (MSAW)	Indicator Percentage of ATS units with ground based safety nets (MSAW) implemented Metric Support: Number of Safety NET (MSAW)

ASBU B0-102: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	NA
Environment	NA
Safety	Significant reduction of the number of major incidents

Performance Improvement Area 4:
Efficient Flight Path – Through Trajectory-based Operations

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-05: Improved Flexibility and Efficiency in Descent Profiles (CDO) **Performance Improvement Area 4:** **Efficient Flight Path – Through Trajectory-based Operations**					
ASBU B0-05: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	Y	N	Y

ASBU B0-05: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. CDO implementation	Dec.2017
2. PBN STARs	Dec.2017

ASBU B0-05: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. CDO implementaion	The ground trajectory calculation function will need to be upgraded.	CDO Function	LOAs and Training	In accordance with application requirements
2. PBN STARs	Airspace Design		LOAs and Training	

ASBU B0-05: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. CDO implementation	Indicator: % of International Aerodromes/TMA with CDO implemented Supporting Metric: Number of International Aerodromes/TMAs with CDO implemented
2. PBN STARs	Indicator: % of International Aerodromes/TMA with PBN STAR implemented Supporting Metric: Number of International Aerodromes/TMAs with PBN STAR implemented

ASBU B0-05: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	Cost savings through reduced fuel burn. Reduction in the number of required radio transmissions
Environment	Reduced emissions as a result of reduced fuel burn
Safety	More consistent flight paths and stabilized approach paths. Reduction in the incidence of controlled flight into terrain (CFIT

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-20: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO) **Performance Improvement Area 4: Efficient Flight Path – Through Trajectory-based Operations**					
ASBU B0-20: Improved Flexibility and Efficiency in Departure Profiles (CCO)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	Y	N	N

ASBU B0-20: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. CCO implementation	Dec.2017
2. PBN SIDs implementation	Dec.2017

ASBU B0-20: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. CCO implementation			LOAs and Training	In accordance with application requirements
2. PBN SIDs implementation	Airspace Design		LOAs and Training	

ASBU B0-20: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. CCO implementation	Indicator: Percentage of international aerodromes with CCO implemented Supporting metric: Number of international airport with CCO implemented
2. PBN SIDs implementation	Indicator: Percentage of international aerodromes with PBN SIDs implemented Supporting metric: Number of international airport with PBN SIDs implemented

ASBU B0-20: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	
Capacity	
Efficiency	Cost savings through reduced fuel burn and efficient aircraft operating profiles. Reduction in the number of required radio transmissions
Environment	Authorization of operations where noise limitations would otherwise result in operations being curtailed or restricted. Environmental benefits through reduced emissions
Safety	More consistent flight paths. Reduction in the number of required radio transmissions. Lower pilot and air traffic control workload

AIR NAVIGATION REPORT FORM (ANRF)

SAM Regional Planning for ASBU Modules

REGIONAL/NATIONAL PERFORMANCE OBJECTIVE – B0-40: Improved Safety and Efficiency through the initial application of Data Link En-Route Performance Improvement Area4: Efficient Flight Path – Through Trajectory-based Operations					
ASBU B0-40: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	Y	Y

ASBU B0-40: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. ADS-C over oceanic and remote areas	June 2018 Service provider
2. Continental CPDLC	June 2018 Service provider

ASBU B0-40: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. ADS-C over oceanic and remote areas	NIL	Implementation of ADS general aviation pending	Implementation of GOLD procedures pending	Lack of duly trained inspectors for approval of operations
2. Continental CPDLC	NIL	Implementation of CPDLC general aviation pending	Implementation of GOLD procedures pending	Lack of duly trained inspectors for approval of operations

ASBU B0-05: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. ADS-C over oceanic and remote areas	Indicators: Percentage of FIRs with ADS C implemented Supporting metric: Number of ADS C approved procedures over oceanic and remote areas
2. Continental CPDLC	Indicators: Percentage of CPDLC implemented at oceanic and remote area FIRs Supporting metric: Number of CPDLC approved procedures over oceanic and remote areas

ASBU B0-35: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	A better localization of traffic and reduced separation allow increased capacity. Reduced communication workload and better organization of controller tasks allowing increasing sector capacity.
Efficiency	Routes/tracks and flights can be separated by reduced minima, allowing to apply flexible routings and vertical profiles closer to the user-preferred ones
Environment	Reduced emissions as a result of reduced fuel burn
Safety	ADS-C based safety nets supports cleared level adherence monitoring, route adherence monitoring, danger area infringement warning and improved search and rescue. Reduced occurrences of misunderstandings; solution to stuck microphone situations.

