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THIRD WORKSHOP/MEETING OF THE SAM IMPLEMENTATION GROUP (SAM/IG/3)
REGIONAL PROJECT RLA/06/901

Lima, Peru, 20-24 April 2009

Agenda Item 2: Optimisation of the ATS Route Structure

FEASIBILITY STUDY FOR OPTIMISING THE ATS ROUTE NETWORK IN THE SOUTH AMERICAN REGION

(Presented by the ATM Expert, Regional Project RLA/06/901)

Summary

This working paper presents the Feasibility Study for Optimising the ATS Route Structure in the South American Region, for review and approval by the SAM/IG/3 Meeting. WP/4 lists the tasks contained in the Programme for Optimising the SAM Route Network that must be fulfilled by the States before the SAM/IG/4 meeting.

References:

- Report of the 36th ICAO Assembly
- Report of the ALLPIRG/5 Meeting
- Doc. 9854 –Global ATM Operational Concept
- Doc. 9750 – Global Air Navigation Plan
- Report of the SAM/IG/1 Meeting
- Report of the SAM/IG/2 Meeting
- CAR/SAM PBN Roadmap
- Manual for Airspace Planning (ASM.ET1.ST03.4000.EAPM.02.02) - EUROCONTROL

1 Background

1.1 The 36th ICAO General Assembly requested the Council to encourage Contracting States to improve air traffic efficiency--that resulted in less emissions--, report on the progress in this area, and expedite the development and implementation of routings and procedures allowing for efficient fuel consumption to reduce aircraft emissions.

1.2 The ALLPIRG/5 meeting, held in March 2006, formulated the following conclusions addressing the relationship between the optimisation of the airspace structure (TMA and ATS route network) and environmental benefits:

Conclusion 5/8 — Air traffic service (ATS) routes coordinated globally

That PIRGs:

a) establish a global, consolidated, and prioritised list of route and terminal area (TMA) improvements, in close coordination with airspace users; and

b) work with the neighbouring PIRGs/States/air navigation service providers (ANSP) to expedite improvements on international routes.

Conclusion 5/9 — Terminal area (TMA) structure and area navigation

That States:

a) use area navigation in all TMAs, including the appropriate arrival and departure procedures, to improve efficiency and reduce emissions around airports; and, in special cases with especially challenging obstacles and very high air traffic density and where it is possible to have additional approach paths, use more precise and contained required navigation performance procedures; and

b) review controller operations, procedures, and training to ensure optimum management of air traffic services.

1.3 In this sense, the ICAO regular programme, among other implementation projects, has focused on the optimisation of the ATS route network. In this respect, the meetings of the SAM Implementation Group (SAM/IG) are being held under the auspices of the new Regional Project RLA/06/901. One of the objectives of these meetings is to organise the ATS route network of the South American Region. The first two meetings of the SAM Implementation Group (SAM/IG/1 and SAM/IG/2) reviewed the status of the route network, and noted the following:

a) Some routes have not met expectations as to their use by operators, despite the insistence of the latter on their implementation.

b) It was noted that some routes, although duly implemented, are in little use because the operators prefer less direct ATS routes, which result in higher operating costs and, in some cases, less airspace capacity and flexibility;

c) A large number of RNAV routes have not yet been linked through the SID and STAR procedures established in the TMAs, making flight and ATC operation difficult;

d) Airspace complexity is more related to air traffic movement than to airspace design *per se*. As a result, in some cases, routes with low traffic could be maintained so long as the corresponding operational benefits are obtained.

1.4 The SAM Region has focused its attention on further improving airspace structure in order to achieve an inter-functional air traffic management system available to all users during all flight phases, that meets the agreed safety levels, provides cost-effective operations, is environmentally sustainable, and meets national security requirements.

1.5 In order to achieve the above, the SAM/IG/2 meeting deemed it appropriate to conduct a feasibility study to develop an ATS route network that responds to the new aviation requirements and takes into account the new performance-based navigation operational concept.

1.6 Taking into account the diversity of scenarios in the Region, the meeting felt that this would be a very complicated task and should be supported by Regional Project RLA/06/901, in order to first make a diagnosis of the existing ATS route network, develop a strategy for carrying out the task in phases, if applicable, prepare a list of deliverables, propose a work programme, identify the data needed and the method for their collection, define the necessary support tools to perform the task, specify the reference documentation required, and other aspects deemed relevant for the task, such as the interests of the States, geographical characteristics, etc. In addition to the aforementioned aspects, safety issues and other expectations described in the global ATM operational concept should be taken into account.

2 Discussion

2.1 Feasibility Study for Optimising the ATS Route Network in the South American Region

2.1.1 The Feasibility Study for Optimising the ATS Route Network in the South American Region, contained in **Appendix A** to this working paper, was conducted with a view to:

a) establishing the planning criteria that were used for assessing the SAM ATS route network;

b) presenting a general diagnosis of the SAM ATS route network; and

c) proposing a Programme for Optimising the SAM ATS Route Network, by phases, involving the establishment of a methodology for modifying the route network and leading to gradual improvements in the regional airspace structure.

2.1.2 Planning Criteria

2.1.2.1 The planning criteria established in the Feasibility Study for Optimising the ATS Route Network in the South American Region were based on the EUROCONTROL Manual for Airspace Planning (ASM.ET1.ST03.4000.EAPM.02.02), which can be obtained from the following web page: **http://www.eurocontrol.int/airspace/gallery/content/public/EUROCONTROL%20APM%20V2_Ed_Released%20Issue_Amendment%202_010606.pdf**. Those interested in deepening the analysis contained in Chapter 2 of the feasibility study should refer to the aforementioned document.

2.1.2.2 It is important to note that the general diagnosis of the SAM ATS route network was done based on the aforementioned planning criteria. These criteria should be used to develop the new route network versions, as envisaged in the programme for optimising the SAM ATS route network.

2.1.3 **Analysis and Diagnosis of the SAM ATS Route Network**

2.1.3.1 In general, the analysis and diagnosis of the SAM ATS route network established that the main problem of the SAM route network was that its development had always been based on the specific requirements of isolated routes, without a global analysis encompassing broader operational requirements aiming at a functional inter-relationship among the various elements of the airspace structure, such as: ATS routes, control sectors, control areas, TMAs, etc.

2.1.3.2 Another important issue is that, as already mentioned, the result of the work done by the States with the support of project RLA/98/003 resulted in the implementation of 77 RNAV routes, the modification of 58 route paths, and the elimination of only 7 routes. Although the work done addressed the operational requirements of airspace users, the addition of RNAV routes to the existing airspace structure in some cases resulted in increased airspace complexity and, thus, a reduced ATC capacity.

2.1.3.3 The complete analysis of the SAM ATS route network appears in Chapter 3 of the Feasibility Study for Optimising the ATS Route Network in the South American Region.

2.1.4 **Programme for Optimising the SAM ATS Route Network**

2.1.4.1 Based on the SAM ATS Route Network Planning and Analysis/Diagnosis Criteria, the Feasibility Study for Optimising the ATS Route Network in the South American Region has concluded that the optimisation of the SAM route network should be done by phases, in order to derive the corresponding operational benefits as soon as possible. Starting on phase 2, the concept of route network versions would be incorporated, taking into account that the airspace structure changes as a function of air traffic growth, the shifting of air traffic demand from one region or airport to another, and available technology, among other factors. The use of route network versions reflects the need for an integrated periodic review to ensure the best possible airspace structure.

2.1.4.2 In view of the above, the following draft conclusion is submitted to the consideration of the Meeting:

Conclusion SAM/IG/3-x Feasibility Study for Optimising the ATS Route Network in the South American Region

That the ICAO SAM States take relevant action to follow the guidelines and meet the target dates established in the Feasibility Study for Optimising the ATS Route Network in the South American Region that appears in **Appendix A** to this *part of the report* (working paper).

