INTERNATIONAL CIVIL AVIATION ORGANIZATION
South American Regional Office - Regional Project RLA/06/901
Assistance for the Implementation of a Regional ATM System, taking into account the ATM operational concept and the corresponding CNS technological support
Tenth Workshop/Meeting of the SAM Implementation Group (SAM/IG/10)
(Lima, Peru, 1-5 October 2012)

SAM/IG/10-WP/17
24/09/12

Agenda Item 2: Optimisation of the ATS route structure - Phase 3 Version 2

Programme for the Optimisation of the SAM ATS Route Network, Phase 3 Version 2 (ATSRO) and the associated Action Plan

(Presented by the Secretariat)

Summary

This working paper presents the updated Programme for the Optimisation of the SAM ATS route network, Phase 3 Version 2 and its associated Action Plan for their analysis, revision, and updating.

References:

- Annex 11 to the ICAO Convention
- Global Air Navigation Plan (Doc 9750)
- SAM ATS route network optimisation programme
- SAMIG meeting reports
- ATSRO meeting reports
- SAM/RA/3 meeting report

ICAO strategic objectives:	*A – Safety* *C – Environmental protection*

1 **Background**

1. **Introduction**

1.1. Since 2001, SAM States and airspace users have been working decidedly and constantly to improve the airspace structure under their jurisdiction.

1.2. Starting in 2008, and with the support of Regional Project RLA/06/901, the SAM Region has been developing an airspace optimisation programme to maximise the efficient use of airspace, while maintaining the required level of safety.

1.3. The ATSRO programme seeks to significantly improve airspace organisation and management, and it was agreed that it should be executed in phases in order to achieve operational benefits as early as possible and acquire the necessary experience in each of these phases in order to facilitate the implementation of the programme.

1.4 **Phase 1** of the route optimisation programme was completed on 20 October 2011 with

the implementation of RNAV5, and **Phase 2** of the implementation of Version 1 of the SAM ATS route network was completed in March 2011.

1.5 **Phase 3**, which corresponds to the implementation of Version 2 of the SAM ATS route network, involves planning the complete re-structuring of the route network to achieve full integration of ATS routes, control sectors, TMAs, etc., applying the flexible use of airspace concept, which adds complexity and requires much coordination and work within the States themselves, in addition to work at regional level.

2. **Discussion**

2.1. The ATS route network optimisation programme, initially approved by the SAMIG/9 meeting, contains the lessons learned during the implementation of Phase 2 of the ATSRO Programme, the general planning principles on which the programme is based, guidelines for the application of the flexible use of airspace concept, and specifies the tools and material used for the analysis of the SAM ATS route network.

2.2. Likewise, this Programme assesses available statistical data on air traffic movement and fleet capabilities, makes a diagnosis of the SAM ATS route network, and makes a series of consistent proposals to improve the regional route network, proposes some guidelines for applying continuous descent (CDO) techniques, and finally, establishes guidelines for the interface between the SAM route network and the route networks of adjacent Regions.

2.3. The ATSRO Programme, as approved by the ATSRO/4 meeting, appears in **Appendix A** to this working paper, and continues to be assessed by States and airspace users. Although a satisfactory level of progress has been achieved, some of the routes that will be implemented still need to be defined, especially in some portions of the regional airspace.

2.4. The Action Plan associated with the implementation of the SAM ATS Route Network Optimisation Programme (implementation of Phase 3, Version 2) that was updated by the ATSRO/4 meeting is shown in **Appendix B** to this working paper.

2.5. As established in the Action Plan of the ATSRO Programme, the SAM/RA/3 meeting was held at the Regional Office on 3-7 September 2012 to assess the risk prior to the implementation of Phase 3, Version 2 of the SAM ATS route network.

2.6. The SAM/RA/3 meeting agreed that the purpose of documenting the safety assessment was to provide a permanent record of the final result of the safety assessment and of the arguments and tests, which showed that the risks associated to the implementation of the proposed system or changes had been eliminated or properly controlled and reduced to a tolerable level.

2.7. Likewise, the experts attending the SAM/RA/3 meeting understood that, based on the safety assessment criteria, States had to develop their national safety plan.

2.8. The SAM/RA/3 meeting agreed on the need to adjust the action plan for the optimisation of the SAM ATS route network, taking into account the studies that were reflected in the hazard identification and risk assessment (HIRA) form and the Safety Plan.

2.9. Accordingly, adjustment made to the action plan of the ATSRO Programme for the optimisation of the SAM ATS route network should include all the products derived from the Safety Plan for the implementation of Phase 3, Version 2 of the ATSRO Programme.

3. **Suggested action**

3.1 The Meeting is invited to take note of the information provided herein, to review **Appendices A** and **B** to this working paper, and to make changes as necessary to update the route network optimisation programme (ATSRO) and its associated action plan to the extent required.

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Project RLA/06/901
Assistance for the implementation of a regional ATM system according to the ATM operational concept and the corresponding technological support for CNS

PROGRAMME FOR THE OPTIMISATION OF THE ATS ROUTE NETWORK IN THE ICAO SOUTH AMERICAN REGION (PHASE 3, VERSION 02)

Version 0.5
April 2012

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Programme for the Optimisation of the ATS Route Network in the ICAO South American Region (Phase 3, Version 02)

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FOREWORD

The Programme for the optimisation of the ATS route network of the ICAO South American Region (SAM ATSRO Programme - Phase 3, Version 02) is published by the ICAO South American Region on behalf of the ICAO South American Implementation Group (SAMIG).

The SAM ATSRO Programme - Phase 3, Version 02 addresses the different aspects that States should take into account when introducing improvements to the ATS route network in the upper airspace, and offers some guidelines regarding terminal areas.