ATTACHMENT F

GLOSSARY OF ACRONYMS

ABAS	Aircraft-based augmentation system
ACC	Area control centre
ADS	Automatic dependence surveillance
ADS-B	ADS-broadcast
ADS-C	ADS-contract
AFTN	Aeronautical fixed telecommunication network
AGA	Aerodromes and ground aids
AIDC	ATS inter-facility data communication
AIM	Aeronautical information management
AIRAC	Aeronautical information regulation and control
AIS	Aeronautical information service
AIXM	Aeronautical information exchange model
AMHS	ATS message handling system
ANP	Regional air navigation plan
ANS	Air navigation services
ANSP	Air navigation service provider
AO	Aerodrome operations
AOM	Airspace organisation and management
AOP	Aerodrome operations
APP	Approach control office or service
A-SMGCS	Advanced surface movement guidance and control system
ASBU	Aviation System Block Upgrades
ATC	Air traffic control
ATFM	Air traffic flow management
ATM	Air traffic management
ATMCP	Air traffic management operational concept panel
ATM SDM	ATM service delivery management
ATN	Aeronautical telecommunication network
ATS	Air traffic services
AUO	Airspace user operations
AWOS	Automated Weather Observing Systems
CAR / SAM	Caribbean and South American Regions
CDO	Continuous descent operations
CFIT	Controlled flight into terrain
CATC	Civil aviation training centre
CM	Conflict management
CNS	Communications, navigation and surveillance
CNS/ATM	Communications, navigation and surveillance/air traffic management
CO2	Carbon dioxide

CPDLC	Controller-pilot Data link communications
D-ATIS	Data link-automatic terminal information service
DCB	Demand/capacity balancing
DCL	Digital flight plan clearances
DME	UHF distance-measuring equipment
eAIP	Aeronautical information publication
eTOD	Terrain and obstacle database
FANS	Future air navigation systems
FASID	Regional plan facilities and services implementation document (Document 8733)
FIR	Flight information region
FL	Flight level
FMS	Flight management system
FUA	Flexible use of airspace
GIS	Geographical information system
GLS	GPS-based *landing* system
GML	Geography markup language
GNSS	Global navigation satellite system
GPI	Global Plan initiatives
GPS	Global positioning system
GPWS	Ground proximity warning system
GREPECAS	CAR/SAM regional planning and implementation group
HF	High frequencies
HFDL	HF Data link
IAVW	International Airways Volcano Watch
IFR	Instrument flight rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
ISO	International Standards Organisation
IVATF	International Volcanic Ash Task Force
KPI	Key performance indicators
LAR	Latin American aeronautical regulations
MET	Meteorological services for air navigation
METAR	Aviation routine weather report, which provides the meteorological conditions prevailing at an aerodrome.
METWSG	Meteorological Warnings Study Group
MLAT	Multilateration – Surveillance system
MSAW	Minimum safe altitude warning
MWO	Meteorological Watch Office
NDB	Non-directional radio beacon
NGAP	New generation of aviation professionals
NM	Nautical miles
NPA	Non-precision approach
NOTAM	Notice to personnel concerned with flight operations