2.2 **Tasks of the Programme for Optimising the SAM ATS Route Network that must be completed by the SAM/IG/4 meeting**

2.2.1 **Collect traffic data to understand airspace traffic flows**

2.2.1.1 Statistical data are essential to create an airspace structure that conforms to airspace planning principles and techniques. Traffic data must be periodically collected in order to analyse the evolution of air traffic demand in the Region. Consequently, SAM States must use the form contained in **Appendix B** to this working paper to collect the necessary data for the development of version 1 of the SAM route network. It is critical for the States to complete the form according to the instructions in order

to ensure that the data can be effectively used for the analysis and to facilitate processing. Accordingly, the following draft conclusion is suggested for approval by the Meeting:

Conclusion SAM/IG/3-x Data Collection

That SAM States:

a) collect data on flights carried out in the SAM Region on **1-31 July 2009** and send them to the SAM Regional Office before **30 September 2009.**

b) use a sample consistent with the form and the instructions for completing the form, contained in **Attachment 2 to Appendix A** to this *part of the report* (working paper), using the EXCEL format.

2.2.2 **Analyse the Fleet Navigation Capacity**

2.2.2.1 The fleet navigation capacity must be known in order to determine the airspace volume in which RNAV can be applied on an exclusionary basis in order to optimise aircraft flow while reducing airspace complexity and pilot and air traffic controller workload. This task corresponds to task 1.3 of the RNAV-5 Implementation Programme and is being fulfilled under project RLA/99/901.

2.2.3 **Define the Gateways for the Main TMAs in the SAM Region**

2.2.3.1 As foreseen in Resolution 36/23 of the 36th ICAO Assembly and Conclusion 15/38 of GREPECAS/15, the States must submit their National PBN Implementation Plans by December 2009. For purposes of planning and implementing the PBN in the TMAs, the States shall develop their own airspace concept, which will help them define the gateways for the main TMAs in the SAM Region. Version 1 of the route network will only include TMA gateways for those States that have already started their PBN implementation process or some other form of TMA airspace restructuring. This phase should also take into account State information available for the development of version 1.

2.2.4 **Identify and Obtain the Necessary Tools for the Development of Version 1 of the Route Network (aeronautical charts, specific software)**

2.2.4.1 The detailed study envisaged under item 2.2.5 of the Action Plan for Phase 2 will require specific tools, such as aeronautical charts and specific software, for properly analysing the SAM route network. Such tools will also be necessary for the workshop foreseen in 2.2.6 of that same action plan. Consequently, Regional Project RLA/06/901, with the support of the SAM/IG/3 meeting, shall identify these tools and find a way to obtain them. In general terms, there will be a need for aeronautical charts containing the route network, the main TMAs, the SIDs and STARs, and the approach procedures for the major airports in the SAM Region. Likewise, it is advisable to use flight-planning software (*e.g.*, FliteStar of Jeppesen) containing the information mentioned in the aeronautical charts in order to facilitate data management. It would also be advisable to use software to design new routes, with automatic determination of approximate geographical coordinates of significant points. In this regard, it would be advisable for the meeting to discuss the tools required for this work, as well as the best way of obtaining them.

2.3 **Interface Between the CAR and SAM ATS Route Networks**

2.3.1 One of the most complicated aspects of the detailed study of the SAM ATS route network for drafting version 1 of the route network is the interface between the CAR and SAM Regions. The best option to perform this task would be a joint effort by the two Regions, following the model of the AP/ATM meetings. However, if this joint effort is not possible, experts should work on one of the two following options:

a) Propose a link between version 1 of the SAM route network and the items that might be considered to be the most appropriate, such as the WATRS airspace, and request the CAR Region to assess the proposal according to the mechanisms established by the NACC Office.

b) Use the existing boundaries between the adjacent FIRs of the two Regions as a basis for the development of version 1 of the SAM route network.

2.3.2 Considering that the interface between the two route networks is an issue that will require extended coordination between the NACC and SAM Offices, it would be advisable for the Meeting to start discussing the proposed strategies in order to begin the cited coordination.

3. Suggested Action

3.1 The Meeting is invited to:

a) take note of the information contained in this working paper.

b) review, validate, and approve the Feasibility Study for Optimising the ATS Route Network in the South American Region, including the draft conclusion in paragraph 2.1.4.2.

c) discuss the best way of collecting data for planning the route network and approve the draft conclusion in paragraph 2.2.1.1.

d) discuss the proper tools for the development of version 1 of the SAM route network, and the best way to obtain them.

e) analyse the strategies for defining the interface between the CAR and SAM ATS route networks, with a view to proposing the best option for furthering this task.

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APPENDIX A

Feasibility Study for Optimising the ATS Route Network in the South American Region

1. Introduction

The main objective of the Airspace Organisation and Management (AOM) component of the Global ATM Operational Concept is to maximise efficient airspace use, while maintaining the required level of safety.

Incorporation of the Global ATM Operational Concept into the Global Air Navigation Plan facilitated the planning and implementation of new and innovative methods that make significant improvements in airspace organisation and management possible. The set of Global Planning Initiatives (GPI) directly involved in AOM offer the necessary guidelines for planning and implementing an optimum airspace structure, among the most important of which are:

a) GPI 1 –Flexible Use of Airspace

b) GPI 5 – RNAV and RNP

c) GPI 7 – Dynamic and Flexible ATS Route Management

d) GPI 8 – Collaborative Airspace Design and Management

e) GPI 10 – Terminal Area Design and Management

f) GPI 11 – RNAV and RNP SIDs and STARs

PBN implementation (GPI 5) will facilitate the use of advanced aircraft navigation capabilities, which, combined with the air navigation system infrastructure, will make it possible to optimise the airspace, including the route network. This will favour ATS routing that will meet the needs of airspace users, thereby reducing controller and pilot workloads and the concentration of aircraft in specific portions of the airspace.

Recognising the importance of PBN for AOM, the 36th ICAO Assembly established Resolution 36/23 urging States to implement ATS routes and RNAV and RNP approach procedures, based on the PBN Manual (Doc. 9613). The 36th Assembly also resolved that States and Regional Planning and Implementation Groups (PIRGs) should prepare a PBN implementation plan by 2009.

Before approving the Global ATM Operational Concept and the new Global Air Navigation Plan, CAR/SAM States, Territories, and International Organisations reviewed the ATS route network and implemented new RNAV routes, with the assistance of Project RLA/98/003 through its support for meetings of ATM authorities and planners --ATM (AP/ATM)-- , thereby helping to reduce some paths, leading to a compatible transition between the en-route flight phase and terminal control areas. It also made it possible to develop the CAR/SAM PBN Route Map, approved through GREPECAS/14 Conclusion 14/46.

As a result of the efforts of States with the support of project RLA 98/003, 77 RNAV routes have been implemented, the flight paths of 58 routes have been modified, and 7 routes have been eliminated. The ICAO Council has approved the respective amendments to the CAR/SAM ANP Route Network.

At the request of States and International Organisations, the ICAO regular programme has, among other implementation projects, focused its attention on optimising the ATS route network. In this respect, the meetings of the SAM Implementation Group (SAM/IG) are being held under the auspices of the new RLA 06/901 project. One of the aims of these meetings is to optimise the ATS route network in the South American Region. During its first two meetings, the SAM Implementation Group (SAM/IG/1 and SAM/IG/2) analysed the current state of the route network and confirmed the following:

a) Some routes have not met expectations as to their use by operators, despite the insistence of the latter on their implementation;

b) It was noted that some routes, although duly implemented, are in little use because the operators prefer less direct ATS routes, which result in higher operating costs and, in some cases, less airspace capacity and flexibility;

c) A large number of RNAV routes have not yet been linked through the SID and STAR procedures established in the TMAs, making flight and ATC operation difficult;

d) Airspace complexity is more related to air traffic movement than to airspace design *per se*. As a result, in some cases, routes with low traffic could be maintained so long as the corresponding operational benefits are obtained.

The SAM Region has seen the need to further improve the airspace structure, in order to achieve an inter-functional air traffic management system available to all users during all flight phases, that meets the agreed safety levels, provides cost-effective operations, is environmentally sustainable, and comply with national security requirements.

In order to achieve the above, the SAM/IG/2 meeting deemed it appropriate to conduct a feasibility study to develop an ATS route network that would meet the new aviation requirements and provide for the new performance-based navigation concept.