The Regional Office, on behalf of the SAMIG, will publish revised versions of the SAM ATSRO Programme as necessary to keep the document duly updated.

Copies of the SAM ATSRO Programme - Phase 3, Version 02 may be requested to:

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This edition (*Version 0.0)* includes all revisions and modifications made since April 2011. Subsequent amendments and/or corrigenda will be listed in the Record of Amendments and Corrigenda table, in accordance with the procedure established in the following page.

The publication of amendments and corrigenda is announced regularly by correspondence sent to the States and International Organizations and on the website of the ICAO South American Regional Office, which should be consulted by those using this publication. Blank boxes facilitate annotations.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Effective date	Date recorded	Recorded by

CORRIGENDA			
No.	Effective date	Date recorded	Recorded by

ACRONYMS AND ABBREVIATIONS

ANIP-PB	Plan de Implantación de navegación aérea basado en rendimiento/Performance-based air navigation implementation plan
ANP	Plan de navegación aérea/Air navigation plan
ANS	Servicios de navegación aérea/ Air navigation services
ANSP	Proveedores de Servicios de Navegación Aérea/Air Navigation Service Providers
ASM	Gestión del espacio aéreo/ Airspace Management
ATC	Control de tránsito aéreo/ Air Traffic Control
ATFM	Gestión de afluencia del tránsito aéreo/ Air Traffic Flow Management
ATM	Gestión del tránsito aéreo/ Air Traffic Management
ATS	Servicio de tránsito aéreo/ Air Traffic Services
ATSRO	Programa de Optimización de la red de rutas ATS/ ATS Route network Optimization Programme
CAR/SAM	Regiones Caribe y Sudamérica/Caribbean/South American Regions
CDO	Operaciones de Descenso Continuo/Continue Descent Operation
CNS/ATM	Comunicaciones, navegación y vigilancia/Gestión del tránsito aéreo/ Communications, Navigation and Surveillance/Air Traffic Management
CO_2	Dióxido de carbono/Carbon dioxide
CTA	Area de control /Control Area
DME	Equipo Radiotelemetrico/Distance-Measuring Equipment
FIR	Región de información de vuelo /Flight Information Region
FUA	Uso flexible del espacio aéreo/Flexible use of airspace
GANP	Plan mundial de navegación aérea/Global air navigation plan
GNSS	Sistema mundial de navegación por satélite / Global Navigation Satellite System
GREPECAS	Grupo Regional de Planificación y Ejecución CAR/SAM/ CAR/SAM Regional Planning and Implementation Group
IATA	Asociación del Transporte Aéreo Internacional/ Internacional Air Transport Association
IFALPA	Federación Internacional de Asociaciones de Pilotos de Líneas Aéreas/International Federation of Air Line Pilots' Associations
IFATCA	Federación Internacional de Asociaciones de Controladores de Tránsito Aéreo/International Federation of Air Traffic Controllers' Associations
IFSET	Herramienta de estimación de ahorro de combustibule/ICAO fuel saving estimation tool)
PBN	Navegación Basada en la Performance /Performance-Based Navigation
RNAV	Navegación de área/Area Navigation - RNAV Route: Ruta de navegación de área/Area navigation route
RNP	Performance de navegación requerida /Required Navigation Performance
RNP AR	Requerimiento de aprobación para la performance de navegación requerida/ Required Navigation Performance Aproval Required
SAMIG	Grupo de Implantación de la Región Sudamericana/South American Region Implementation Group
SARPS	Normas y métodos recomendados (OACI)/ Standards and Recommended Practices (ICAO)

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SID	Salida Normalizada por Instrumentos/Standard Instrument Departure
SSR	Radar secundario de vigilancia/Secondary Surveillance Radar
STAR	Llegada Normalizada por Instrumentos/Standard Instrument Arrival
TLS	Nivel de seguridad deseado/Target Level of Safety
TMA	Area Terminal/Terminal Area
VHF	Muy alta frecuencia /Very High Frequency
VOR/DME	Radiofaro omnidireccional VHF/Equipo radiotelemétrico/Very High Frequency Omnidirectional Radio Range/Distance-Measuring Equipment

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1 Introduction

1.1 Since 2001, the States of the ICAO South American Region, together with airspace users, have been decidedly and constantly working for the introduction of improvements to the structure of the airspace under their jurisdiction.

1.2 Starting in 2008 and with the support of Project RLA 06/901, the SAM Region developed an airspace optimisation programme to maximise the efficient use of airspace, while maintaining the required level of safety.

1.3 One of the first steps taken in the Region in this regard was the conduction of a feasibility study to design an ATS route network that would respond to the new aviation requirements and address the new operational concept of performance-based navigation.

1.4 The feasibility study made a diagnosis of the ATS route network, developed a strategy for the completion of tasks in phases, drafted a list of deliverables, proposed a work programme, identified the data required and a data collection method, defined the support tools required to execute the task, specified the required reference documentation, and other aspects deemed relevant for the execution of the task, such as the interests of each State, geographical characteristics, etc. In addition to the aforementioned aspects, consideration was given to issues related to safety and other expectations described in the Global ATM Operational Concept.

1.5 As a result of this feasibility study, the airspace optimisation programme was approved, covering two essential elements: the optimisation of the SAM ATS route network and the implementation of performance-based navigation (PBN) pursuant to GREPECAS guidance contained in the PBN Roadmap. In order to facilitate project management, both objectives were included in the SAM ATS Route Network Optimisation Programme (SAM ATSRO Programme).

1.6 The ATSRO Programme is aimed at achieving significant improvements in airspace organisation and management, based on the Global Plan Initiatives (GPIs) directly related to the set of airspace management (AOM) initiatives that provide the necessary guidance for planning and implementing a optimum airspace structure.