ICAO	International Civil Aviation Organization
OLDI	Direct data interchange
OMA	Automatic weather office
WMO	World Meteorological Organization
OPMET	Operational meteorological information
PDC	Predeparture clearance
PFF	Performance Framework Form
PIRG	Planning and implementation regional group
PSR	Primary surveillance radar
QMS	Quality management system
RASG-PA	Regional aviation safety group - Pan-American
REDDIG	South American digital communication network
RNAV	Area navigation
RNP	Required navigation performance
RVR	Runway visual range
RVSM	Reduced vertical separation minimum
SADIS	Satellite distribution system for information relating to air navigation
SAM	South American Region
SARPS	Standards and recommended practices
SID	Standard instrument departure
SIGMET	Significant weather
SLA	Service level agreement
AMSS	Aeronautical mobile-satellite service
SMGCS	Surface movement guidance and control system
SPECI	Special aviation weather report
SSR	Secondary surveillance radar
STAR	Standard instrument arrival
TMA	Terminal control area
TRA	Temporary reservation of airspace
TS	Traffic synchronisation
TWR	Aerodrome control tower or aerodrome control
UAS	Unmanned aircraft systems
VDL	VHF digital Relation-ship
VFR	Visual flight rules
VHF	Very high frequency
VOLMET	Meteorological information for aircraft in flight
VOR	VHF omnidirectional radio range
WAFS	World area forecast system
WATRS	Western Atlantic route system
WGS-84	World geodetic system — 1984
XML	Extensible markup language

ATTACHMENT G

AERONAUTICAL METEOROLOGICAL INFORMATION (MET) PROVIDED BAND MET UNITS

.0	*Distributor*	*Destiny*	*Frequency Hour (h)*	*Communication Means*	*Flight phase*
METAR and METREPORT with TR[*]in (FASID Table MET 1A)	AMS	TWR, APP, ACC, FIC, COM Station	Each hour	AFTN / Intranet / CCTV, etc.	F1,F2;F3,F4 and F5
SPECI and SPECIAL with TR[*]in (FASID Table MET 1A)	AMS	TWR, APP, ACC, FIC, COM Station	Each hour	AFTN / Intranet / CCTV, etc.	F1,F2;F3,F4 and F5
TAF	AMO	TWR, APP, ACC, FIC, COM Station	Each hour	AFTN / Intranet / CCTV, etc.	F1,F2;F3,F4 and F5
Aerodrome warnings	AMO	TWR, APP, COM Station, AGA Services	When justified	AFTN / Intranet / CCTV, etc.	F1,F2,F4 and F5
WINTEM (data obtained of WAFS)	AMO and/or MWO	ACC, FIC	Every 6h (if justified)	AFTN / Intranet / CCTV, etc.	F3
Significant weather forecast in (data obtained of WAFS)	AMO and/or MWO	ACC, FIC	Every 6h (if justified)	AFTN / Intranet / CCTV, etc.	F3
SIGMET	AMO and/or MWO	ACC, FIC	Every 6h (if justified)	AFTN / Intranet / CCTV, etc.	F3
Wind shear warnings and alerts	AMO	TWR and APP	When justified	AFTN / Intranet / CCTV, etc.	F1,F2,F4 and F5
Tropical cyclones advisories	AMO	TWR and APP	When justified	AFTN / Intranet / CCTV, etc.	F1,F2,F4 and F5
Volcanic ash advisories	TCA/MWO	ACC AND FIC	When justified	AFTN / Intranet / CCTV, etc.	F3
Information on accidental release of radioactive materials, that means the location of the accident and projected trajectories of the radioactive material.	MWO (normally the information is obtained from the RMSC of the MWO involved)	ACC AND FIC	When justified	AFTN / Intranet / CCTV, etc.	F3
Information on volcanic eruptions and volcanic ash on which no SIGMET has been issued yet	MWO/VAAC	ACC AND FIC	When justified	AFTN / Intranet / CCTV, etc.	F3

Phase 1: Take-Off
Phase 2: Departure
Phase 3: En route
Phase 4: Approach
Phase 5: Landing

[*] Prepared by the AMO

ATTACHMENT H

REFERENCE DOCUMENTS

- ICAO Document 7192 -AN/857: Training Manual
- ICAO Document 8126 “Aeronautical Information Services Manual”
- ICAO Document 8697 “Aeronautical Chart Manual”
- ICAO Document 8733: CAR/SAM Regional Air Navigation Plan
- ICAO Document 8896: Manual of aeronautical meteorological practice
- ICAO Document 9137. Airport Services Manual.
- ICAO Document 9157. Aerodrome Design Manual
- ICAO Document 9184. Airport Planning Manual.
- ICAO Document 9377: Manual on coordination between air traffic services, aeronautical information services and aeronautical meteorological services
- ICAO Document 9674 “World Geodetic System (WGS-84) Manual”.
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