Considering the diversity of scenarios in the Region, the Meeting felt that this task would be very complicated and should be supported by the Regional Project RLA/06/901, in order to first make a diagnosis of the existing ATS Route Network, develop a strategy for carrying out the task in phases, if appropriate, prepare a list of deliverables, propose a work programme, identify the data needed and the means for their collection, define the necessary support tools to perform the task, specify the reference documentation required, and other aspects deemed relevant for the task, such as the interests of each State, geographic characteristics, etc. In addition to the aforementioned aspects, safety issues and other expectations described in the Global ATM Operational Concept should be taken into account.

Optimising the ATS route network in the South American Region is expected to contribute to the accomplishment of the following Strategic Objectives of ICAO:

A: Safety — *Enhance global civil aviation safety*

C: Environmental protection — *Minimise the adverse effect of global civil aviation on the environment*

D: Efficiency — *Enhance the efficiency of aviation operations*

2. Planning criteria

2.1. General Considerations

This chapter of the present study was based on the EUROCONTROL Manual for Airspace Planning (ASM.ET1.ST03.4000.EAPM.02.02), which can be obtained at the following website address:http://www.eurocontrol.int/airspace/gallery/content/public/EUROCONTROL%20APM%20V2_Ed-2_Released%20Issue_Amendment%202_010606.pdf. Those interested in deepening the analysis contained in this chapter are recommended to refer to that document.

The ATS route network should serve as a basis for airspace organisation and air traffic service requirements. It should be established in such a way as to permit most flights to operate on direct routes, or as close to such routes as possible, in order to unite flight origin/destination areas. This structure must be operationally viable. In order to achieve optimum ATC capacity, it may be necessary to establish non-optimum flight levels and/or paths, but this could reduce the complexity of the airspace structure.

There is a very close relationship between the route network structure and airspace sectorisation. Therefore, that relationship should be considered as of the planning phase, in order to ensure the viability of sectorisation that would make optimum ATC capacity possible, including the possibility of ATS delegation. Definition of the route type (one-way/two-way) and the direction of one-way routes can take into consideration the need for more efficient sectorisation. In more complex airspace structures, validation through ATC simulations may be necessary before implementation.

Civil/military coordination is essential to ensure route network efficiency. The flexible use of airspace (FUA) concept is of key importance for guaranteeing that the requirements of all airspace users are met. FUA application permits the implementation of additional direct routes, as of the moment direct aircraft routing practices are adopted at the ATC tactical level, in cases where temporary special use airspaces (SUA)[1] are not activated. Automatic flight plan reprocessing may facilitate FUA application, permitting flight planning, if information about SUA availability for civil aviation is made viable sufficiently in advance.

Definition of the main traffic flows should include domestic air traffic routes and segments, in order to make the development of an integrated structure possible in the initial planning phase. Efforts should be made to eliminate points of congestion. In that case, special care should be taken to avoid worsening the situation of one area when attempting to resolve problems in another area.

The number of ATS routes should be kept to a minimum, always considering the traffic demand in relation to ATC capacity and the possibility of applying direct routes. Utilisation of a large number of ATS routes improves the possibility of using direct routes. Having a large number of crossing points, however, especially in areas that are already congested, normally reduces ATC capacity, in accordance with growing airspace complexity. Airspace planners should optimise ATC capacity by introducing new routes with the least number of crossing points possible and/or inserting the crossing

[1] Special Use Airspaces are those provided for in Doc 8126 (AIS Manual), which should be inserted in the ENR part of the AIP of each State, as follows:
ENR 5.1 –Restricted / Prohibited / Dangerous Areas
ENR 5.2 – Areas for Training and Military Exercises / Air Defence Identification Zones (ADIZ)
ENR 5.3 – Other Dangerous Activities and Other Potential Risks

points as far from the congested areas as possible. In that way, if the implementation of a new route is planned to accommodate a foreseen demand in air traffic that is not confirmed during the implementation phase, its implementation should be reconsidered. Furthermore, redundant ATS routes should be eliminated.

The use of one-way routes should be considered, particularly in areas where the interaction between ascending/descending traffic is a limiting factor, and represents an advantage in improving airspace structure that will lead to increased ATC capacity in ATC sectors. Likewise, in congested areas, aircraft overflights should not, insofar as possible, cross each other or interfere with the arrival and departure flow of the main TMAs, and the duration of possible crossings should be minimised and preferably carried out at 90º angles.

2.2. Use of Performance-Based Navigation

The use of Performance-Based Navigation creates the necessary conditions for optimising the ATS route network, inasmuch as it makes it possible to harmonise aircraft and operator approval criteria for en-route RNAV operations and permits the establishment of appropriate route spacing with the application of the Protected Airspace Concept. With PBN implementation, the airspace can be made less complex through the elimination of conventional routes, reduction of crossing points between flight paths, and orderly arrangement of the airspace as a whole.

2.3. Regional Routes and Domestic Routes

In airspaces where international operations are responsible for most of the traffic, development of the route network requires coherent coordination among the States involved. In airspaces where most of the air traffic consists of domestic operations, the route network must be harmonised with the adjacent States, in order to optimise the airspace structure.

Isolated State development of domestic ATS routes should be limited to airspaces that serve national purposes only. In addition, such efforts normally have direct and perceptible effects on air traffic beyond the jurisdiction of the State involved.

Development of a harmonised and consistent route network requires active participation by States in the international working groups formed to establish or review the regional route network, considering a top down strategy, based on regional operational requirements for increasing ATC capacity, bearing in mind the following criteria:

a) First, identify the main regional air traffic flows, together with those that extend beyond the Region and have a direct impact on the regional route network, in order to seek out shortcomings in the route network and in ATC sector organisation.

b) Establish and review the ATS route network and support sectorisation in order to accommodate the main air traffic flows, thereby reducing airspace complexity and balancing ATC workload.

c) Integrate the required routes to provide access to the regional route network from/to airports not served by it. It is also necessary to integrate non-permanent

routes that are needed to alleviate the air traffic load in the main ATS routes and to ensure flight at the most optimum profile possible.

d) Ensure connectivity between the ATS route network from/to TMA airspace.

e) Establish phased implementation to ensure consistency with State implementation.

2.4. Relationship between ATS Routes and Control Areas (CTA)

Use of Control Areas (CTA) in significant portions of the airspace beyond the ATS routes has the advantage of allowing the controller, when air traffic conditions permit, to authorise a specific flight under his/her control to deviate from an established ATS route without having the aircraft leave the controlled airspace and without losing the ATC benefits.

Within the CTA, however, the protected airspace of ATS Routes is not visible, because, by definition, all airspace around the routes is controlled airspace and this does not facilitate the demarcation of special use airspace (SUA) adjacent to ATS routes. On the other hand, establishing ATS routes in the form of corridors (airways) offers a clear description of the associated protected airspaces, within which controlled flights should remain.

To give flexibility to VFR flights outside airways and TMAs, the lower limits of controlled airspace must be established in order to avoid unnecessarily restricting flights that do not require air traffic control services, while keeping IFR traffic within the controlled airspace during the departure, en-route, arrival and approach phases.

2.5. Flexible Use of Airspace (FUA)

Most ATS routes must be established on a permanent basis. There are cases, however, in which the application of non-permanent routes, in keeping with the existence of temporary special use airspace (SUA), can make it possible to optimise the airspace structure, either reducing the traffic load on the main routes or permitting flights at more convenient profiles.

By way of example, EUROCONTROL has established Conditional Routes (CDRs), according to a specific classification for each operational situation:

a) CDR 1 – Routes that can only be used during specific periods, for example, during weekends or at night. These routes can be used permanently for flight planning purposes during the periods specified in the AIP. Changes in periods specified in the AIP should be published through standard AIS procedures.

b) CDR 2 – Routes that can be used through pre-tactical coordination procedures established by the Airspace Management Control (AMC) units. These routes can be used for flight planning, but not permanently, depending upon AMC coordination. They normally depend upon the capacity for reprocessing flight plans.

c) CDR 3 – Routes that can be used tactically by the ATC unit through direct coordination between the ATC and the user of the special use area. These routes are not used for flight planning purposes.

ATS routes used under the Flexible Use of Airspace concept should be included in the ATS route network, with a clear indication of the limitations imposed by their non-permanent nature. These routes should be reviewed at regular intervals in order to assess their type (1, 2 or 3), whenever fuller use of these routes is needed.