1.7 It was agreed that the ATSRO Programme should be implemented in phases in order to achieve operational benefits as soon as possible and acquire the necessary experience in each phase to facilitate the execution of the programme.

1.8 Phase 1 corresponded to the implementation of RNAV-5, taking into account that the implementation of this concept would facilitate optimisation. This phase of the programme was implemented in October 2011. RNAV-5 was implemented on all RNAV routes that existed in the SAM Region; consequently, it is not necessary to extend the volume of exclusionary RNAV-5 airspace.

1.9 It was agreed that, starting in Phase 2 of the programme, the route network version concept would be incorporated, taking into account that airspace structure changes based on air traffic growth, the displacement of air traffic demand from one region or airport to another, available technology, amongst other aspects. The use of route network versions reflects the need for an

integrated periodic revision to ensure the best possible airspace structure at all times. Version 01 of the ATS route network was successfully implemented in March 2011.

1.10 The SAM Implementation Group, at its eighth meeting (SAMIG/8) held in Lima in October 2011, reviewed the results of the analysis conducted at the third meeting of the ATS Route Network Optimisation Group (ATSRO/3, Lima, July 2011) regarding Phases 1 and 2 of the programme, particularly the lessons learned during the implementation of Phase 2, in order to incorporate that experience in Phase 3 of the Programme.

1.11 Furthermore, the performance-based air navigation plan for the SAM Region (SAM-ANIP/PB), upon analysing ATM evolution, recognised that it should be based on the following scenarios:

a) En-route operations;

b) TMA operations; and

c) Air operations in general

1.12 The SAM ANIP/PB establishes the gradual strategy for achieving the objective(s) identified, and includes the tasks and activities that better represent regional planning processes, in accordance with the global planning framework. The goal is to achieve a harmonised implementation process that evolves towards a seamless regional ATM system. To that end, a short- and medium-term work programme was developed, focusing on system improvements reflecting a clear work commitment of the parties involved.

1.13 Amongst its performance objectives, the SAM ANIP/PB included the optimisation of en-route airspace (PFF SAM 01), establishing the benefits to be derived in terms of safety and environmental protection and sustainable development of air transport. This performance objective includes, in addition to the optimisation of the ATS route network, the evolution towards en-route application of more precise navigation specifications, such as RNP2 in selected continental airspaces and RNP4 in oceanic areas.

1.14 Regarding safety, it was noted that en-route airspace optimisation would strengthen airspace safety, and with respect to environmental protection and sustainable development of air transport, it would reduce miles flown, fuel consumption and, consequently, CO_2 emissions into the atmosphere; it would increase airspace capacity; and finally, it would be possible to use aircraft capabilities to fly optimum paths.

Note: The goals of SAM PFF 01 are the number of PBN routes (RNAV/RNP) implemented and the reduction of CO_2 emissions.

1.15 It should also be noted that, in light of the new *Aviation System Block Upgrade* (ASBU) methodology advocated by ICAO, the SAM Region will have to update the SAM ANIP-PB and the PFFs, which will be replaced by air navigation report forms (ANRFs). The purpose of this new methodology is to develop a set of ATM solutions or improvements, take advantage of existing equipment, establish a transition plan, and allow system interoperability.

1.16 The aviation system block upgrade concept is a new way of approaching global, regional, and national planning in the short, medium and long term, and is intended to define the way of achieving system interoperability, generate more certainty amongst ATSPs and airspace users with

respect to implementation, give transparency to early benefits, and finally generate competition based on information known to equipment manufacturers. The current initiatives of the global plan (GPIs) will be inserted in the various modules of each of the blocks proposed in this methodology.

2 Lessons learned during the implementation of Phase 2 of the ATSRO Programme

2.1 The Meeting noted that during the implementation of Version 01 of the ATS route network, some difficulties and other aspects had been identified that should be taken into account when analysing Version 02 of the ATS route network, as listed below:

a) The route network should meet all the requirements of the users (civil, military, general aviation, UAS, etc.), and allow most flights to operate direct routes or as direct as possible between points of origin and destination.

b) Optimum capacity should be achieved, taking into account the need to reduce the complexity of the airspace structure.

c) Improve airspace sectorisation to optimise ATC capacity, including the possibility of ATS delegation.

d) Reduce controller workload, reorganising the airspace as necessary.

e) Define the type of route (unidirectional/bidirectional) and the direction of unidirectional routes, taking into account the need to have a more efficient sectorisation.

f) Resolve civil/military coordination deficiencies to ensure the efficiency of the route network.

g) Permit the use of the flexible use of airspace (FUA) concept to ensure that the requirements of all airspace users are met.

h) Permit integration with the domestic route network of the States.

i) Eliminate or reduce congested areas as much as possible.

j) Keep the number of ATS routes as low as possible, always taking into account traffic demand in relation to ATC capacity and the possibility of applying direct routes.

k) Keep the number of crossings as low as possible, and where crossing are necessary, they should be planned in such a way as to avoid more congested sectors.

l) Avoid redundant ATS routes.

m) Airspace planners and procedure designers should coordinate to ensure compliance with ICAO SARPs and, where applicable, make sure that air navigation data include the information contained in Doc 8168 Vol. 2, PANS-OPS.

n) Consider the use of unidirectional routes, especially in areas where the interaction of climbing/descending traffic is a limiting factor.

o) Consider the application of parallel routes in areas where it is necessary to increase airspace capacity, using RNAV 5.

p) States should avoid taking isolated action to restructure the airspace or the domestic ATS route network in a way that could have significant effect on traffic beyond the area under the jurisdiction of the State involved.

q) Administrations should meet the dates agreed for the publication of amendments to their respective AIP, since failure to do so would jeopardise the implementation of the route network on the date agreed and generate a safety hazard.

r) Define, in addition to the implementation date, a common schedule that is convenient to all States for the implementation of the various versions of the ATS route network.

s) The ATS Route Working Group should set, duly in advance, a deadline for presenting optimisation proposals to allow States and users duly plan the implementation.

t) Assess the transfer of airspaces between States.