2.6. Protected Airspace – Route Spacing Concept

Item 2.11 of Annex 11 establishes the requirement to provide protected airspace and adequate spacing between adjacent ATS routes. This spacing between the centre lines of parallel runways where PBN is applied depends upon the type of RNAV or RNP specified by each State or on the basis of regional agreements.

In the case of RNAV-5 (B-RNAV) application in Europe, the minimum route spacing was established at between 10 and 15 NM, depending upon whether or not radar was used and ATC intervention capacity.

Route spacing should be assessed as provided for in Doc. 9689, bearing in mind, among other aspects, the available ATS surveillance capacity and air traffic controller workload.

2.7. Harmonisation in route network publication

Doc 8126 (AIS Manual) recommends that part ENR 3 of the AIP contain a list of all ATS routes established within the territory of a State, whether as part of the Regional or of the National Route Network.

As specified in Doc. 8126 (ENR 3 – ATS Routes), a description of the special procedures required in a route or part of a route must be included where applicable.

Under these circumstances, permanent or non-permanent routes should be listed together, inasmuch as a route can contain permanent and non-permanent segments. Special procedures for each route or segment, however, should be published in a specific part of the AIP.

2.8. Planning Principles

The planning principles for developing an ATS route network were established in the Guide for the Implementation of RNAV Routes in the CAR/SAM Regions, approved through Conclusion 12/7 of the GREPECAS/12 meeting. To facilitate reference to those principles, they will be included in this document.

2.8.1. Airspace planners should keep the following planning principles in mind:

a) Air traffic volume in existing and proposed routes;

b) Establishment of the shortest routes possible for most of the flights;

c) Prioritise the planning of areas of greater air traffic volume;

d) Meet the needs of civil and military users;

e) Integration of the route network and support sectorisation at the start of the planning process;

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

2.8.2. **Air traffic volume in existing and proposed routes**

Considering the advantages of RNAV routes and the growing number of users trained in RNAV flight, implementation of an RNAV route normally absorbs most of the air traffic of one or more "conventional" routes. Therefore, the elimination of any of the existing "conventional" routes should be evaluated and accomplished, if necessary, through an analysis of the air traffic volume in each of the routes involved, whether they are RNAV routes or not. It is important to stress that maintaining "conventional" routes for a small number of users not equipped for RNAV flights does not necessarily mean increasing airspace complexity, for that complexity is due to the number of existing flights for each route and not to the additional crossings that would appear on the aeronautical charts.

2.8.3. **Establishment of the shortest routes possible for most of the flights**

Considering the need to serve most users at their optimum flight profiles, the establishment of direct routes as close as possible to the origin/destination paths should be prioritised. Inasmuch as the RNAV route normally absorbs most of the air traffic, implementation of the RNAV route will most likely take preference over the "conventional" route. It is important to emphasise that it may be necessary to maintain routes for users whose aircraft are not RNAV-equipped. Inasmuch as it is not always possible to establish a route between origin and destination, the need should be considered for implementing specific one-way routes for departure from and arrival at a TMA, using specific arrival and departure control sectors. Airspace planning should consider the requirement for establishing new airspace sectorisation when beginning the implementation of a new version of the route network.

2.8.4. **Prioritise the planning of areas of greater air traffic volume**

In order to accomplish the aim of giving most users the shortest routes possible, airspace planning should start in airspace regions with the greatest air traffic volume and proceed to those with the least volume, giving priority to flows with the highest air traffic volume.

2.8.5. **Integration of the RNAV route network and support sectorisation at the start of the planning process**

Adequate airspace sectorisation needs to be guaranteed from the very beginning of the planning process. Furthermore, the planning should not consider FIR boundaries, in order to create a seamless airspace, including, if necessary, the delegation of air traffic services.

2.8.5. **Integration of the route network and TMA arrival and departure paths**

Integration of the RNAV route network and TMA arrival and departure paths should be considered during the initial planning phase for implementation of a new route network, considering the need to reduce pilot and air traffic controller workloads, mainly through more effective use of flight management systems (FMS) and by reducing the ground/air/ground communications load.

2.9. Concepts facilitating route network implementation

Some concepts facilitate consistent and harmonised implementation of a route network.

These concepts are:

a) PBN – as already mentioned in item 2.2

b) FUA – as already mentioned in item 2.5

c) Seamless Airspace – Route network planning and implementation should be accomplished with the application of the seamless concept, without considering FIR boundaries. ATS delegation should be applied as needed to increase ATM capacity and efficiency. This delegation should normally occur:

- When the crossing points are located near the FIR or sector boundaries, to give the controller the necessary information sufficiently in advance to be able to manage the traffic entering the adjacent FIR.
- When the flying time in a given FIR is short, in order to reduce coordination among ATC units responsible for adjacent FIRS, thereby reducing the workload.
- In TMA sectors, to allow the controller to anticipate the regulation/radar vectors for the incoming flow.

d) RVSM – RVSM has permitted the application of additional flight levels that favour the conditions required for distributing aircraft into Flight Level Assignment Systems (FLAS), in order to improve flight safety, thereby minimising the effect on the efficiency of air operations.

Planning Techniques

2.9.1. Establishment of specialised routes

In high traffic density areas, additional ATC capacity may be obtained by segregating arrival and departure routes and separating them from overflight routes. This increase in capacity is due to the fact that this structure normally avoids conflicts among ascending and descending aircraft and between these and overflying aircraft. As a result, this structure should be applied for the arrival and departure phases. Application of Continuous Descent Approaches (CDAs) depends upon the establishment of specialised arrival paths, through either one-way routes or STARs, with the least possible number of crossings, to allow aircraft to descend without interruption.

2.9.2. Establishment of specialised sectors

Based upon the structure described in item 2.10.1, specialised sectors may be established by grouping routes of a similar nature, like arrival sectors, departure sectors or overflight sectors. These sectors are applied especially in ACC sectors responsible for "feeding" a highly complex TMA, as well as in TMAs themselves.

2.9.3. Crossings as close as possible to the origin of the flights

The route network must be developed in such a way that the essential route crossings used by the main traffic flows are as close as possible to their origin. Considering the complexity of the area of origin, however, it may be appropriate to transfer the crossings to areas with lower traffic/route densities. Crossings should also be executed preferably in areas with ATS surveillance.

3. Analysis and Diagnosis of the SAM ATS Route Network

3.1. General Considerations

The purpose of this chapter is to make a general analysis and diagnosis of the SAM ATS route network, in light of the planning criteria presented in chapter 2. The items in this chapter correspond to the items in chapter 2, in order to facilitate an understanding of the criteria applied in the analysis and diagnosis of the SAM ATS route network.

Based on material available at the ICAO South American Office, it can be noted that information was already available in 1957 about the development of a route network for the SAM Region and the South Atlantic. It can also be noted in reports of the First and Second CAR/SAM Air Navigation Meetings, held in 1976 and 1989, respectively, that the stability of the route network was always a matter of concern and that there were a prevalence of isolated State initiatives for the development of their own route networks. There were initiatives in the Region for the development of an integrated route network, with the holding of panel meetings starting in 1980, but with limited results, considering the complexity of the subject and the limited time available for the studies. It was only in 1999, during the Third CAR/SAM Air Navigation Meeting (CAR/SAM/3 RAN - Buenos Aires, Argentina, 5-15 October 1999) that the ATS route network was considered stable and fit to be a part of the Regional Air Navigation Plan.

Generally speaking, the development of the route network in the SAM Region was always based on the specific requirements of isolated routes; there was no global analysis that considered broader operational requirements, and in which a functional interrelationship among the various elements of airspace structure were sought, such as: ATS Routes, Control Sectors, Control Areas, TMAs, etc.

As already mentioned, the work performed by the States with the support of Regional Project RLA/98/ resulted in the implementation of 77 RNAV routes, the modification of the paths of 58 routes, and the elimination of only 7 routes. Although this effort has met the operational requirements of airspace users, the addition of RNAV routes to the existing airspace structure ended up, in some cases, by increasing airspace complexity and thus reducing ATC capacity.

3.2. Use of Performance-Based Navigation

RNAV-5 application in the South American Region, foreseen for November 2010, will create the necessary conditions for harmonising aircraft and operator approval criteria for flights in RNAV routes and will provide the necessary elements for establishing adequate spacing between routes.

According to conclusion SAM/IG/2- 3, the assessment of fleet navigation capacity will make it possible to analyse the feasibility of implementing an exclusive RNAV-5 airspace in the SAM Region in a given volume of airspace (for example, between FL 290 and FL 410). This exclusionary airspace would constitute an important element for reducing airspace complexity, with the corresponding increase in airspace capacity.

Another important aspect to be considered is that the maintenance of conventional routes in the SAM Region should take into account the coverage of available radio aids, so that they can be effectively flown by aircraft not equipped for RNAV operations.

3.3. Regional and Domestic Routes

The SAM route network has always been planned and implemented on an isolated basis. International routes are normally analysed in an international forum like the RNAV/RNP Task Force, the ATM/CNS Subgroup, AP/ATM meetings, etc., individually, without any specific concern for an integrated analysis based on the need to assess the impact on ATC capacity. States are responsible for domestic routes, which are implemented without any specific integration into the regional route network. In light of the interrelationship between domestic and regional routes, planning and implementation should be integrated, with a view towards obtaining an optimum structure of the airspace, including ATC control sectors.

SAM ATS routes should be implemented using a top-down strategy, in order to identify the main regional air traffic flows, as well as the shortcomings in the route network and in the sectorisation of the ATC units involved. Based on that identification, it would be possible to conceive an integrated regional/national network that would meet the needs of airspace users and ATS providers. That network should consider the need for sectorisation, integration of the airports it does not serve, the use of non-permanent routes, and connectivity among TMAs.

3.4. Relationship between ATS Routes and Control Areas (CTAs)

According to the information contained in the CAR/SAM Regional Air Navigation Plan (Doc. 8733), six States in the SAM Region have adopted widespread use of CTAs in their airspace above and beyond the ATS routes. Nonetheless, in a significant portion, air traffic control service is not provided to flights that are occasionally made outside the ATS routes. As a result, ATS routes must be established to serve IFR flights, even though the air traffic flow may not be significant, in order to guarantee that they receive air traffic control service.

More widespread adoption of CTAs in the SAM Region could avoid the need for implementing ATS routes in significantly less dense air traffic flows.

3.5. Flexible Use of Airspace (FUA)

In the SAM Region, there is no systematic and harmonised application of a Flexible Use of Airspace, unlike EUROCONTROL. There is a close relationship between FUA application and ATFM, inasmuch as the adoption of non-permanent routes can increase airspace capacity in a given portion of the airspace.

The expansion and systematic application of FUA in the SAM Region is a key element for optimising the route network, in view of its importance for ensuring, at least partially, that aircraft fly their optimum profiles and, in some cases, that airspace complexity is reduced.

Note the need for full development of documentation concerning FUA application, including standards and procedures, as well as the harmonised publication of special procedures applied to non-permanent routes, as provided for in Doc 8126.

3.6. Protected Airspace – Route Spacing Concept

The protected airspace and RNAV route spacing concept envisaged in Annex 11 was not defined in the SAM Region. As a result, spacing between RNAV routes, one of the key elements of airspace planning, has not yet been established, leaving controllers to apply vertical and/or horizontal separation based on ATS Surveillance.

One of the most important factors in optimising the route network would be to establish minimum spacing between RNAV routes, based on the specific characteristics of the SAM Region, such as air traffic volume, air traffic concentration, passing frequency, operational errors, available ATS surveillance, aeronautical communications, and ATC intervention capacity, etc.

Airspace complexity is intrinsically related to the need for controller intervention to provide aircraft separation. The more “natural” the separation between aircraft, ensured by appropriate spacing between ATS routes, the less the need for controller intervention and, consequently, the greater the available ATC capacity.

3.7. Harmonised route network publication

As already mentioned in item 3.5, there is a need to harmonise the way special procedures established for non-permanent routes are published, as required by Doc. 8126. That harmonisation will enable aircraft operators to find out about the operating restrictions on the use of those routes, particularly if they can be used for flight planning and when they can be used for that purpose. Likewise, the restrictions could also establish specific fuel requirements in the event that more appropriate routes were not available.

3.8. Planning Principles

The planning principles should be applied in order to make an objective analysis based on statistical data and the experience of State experts, in order to remedy shortcomings in the route network and in the sectorisation of the ATC units involved.

Collection and analysis of flight data in a significant time sample is key to planning route optimisation, considering that it will be possible through that data to determine the main air traffic flows and, as a result, to prioritise the implementation of routes designed to serve those flows, thereby establishing the most direct routes possible for most flights. Collection of that data has always been limited, thus preventing an in-depth analysis of the main air traffic flows.

Data collection by CARSAMMA, which is limited to the airspace between FL 290 and FL 410 (sample used in RVSM safety assessment), is normally applied, allowing for a preliminary

analysis, considering that data are not available for all SAM States. The data obtained from CARSAMMA, processed and analysed in the PBN Implementation Programme for En route Operations, approved by Conclusion SAM/IG/2-1, were inserted in the table. A preliminary analysis of that data reveals that in most of the SAM FIRs, considering the States for which data are available, a small number of ATS routes (up to 14) are used by a large number of flights (85% or more). Table 2, for its part, shows that a small number of city-pairs (up to 16) accounts for most of the air traffic movement (51% or more) in the FIRs.

Air traffic movement between FL 290 and FL 410, by FIR, and percentage of flights on the main ATS Routes
Period: 13 to 28 January 2008

Country	FIR	Amount of air traffic in the sample	Percentage of flights on the main ATS routes	Number of ATS Routes
Argentina	Cordoba	1769	92%	13
	Comodoro Rivadavia	713	96%	9
Bolivia	La Paz	684	97%	13
Brazil	Amazonica	4085	67%	13
	Brasilia	11333	50%	12
	Curitiba	10499	44%	13
	Recife	3418	66%	13
	Sao Paulo (TMA)*	1911	100%	4
Chile	Antofagasta	1480	89%	10
	Pascua	164	100%	4
	Puerto Montt	412	94%	6
	Punta Arenas**	281	98%	7
	Santiago	2109	89%	13
Guyana	Georgetown	187	97%	9
Panama	Panama	1389	70%	14
Paraguay	Asuncion	605	90%	14
Peru	Lima	3599	69%	14
Suriname	Paramaribo	369	98%	11
Uruguay	Montevideo***	892	100%	12

* Provides ACC service in the segment between Rio de Janeiro and Sao Paulo. This sample does not cover a significant volume of flights because the aircraft fly below FL 290.

** 91% on ATS UT 100 route
*** A significant volume of flights does not appear in the sample because the aircraft fly below FL 290.

Table 1 – Air Traffic Movement between FL 290 and FL 410, by FIR, and percentage of flights on the main ATS Routes

Air traffic movement between FL 290 and FL 410, by FIR, and percentage in the main city-pairs Period: 13 to 28 January 2008				
Country	**FIR**	**Amount of air traffic in the sample**	**Percentage of flights of the sample in the main city-pairs**	**Number of city-pairs**
Argentina	Cordoba	1769	51%	14
	Comodoro Rivadavia	713	65%	13
Bolivia	La Paz	684	60%	14
Brazil	Amazonica	4085	27%	14
	Brasilia	11333	28%	17
	Curitiba	10499	28%	16
	Recife	3418	31%	16
	Sao Paulo (TMA)*	1911	76%	15
Chile	Antofagasta	1480	70%	15
	Pascua	164	89%	11
	Puerto Montt	412	94%	10
	Punta Arenas**	281	92%	8
	Santiago	2109	58%	13
Guyana	Georgetown	187	79%	10
Panama	Panama	1389	48%	15
Paraguay	Asuncion	605	53%	13
Peru	Lima	3599	39%	16
Suriname	Paramaribo	369	71%	15
Uruguay	Montevideo**	892	75%	11

* Provides ACC Service in the segment between Rio de Janeiro and Sao Paulo. A significant volume of flights is not covered in the sample because the aircraft fly below FL 290.