2.2 Following the discussion and exchange of opinions at the SAMIG/8 meeting, and taking into account the experience obtained, the Group introduced a series of improvements to the action plan Phase 2 Version 02 of the ATSRO Programme.

2.3 One of the critical issues identified was the need and advisability to collect new data on aircraft movement in order to analyse the evolution of air traffic demand in the Region for all flights conducted in the upper airspace (FL245 or above), in domestic and international routes, during the period between 1 and 31 August 2011, and for that information to be sent to the SAM Regional Office before 30 September 2011. However, only 4 States (Argentina, Chile, Colombia, and Paraguay) sent the data, and out of the data received, few could be analysed since they did not contain the information requested or it was not complete.

2.4 Another aspect to highlight is that States should send to the ICAO SAM Regional Office information on gateways of the main TMAs in the Region (see 3.2.3 of the plan of action of Phase 3) in order to facilitate the analysis and its incorporation in Version 02 of the ATS route network. At the time of conducting this preliminary study, only one State had sent such information.

2.5 SAMIG established a series of general and planning principles to be taken into account by airspace planners of the States, and that were also considered during the analysis of Phase 3 Version 02 of the ATS route network.

3 General principles

3.1 The general principles to be taken into account during Phase 3 Version 02 of the ATS route network are as follows:

a) the development of a harmonised and consistent route network requires States to participate actively in the international working groups established for conducting the planning or review of the regional route network,

b) the main regional air traffic flows must be identified, as well as those that extend beyond the Region and that have a direct impact on the regional route network, in order to identify deficiencies in the route network and in ATC sectorisation,

c) establish and review the ATS route network and supporting sectors to accommodate the main air traffic flows, reducing the complexity of the airspace structure and balancing ATC workload,

d) integrate the routes required in order to provide access to the regional route network to/from airports not served by that network. Likewise, non-permanent routes must be integrated as needed to alleviate air traffic load in the main ATS routes and ensure flights use their optimum profiles,

e) ensure the connectivity between the ATS route network to/from TMA airspace,

f) establish a phased implementation to ensure consistency with State implementation.

4 Planning principles

4.1 The following planning principles were established:

a) Air traffic volume in existing and proposed routes;

b) Establish paths as short as possible for most flights;

c) Prioritise planning in areas with higher air traffic volume;

d) Meet the needs of civil and military users;

e) Integrate the route network and supporting sectors at the beginning of the planning process;

f) Integrate the route network and TMA arrival and departure paths (SIDs and STARs).

g) Check that at least 30 monthly flights are conducted on the route requested. This criterion should also be applied when considering the elimination of an existing route.

h) Avoid the independent implementation of RNAV routes unless absolutely necessary.

4.2 Furthermore, it was recognised that, in addition to the expected growth of air traffic, planners will have to face other challenges when designing the airspace, including:

a) Meet ATS demands to ensure that capacity is at least maintained at current levels and that delays due to terminal airspace restrictions are minimised;

b) Meet safety requirements;

c) Meet environmental protection requirements;

d) Meet the various demands and requirements of airspace users, taking into account new and various development plans of users.

4.3 The purpose of these guidelines is to avoid the tendency to create an airspace that is "independent" from the route network, and planners, together with PANS/OPS procedure designers, must consider ATC operational requirements in their TMA design, obviously taking into account environmental protection and the associated costs and benefits.

4.4 As already seen, the route network is closely related to TMAs and approach procedures. Accordingly, it was deemed appropriate that the following aspects be also taken into account in the design of TMAs and instrument approaches:

a) systematic implementation of the FUA and progress in PBN implementation in TMAs and instrument approaches,

b) safety must be enhanced or at least maintained at current levels, complying with ICAO SARPs on this matter and conducting the corresponding risk analysis,

c) the design must respond to operational requirements, maintaining a balance between the interests of ATC, airspace users, and the environment, promoting the flexible use of airspace,

d) the collaborative decision-making concept (see the SAM collaborative decision-making manual) must be applied to airspace design; therefore, the TMA redesign project must involve a multidisciplinary team of experts representing all those involved,

e) the terminal area should be designed as an integral part of airspace, from both the horizontal and vertical viewpoints, to ensure a continuous flow of operations, and

f) use continuous descent techniques to maximise operational efficiency between airspace requirements and restrictions, optimising arrivals as much as possible (Doc 9931),

g) States should present their airspace optimisation plans to the SAMIG and ATSRO meetings.

5 Flexible use of airspace

5.1 There is regional agreement that in order to develop a comprehensive ATS route network that responds to the interests of all users, including commercial, military, general, and sport aviation, and unmanned aircraft systems, it is necessary to establish a civil/military cooperation system to analyse all the restricted, prohibited, and dangerous areas established in the South American Region with a view to implementing the flexible use of airspace concept.

5.2 Furthermore, it was recognised that the analysis is not aimed to arbitrarily eliminate or reduce special use airspaces, but rather implement the collaborative decision-making concept, which looks for the best options to satisfy all airspace users and ensure that the needs set forth are met, regardless of the application of airspace restrictions.

5.3 In view of the above, Project RLA 06/901, at the request of the SAMIG, and with the assistance of two experts, drafted the Guidelines for the Implementation of the Flexible Use of Airspace (FUA) Concept in the South American Region (SAM/FUA Guidelines). These guidelines

will be presented to the corresponding regional instances for assessment and, if applicable, for use at regional level.