** A significant volume of flights is not covered in the sample because the aircarft fly below FL 290

Table 2 – Air Traffic Movement between FL 290 and FL 410, by FIR, and percentage in the main city-pairs

Another important planning phase is the consideration, at the beginning of the work, of airspace sectorisation under ATS unit jurisdiction, inasmuch as the route network has a decisive influence on the sectors and, *vice versa*, the latter can influence the composition of the route network. Route network and ATC planning are not integrated in the SAM Region. In the more complex airspaces, airspace modeling and ATC simulation (in real and/or fast time) tools need to be applied to assess the interrelationship between the route network and airspace sectorisation.

Another analysis that is needed is the integration of the route network and TMA arrival/departure paths (SIDs and STARs), considering that RNAV promotes conditions for the establishment of specific arrival/departure sectors, thereby reducing airspace complexity. It can be noted that most SAM States have not yet implemented the necessary SIDs and STARs to link up departure/arrival paths with the route network. It is important to consider those procedures during the route network planning phase.

3.9. Concepts that facilitate implementation of the Route Network

Of the concepts mentioned in item 2.9, the CAR/SAM Regions have already implemented RVSM in January 2005. RNAV-5 implementation, foreseen for November 2010, will contribute enormously to the optimisation of the SAM route network. As already mentioned in item 3.5, there is a need to systematise FUA application in the Region, as a means for optimising use of the available airspace. In addition, the planning of airspace in general and of the new route network in particular, should consider the seamless concept in order to achieve a better airspace structure. As a result, the conception of a new SAM route network should not consider FIR and sector boundaries for its development.

3.10. Planning Techniques

From the available information, it is not possible to identify whether the planning techniques mentioned in item 2.10 are being applied. Nevertheless, the use of one-way routes can be noted in the following TMAs, indicating the possibility that specialised arrival and departure routes and sectors are being used:

a) Argentina: Ezeiza

b) Brazil: Belo Horizonte, Brasilia, Rio de Janeiro, and Sao Paulo.

c) Chile: Santiago

d) Uruguay: Montevideo.

In optimising the route network, it would be important to assess the specific operational requirements of the main TMAs, in order to identify the need for specialised arrival and departure sectors. Should the TMAs need such, it would be necessary to establish points of entry and departure, in order to allow for the development and integration of the route network into the structure of the main TMAs of the SAM Region. It would also be necessary to evaluate whether that integration would be accomplished by means of the route network or through SIDs/STARs linking the main airports to trunk routes that would serve the main regional flows.

4. Implementation Phases

The SAM route network should be optimised in phases, in order to achieve the corresponding operational benefits as early as possible. The concept of route network versions would be incorporated starting in phase 2, considering that the airspace structure is changing in keeping with the growth in air traffic movement, the shift in air traffic demand from one Region or airport to another, and the available technology, among other aspects. The use of route network versions reflects the need for their periodic comprehensive revision, in order to always guarantee the best possible airspace structure. The implementation phases, with their corresponding activities, are set forth in the Programme for Optimising the ATS Route Network of the South American Region that is presented as Attachment A to this study. This chapter describes the activities listed in Attachment A.

4.1. Phase 1 – RNAV-5 Implementation

It is advisable to consider RNAV-5 implementation as the beginning of the route network optimisation programme for, as mentioned in item 2.9 of this study, it is a concept that will facilitate that optimisation. That implementation phase will be carried out in keeping with the SAM PBN Implementation Programme, approved by the SAM/IG/2 meeting and which is based on the PBN Roadmap approved by GREPECAS.

4.2. Phase 2 – Implementation of Version 1 of the SAM ATS Route Network

The second phase would correspond to the first version of the SAM ATS route network, within a new integrated development concept. This new version should consist of a broader analysis of the route network, based on statistical data about air traffic movement and fleet navigation capacity, seeking the elimination of unused routes and the exclusion or reduced use of “conventional” routes in a volume of airspace yet to be determined, in which a significant majority of users are equipped for RNAV-5 operations. That phase is directly related to phase 1 and a significant portion of the part relating to the Airspace Concept, envisaged in the RNAV-5 Implementation Programme in the SAM Region, would be detailed during said phase of the Route Network Optimisation Programme. It would be desirable for phases 1 and 2 to be implemented at the same time. Inasmuch as that may not be possible, given the complexity of the route network studies, this study will maintain two separate phases.

4.2.1. Draft the Feasibility Study for Optimising the SAM Route Network

This activity aimed at assessing the feasibility of optimising the route network, the strategy to be used, and the proposal of a detailed action plan to accomplish said optimisation, is part of this study.

4.2.2. Airspace Concept

The development of the Airspace Concept is the basis for optimising the route network, inasmuch as that concept is fundamental for instituting measurable benefits for airspace users. In that connection, the necessary analyses for the development of that concept should be based on statistical data about air traffic movement and the capacity of the aircraft fleet operating in the SAM Region.

4.2.2.1. Collect traffic data in order to understand airspace traffic flows

Statistical data are essential for shaping an airspace structure that conforms to the airspace planning principles and techniques presented in items 2.8 and 2.10 of this study, respectively. Traffic data should be collected periodically in order to analyse the evolution of air traffic demand in the Region. According to the discussions held by the SAM/IG meetings, the SAM States should use the form presented in Attachment B to this study, to collect the necessary data for developing version 1 of the SAM route network. It is essential for States to fill in the form according to the instructions given, in order to ensure that the data are consistent and effectively used in the analysis, as well as to facilitate their processing.

4.2.2.2. Analyse the Fleet Navigation Capacity

The Fleet Navigation Capacity is necessary to determine the airspace volume in which it is possible to apply RNAV on an exclusionary basis, in order to optimise aircraft flow and, at the same time, reduce the complexity and the pilot and air traffic controller workload. This task corresponds to task 1.3 of the SAM RNAV-5 Implementation Programme and should be completed in 2009.

4.2.2.3. Determine the gateways of the main TMAs in the SAM Region

States should present their National PBN Implementation Plans, as foreseen in Resolution 36/23 of the 36th ICAO Assembly and in Conclusion 15/38 of GREPECAS/15. States should develop their own airspace concepts for PBN planning and implementation in the TMAs. This will lead them to define the gateways for the main TMAs in the SAM Region. In version 1 of the route network, it will only be possible to have TMA gateways for the States that have already undertaken their PBN implementation process or any other way to restructure airspace in the TMAs. Furthermore, the information available from the States in developing version 1 should also be considered in this phase.

4.2.2.4. Determine and obtain the necessary tools for conducting the study mentioned in item 4.2.2.5 (aeronautical charts, specific software)

The detailed study specified in item 2.2.5 of the Action Plan for Phase 2 calls for specific tools, like aeronautical charts and specific software, to permit an adequate analysis of the SAM route network. Such tools will also be necessary for the workshop envisaged in item 2.2.6 of the same action plan. In this way, Regional Project RLA/06/901, with the support of the SAM/IG/3 meeting, shall determine these tools and seek the means to obtain them. Generally speaking, it will be necessary to have aeronautical charts containing the route network, the main TMAs, the SIDs and STARs and the approach procedures of the main airports in the SAM Region. It would also be advisable to use flight planning software like, for example, FliteStar (Jeppesen), containing the information mentioned in the aeronautical charts, in order to facilitate information management. Furthermore, it would be advisable to use software that would allow for the design of new routes, with the automatic determination of approximate geographic coordinates of significant points.

4.2.2.5. Conduct a detailed study of the SAM ATS route network, with a view to preparing version 1 of the route network

Considering the complexity of the task of developing a new version of the route network for the SAM Region, it will be necessary for a group of experts to be assigned to prepare a preliminary version containing all of the relevant information, permitting experts of each SAM State to evaluate it, for purposes of reviewing and validating the study. The main aim of version 1 of the SAM route network will be to minimise airspace complexity through the elimination of ATS routes not being used, and the

elimination of "conventional" routes in an appropriate volume of airspace. The study should also seek to integrate regional and domestic routes, including proposals for the elimination and/or realignment of domestic routes, to be considered by the States involved. It is important to stress that the determination of the interface points between the CAR and SAM Regions will be of key importance for guaranteeing the interoperability of the route networks of the two Regions. It will also be possible in that phase to obtain operational advantages from realigning ATS routes to serve TMA gateways of States that already possess that information.

The study should develop a proposed preliminary amendment to the CAR/SAM Air Navigation Plan. It will also be necessary for the study to establish the required safety assessment methodology, in accordance with the magnitude of the proposed changes and of the need to determine the spacing between RNAV-5 routes in the SAM Region. The SAM/IG/5 Meeting should review the complete study in order to seek a version in keeping with the planning of the States involved.

4.2.2.6. Hold a workshop of SAM experts to review and validate the study referred to in item 4.2.2.5.

The SAM States should review and validate the work described in item 4.2.2.5, including proposals for the elimination and/or realignment of domestic routes. The most rapid and effective way of performing that review and validation would be through a workshop where the responsible experts could present the work done, in the necessary detail for an appropriate evaluation. The State experts could use the same tools used for the study, thereby facilitating its understanding. It is expected that the experts participating in the workshop will have the authority to decide on the implementation of the route network, using the same model applied in the AP/ATM meetings.

4.2.3. Implementation of Version 1 of the SAM ATS Route Network

The SAM Regional Office and the States are responsible for the activities of this item, in terms of processing the proposed amendment to the CAR/SAM Air Navigation Plan and publishing version 1 of the SAM ATS Route Network, respectively. The dates for the implementation activities will be established in keeping with the complexity of the amendments proposed to the study mentioned in 4.2.2.5 and decided in the workshop mentioned in 4.2.2.6.

4.3. Phase 3 – Implementation of Version 2 of the SAM ATS Route Network

The third phase would correspond to version 2 of the SAM ATS route network and should consist of the complete restructuring of the route network in a search for complete integration between ATS routes, control sectors, TMAs, etc., applying the Flexible Use of Airspace concept. This phase would require specific airspace modeling and ATC fast-time simulation tools.

4.3.1. Flexible Use of Airspace

As already mentioned in items 2.9 and 3.5, Flexible Use of Airspace is one of the concepts that facilitates optimisation of the route network and that is not being systematically applied in the SAM Region. Inasmuch as the various implementation projects existing in the Region would not permit this subject to be addressed in version 1 of the SAM route network, an FUA application model would be established for version 2 of the route network.

4.3.1.1. Develop Guidance Material for Application of the Flexible Use of Airspace Concept

FUA application depends upon the development of appropriate guidance material, from which States may obtain, in a harmonised way, all of the procedures applicable at regional level. An example of FUA application is that carried out by EUROCONTROL, which can be obtained from the EUROCONTROL Manual for Airspace Planning (ASM.ET1.ST03.4000.EAPM.02.02), at its website address:http://www.eurocontrol.int/airspace/gallery/content/public/EUROCONTROL%20APM%20V2_Ed-2_Released%20Issue_Amendment%202_010606.pdf. Other EUROCONTROL guidance documents can be obtained at the following web address: http://www.eurocontrol.int/airspace/public/site_preferences/display_library_list_public.html. This initial guidance material should be limited to basic FUA application, considering the lack of specific tools for airspace management (ASM) in real time. In general terms, that application would be based on the use of routes similar to those used by EUROCONTROL as CDR 1 and CDR 3. The CDR 2s depend upon the cited ASM tools that shall not be available for version 2 of the route network.

The guidance material should include, *inter alia*, the following aspects:

- Model for the use of non-permanent routes, similar to that applied by EUROCONTROL (Conditional Routes – CDR).
- Criteria for defining scenarios in which non-permanent routes are applied.
- Criteria for categorising non-permanent routes.
- Harmonised publication of non-permanent routes.
- Representation of non-permanent routes in aeronautical charts.

4.3.1.2. Establish a Civil-Military Coordination Committee to evaluate application of the Flexible Use of Airspace Concept

To ensure FUA application, each State should create a Civil/Military Coordination Committee to evaluate the opportunities for using the Special Use Airspaces (SUA). It is important to stress that the success of this initiative will depend on the power of the committee to guarantee airspace use to all users, according to their specific needs, while avoiding, inasmuch as possible, the permanent reservation of airspace that would lead to the waste of airspace whenever it is not being used.

4.3.1.3. Develop proposals for route implementation and/or realignment, in keeping with the use of FUA

Based on the flexible use of airspace achieved through the Civil-Military Coordination Committee, State airspace planners should develop route implementation or realignment proposals that would have a significant impact on the development of version 2 of the route network, bearing in mind opportunities for offering users better flight profiles and a possible reduction in airspace complexity.

4.3.2. Airspace Concept

The general methodology used for version 1 and described in item 4.2.2. should be used to develop the airspace concept for version 2 of the route network. The items below will describe only the particular elements to be applied in the development of version 2.

4.3.2.1. Collect traffic data to understand airspace traffic flows

It is important to stress that States should develop a methodology for routine data collection to permit appropriate airspace planning and also the verification of an increase and/or shift in air traffic demand that would require a change in the existing airspace structure.

4.3.2.2. Analyse Fleet Navigation Capacity

In the same way mentioned in item 4.3.2.1 for data collection, States are expected to implement a permanent fleet navigation capacity analysis system to assess the extent of the airspace volume where RNAV-5 would be applied on an exclusionary basis, and to enable the evolution foreseen in the PBN Roadmap for the medium term (RNP-2).

4.3.2.3. Determine the gateways of the main TMAs in the SAM Region

The gateways of the main TMAs in the SAM Region may evolve in accordance with systematic application of FUA and progress in PBN implementation in TMAs and approaches.

4.3.2.4. Determine and obtain the necessary tools for conducting the study mentioned in item 4.3.3.5 (aeronautical charts, specific software)

Continuous evaluation of the tools available for developing the route network is necessary, in order to obtain the most appropriate material to ensure an effective and efficiency work.

4.3.2.5. Make a detailed study of the SAM ATS route network, with a view to developing version 2 of the route network

The development of version 2 of the route network will require a more in-depth analysis, considering that. in addition to the route network itself, the study should also include other aspects, like control sectors, TMA interface, etc. In this sense, and in view of the complexity of version 2, the main objective of the study is to propose scenarios that can be evaluated through the use of airspace modelling and fast-time simulation tools. Such scenarios would be the various options for version 2 of the route network, which would require objective data in order to select the best implementation option, considering the metrics defined in the study, such as fuel consumption, CO^2 emissions, the number of aircraft crossings, etc.

4.3.2.6. Conduct studies of Airspace Modeling and Fast-Time Simulation

Based on the study carried out in 4.3.2.5, Airspace Modeling and Fast-Time Simulation studies should be conducted in order to obtain the necessary data for the analysis to be made by State experts, permitting a decision to be taken regarding the option to be implemented.

4.3.2.7. Hold a workshop among experts from SAM States

Based on the studies mentioned in items 4.3.2.5 and 4.3.2.6, State experts shall review and validate the option of version 2 of the route network to be implemented.

The study should develop a preliminary proposal of amendment to the CAR/SAM Air Navigation Plan. It will still be necessary for the study to establish the required safety assessment methodology, in keeping with extent of the proposed changes and the need to determine RNAV-5 route

spacing in the SAM Region. The SAM/IG/9 should review the complete study in order to seek a version that is in line with the planning of the States involved.

4.3.2.8. Implementation of Version 2 of the SAM ATS Route Network

The SAM Regional Office and the States are responsible for the activities under this item, in terms of processing the proposed amendment to the CAR/SAM Air Navigation Plan and publishing version 2 of the SAM ATS Route Network, respectively. The dates for the implementation activities will be established in accordance with the complexity of the modifications proposed in the studies mentioned in 4.3.2.5 and 4.3.2.6 and determined in the workshop mentioned in item 4.3.2.7.