6 Tools and material used for the analysis of the SAM ATS route network

6.1 For the analysis, two tools were basically used: Jeppesen's FliteStar, provided by the Regional office, and the Google Earth programme, which was used by the experts of Project RLA 06/901 for the study on DME/DME coverage, which included upper airspace ATS routes. For the purpose of using this tool, it was necessary to update the data on new routes implemented after the aforementioned work was completed.

6.2 Jeppesen and DOD aeronautical charts were also used, as well as aeronautical charts published by the States.

6.3 As established in the action plan of the ATS route network optimisation programme, once Phase 3 Version 02 of the ATS route network has been analysed by the States of the Region and airspace users prior to its implementation, it should be assessed using "airspace modelling" and fast-time ATC simulation tools. This task will permit an assessment of how aircraft operations will be affected in the new scenario and, if applicable, the adoption of additional measures prior to implementation.

6.4 Also prior to implementation, a regional risk analysis will be required to ensure that the new version of the route network will not create additional and/or residual safety risks within the system. This risk analysis will not replace the safety assessment that each State must conduct in accordance with ICAO SARPs.

6.5 In the absence of updated information, 2009 data had to be used, year in which data was collected on aircraft movements in the Region to study the possibility of implementing RNAV 5. This data was adjusted in 6% for 2010 and a similar adjustment was applied to the data resulting from the aforementioned increase, for 2011. Although this information is not precise, it is the only one available for conducting an approximate analysis of traffic movement in the Region. A summary of the resulting data is shown in **Appendix A**. The whole information is posted on the SAM Regional Office website.

6.6 Likewise, since information on the entry and exit points of the main terminal areas of the Region was not available, the traffic flow shown in available aeronautical charts was taken into account.

6.7 Although States were requested to send information on their airspace optimisation plans, no information was received, except from two States. Consequently, available information from the ATSRO and SAMIG meetings was analysed, together with information sent by an airline requesting the revision of some paths that could be improved.

6.8 In order to assess fuel savings and environmental benefits derived from the new proposed paths, the ICAO IFSET tool was used. The results of this task are for reference purposes only, because, since SIDs and STARs were not available, it was not possible to conduct a complete assessment. Once the final paths and the SIDs and STARs connecting the new paths are defined, a new assessment should be done on fuel savings and the corresponding environmental benefit.

7 Statistical data on air traffic movement and fleet capacity

7.1 The analysis of the route network based on statistical data on air traffic movement has resulted in a database that has permitted a diagnosis of the main air traffic flows in the SAM Region, defined by the number of operations recorded along the various routes, whether ATS or RNAV.

7.2 The analysis addressed the following general aspects, which can be seen individually in Appendix A, and Attachment 1 to that appendix, by FIR.

Number of flights by city pairs

7.3 The number of flights by city pairs has permitted the identification of the main air traffic flows in the SAM Region, based on which suggestions were made for the implementation of RNAV routes with paths as direct as possible, or the elimination, realignment, extension, or implementation of new or parallel routes, and for the reorganisation of the paths of traffic flows therein.

Number of flights in each ATS route

7.4 The number of flights in each ATS route provides information on the number of operations in each of them, indicating the individual and cumulative percentage of each route over the total sample. This information is important because it shows if the routes are being used and, based on that, decide whether or not they should continue to be operational.

7.5 Upon reviewing the number of operations by route, it was determined that routes with more movement owe such movement to their location in FIRs with a greater number of operations, and to their crossing of several other FIRs, thus increasing the number of users in the respective routes. Based on this, the possibility was identified of improving capacity by reorganising flows through the incorporation of parallel routes.

City pairs served by each ATS route

7.6 The combination of the number of flights by city pair with the number of flights in each ATS route has permitted the identification of city pairs served by each ATS route. These values permit the analysis of traffic flows between each city pair and route, facilitating the realignment of existing routes when implementing parallel routes and reorienting the existing traffic flow.

7.7 In this regard, the main flows between cities that register greater movement have been considered, based on which situations have been identified in which it would be advisable to implement parallel routes to optimise the airspace involved.

7.8 The identification of flows between city pairs reflects the need to reorganise, in some cases, the direction of traffic. This will result in a substantial improvement of airspace capacity and will contribute to its optimisation.

7.9 Within this same context, routes have been identified between city pairs that do not have sufficient traffic to maintain such routes. It would be necessary to study the possibility of eliminating them or, otherwise, depending on their low utilisation, moving them to temporary routes in case there is no intention to eliminate them.

7.10 The main flows between city pairs allow benefits from PBN procedures to be derived. This is noted in airspaces with high traffic density, which benefit from the implementation of parallel

routes with differed traffic directions, that is unidirectional, thus optimising the capacity of the area involved.

Number of flights by aircraft operator

7.11 The data contained in this part identifies companies or operators and the number of operations and types of aircraft used in the Region.

7.12 It was noted that the aircraft fleet operating in the Region has improved significantly, since most aircraft are of the latest generation, thus contributing to the improvement of the airspace structure.

Number of flights by flight level

7.13 Based on the analysis of the number of flights by flight level, the flight levels with the highest demand for the various operations in the Region were identified.

7.14 In order to meet the growing demand for optimum flight profiles, it would be interesting for service providers to take into account the facilities offered by continuous descent or climb procedures applied to flight paths with significant flows, and implement parallel routes with a defined traffic direction for arrivals and departures, thus increasing airspace capacity.

8 Diagnosis of the SAM ATS route network and resulting proposals

8.1 In view of the foregoing, a study of the existing ATS route network in the upper airspace was conducted in order to propose a possible improvement to the route network to the States.

8.2 The requests of States and airspace users concerning specific routes/paths were addressed first.

8.3 The available traffic sample was compared with the SAM ATS route network published in the CAR/SAM ANP, which lists 167 routes, defining the traffic volume in each of the routes studied.

8.4 Subsequently, using FliteStar, 86 routes were analysed, from origin to destination, including path and distances. Based on the information available, the number and type of aircraft most frequently used on the route involved were analysed, to finally analyse the advantages and/or disadvantages of a new route, the realignment of some, as well as the possible elimination of routes that did not offer any operational advantage and/or were not being used or were barely used by airspace users.

8.5 The path of most of the routes assessed lied within the Region. In some cases, however, routes affecting other Regions were also reviewed. In such cases, an attempt was made to select a point of entry into the adjacent Region that did not affect its route network structure.

8.6 Notwithstanding the above, States could deem it advisable to propose changes that affect adjacent Regions, in which case, the ICAO Secretariat could coordinate as necessary.

8.7 Following that initial analysis, and taking into account the principles established by the SAM/IG, an assessment was made of the best possible path, balancing advantages and

disadvantages and, where applicable, a series of RNAV routes was submitted to the consideration of the States.

8.8 This preliminary analysis identified 45 routes that could improve the regional airspace structure. Subsequent meetings analysed the list of routes, and a preliminary agreement was reached at the ATSRO/4 meeting (May 2012). However, the work of States and airspace users continues under the coordination of the Regional Office. **Appendix B** lists SAM routes and those suggested for implementation in Version 02. It should be noted that work will continue at subsequent SAMIG and ATSRO meetings. In order to keep the Table updated until a consensus is reached on the routes to be implemented, this programme will be modified as necessary.
~~que se sugiere evaluar, con una descripción detallada de los aspectos que se consideraron importantes y que podrían ayudar a tomar una decisión sobre la conveniencia de implementar figura en el **Apéndice B** de este in~~

8.9 The description includes the scenario with cities of origin and destination, the route normally being used, the distance, number of flights, and types of aircraft most frequently used in this segment. Likewise, a proposal is made for a new path, with its distance, number of nautical miles saved, and the resulting reduction in fuel consumption and CO_2 emissions. Finally, States involved in the new proposed path are listed and, where applicable, remarks on the assessed path.

8.10 As already stated, in order to calculate fuel currently used and fuel to be saved with the implementation of the new paths, the ICAO IFSET tool was used.

8.11 In the absence of SIDs and STARs to relate the route to the departure and arrival airport, the calculation was based on the total distance between the points in question and assuming that the aircraft would be at FL 360 throughout the flight, which is the most representative level used in the Region. In other words, the climb and descent phases were not taken into account.

8.12 Calculations have been conservative since only operations with origin and destination on the proposed path were taken into account, excluding other operations that could use that given route. For example, overflights from adjacent Regions using that same path were not considered.

8.11 For calculating CO_2 emissions, a conversion factor of 3.157 per kg of fuel approved by the Intergovernmental Panel on Climate Change (IPCC) was used.

8.13 In general terms and approximate figures, it could be said that fuel consumption in one month of operations in the assessed scenario could be reduced by 1'440,500 kg, *i.e.*, 1.536% of the total and, in terms of reduction of CO_2 emissions, it amounts to 4'547,658.5 kg, *i.e.*, 0.920%. If the figure for saved fuel were converted into litres, calculating the price per litre of fuel at $ 1.57, savings would amount to $2'713,902 per month. For better reference, **Appendix C** contains the table on fuel savings, with calculations for each path proposed. These calculations shall be updated following approval of the routes to be implemented in Version 02 of the ATS route network.

8.14 Appendix A also lists the routes that should be analysed in light of their low occupancy or lack of information on operations in those routes. States should analyse the relevance of maintaining such routes and, if applicable, propose their elimination from the corresponding air navigation plan.

9 Application of techniques for continuous descent operations (CDO)

9.1 Continuous descent is one of the various tools that aircraft operators and ANSPs have for improving safety, flight prediction capabilities, and airspace capacity, while reducing noise, ATC/pilot communications, fuel, and greenhouse gas emissions. Throughout the years, different route models have been developed to facilitate continuous descent, and several attempts have been made to strike a balance between environmentally friendly procedures and the requirements of a given airport or airspace.

9.2 Phase 3 Version 02 of the route network requires that States analyse the application of CDO techniques. It is recognised that these continuous descent (CD) operations are possible by virtue of airspace design, procedure design, and ATC facilitation, whereby an incoming aircraft descends continuously to the extent possible, using minimum engine thrust, ideally in a low resistance configuration, prior to the final approach fix (FAF)/final approach point (FAP).

9.3 The application of CDO must be reviewed on a case-by-case basis, depending on the individual requirements of each airport of the Region, taking into account that an optimum CD starts at the top of descent, and uses descent profiles that reduce ATC/pilot communications, level flight segments, noise, fuel burn, and emissions, while increasing ATC/pilot prediction capability, and flight stability.

9.4 It is extremely important to maintain safety in all flight phases, and nothing in the guidance will prevail over the requirement for a safe operation and control of aircraft at all times. In order to eliminate any doubts, all recommendations shall be understood as "subject to safety requirements". Before starting any CD testing or operation, the proposed implementation should be subject to a local safety assessment.

9.5 In order to standardise and harmonise the development and implementation of CD operations, airspace and instrument flight procedure design should be used, together with ATC techniques. This will allow flight crews to use in-flight techniques to reduce the overall environmental footprint and increase the efficiency of commercial aviation. ICAO Doc 9931, Continuous Descent Operations Manual, provides full information on the application of CDO techniques.

10 Interface between the SAM route network and the route network of adjacent Regions

10.1 One of the most complex aspects of ATS route network optimisation is the interface with adjacent Regions. For an overall improvement of the route network, States must be able to analyse changes and amendments on a bilateral or multilateral basis, depending on the circumstances. In many cases, it is also necessary to include improvements in letters of operational agreement between ATC units, as well as in the corresponding ATS contingency plans.