ATTACHMENT 1 TO APPENDIX A

PROGRAMME FOR OPTIMISING THE ATS ROUTE NETWORK IN THE SOUTH AMERICAN REGION (GPIs 1, 5, 7, 8, 10, 11)

Activity	Start	End	Responsible party	Observations
1. **Phase One – RNAV-5 Implementation**				
1.1. RNAV-5 implementation in the SAM Region	**Apr 2008**	**Nov 2010**	**Regional Project RLA/06/901**	The implementation will be carried out according to the Implementation Programme approved at the SAM/IG/2 meeting
2. **Phase Two – Implementation of Version 1 of the SAM ATS Route Network**				
Activity	**Start**	**End**	**Responsible party**	**Observations**
2.1. Conduct a Feasibility Study for Optimising the SAM Route Network	March 2009	Apr 2009	Regional Project RLA/06/901	
2.2. Airspace Concept				
2.3. Collect traffic data to understand air traffic flows	June 2008	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901) States	Task 1.2 of the RNAV-5 Implementation Project
2.4. Analyse the fleet navigation capacity	June 2008	SAM/IG/4	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	Task 1.3 of the RNAV-5 Implementation Project

2.4.1. Determine the gateways of the main TMAs in the SAM Region	SAM/IG/3	SAM/IG/4	States	
2.4.2. Determine and obtain the necessary tools to make the study mentioned in item 2.2.5 (aeronautical charts, specific software)	SAM/IG/3	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	
2.4.3. Make a detailed study of the SAM ATS route network, with a view to preparing version 1 of the route network, including the following: • Indicate the ATS routes that should be eliminated, in accordance with their use; • Propose the volume of exclusionary airspace for RNAV-5 application • Indicate the "conventional" RNAV routes that should be eliminated or replaced by RNAV routes in the exclusionary RNAV-5 airspace. • Indicate the RNAV routes that should be realigned, in accordance with the gateways of the main SAM TMAs (see 2.2.3). • Describe in detail the proposed new SAM route network, based on the analysis of the aforementioned items. • Describe in detail the interface between the SAM route network and the CAR route network. • Propose the initial draft Proposal of Amendment to the CAR/SAM ANP • Define the required safety assessment (qualitative or quantitative).	SAM/IG/4	March 2010	SAM/PBN/IG (Project RLA/06/901)	
2.4.4. Hold the Workshop of Experts from the SAM States to review and validate the study made under item 2.2.5.	SAM/IG/5	June 2010	SAM/PBN/IG (Project RLA/06/901) States	

2.5.	**Implementation of Version 1 of the SAM ATS Route Network**			
2.5.1.	Process the proposal of amendment to the CAR/SAM Air Navigation Plan	TBD	SAM Regional Office	
2.5.2.	Publish version 1 of the SAM ATS Route Network	TBD	States	
2.5.3.	Entry into effect of version 1 of the SAM ATS Route Network	TBD		
3.	**Phase Three – Implementation of Version 2 of the SAM ATS Route Network**			
	Activity	**Start**	**End**	**Responsible party**	**Observations**
3.1.	**Flexible Use of Airspace**				
3.1.1.	Develop guidance material for the application of the Flexible Use of Airspace concept, including: • Model for using non-permanent routes similar to that applied in EUROCONTROL (Conditional Routes – CDR). • Criterion for defining scenarios in which non-permanent routes are applied • Criterion for categorising non-permanent routes • Harmonised publication of non-permanent routes • Representation of non-permanent routes in aeronautical charts	SAM/IG/5	SAM/IG/6	SAM/PBN/IG (Project RLA/06/901)	

3.1.2. Establish the Civil-Military Coordination Committee to evaluate application of the Flexible Use of Airspace concept mentioned in 3.1.1.	SAM/IG/6	SAM/IG/7	States	
	Start	**End**	**Responsible party**	**Observations**
3.1.3. Develop proposals for route implementation and/or realignment, in keeping with the utilisation of FUA	SAM/IG/6	SAM/IG/7	States	
3.2. **Airspace Concept**				
3.2.1. Collect traffic data to understand air traffic flows	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Project RLA/06/901) States	
3.2.2. Analyse the fleet navigation capacity	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	
3.2.3. Determine the gateways of the main TMAs in the SAM Region	SAM/IG/6	SAM/IG/7	States	
3.2.4. Determine the necessary tools for making the study mentioned in item 3.1.5 (aeronautical charts, specific software)	SAM/IG/6	SAM/IG/7	SAM/PBN/IG (Project RLA/06/901)	
3.2.5. Make a detailed study of the SAM ATS route network with a view to developing version 2 of the route network, including: • Definition of scenarios for the SAM airspace structure, including ATS routes, control sectors, TMA interface, for assessment using airspace modelling and fast-time ATC simulation tools. • Indicate the ATS routes that should be eliminated in accordance with their	SAM/IG/7	June 2011	SAM/PBN/IG (Project RLA/06/901)	

utilisation; • Propose, if necessary, the extent of exclusionary airspace volume for RNAV-5 application • Indicate, as necessary, the "conventional" ATS routes that should be eliminated or replaced by RNAV routes in accordance with the possible extension of the exclusive RNAV-5 airspace volume. • Indicate the RNAV routes that should be realigned in keeping with possible modifications to the gateways of the main TMAs in the SAM Region. • Detail possible scenarios for version 2 of the SAM route network and of control sectors, based on the analysis of the previous items • Detail the interface between the SAM route network and the CAR route network • Propose the initial draft Proposal of Amendment to the CAR/SAM ANP. • Define the required safety assessment (qualitative or quantitative).				
3.2.6. Make Airspace Modelling and Fast-Time Simulation studies to assess the scenarios developed in 3.2.5	August 2011	SAM/IG/9		
3.2.7. Hold the Workshop of Experts from the SAM States to review and validate the studies made in items 3.2.5 and 3.2.6.	SAM/IG/9	June 2012	Project RLA/06/901 States	
3.3. **Implementation of Version 2 of the SAM ATS Route Network**				
3.3.1. Process the proposal of amendment to the CAR/SAM Air Navigation Plan	TBD		SAM Regional Office	
3.3.2. Publish version 1 of the SAM ATS Route Network	TBD		States	

3.3.3. Entry into effect of version 2 of the SAM ATS Route Network	TBD		

ATTACHMENT 2 TO APPENDIX A

FORM FOR COLLECTING AIR TRAFFIC MOVEMENT DATA

FIR Identification:

Date	ACFT Call Sign	Type of Aircraft	Aerodrome of origin	Destination Aerodrome	ATS Route	Flight Level

Attachment 2 to Appendix A

GUIDANCE FOR COMPLETING THE DATA COLLECTION FORM

1. Introduction

- This form is intended for data collection to obtain a sample of the air traffic movement, in order to plan the optimisation of the SAM ATS route network.

- The form should be filled out in **EXCEL** format so that all events (air traffic movements) over the days of the chosen period are entered chronologically **in a single file** (**without blank lines or spaces or intermediate titles**).

- The data should correspond to the daily air traffic movement of all IFR flights in the airspace established by the SAM/IG meetings (*e.g.*, upper airspace), over the period in question, by FIR and in all routes in the FIRs, together with IFR flights made outside ATS routes.

2. Completing the fields in the Excel spreadsheet

- " FIR Identification " field
  To be completed in accordance with the code contained in ICAO Doc. 7910.
  Example: **SBBS, SLLF, SAEU**.

- "Date" field
  To be filled in only with **numerical characters** in the following order: **dd/mm/yy**
  Example: enter **01/09/09** for 01 September 2009.

- "Call Sign" field
  Fill in with a maximum of **7 alphanumeric characters, without any spaces or hyphens**.
  Examples: **AAL906, PTLCN, VRG8764**.

- " Type of Aircraft" field
  To be filled in according to the codes contained in **ICAO Doc. 8643.**
  Examples: **A320** should be entered for Airbus A320-211; **B744** for Boeing B747-438

- " Aerodrome of origin" field
  To be filled according to the codes contained in **ICAO Doc. 7910**.
  Examples: **SBGR, SCEL, SAEZ**.

- "Destination Aerodrome" field
  To be filled according to the codes contained in **ICAO Doc. 7910**.
  Examples: **SBSP, SCEL, SAEZ**.

- "ATS Route" field
  To be filled with a maximum of **5 alphanumeric characters, without any spaces or hyphens**. If, during flight, the aircraft changes airway, the new airway should be entered following the first one, separated by a slash (/).
  Examples: **UA301, UB689, UW20/UW7.**

- "Flight Level at point of entry" field
  To be filled in with **3 numeric characters** that correspond to the flight level during the first flight segment.
  Example: enter 290 for FL 290.

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