10.2 In the SAM Region, this has been achieved through the SAMIG and ATS/RO meetings, under the auspices of Regional Project RLA/06/901, providing the appropriate spaces to analyse each proposal, but this facility is not available with the States of adjacent Regions.

10.3 In order to solve this issue, the ICAO Secretariat, through its official channels, normally coordinates with those involved in order to resolve any issue that may arise in the implementation process. If any improvement that is to be introduced affects or could affect States of other Regions, the Secretariat encourages the holding of bilateral or multilateral meetings.

10.4 In addition to the above, consideration could be given to the possibility of holding broader inter-regional meetings at given periods, in accordance with the process of implementation of the

SAM ATSRO programme, to analyse how the ATS route network could be further improved.

11 Initial draft proposal of amendment to the CAR/SAM ANP

11.1 This work is an initial proposal that shall be assessed by the States and by the ATM community, in general. Accordingly, it is at a very initial stage and will undergo various changes, and it would not be advisable, at this point, to prepare an initial draft proposal of amendment to the CAR/SAM ANP.

11.2 However, by way of information, **Appendix D** contains the format that would be used for circulating the proposal of amendment to the plan once the paths, geographical coordinates, and other data required for processing the amendment have been defined.

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APPENDIX B (revised 07/09/12)

ACTION PLAN FOR THE OPTIMISATION OF THE SAM ATS ROUTE NETWORK
(GPIs 1, 5, 7, 8, 10, 11)

Activity	Start	End	Responsible party	Remarks
1. **First Phase – Implementation of RNAV-5**				
1.1. Implementation of RNAV-5 in the SAM Region	**Apr 2008**	**Oct 2011**	**Regional Project RLA/06/901**	**Completed Implemented on 20 October 2011**
2. **Second Phase – Implementation of Version 1 of the SAM ATS route network**				
Activity	**Start**	**End**	**Responsible party**	**Remarks**
2.1. Draft feasibility study for the optimisation of the SAM route network	March 2009	Apr 2009	Regional Project RLA/06/901	**Completed**
2.2. Airspace concept				
2.2.1. Collect traffic data to understand airspace traffic flows	June 2008	SAM/IG/4	SAM/PBN/IG (Regional Project RLA/06/901) Sates	**Completed** The Secretariat sent request to the States: Ref. LT 2/3A.13-LN 3/24.6.1-SA364 dated 8 June 2009. Response date: September 2009 Except for French Guiana and Panama, all SAM States sent their data collection.
2.2.2. Analyse the navigation capabilities of the fleet	June 2008	SAM/IG/4	SAM/PBN/IG Regional Projects RLA/06/901 and RLA/99/901)	**Completed** Task 1.3 of the RNAV-5 Implementation Project

			States IATA	Database under development
2.2.3. Identify the gateways of the main TMAs of the SAM Region	SAM/IG/3	SAM/IG/4	States	**Completed** Argentina, Bolivia, Chile, Colombia, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela, Brazil.
2.2.4. Identify and obtain the tools required for the study mentioned in item 2.2.5 (Aeronautical Charts, specific software)	SAM/IG/3	SAM/IG/4	SAM/PBN/IG (Regional Project RLA/06/901)	**Completed** Flight Star. Check if another software needs to be purchased.
2.2.5. Conduct an in-depth study of the SAM ATS route network, with a view to preparing Version 1 of the route network, including: • List domestic and international ATS routes that should be eliminated, based on their utilisation. • Propose the exclusionary airspace volume for the application of RNAV-5 • List the "conventional" ATS routes that should be eliminated or replaced by RNAV routes within exclusionary RNAV-5 airspace. • List the RNAV routes that should be realigned, based on the gateways of the main SAM TMAs (see 2.2.3). • Describe the proposed new SAM route network, based on the analysis of the previous items. • Describe the interface between the SAM route network and the CAR route network. • Propose an initial draft proposal of amendment to the CAR/SAM ANP. • Prepare a plan to measure performance, including gas emissions, safety, efficiency, etc.	SAM/IG/4	March 2010	SAM/PBN/IG (Regional Project RLA/06/901)	**Completed** This task requires the engagement of 3 experts to conduct the study. This requirement will be submitted to the RCC meeting of Project RLA/06901. 3 persons for a period of 3 weeks IATA and the operators would be invited to designate a person to assist in the execution of this task.

2.2.6. Conduct the required safety assessment, applying a qualitative methodology using the SMS	April 2010	October 2010	Project RLA/06/901	**Completed** This task requires the engagement of 1 expert to conduct the required assessment applying the SMS. This requirement will be submitted to the RCC meeting of Project RLA/06901. 1 person for 2 weeks
2.2.7. Conduct a workshop with the participation of experts of SAM States, to review and validate the study cited in items 2.2.5 and 2.2.6	SAM/IG/5	June 2010	SAM/PBN/IG (Project RLA/06/901) States	**Completed** This task requires the approval by the RCC meeting in order to have the support of Project RLA/06/901 Subsequent to SAM/IG/5
2.3 Implementation of Version 1 of the SAM ATS route network				
2.3.1. Process the proposal of amendment to the CAR/SAM Air Navigation Plan	TBD		SAM Regional Office	**Completed** It will depend on the decisions to be adopted at the Workshop on Routes cited in item 2.2.6
2.3.2. Publish Version 1 of the SAM ATS route network	TBD		States	**Completed** It will depend on the decisions to be adopted at the Workshop on Routes cited in item 2.2.6
2.3.3. Entry into force of Version 1 of the SAM ATS route network	TBD			**Completed**
3. **Third Phase – Implementation of Version 2 of the SAM ATS route network**				
Activity	**Start**	**End**	**Responsible party**	**Remarks**

3.1. **Flexible use of airspace**				
3.1.1. Develop guidance material for the application of the flexible use of airspace concept, including: • Model letter of agreement on FUA • Model for the use of non-permanent routes, similar to the one applied in EUROCONTROL (Conditional Routes – CDR). • Criterion for defining the scenarios in which non-permanent routes are applied • Criterion for classifying routes as non-permanent • Harmonised publication of non-permanent routes • Representation of non-permanent routes on aeronautical charts	SAM/ATS/RO/3	SAM/IG/9	SAM/PBN/IG (Project RLA/06/901)	Completed
3.1.2. Establish a civil/military coordination committee to assess the application of the flexible use of airspace concept cited in item 3.1.1.	SAM/IG/7	SAM/IG/10	States	Civil/military committees must be implemented in those States that have not done it yet. Meeting/Workshop on Civil/Military Coordination held on 16-19 August 2011.
3.1.3. Develop proposals of implementation and/or realignment of routes, based on FUA application	SAM/IG/7	SAM/IG/10	States	See 3.1.2
3.2. **Airspace concept**				
3.2.1. Collect traffic data to understand airspace traffic flows	SAM/IG/9	30 Sep 2012	SAM/PBN/IG (Project RLA/06/901) States	The Secretariat sent a letter to States: Response date: September 2012

3.2.2. Analyse the navigation capabilities of the fleet	SAM/IG/7	SAM/IG/9	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	**Completed** Information on RNAV5 approval was sent to CARSAMMA. The navigation capability database will be completed, as foreseen in the SAM/IG/2 and SAM/IG/4 meeting reports (Conclusion SAM/IG/4-3).
3.2.3. Identify the gateways of the main TMAs of the SAM Region	SAM/IG/7	SAM/IG/10	States	
3.2.4. Prepare the update of the letters of agreement and contingency with adjacent States		SAMIG/10	States	
3.2.5. Conduct a comprehensive study of the SAM ATS route network with a view to preparing Version 2 of the route network, including: • Identify the tools required for conducting the study cited in item 3.2.5 (Aeronautical Charts, specific software) • Define SAM airspace structure scenarios, including ATS routes, control sectors, interface with TMAs, to be assessed using "airspace modelling" and fast-time ATC simulation tools • List the ATS routes that should be eliminated, based on their utilisation; • Propose, if necessary, the expansion of exclusionary airspace volume for RNAV-5 application • List, if necessary, the "conventional" ATS routes that should be eliminated or replaced with RNAV routes based on possible expansion of exclusionary RNAV-5 airspace volume. • List the RNAV routes that should be realigned, based on possible modification of	SAM/IG/7	SAM/IG/9 SAM/IG/11	SAM/PBN/IG (Project RLA/06/901)	The hiring of 2 experts for a period of 3 weeks during the second half of February 2012 has been foreseen. First part completed. The first draft to be submitted to the States and operators was completed, and support was requested from the Project to proceed with the optimisation study through the engagement of 2 experts for a second period of 3 weeks before March 2013, with the new traffic data to be collected in August 2012 and the feasibility studies conducted by the States, together with the modified TMAs of the Region.

the gateways of the main SAM TMAs. • Describe possible scenarios for Version 2 of the SAM route network and control sectors, based on the analysis of the aforementioned items. • Describe the interface between the SAM route network and the CAR route network. • Submit an initial draft proposal of amendment of the CAR/SAM ANP. • Based on traffic data, consider the possibility of implementing parallel RNAV routes with the appropriate separation. • Draft planning criteria to be used by States and airspace users in this implementation process (see paragraph 2.13 of the ATSRO/03 report). • Draft the optimisation plan for restricted, prohibited, dangerous, and reserved use areas in the SAM Region. • Apply CDO techniques.				
3.2.6. Conduct seminar/workshop/work meeting on airspace planning	ATSRO/3	September 2012	Project RLA/06/901	Request the support of Project RLA/06/901 and DECEA (Brazil). The Secretariat should send a letter to DECEA requesting two instructors. The objective is to train airspace planners of the States of the Region during the second half of September in Lima.
3.2.7. Conduct the fourth workshop/meeting for the optimisation of the SAM ATS route network (SAM ATSRO/4)		July 2012	Project RLA/06/901	**Completed**

3.2.8.	Conduct "Airspace Modelling" and fast-time simulation studies to assess the scenarios described in 3.2.5	August 2012	SAM/IG/11	Project RLA/06/901 States	The Secretariat should consult on the use of the tool available in Brazil. If the tool can be used, secure, through Project RLA/06/901, the participation of 2 experts of the States of the Region.
3.2.9.	Conduct the required safety assessment applying the qualitative methodology using the SMS	31/07/12	SAM/IG/10	Project RLA/06/901 States	An expert needs to be hired for 2 weeks to carry out this task. States shall conduct a safety analysis for introducing changes in their terminal areas (TMAs)
3.2.10.	Conduct the fifth workshop/meeting for the optimisation of the SAM ATS route network (SAM ATSRO/5) to review and validate the studies cited in items 3.2.-5 and 3.2.8.	SAM/IG/10	July 2013	Project RLA/06/901 States	
3.2.11.	Conduct the third workshop/seminar/meeting on the risk assessment of Version 2 of the SAM ATS route network. Validation of the study cited in 3.2.9.	4th week of March or 1st week of April 2013	SAM/IG/11	Project RLA/06/901 States	
3.3.	**Implementation of Version 2 of the SAM ATS route network**				
3.3.1.	Process proposal of amendment to the CAR/SAM Air Navigation Plan	August 2013		SAM Regional Office	
3.3.2.	Publish Version 2 of the SAM ATS route network.	22 August 2013		States	
3.3.3.	Entry into force of Version 2 of the SAM ATS route network.	17 October 2013			